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Salinity Mobilization and Transport: Hydrologic and Aeolian Processes and Remediation Techniques for Rangelands

A Selected Bibliography

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Salinity Mobilization and Transport: Hydrologic and Aeolian Processes and Remediation Techniques for Rangelands

A Selected Bibliography

Special Reference Briefs Series no. SRB 2014-01

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Abstract

Salinity Mobilization and Transport: Hydrologic and Aeolian Processes and Remediation Techniques for Rangelands: a Selected Bibliography, Special Reference Brief 2014-01. U.S. Department of Agriculture, National Agricultural Library.

This bibliography is a guide to the scientific literature covering salinity sources, mobilization, and transport from rangelands to river systems, with particular emphasis on the Colorado River Basin. It also serves as the basis for a literature synthesis on what is known about salinity transport from rangelands and how management/conservation practices may alter dissolved salt transport. Salinity issues related to irrigated agriculture and dry-land farming are beyond the scope of this bibliography. The bibliography was compiled by the Water Quality Information Center (WQIC) at U.S. Department of Agriculture's (USDA) National Agricultural Library in cooperation with researchers from USDA-Agricultural Research Service's (ARS) Great Basin Rangelands Research Unit, the Bureau of Land Management, University of Nevada at Reno, and other collaborators.

Keywords: salinity transport, rangelands, rangeland management practices, upland surface runoff processes, conservation management, salts, hydrology, groundwater, leaching, soil properties, land use, riparian environment, bank erosion, aeolian transport, plant ecology, land disturbances.

This work is available in HTML, PDF, and dynamic formats at http://wqic.nal.usda.gov/.

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Preface

This bibliography was developed by the Water Quality Information Center at the National Agricultural Library in support of the U.S. Department of Agriculture's Rangeland Hydrologic Processes and Salinity Transport: Uplands to River Systems project.

The purpose of the salinity project is to improve the understanding of sources and transport mechanisms in rangeland catchments that deliver dissolved solids (salts) to streams of the Upper Colorado River Basin. Relevant research conducted outside the U.S. is also included.

In addition to documenting the physical, chemical, and biological processes involved in salt mobilization and transport, an important goal is to gain knowledge about how certain land management practices or land conditions may be affecting dissolved-solids yields to streams, such that changes in the land and water management could be made to reduce dissolved-solids yields and enhance the health and sustainability of rangeland plant communities.

Management practices searched for in the literature include soil property control (e.g., planting, stabilization, reclamation), vegetation control (e.g., aeration, disking, prescribed grazing, prescribed burning), hydraulic structures and hydrogeomorphic controls (e.g., constructed wetlands, riparian buffers, bank stabilization), and access control (e.g., fencing, offroad vehicles, heavy use).

There is minimal peer reviewed literature that directly documents the reductions in salt mobilization and transport from rangelands as a result of implementing rangeland management practices in the Colorado River Basin. Therefore, we expanded the literature search to include published literature that addressed fundamental hydrologic and erosion processes.

It is well documented that on rangelands the amount, kind, and distribution of vegetation and ground cover are often the only factor that can be cost-effectively manipulated to alter surface runoff and soil erosion. Therefore, in the "Selected References of Broad Relevance" section, citations are included that reference the dominant impacts of the practices (e.g., grazing) that can directly impact runoff and soil loss. These references were retained even if the original work was not conducted on saline soils to guide the reader in potential impacts this practice might have on salinity transport through altering surface runoff and soil erosion processes, if, for example, grazing is an issue.

This information will allow inferences to be made on reductions in salt loading to the Colorado River Basin if surface runoff and upland soil erosion processes are controlled through management actions.

A panel of subject matter experts assisted in preparing this bibliography by

- providing suggestions for literature searching and keywords
- addressing technical questions
- reviewing citations for relevance
- providing citations to relevant documents not accessible through bibliographic databases
- and advising on bibliography organization.

Acknowledgments

Special thanks to these individuals who reviewed citations, offered suggestions, and helped in other ways:

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- John Stout, Wind Erosion and Water Conservation Research Unit, Agricultural Research Service
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The following databases, repositories, discovery services, and publisher search engines were the main tools used to develop this bibliography:

- AGRICOLA (National Agricultural Library)
- Aquatic Science and Fisheries Abstracts (ProQuest)
- BIOSIS Previews (Thomson Reuters)
- CAB Abstracts (CABI Publishing)
- GeoRef (American Geosciences Institute/ProQuest)
- Google Scholar (Google)
- *Rangelands* and *Journal of Range Management* Archives (Society for Range Management, Allen Press, and the University of Arizona Libraries)
- Scopus (Elsevier)
- Water Resources Abstracts (ProQuest)
- Wiley Online Library

The center gratefully acknowledges the organizations who granted permission, when required, to use their citations and abstracts.

Finally, support from the Bureau of Land Management and Bureau of Reclamation for the development of this bibliography and associated projects related to salinity mobilization and transport on western rangelands is greatly appreciated.

About This Bibliography

About 55% of the salt loading in the Colorado River Basin comes from natural, non-irrigated sources[1] (i.e., rangelands), suggesting a significant potential to further reduce salt loading through implementing appropriate range management practices.

As the first phase of a literature synthesis of this multifaceted issue by the USDA Agricultural Research Service and collaborators, this bibliography is a guide to the scientific literature covering salinity sources, mobilization, and transport from rangelands to river systems, with particular focus on the Colorado River Basin.

This information is useful in understanding the underlying physical, chemical, and biological processes of salt transport and related human impacts, and in designing policies and management practices to limit salinization.

Citations are categorized according to the schema developed by the project team. Cross-references are indicated when a record is applicable to more than one category. Within each category, citations are arranged alphabetically by title.

To locate information on a specific topic, for example, “erosion,” use the Subject Index beginning on page 331. To ensure that you see all the relevant citations for a particular topic, be sure to also look up related terms in the subject index, such as “soil erosion, wind erosion," etc., from this example above. Author and geographical indexes are also available beginning on pages 351 and 363, respectively.

There are 768 unique citations with abstracts (when available) in this bibliography. Citations were found through literature searches of the AGRICOLA database, produced by the National Agricultural Library, and several commercial bibliographic databases, discovery services, repositories, and publisher search engines.

Many relevant citations were also found in the document, *Mancos Shale Literature Review on the Colorado Plateau* (April 2005), citation number 166. In addition, Water Quality Information Center staff created citations for documents that were located by other means.

Documents cited were published from 1902 through mid-2013. URLs and DOIs (Digital Object Identifiers) are provided for online documents when available. (Access charges may apply.) The inclusion or omission of a particular citation does not imply endorsement or disapproval.

To obtain a specific print document, please contact your local library. Information on how to obtain documents from the National Agricultural Library can be found at http://www.nal.usda.gov/nal-services/request-library-materials.

[1] Kenney, T.A., Gerner, S.J., Buto, S.G., and Spangler, L.E., 2009. Spatially referenced statistical assessment of dissolved-solids load sources and transport in streams of the Upper Colorado River Basin. U.S. Geological Survey Scientific Investigations Report 2009-5007, 50 p. Available at http://pubs.usgs.gov/sir/2009/5007.

Rangeland Management Practices and Potential Impact on Salinity

1. **Accelerated erosion in areas disturbed by OHV activity in the Mancos Shale badlands of the Factory Butte-North Caineville Mesa area, Wayne County, Utah**.
Dohrenwend, J. C.
Report prepared for Richfield Field Office, Bureau of Land Management (2003).
Keywords: erosion/ soil crusts/ off-road vehicles/ OHV/ hillslopes/ disturbed areas/ rills/ gullies
Abstract: This study is a preliminary assessment of the erosional impacts of OHV use in the Mancos Shale badlands of the Caineville area of central Wayne County, Utah. This assessment is based on a comparative geomorphic analysis of the microtopographic characteristics of undisturbed versus heavily disturbed hillslopes in these badlands. This comparative analysis focuses on a determination of what is present in the undisturbed landscape, but is missing from disturbed areas. Therefore, it provides a direct determination of the additional erosion that has occurred in the disturbed areas. Three geomorphic elements characteristic of the natural, undisturbed hillslopes within the Caineville badlands were identified and measured: surface soil crust, rills and small gullies, and the hillslope mantel of soil and colluvium. Soil crust relief averages approximately 1.5 inches on undisturbed slopes; but soil crust is not present on heavily disturbed hillslopes. Rill depth averages 3.1 inches on undisturbed hillslopes; but rills and small gullies are not present on heavily disturbed hillslopes. The thickness of soil and colluvium averages 5 inches on undisturbed hillslopes. Structured soil and colluvium are not present on heavily disturbed hillslopes. Instead, these slopes are covered by a thin mantel of pulverized rock and soil with an average thickness of 1.9 inches. The absence of soil crust, rills and small gullies, and soil-colluvium on hillslopes that have been heavily disturbed by OHV activity demonstrates that at least 3 inches of additional erosion has occurred on these hillslopes as compared to natural, undisturbed slopes. This amount of additional erosion is equivalent to a soil loss of one million pounds (500 tons) per hillslope acre; and this additional erosion has been occurring at a rate that is approximately five times higher than the natural (late Quaternary) erosion rate in the Caineville badlands.

2. **Analysis of a small agricultural watershed using remote sensing techniques**.
Tamas, J. and Lenart, C.
International Journal of Remote Sensing 27: 3727-3738 (2006). ISSN: 0143-1161
http://dx.doi.org/10.1080/01431160500500474
Keywords: remote sensing/ reflectance/ sensors/ absorption bands/ remote sensing techniques/ correlations/ LANDSAT/ soil salinity/ salinity/ absorption spectroscopy/ soil properties/ absorption/ canopy/ saline soils/ data acquisition/ irrigation/ spectral analysis/ absorption spectra/ salinization/ instruments/ monitoring and analysis of water and wastes/ land use/ wavelengths/ salts/ Hungary/ sound absorption/ cameras
Abstract: Salinization of land and sweet water is an increasing problem worldwide. In the Carpathian Basin, particularly in arid and semi-arid regions, irrigation is a contributing factor to the secondary salinization problems, one of the major problems affecting soils in Hungary. Conventional broadband sensors such as SPOT, Landsat MSS, and Landsat ETM+ are not suitable for mapping soil properties, because their bandwidth of 100-200 mm cannot resolve diagnostic spectral features of terrestrial materials. Analytical techniques, developed for analysis of broadband spectral data, are incapable of taking advantage of the full range of information present in hyperspectral remote sensing imagery. In our pilot project in Tedej farm in the Great Plain Region, Hungary, the DAIS sensor was used to assess salinity risk, covering the spectral range from the visible to the thermal infrared wavelengths at 5 m spatial resolution, and other major indicators of soil salinization (NDVI, SAVI, canopy cover) were quantified with advanced remote sensing techniques using the TETRACAM ADC agricultural multispectral camera which offers red/green and NIR imaging at megapixel resolution. As a result, prominent absorption bands around 1450 nm and 1950 nm wavelength in most soil spectra are attributed to water and hydroxyl ions. Occasional weaker absorption bands caused by water also occur at 970, 1200, and 1700 nm. Absorption features near the 400 nm wavelength for all samples are also noticeable. Absorption bands at 1800 and 2300 nm are attributed to gypsum, while strong absorption features near 2350 nm are assigned to calcite (CaCo sub(3)). Saline soils exhibited

significantly higher reflectance values all throughout the 325-2500 nm wavelengths of the spectrum. Soils with a high amount of soluble salts gave a higher average reflectance than soils with a low salt content. In the project, an ADC camera-based real-time integrated system was developed to take advantage of more specialized spectral information and to provide even more accurate and useful data directly from the field. The results revealed that the NDVI and SAVI index and the canopy cover mapping taken with multispectral cameras can be useful as an indirect marker and help for detecting salinization. However, we did not find a strong correlation between NDVI and soil salinity. This is probably because the detection and assessment of lower levels of salinity are difficult, mainly owing to the nature of the remotely sensed images; with such images, it is not possible to obtain information on the third dimension of the 3-D soil body. Also, the impact of salinity on electromagnetic properties needs to be explored further to understand how it can be derived indirectly from remotely sensed information. With the rapid validation of remotely sensed hyperspectral data, the decision in the future, with the best trade-off between irrigation and sustainable land use made by agricultural specialists in this region, can be more environmentally sound and more accurate using the results from the pilot.
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3. **Consequences of water diversion in arid coastal systems within the Rio Grande, Colorado, and other world deltas**.
Stanley, J. D., Warne, A. G. and Anonymous
Abstracts with Programs - Geological Society of America 33: 41-42 (2001). ISSN: 0016-7592
Keywords: water quality/ terrestrial environment/ Basrah Delta/ erosion/ North Africa/ Indus River/ water management/ New Mexico/ Iraq/ irrigation/ Colorado River delta/ deltas/ waterways/ Asia/ environmental geology/ water diversion/ Middle East/ Rio Grande River/ Nile Delta/ canals/ shore features/ deltaic sedimentation/ arid environment/ global/ sedimentation/ shorelines/ Texas/ Egypt/ Mexico/ land management/ Africa/ coastal sedimentation/ salinization
Abstract: Nearly 500 million people live on and adjacent to modern deltas, although anthropogenic modifications have made these low-lying coastal systems increasingly vulnerable to environmental degradation. Little research has been conducted on arid-region deltas in North America. For example, the Rio Grande (Rio Bravo) delta along the south Texas-northeast Mexico border, has been significantly impacted by drought during the past 6 years, while its coast is periodically modified by hurricanes and storm surges. Moreover, seaward portions of the delta plain are affected continuously by land subsidence and consequent relative sea-level rise. Although these natural processes played a major role in the Rio Grande delta development, human influences now prevail and are resulting in accelerated degradation of this system. Water and sediment influx to the delta has been extensively modified by a series of upstream dams and reservoirs to such a degree water and sediment are no longer discharged in the western Gulf of Mexico. Loss of river sediment influx to the delta front has brought about widespread erosion and degradation of coastal (including wetland) environments. Moreover, irrigation and reclamation projects have caused major changes in the flow of water and sediment within the delta. Construction of >2000 km of closely spaced ship channels, irrigation canals and ditches, most bordered by levees, precludes widespread flooding and sediment accretion on the delta plain. Major impacts caused by reduced flow of the delta water and sediment regime include 1) increased salinization of surface and ground water; 2) reduced water quality (i.e., increased chemical loading) leading to decreased soil productivity and degradation of natural habitats; and 3) accelerated coastal erosion. The other large arid-climate delta in North America, the Colorado formed in the northern Gulf of California high-tide setting, has also been extensively modified by artificial water diversion and, consequently, is undergoing destructional rather than progradational development. Comparative study of the Rio Grande and Colorado with other world deltas in arid-climate settings, such as Egypt's and India's densely populated Nile and Indus deltas, Iraq's largely drained Basrah delta, and northern Australia's less modified systems is warranted.
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4. **Contour furrowing, pitting, and ripping on rangelands of the western United States**.
Branson, F. A., Miller, R. F. and Mcqueen, I. S.
Journal of Range Management 19: 182-190 (1966). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/5409/5019

Keywords: contour furrows/ tillage/ grazing intensity/ ripping/ soil water / soil transport processes/ vegetation cover/ forage yield/ rangelands/ range management
Abstract: The effects of mechanical treatments, such as contour furrowing, pitting, and ripping, on forage production and water storage were measured in Montana, Wyoming, Colorado, Utah, New Mexico, and Arizona. Of seven kinds of mechanical treatment evaluated, contour furrowing at 3- to 5-foot intervals and broadbase furrowing were most effective. The greatest beneficial responses occurred on medium-to fine-textured soils. Measurements at 20 locations including 8 types of vegetation receiving a single kind of treatment, contour furrowing, revealed that nuttall saltbush responds most favorably to the treatment. Winterfat, black grama, and needleandthread provided unfavorable sites for mechanical treatments.
This citation is from the University of Arizona Institutional Repository.

5. **Diagnosis and Improvement of Saline and Alkali Soils**.
Brown, J. W., Hayward, H. E., Richards, A., Bernstein, L., Hatcher, J. T., Reeve, R. C. and Richards, L. A.
Agriculture Handbook, U. S. Department of Agriculture, United States Salinity Laboratory, 160 p. (1954).
http://www.ars.usda.gov/SP2UserFiles/Place/53102000/hb60_pdf/hb60complete.pdf
Keywords: saline soils/ soil salinity/ alkaline soils/ soil improvement
Abstract: This handbook brings together and summarizes information that will be useful, particularly to professional agricultural workers, for the diagnosis and improvement of saline and alkali soils.

6. **Distinguishing natural and anthropogenic sources of water quality variability, southeastern Piceance Basin, Colorado**.
Albrecht, T. R. and Thyne, G.
Abstracts with Programs - Geological Society of America 39: 46-46 (2007). ISSN: 0016-7592
Keywords: water quality/ concentration/ methane/ pollutants/ natural gas/ human activity/ Mamm Creek Field/ aliphatic hydrocarbons/ pollution/ petroleum/ alkanes/ Piceance Creek basin/ seepage/ aquifers/ groundwater/ variations/ organic compounds/ sampling/ hydrocarbons/ Colorado/ water resources/ environmental geology
Abstract: Water resources in semi-arid western Colorado are scarce and especially vulnerable to impact by petroleum production activities. In Mamm Creek natural gas field in the southeastern Piceance Basin, gas well completion problems caused gas seepage into a tributary of the Colorado River. Using this case to define impact, hydrochemical data from the surrounding area was analyzed. Normalized and standardized inorganic data from 648 water samples were separated into five statistically distinct groups, representing water facies, using hierarchical clustering. One cluster was low TDS, Ca-Mg-HCO3 water consistent with natural background. Other clusters showed "impacted" signatures: high Fe-Mn, high TDS Na-Cl or high TDS Na-SO4-HCO3. Samples with high Fe-Mn signatures are found primarily at the methane seep location where reducing conditions dominate during active seeping. These samples also show elevated benzene and methane concentrations, indicating direct petroleum contamination. Samples with high Na-Cl signatures are indicative of formation water from the gas production zone. These samples have the highest average methane concentrations, but low benzene concentrations suggesting migration from the petroleum source has degraded the benzene. Samples with high Na-SO4-HCO3 signatures are not associated with hydrocarbon deposits, due to their characteristic reducing environment. The presence of this water facies suggests upward migration of formation waters from a deep source. The positive correlation between average groundwater methane concentration by year and the total number of wells in the study area, in addition to the lack of correlation between water facies and structural trends, suggests that these impacted waters may be due to additional transport pathways caused by well drilling. Possible sources of methane include: geologic deposits, gas wells leaking petroleum product, or bradenhead gas escaping from well casings. Geochemical modeling, including one-dimensional reactive transport and inverse mixing, is being conducted to evaluate sources of Na-Cl, Na-SO4, methane and benzene.
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7. **Drag coefficients, roughness length, and zero-plane displacement height as disturbed by artificial standing vegetation**.
Dong, Z. B., Gao, S. Y. and Fryrear, D. W.
Journal of Arid Environments 49: 485-505 (2001).
http://dx.doi.org/10.1006/jare.2001.0807
Keywords: drag coefficient/ roughness length/ displacement height/ velocity/ structural parameters/ standing vegetation/ wind erosion/ sparse vegetation/ transport/ sand/ simulation/ profiles/ surfaces/ forests/ field/ flow
Abstract: Standing vegetation, for its disturbance to the near-surface airflow, is widely used in the arid and some semi-arid lands over the world to control wind erosion. Knowledge of drag coefficient (C-D), roughness length (Z(0)) and displacement height (D) is essential to completely define the state of wind and the protective role of standing vegetation in wind erosion. Using standing sticks as model standing vegetation, detailed wind velocity distributions were measured above the vegetated surface in wind tunnel, a mass conservation method to estimate the zero-plane displacement height was tried, and the drag coefficients and roughness length were derived by a curve-fit method. Due to the disturbance of standing vegetation, the velocity distributions deviated from the logarithmic profile. The deviation increased with increasing vegetation density and height. The wind velocity profile disturbed by standing vegetation can be divided into three sections, and each section can be expressed by a logarithmic function. Displacement height is a significant parameter for tall and dense vegetation; choice of the value for displacement height greatly influences other parameters such as roughness length and drag coefficient, but its accurate value is not available yet. In the authors' philosophy, drag coefficient and roughness length should be recommended. However, caution should also be taken in selecting the wind velocity measurements used to derive drag coefficient and roughness length. Both the height and density of standing vegetation influenced drag coefficient and roughness length, but their relative importance was different. A new parameter, effective lateral cover (L-ec) was introduced to characterize the structure of standing vegetation. It was found that effective lateral cover and height/spacing ratio were better structural parameters than the others when the effects of standing vegetation on drag coefficient and roughness length were assessed. Good correlation existed between the derived roughness length and drag coefficient, implying that obtaining drag coefficient and roughness length of vegetated surface by curve fit method is reliable so long as caution is taken in selecting the appropriate measurements. Of the three parameters roughness length is the most sensitive to characterize the effects of roughness length on nearsurface airflow. (C) 2001 Academic Press.
© *Elsevier*

8. **Dryland salinity in south east Australia: Which scenario makes more sense?**
Bann, G. R. and Field, J. B.
AESC2006: Australian Earth Sciences Convention 2006, Melbourne, Australia (2006).
Keywords: EM surveys/ dryland salinity/ groundwater
Abstract: Primary dryland salinity predates European settlement in southern Australia and secondary dryland salinity was first identified over 100 years ago. The dryland salinity model that has gained national acceptance promotes increased ‘recharge’ and ‘discharge’ from rising groundwater following increased water flow through the landscape as a result of European land clearing. However, the model does not consider the many complex processes, both natural and anthropogenic, that also influence salinity outbreaks. This research investigates the current dryland salinity model with respect to upland sites in south-eastern Australia. Data obtained from ground-based EM31 and EM38 surveys, soil profile analyses, electrical conductivity (EC) measurements, piezometer and soil infiltration tests suggest that other processes may be more important than modified groundwater processes for explaining salinity outbreaks. Most salinised sites investigated were found to be intensively grazed and associated with soil degradation and erosion. Roads and tracks also play a significant role in many outbreaks. Measured salinity EC levels varied both spatially and temporally between and within salinised sites and, furthermore, varied considerably following rainfall. In contrast with the traditional salinity model, salinity outbreaks are not exclusive to sites that are cleared of their vegetation, suggesting that while clearing probably exacerbates the problem, it cannot be the primary cause. Dryland salinity in these south east Australian sites appears, therefore, to be influenced by a plethora of soil surface parameters, rather than simply as a result of modified deep groundwater processes.

We suggest that a more appropriate term to describe the surface water expressions of salinity in the uplands of south-east Australia is 'surface-water salinity'. The distinction between these two types of salinity has major implications for current salinity mapping methods, mitigation and remediation activities.

9. **Effects of contour furrowing, grazing intensities and soils on infiltration rates, soil moisture and vegetation near Fort Peck, Montana**.
Branson, F. A., Miller, R. F. and Mcqueen, I. S.
Journal of Range Management 15: 151-158 (1962). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/5113/4723
Keywords: contour furrows/ tillage/ grazing intensity/ *Agropyron cristatum*/ soil water/ soil transport processes/ vegetation cover/ forage yield
Abstract: An area near Fort Peck, Montana was contour furrowed and seeded to crested wheatgrass. After 10 years vegetation measurements were made to determine the consequences. Three grazing intensities and two soil conditions were also available for study. Before treatment, the area had a sparse stand of nuttall saltbush and pricklypear cactus. After furrowing and seeding, especially on the more favorable soils, there was a satisfactory stand of crested wheatgrass producing 500 to 700 pounds per acre. The yield of nuttall saltbush on treated and untreated land was about 200 pounds per acre. Light and heavy grazing caused some reductions in plant yields. There were great contrasts in plant yields and wheatgrass presence on the two soil conditions, slick and semi-slick. Slick soils had lower plant yields, poorer establishment of wheatgrass, lower infiltration rates, and lower soil moisture percentages than semi-slick soils. Slick soils were characterized by a sodium-dispersed zone near the soil surface that greatly reduced rates of water entry. It is possible that some soils that would have been classed as slick prior to treatment were improved to semi-slick conditions by contour furrowing. However, the fact that furrowed and seeded slick areas remained almost barren under protection from grazing shows that slicks cannot be completely eliminated by this treatment. A different kind of furrowing treatment might have beneficially modified the slick soils. A contour furrowing machine that made small dams within furrows at intervals of about 40 feet was used on similar silty clay soils in the Willow Creek valley in 1955. Five years after treatment it was apparent that the small dams in furrows had prevented movement of water from the relatively impermeable slicks and provided conditions favorable for plant growth.
This citation is from the University of Arizona Institutional Repository.

10. **Effects of surface disturbance (primarily livestock use) on the salinity of public lands in the upper Colorado River basin: 1977 status report**.
Bentley, R. G.,
Denver, Colorado, U. S. Bureau of Land Management, 274 p. (1978).
http://archive.org/details/effectsofsurface14unit
Keywords: runoff/ Colorado River watershed/ salinity/ soil erosion

11. **Historical BLM Mancos Shale management in NW CO**.
Leet, C. W.
Proceedings of the Fourth Federal Interagency Sedimentation Conference March 24-27, 1986, Las Vegas, Nevada, Las Vegas, Nevada (1986).
http://pubs.usgs.gov/misc/FISC_1947-2006/pdf/1st-7thFISCs-CD/4thFISC/4Fisc-V1/4Fisc1-2.PDF
Keywords: water quality control/ Mancos Shale/ Colorado/ Wolf Creek/ erosion control/ watersheds/ runoff rates/ salinity/ soil stabilization
Abstract: The Bureau of Land Management (BLM) has been implementing salinity and erosion control structures in the Lower Wolf Creek (LWC) watershed for the past 40 years. The LWC watershed has a semi-arid climate and sparse vegetation. It is characterized by highly erodible Mancos Shale, a marine sedimentary formation that is exposed on the surface and contains a high concentration of soluble salts. In this 31,858-ha (78,720-acre) watershed, about 80 projects have been completed to reduce erosion which accelerated because of overgrazing by cattle, sheep, and horses, from approximately 1897 to 1936. Project work was started in 1938 by the Civilian Conservation Corps (CCC) and has continued sporadically by the BLM to the present. Stabilization techniques include: contour furrows, reseedings, spreader dikes, detention and retention dams, pit reservoirs, and gully

plugs. Many of the original erosion control projects have silted full, but most are still functional in slowing runoff velocities and depositing sediment. Some of the old reservoirs have spillways that are too steep, and the spillways are eroding into the existing reservoirs and are threatening the stability of the stored sediment. In 1984 the Lower Creek Watershed Management Plan (LWC WMP) was written to develop a systematic approach to salinity and erosion control from the discontinuous and continuous gully systems on the Mancos Shale Formation. The watershed was divided into treatment units for project implementation. Hypalon drop structures and new pit reservoirs are being designed for construction in 1985, and in the future, as funds become available for salinity control, and for the establishment of riparian habitat. (Author's abstract)
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12. **Interrelationship between physiography, hydrology, sedimentation, and salinization of the Loddon River plains, Australia**.
Macumber, P. G.
Journal of Hydrology 7(1): 39-57 (1968).
http://dx.doi.org/10.1016/0022-1694(68)90194-7
Keywords: erosion and sedimentation/ precipitation
Abstract: The causes of salinization of the Loddon River plain, Australia, were studied in an attempt to find a means of halting the deterioration of irrigated farms and grazing land. The pattern of salinization was found to be closely linked to the fluvial and aeolian patterns of quaternary sedimentation, with the most severe salinization in clays and fine soils. Flood control projects eliminated the winter sheet flood which leached salt from the upper soil profile each year, while summer irrigation causes rising water tables and soil salinization. Alluvial sand aquifers are found along some of the streams; pumping them heavily as groundwater drains can be done locally to lower the water table and alleviate soil salinity. Buried alluvial aquifers parallel to surface drainage were found and may also be pumped for drainage. (KNAPP-USGS)
© *ProQuest*

13. **Meadow saline soil changes in a marginal oasis, northwest China**.
Wang, F., Xiao, H. and Zou, S.
Environmental Earth Sciences 67: 265-272 (2012). ISSN: 1866-6280
http://dx.doi.org/10.1007/s12665-011-1505-y
Keywords: clay/ electrical conductivity/ land cover/ reclamation/ global change/ soil organic matter/ alluvial plains/ meadow soils/ salinity/ Linze Oasis/ Heihe River/ sediment/ pH/ China/ granulometry/ bulk density/ principal components analysis/ clastic sediments/ human activity/ physicochemical properties/ agriculture/ saline soils/ statistical analysis/ nutrients/ water table/ fluvial features/ soil quality/ tillage/ land use/ salinization
Abstract: This research on an alluvial plain oasis in the middle reaches of the Heihe River used the trend estimation model of principal component analysis through fixed position experiments to investigate and analyze changes in saline meadow soil characteristics after reclamation of the oasis. The conclusion is that after cultivation for a number of years, clay content increased from 9.18% (before cultivation) to 12.93% (after 30 years of cultivation) and soil nutrient content increased as well, but available potassium decreased from 1,315.50 mg/kg (before cultivation) to 240.84 mg/kg (after 30 years of cultivation). As a result of engineering, biological, and agricultural methods, total salt content significantly decreased by 97.15% from 70.28 g/kg (before cultivation) to 2.00 g/kg (after 30 years of cultivation). Through the trend estimation model of principal components analysis (PCA), it was found that soil quality improved over time. Synthetic analysis of various indexes of soil quality revealed that meadow saline soil could be used for agricultural production with responsible tillage. Copyright 2011 Springer-Verlag
© *ProQuest*

14. **Nature and Management of Salt-Affected Soils in Saskatchewan**.
Henry, J. L. and Johnson, W. E.
Regina, Saskatchewan, Canada, Department of Agriculture, 27 p. (1970).
http://library.wur.nl/isric/fulltext/isricu_i29443_001.pdf
Keywords: saline soils/ soil salinity/ water quality/ range management/ conservation practices

15. **Options for salinity mitigation in the Murray–Darling Basin**.
Schrobback, P., Adamson, D. and Quiggin, J.
Murray Darling Program Working Paper, Brisbane Qld., University of Queensland, Risk and Sustainable Management Group, 17 p. (2008).
Keywords: rivers/ salinity/ water quality/ water quantity/ watershed management/ conservation measures/ land use/ models/ government programs and projects
Abstract: The Murray–Darling Basin faces increasing pressure on water quantity and quality. In 2006-07, salt interception schemes implemented as part of the Murray–Darling Basin Salinity Management strategy removed over 470,000 tonnes of salt from the water supply, reducing the salinity of water flowing to Adelaide by about 200 EC units. However, the costs of salinity mitigation schemes are increasing. With possible continuing declines in average inflows, costs of salinity and salinity mitigation are expected to increase even further in the future. In this paper, a state-contingent model of land and water allocation is used to compare alternative options for salinity mitigation.

16. **Performance of selected tree and shrub species grown for stream salinity control in the Wellington reservoir catchment**.
Pettit, N. E., Ritson, P. and Water Authority of Western Australia
Leederville, W.A., Water Authority of Western Australia, 60 p. 1991.
Keywords: rivers/ riparian areas/ trees/ shrubs/ water quality/ saline water/ watershed management/ conservation practices

17. **Phenology of salt desert plants near contour furrows**.
Wein, R. W. and West, N. E.
Journal of Range Management 24: 299-304 (1971). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/5948/5558
Keywords: contour furrows/ vegetation/ Mancos shale/ precipitation
Abstract: The phenology of galleta (*Hilaria jamesii*), shadscale (*Atriplex confertifolia*), nuttall saltbush (*A. nuttallii*) and mat saltbush (*A. corrugata*) was studied to determine the effect of contour furrows on their vigor. Four years following treatment of the areas, the plants within 1 meter of the furrows were larger than control plants at least 3 meters from the treatments. Phenological index scores indicated earlier spring growth for the *Atriplex* species, and a longer summer and fall growth period for all species near furrows. Seed yields were significantly greater for plants near the furrows, providing a sustained seed source for natural establishment when artificial seedings in the salt desert area fail.
This citation is from the University of Arizona Institutional Repository.

18. **Plant community patterns in old embanked grasslands and the survival of halophytic flora**.
Bonis, A., Bouzillé, J. B., Amiaud, B. and Loucougaray, G.
Flora 200: 74-87 (2005). ISSN: 0367-2530
http://dx.doi.org/10.1016/j.flora.2004.06.002
Keywords: embankment/ grazing/ halophyte survival/ sub-halophyte survival/ mowing/ plant succession/ soil salinity/ plant communities/ France
Abstract: The presence of a halophytic and sub-halophytic flora in grasslands reclaimed from the sea several centuries ago on the west Atlantic coast in France appears very unusual and the reasons for its survival are still uncertain. Our objective is to document its distribution pattern and to investigate whether its persistence is related to abiotic conditions and/or management practices. Vegetation surveys were carried out in seven different sites with 26 relevés on grazed sites (15 on slopes and 10 on flats) and 11 on mown sites (six on slopes and five on flats). This flora shows some important similarity with the vegetation of recent polders and can be classified into groups of species differing by their degree of salt tolerance but also their response to management mode. It was found that halophytes are only present on very saline soils, in a situation where the level of competition with more competitive species is reduced. The sub-halophytes also required low competition on lower soil salinity. In old polders, these two groups only occurred on grazed slopes and declined or even disappeared in the absence of grazing. In exclosures, the community became strongly dominated by competitive species and the soil salinity decreased on the slopes. The maintenance of sub-halophytes in old polders seems to be mainly conditioned by competition limitation whereas halophytes showed also a strong dependency to soil salt level, two

requirements, which are met on continuously grazed slopes. Grazing maintains inter-specific competition at a low level while trampling increases soil compaction. Soil compaction modifies water and salt circulation, which could explain the high level of soil conductivity observed on grazed slopes. © 2005 Elsevier GmbH. All rights reserved.

19. **Potential impact of various range improvement practices on salt loading in Colorado River basin**.
Hessary, I. K.
Logan, Utah, Utah State University, 216 p. (1977).
Keywords: watersheds/ salts/ soil/ Colorado River/ chaining/ range/ treatments/ fertilizers
Abstract: The objectives of this study were to investigate the impacts of various selected range improvement practices on natural resource lands on probable salt loading, watershed cover, and annual production. Representative "treated" and nearby similar "untreated" sampling sites were selected for various treatments in Utah, Colorado, New Mexico, and Arizona, and impacts of the various treatments on soil profile salt concentrations, percent cover and annual production were evaluated. Effective life expectancy of various treatments were also studied. The results of soil profile analyses indicated; (a) though salt accumulations were significantly different among sampling positions on 50 percent of gully plug treatments and among the depth increments on 67 percent of the treatments, the pattern was not consistent among either sampling positions or depth increments in gully plug treatments; (b) on 27 percent of contour furrowed sites, salt concentrations were significantly different among sampling locations, from which more than half had significantly higher salt inside the furrow while the rest had significantly higher salt outside the furrow; (c) the general lack of difference in salt concentrations between treated and untreated sites on pinyon-juniper and the various sagebrush treatments was the only consistent trend. In general the measured salt concentrations in surface soils of either pinyon-juniper or sagebrush sites present a problem of little concern as related to salt production within the major river basins. Results from annual vegetative production studies indicated, (a) about 33 percent of the contour furrowed sites indicated increased annual production. Best responses were found on loam and clay loam soils while soils of sandy loam or clay texture indicated a poor response to treatment. Soils classified as Typic Ustifluvents and Ustollic Haplargids were most favorable in terms of increased production; (b) annual production on pinyon-juniper chainings was significantly increased across a variety of soil types (growth of trees excluded). The greatest increases in production were measured on sites with loam soils classified as Typic Haplustolls; (c) neither of the two pitting treatments indicated increased annual production on either clay or sandy clay loam sites; (d) less than 50 percent of the various sagebrush treatments indicated increased annual production. There appears to be a general trend for best responses on loam soils, though significant decreases in production were also indicated on this type of soil; (c) plowing was the least successful sagebrush treatment studied. Best cover responses on the various range improvement practices were found on contour furrowing treatments on sandy clay loam and loam textured soils and on Typic Torriorthent or Ustic Torriorthent soil types. Though cover increases due to chaining were noted on 57 percent of pinyon-juniper sites, on a variety of soil textures and soil types, the increases were uniformly small (tree cover included) and no clear pattern emerged with either soil texture or soil type. Only about 20 percent of the various sagebrush treatments showed increased cover, ten percent indicated decreased cover, and there was no impact on cover on the remaining 70 percent of the treatments. Pitting treatment in this study had no impact on cover. Age of contour furrow treatments made little difference as to whether there was a significant increase or decrease in either production or cover. Cover data from pinyon-juniper chainings indicate either that significant increases in cover (if they occur) are slightly more dramatic on more recent treatments or that treatments approximately 11 years old represent conditions most ideal for enhanced cover (if an increase in cover occurs), which the former interpretation is nearly correct. Production data suggest that pinyon-juniper sites chained since 1964 are not as favorable in terms of increased cover as those chained prior to 1964. Age of sagebrush treatment had no impact on significant changes in cover, however some general t end indicated that production increases are slightly higher for more recent sagebrush ripping and sagebrush chaining treatments than for older ones. Results from regression analyses to relate production to cover

on both treated and untreated sites on all improvement practices were not promising. Gully plugs on loam soils have a projected life expectancy of 37 years and contour furrows on sandy loam and clay loam soils have a projected life expectancy of 30 and 36 years, respectively.
This citation is from Utah State University.

20. **Potential of Water and Salt Yields From Surface Runoff on Public Lands in the Price River Basin**.
Riley, J. P., Israelsen, E. K., Mcneill, W. N. and Peckins, B.
Reports, Utah Water Research Lab., 99 p. (1982).
http://digitalcommons.usu.edu/water_rep/119/
Keywords: rivers/ watershed management/ water salinization/ ephemeral streams/ runoff/ water quality/ conservation practices
Abstract: The report examines possible sources of dissolved salts in the Price River basin. Ephemeral and intermittent streams contributed dissolved salts and are the focus of the study. Seven subwatersheds and the Price River at Heiner are investigated to examine the effects of existing watershed characteristics on runoff and dissolved salts production. Alternately, the report examines the effects of specific land treatments on surface runoff quantity and quality. Various instrumentation techniques are evaluated to help improve future data collected capabilities in intermittent channels. The examination of the data reveals various trends that might be considered for further investigation in subsequent studies.
This citation is from Utah State University.

21. **Preclearing hydrology of the Western Australia wheatbelt: Target for the future?**
Hatton, T. J., Ruprecht, J. and George, R. J.
Plant and Soil 257: 341-356 (2003).
http://dx.doi.org/10.1023/A:1027310511299
Keywords: regolith salt loads/ runoff/ groundwater recharge/ saline water/ precipitation/ flooding/ hydrology/ land restoration/ soil salinity
Abstract: The wheatbelt of Western Australia largely corresponds to a zone of ancient drainage, characterised by highly variable rainfall, long dry summers, low hydraulic gradients, intermittent surface flows and high regolith salt loads. The accumulation and distribution of salt, the rudimentary aquifers with deep watertables, the intermittent flooding and subsequent transpiration of water from the valley sediments, and the low yields of water reaching the ocean were a product of the underlying physical environment and vegetation types capable of using deeply infiltrated water through the dry season. The hydrological and hydrogeochemical changes induced by widespread clearing of this vegetation for dryland agriculture are profound and enduring. Run-off onto and through the valley floors has increased by a factor of five; combined with local rainfall on these valley floors, the resulting increase in groundwater recharge is filling the deep sedimentary materials and bringing highly saline water to the surface. Diffuse recharge has also increased on the slopes and ridges, with saline watertables rising in these lateritic formations as well, providing additional hydraulic heads forcing groundwater towards the valleys. The resulting increase in the groundwater discharge areas is projected to greatly increase flooding risk downstream into the future. A variety of natural, built and agricultural assets are either already impacted or at risk to these phenomena. It is hypothesised that restoring the original hydraulic and hydrological functions of the system will lead to its recovery. This raises several issues: can we design remedies in terms of restoring the original rates of flux (recharge, runoff, etc) or in terms of the original balances (recharge less than aquifer discharge, input of salt into the root zone equal to output)? Secondly, to what degree can revegetation or engineering now restore these original conditions? Finally, we examine the potential for the landscape to recover to its original hydrological and hydrogeochemical state once salinised. Given the advanced state of saline watertable development, with its implications for successful revegetation and restoration of valley transpiration, the changes in soil structure and chemistry, and the immediate implications to valued assets, we posit that an aim of restoring the landscape solely with revegetation, either in terms of rates or balances, is not feasible or even possible. To a degree, one can only restore certain aspects of the original balance via revegetation combined with discharge enhancement and flood mitigation.

22. **Probable Impacts of Various Range Improvement Practices on Diffuse Salt Production**.
Hessary, I. K. and Gifford, G. F.
Journal of Range Management 32: 189-193 (1979).
https://journals.uair.arizona.edu/index.php/jrm/article/view/6932/6542
Keywords: soil salinity/ salt loading/ runoff/ salt movement/ rangeland management/ range improvement practices/ gully plugs/ contour furrowing/ pitting/ chaining/ sagebrush control/ pinyon-juniper
Abstract: During 1976 a study of soil profile salt concentrations and probable salt loading by surface runoff was made on 73 range improvement sites in Utah, Colorado, New Mexico, and Arizona. The range improvement practices studied included gully plugs, contour furrowing, pitting, pinyon-juniper chaining, and various sagebrush-control treatments. Results of these studies indicated that the impact of gully plugs and contour furrows on potential diffuse salt production is somewhat variable and may in fact indicate that these treatments have only a minor potential impact, probably because the overland flow route is not a major source of diffuse salt movement, at least on lands sampled in this study. On pinyon-juniper sites and the various sagebrush treatments, the lack of difference in salt concentrations between treated and untreated sites was the only consistent trend. In general the measured salt concentrations in surface soils of either pinyon-juniper or sagebrush sites present a problem of little concern as related to salt production within the major river basins.
This citation is from the University of Arizona Institutional Repository.

23. **Reducing Salinity of Surface Runoff from Rangeland**.
Bentley, R. G., Janes, E. B. and Eggleston, K. O.
U.S. Bureau of Land Management, Denver Service Center, pp. 69-79. (1980).
Keywords: rangelands/ runoff/ saline water/ salinization control/ salts/ sedimentation/ soil/ salinity management/ water analysis/ watersheds
Abstract: This paper shows how Bureau of Land Management (BLM) Manual procedures are used to determine the volumes of runoff, sediment and salt yielded from a rangeland watershed. Yields are calculated for each geologic formation, soil type, or vegetation community. Other important site information is used as rating factors, such as climate, percent of ground covered by live vegetation, kind of land use, degree of erosion, and channel characteristics. The potential salt yield from each soil type is obtained from soil survey data and/or actual runoff measurements. Possible control methods, including grazing management, contour furrows, and retention-detention dams, are compared and their advantages and hazards discussed.

24. **Roles of saltcedar (*Tamarix* spp.) and capillary rise in salinizing a non-flooding terrace on a flow-regulated desert river**.
Glenn, E. P., Morino, K., Nagler, P. L., Murray, R. S., Pearlstein, S. and Hultine, K. R.
Journal of Arid Environments 79: 56-65 (2012).
ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2011.11.025
Keywords: arid-zone rivers/ riparian processes/ riparian restoration/ salt exudation/ tamarisk/ *Tamarix*/ saltcedar
Abstract: Tamarix spp. (saltcedar) secretes salts and has been considered to be a major factor contributing to the salinization of river terraces in western US riparian zones. However, salinization can also occur from the capillary rise of salts from the aquifer into the vadose zone. We investigated the roles of saltcedar and physical factors in salinizing the soil profile of a non-flooding terrace at sites on the Cibola National Wildlife Refuge on the Lower Colorado River, USA. We placed salt traps under and between saltcedar shrubs and estimated the annual deposition rate of salts from saltcedar. These were then compared to the quantities and distribution on of salts in the soil profile. Dense stands of saltcedar deposited $0.159\ kg\ m^{-2}\ yr^{-1}$ of salts to the soil surface. If this rate was constant since seasonal flooding ceased in 1938 and all of the salts were retained in the soil profile, they could account for $11.4\ kg\ m^{-2}$ of salt, about 30% of total salts in the profile today. Eliminating saltcedar would not necessarily reduce salts, because vegetation reduces the upward migration of salts in bulk flow from the aquifer. The densest saltcedar stand had the lowest salt levels in the vadose zone in this study.
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25. **The saline deposits of California**.
Bailey, G. E.
Bulletin California State Mining Bureau, San Francisco, Calif., California State Mining Bureau, 216 p. (1902).
http://archive.org/details/salinedepositsof00bailrich
Keywords: salt deposits/ salt industry and trade/ borax/ carbonates/ Chile saltpeter

26. **Saline land of the United States of America and Canada**.
Mckell, C. M., Goodin, J. R. and Jefferies, R. L.
Reclamation & Revegetation Research 5: 159-165 (1986). ISSN: 0167-644X
Keywords: Canada/ salinity causes/ salt affected soils/ United States/ vegetation types
Abstract: Saline land in the USA and Canada is largely found in arid and semi-arid areas; the proportion of land subject to salinity- forming influences is extensive. A high proportion of the irrigated crop land in the USA is in the west. Inadequate attention to proper drainage management, over-drawing existing water supplies and wasteful agricultural practices threaten the continued productivity of this land. Saline soils are also scattered throughout the N Great Plains of the USA extending into Canada. Some saline areas are natural, but most of the 2.2 X 106 ha of salt affected land results from dryland farming; cultivation of the prairie grassland and the practice of summer fallowing have altered the groundwater regime and led to increasing recharge. Alternative cropping programmes have been developed to reverse these hydrological changes. Also, salt tolerant grasses are sown on some salt affected areas. - Authors
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27. **Salinity and waterlogging as constraints to saltland pasture production: A review**.
Bennett, S. J., Barrett-Lennard, E. G. and Colmer, T. D.
Agriculture, Ecosystems and Environment 129: 349-360 (2009). ISSN: 0167-8809
http://dx.doi.org/10.1016/j.agee.2008.10.013
Keywords: salinity/ waterlogging/ land capability assessment/ salt land/ ecological zonation/ economic value
Abstract: This review considers the issue of targeting plants for forage/fodder production in landscapes affected by dryland salinity, and two principal factors that affect saltland capability—salinity and waterlogging. Saltland differs in its capacity to support plant growth, and the species used differ in grazing value, so that greatest economic gain will be achieved by focusing revegetation into areas of highest capability. Both salinity and waterlogging are temporally and spatially variable: plant ecological zonation on saltland is a reflection of plant adaptation to these variable stresses. The review has three parts. First, we consider the case for ecological zonation to be caused by variation in salinity and waterlogging. Secondly, we review the current means by which salinity and waterlogging are measured and the suitability of these techniques for rapid field appraisal of saltland capability. Thirdly, we suggest three critical questions that need to be answered if we are to establish a framework to make rapid saltland capability assessments. These are: (a) can a plant use the groundwater, (b) is the soil water above the water table suitable for use, and for what period is it sufficient in volume to support growth, and (c) is the soil sufficiently aerobic for root-growth and function. We conclude with some recommendations about the types of data around which a saltland capability assessment protocol might be designed.
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28. **Salinity control on BLM-administered public lands in the Colorado River basin: A report to Congress**.
U. S. Bureau of Land Management, Washington, D.C.,
The Bureau, 43 p. (1987).
http://archive.org/details/salinitycontrolo72unit
Keywords: water quality management/ Colorado River Watershed (Colo.-Mexico)/ water salinization control/ stream salinity/ public lands/ U.S. Bureau of Land Management
Abstract: This report has been prepared in response to the 1984 amendment to the Colorado River Basin Salinity Control Act (P.L. 98-569). Section 203(b)(3) directed the Secretary of the Interior to "develop a comprehensive program for minimizing salt contributions to the Colorado River from lands administered by the Bureau of Land Management (BLM) and submit a report which describes the program and recommended implementation actions to the Congress and to the members of the advisory council established by section 204(a) of this title by July 1, 1987."

This report describes salinity problems in the Colorado River Basin and the BLM's role in controlling salinity. Under the Future Actions section, BLM recommends actions necessary to implement salinity control activities.

29. **Salinity Control on Bureau of Land Management (BLM)-Administered Public Lands in the Colorado River Basin: A Report to Congress**.
U. S. Bureau of Land Management,
41 p. (2004).
http://www.coloradoriversalinity.org/docs/Report%20to%20Congress-BLM%202004%20-%20Salinity%20Control%20on%20BLM-Administered%20Public%20Lands%20in%20the%20Colorado%20River%20Basin.pdf
Keywords: salinity/ control methods/ rivers/ rangelands/ range management/ erosion control/ saline soils/ soil salinization
Abstract: Public Law 106-459, Amendment of the Colorado River Basin Salinity Control Act, requires the Secretary of the Interior to prepare a report to Congress on the status of implementation of a comprehensive program for minimizing salt contributions to the Colorado River from lands administered by the Bureau of Land Management (BLM). This report describes salinity sources on ELM-administered public lands and the BLM's role and accomplishments in controlling point and nonpoint sources of salinity on those lands. The report updates a previous report on Colorado River Basin salinity submitted to the Congress by BLM in 1987 (BLM, 1987). This report also recommends actions necessary to implement future salinity control activities and additional research needed to better understand salt mobilization and transport in arid ecosystems. Salinity, or the total dissolved solids concentration, in the Colorado River has increased as a result of water-resources development in two major ways: (1) the addition of salts from water use (salt loading); and (2) the consumption and evaporation of water (salt concentrating). The combined effects of salt loading and water consumption have had a significant impact on salinity in the Colorado River Basin. Nearly half of the salt loading in the Colorado River Basin comes from natural geologic sources, including both point and nonpoint sources. Saline springs and seeps, erosion of marine geologic formations, groundwater discharge to streams, and surface runoff all contribute to this background salt loading. The majority of this natural salt load enters the Colorado River and its tributaries from groundwater and saline springs. The BLM administers approximately 53 million acres of public lands in the Basin above Yuma, Arizona, including 48 million acres above Imperial Dam. The BLM uses a comprehensive, three-pronged approach to salinity control that incorporates: (1) the control of point sources of salinity such as saline springs and seeps and abandoned flowing wells that yield saline water; (2) the control of nonpoint sources of salinity through cost-effective land management techniques that result in multiple-resource benefits; and (3) the control of nonpoint source salt mobilization through land-use planning, permit stipulations, land-use authorizations, best management practices, watershed protection strategies, and ecological restoration. The BLM is committed to further the understanding of naturally-occurring, diffuse sources of salt on arid and semiarid rangelands. Very little is known about salt mobilization and transport in these environments.

30. **Salt impacts on organic carbon and nitrogen leaching from senesced vegetation**.
Steele, M. K. and Aitkenhead-Peterson, J. A.
Biogeochemistry: 1-15 (2012). ISSN: 0168-2563
http://dx.doi.org/10.1007/s10533-012-9722-3
Keywords: dissolved organic carbon (DOC)/ dissolved organic nitrogen/ leaf litter/ salinity/ sodium
Abstract: Senesced vegetation is exposed to a wide range of salt concentrations in surface waters resulting from human activities which include deicing salts and irrigation water chemistry. Both dissolved organic carbon (DOC) and salt concentrations are rising in northern hemisphere watersheds, yet there has been little investigation of sodium as a potential mechanism for DOC increases. The objective of this study was to investigate the impact of solution sodicity and salinity on DOC and dissolved organic nitrogen (DON) leaching from five types of senesced and cut vegetation. Vegetation was soaked for 24 h in a series of sodium chloride (NaCl)-calcium chloride (CaCl 2) solutions with sodium adsorption ratios (SAR) of 2, 10, or 30 and electrical conductivities of 0.1 dS m -1 through 3.0 dS m -1. Vegetation was also soaked in a sodium bicarbonate (NaHCO 3) solution at SAR = 30 and stream water from local watersheds with a range of sodicity and salinity. The mass of both DOC and DON released increased as SAR increased in

the NaCl solutions, but the total salinity had inconsistent effects on DOC and DON release. NaHCO 3 leached similar amounts of DOC and DON as NaCl. The SAR of the stream water solutions was able to explain 88 % of the variability in DOC leached from vegetation ($p < 0.05$). The results indicated that sodicity, quantified by SAR, had a significant impact on DOC and DON leaching from senesced vegetation and could be a potential mechanism to explain the observed increases in surface water DOC. © 2012 Springer Science+Business Media B.V.
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31. **Salt movement, leaching efficiency, and leaching requirement**.
Van Hoorn, J. W.
Agricultural Water Management 4: 409-428 (1981). ISSN: 0378-3774
http://dx.doi.org/10.1016/0378-3774(81)90030-5
Keywords: salt transport/ leaching/ percolation
Abstract: To study the salt movement in a soil profile, experiments were conducted on sandy loam and silty clay loam in tanks. The chloride concentration and electrical conductivity of the soil water were found from soil water samplers and salinity sensors. The standard deviation of the chloride concentration at each depth was small at the beginning of the percolation process when the soil was uniformly non-saline or highly saline; it increased strongly during the process and returned to its original value at the end. This points to a very heterogeneous water and salt movement through the soil profile. The chloride concentration, when increasing or decreasing rapidly, shows a large scattering. The effective mixing length in the tank experiments appears to be much greater than in laboratory soil columns. It varies between 10 and 15 cm in sandy loam and between 15 and 30 cm in silty clay loam. Irrigation water and soil moisture do not mix completely. An increasing part of the irrigation water moves through the soil without contributing to the leaching process. The results of the tank experiments agree with those of field experiments on similar soils. The consequences for the calculation of the leaching requirement in practice are discussed.
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32. **Seed inoculation with effective root-nodule bacteria enhances revegetation success**.
Thrall, P. H., Millsom, D. A., Jeavons, A. C., Waayers, M., Harvey, G. R., Bagnall, D. J. and Brockwell, J.
Journal of Applied Ecology 42: 740-751 (2005). ISSN: 1365-2664
http://dx.doi.org/10.1111/j.1365-2664.2005.01058.x
Keywords: Acacia spp./ Bradyrhizobium/ direct-seeding/ inoculation/ land restoration/ legumes/ nitrogen fixation/ rhizobia/ symbiosis
Abstract: Extensive clearing of native vegetation in Australia has contributed to major environmental problems including: land degradation, dryland salinity, soil erosion and loss of biodiversity. Re-establishing cover with deep-rooted perennial species is a major focus for conservation and sustainable land management, particularly with regard to hydrological control of recharge and saline discharge areas. However, considerable expense is involved in large-scale revegetation programmes and cost effectiveness is a real concern. Low-cost revegetation approaches are needed that require little maintenance yet can substantially enhance reliable establishment and growth of native trees and shrubs. We evaluated results from direct-seeding field trials that examined the benefits of using native Australian Acacia species inoculated with effective strains of nitrogen-fixing root-nodule bacteria to revegetate degraded landscapes. On average, inoculation led to a 118% increase in establishment of acacia seedlings, indicating that the use of elite strains of native bacteria can substantially reduce seed requirements. This is a major benefit given the expense of collecting sufficient native seed and the impacts of this activity on remnant population viability. Particularly at sites experiencing harsher climatic conditions, subsequent survival of inoculated seedlings was significantly greater than for uninoculated controls. Moreover, inoculated acacias grew 10–58% faster than uninoculated controls during the critical early phase of establishment, although this varied among species and sites. Synthesis and applications. Inoculation of Acacia species or other native leguminous shrubs and trees with elite strains of native rhizobia as part of direct-seeding techniques has the potential to increase the scope, rate and success of land restoration world-wide. Re-establishment of important

plant–soil interactions in degraded soils can contribute significantly to the development of biodiverse self-regenerating native ecosystems in agricultural landscapes.
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33. **Soil and water salinity in Queensland: the prospect of ecological sustainability through the implementation of land clearing policy**.
Thorburn, P. J., Gordon, I. J. and Mcintyre, S.
Rangeland Journal 24: 133-151 (2002).
http://dx.doi.org/10.1071/RJ02007
Keywords: vegetation/ biodiversity/ legislation/ policy/ land management
Abstract: In Queensland, legislation has recently been enacted that outlines minimum standards for the retention of native vegetation in bioregions and prescribes Performance Requirements for the maintenance of biodiversity and ecological processes, and the prevention of land degradation. It also details Acceptable Solutions to satisfy the Performance Requirements. It this paper we analyse the links between science and action to determine whether the legislation and associated policy are likely to lead to sound management decisions being made for prevention of land and water salinity. We also compared the requirements for biodiversity protection relative to those for salinity control. For salinity (and biodiversity) the minimum standards and Acceptable Solutions in the legislation have a sound technical basis. The main challenge in implementing the salinity Performance Requirements will be provision of information required to assess salinity risk at appropriate scales. This information is: (1) salinity hazard assessment at catchment/regional scale planning scale; (2) technical information to support a sub-catchment scale implementation; (3) guidelines, procedures and local expertise for interpretation of salinity hazard at the property scale. In the process of assessing clearing applications there is no formal role for planners or decision makers at the sub-catchment level who could play an important role in coordinating information gathering for land managers developing clearing applications. There are also limited pathways for accessing relevant scientific information and expertise at an appropriate level to provide support for land managers. We suggest that this situation is likely to limit the successful implementation of the policy for preventing land and water salinity. The minimum standard of 30% retained vegetation would provide similar protection for biodiversity and salinity control at the bioregional level. In smaller areas (e.g. an individual property) however, there could be contrasting requirements for the retention of vegetation.
This citation is from the Australian Rangeland Society.

34. **Soil changes caused by erosion control treatments on a salt desert area**.
Wein, R. W. and West, N. E.
Soil Science Society of America Journal 37: 98-103 (1973).
Keywords: erosion/ treatments/ deserts/ sodium/ electrical conductivity
This citation is from the Soil Science Society of America.

35. **Soil salinity patterns in *Tamarix* invasions in the Bighorn Basin, Wyoming, USA**.
Ladenburger, C. G., Hild, A. L., Kazmer, D. J. and Munn, L. C.
Journal of Arid Environments 65: 111-128 (2006). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2005.07.004
Keywords: saltcedar/ tamarisk/ soil pH/ soil nutrients/ invasive/ riparian areas/ *Tamarix*
Abstract: Saltcedar (*Tamarix* spp.) is an exotic, invasive shrub of riparian corridors in the western United States that can promote soil salinization via leaf exudates as *Tamarix* litter accumulates on the soil surface. *Tamarix* stands occur in association with big sagebrush (*Artemisia tridentata*), greasewood (*Sarcobatus vermiculatus*), and cottonwood (*Populus deltoides*) in northern Wyoming, depending on topographic position. Revegetation of *Tamarix*-invaded sites can be limited by altered soil conditions. *Tamarix* stands in northcentral Wyoming were selected to determine the relationship of *Tamarix* shrubs and associated vegetation to soil salinity, pH, and nutrients. In general, salinity of surface soils (0–5 cm) was greater and pH was lower than in deeper soils. Surface soils (0–5 cm) beneath *Tamarix* have greater salinity and lower pH than soil in interspaces. Because soil salinity in the Bighorn Basin is lower than levels documented in most *Tamarix* stands of the southwestern United States, many species used for revegetation should tolerate soil conditions here following *Tamarix* control.
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36. **State and Local Management Actions to Reduce Colorado River Salinity**.
Milliken, J. G., Lohman, L. C., Lyon, S. A. and Shrek, G. W.,
370 p. (1978).
http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9100DRSG.txt
Keywords: rivers/ watershed management/ government programs and projects/ salinity/ saline water/ water salinization/ conservation practices/ erosion control/ vegetation cover/ water quality
Abstract: This report identifies and provides analysis of state and local management actions which may be taken state-by-state to reduce salinity in the Colorado River. The analysis and evaluation procedures focus on management actions to reduce salinity and only on actions which may be taken within the scope of existing legislation. The management actions were discussed and amended on the bases of technical feasibility, cost, legality, effectiveness in salinity control, scope of applicability, and political and social implications. Of over 30 possible state and local management actions considered, twelve have been proposed for implementation in the Colorado River Basin. The remaining actions were considered as already underway in each, or some, of the Colorado River Basin states; actions not feasible in the Colorado River Basin; or actions considered to be out-of-scope of this study. A statement of each of these actions followed by a brief summary of current status or reason for not including with actions proposed for implementation is provided in the report.

37. **Surface-water salinity in the Gunnison River Basin, Colorado, water years 1989 through 2007**.
Schaffrath, K. R.
Scientific Investigations Report, USGS, Reston, Virginia, U.S. Geological Survey, 47 p. (2012).
http://pubs.usgs.gov/sir/2012/5128/
Keywords: saline water/ water salinization/ rivers/ watersheds/ total dissolved solids/ rivers/ watershed management/ salinity/ environmental projects/ water quality/ land use/ conservation practices
Abstract: Elevated levels of dissolved solids in water (salinity) can result in numerous and costly issues for agricultural, industrial, and municipal water users. The Colorado River Basin Salinity Control Act of 1974 (Public Law 93–320) authorized planning and construction of salinity-control projects in the Colorado River Basin. One of the first projects was the Lower Gunnison Unit, a project to mitigate salinity in the Lower Gunnison and Uncompahgre River Basins. In cooperation with the Bureau of Reclamation (USBR), the U.S. Geological Survey conducted a study to quantify changes in salinity in the Gunnison River Basin. Trends in salinity concentration and load during the period water years (WY) 1989 through 2004 (1989–2004) were determined for 15 selected streamflow-gaging stations in the Gunnison River Basin. Additionally, trends in salinity concentration and load during the period WY1989 through 2007 (1989–2007) were determined for 5 of the 15 sites for which sufficient data were available. Trend results also were used to identify regions in the Lower Gunnison River Basin (downstream from the Gunnison Tunnel) where the largest changes in salinity loads occur. Additional sources of salinity, including residential development (urbanization), changes in land cover, and natural sources, were estimated within the context of the trend results. The trend results and salinity loads estimated from trends testing also were compared to USBR and Natural Resources Conservation Service (NRCS) estimates of off-farm and on-farm salinity reduction from salinity-control projects in the basin. Finally, salinity from six additional sites in basins that are not affected by irrigated agriculture or urbanization was monitored from WY 2008 to 2010 to quantify what portion of salinity may be from nonagricultural or natural sources. In the Upper Gunnison area, which refers to Gunnison River Basin above the site located on the Gunnison River below the Gunnison Tunnel, estimated mean annual salinity load was 110,000 tons during WY 1989–2004. Analysis of both study periods (WY 1989–2004 and WY 1989–2007) showed an initial decrease in salinity load with a minimum in 1997. The net change over either study period was only significant during WY 1989–2007. Salinity load significantly decreased at the Gunnison River near Delta by 179,000 tons during WY 1989–2004. Just downstream, the Uncompahgre River enters the Gunnison River where there also was a highly significant decrease in salinity load of 55,500 tons. The site that is located at the mouth of the study area is the Gunnison River near Grand Junction where the decrease was the largest. Salinity loads decreased by 247,000 tons during WY 1989–2004 at this site though the decrease attenuated

by 2007 and the net change was a decrease of 207,000 tons. The trend results presented in this study indicate that the effect of urbanization on salinity loads is difficult to discern from the effects of irrigated agriculture and that natural sources contribute a fraction of the total salinity load for the entire basin. Based on the calculated yields and geology, 23–63 percent of the estimated annual salinity load was from natural sources at the Gunnison River near Grand Junction during WY 1989–2007. The largest changes in salinity load occurred at the Gunnison River near Grand Junction as well as the two sites located in Delta: the Gunnison River at Delta and the Uncompahgre River at Delta. Those three sites, especially the two sites at Delta, were the most affected by irrigated agriculture, which was observed in the estimated mean annual loads. Irrigated acreage, especially acreage underlain by Mancos Shale, is the target of salinity-control projects intended to decrease salinity loads. The NRCS and the USBR have done the majority of salinity control work in the Lower Gunnison area of the Gunnison River Basin, and the focus has been in the Uncompahgre River Basin and in portions of the Lower Gunnison River Basin (downstream from the Gunnison Tunnel). According to the estimates from the USBR and NRCS, salinity-control projects may be responsible for a reduction of 117,300 tons of salinity as of 2004 and 142,000 tons as of 2007 at the Gunnison River near Grand Junction, Colo. (streamflow-gaging station 09152500). USBR and NRCS estimates account for all but 130,000 tons in 2004 and 65,000 tons in 2007 of salinity load reduction. The additional reduction could be a reduction in natural salt loading to the streams because of land-cover changes during the study period. It is possible also that the USBR and NRCS have underestimated changes in salinity loads as a result of the implementation of salinity-control projects.

38. **A sustainable agricultural landscape for Australia: A review of interlacing carbon sequestration, biodiversity and salinity management in agroforestry systems**.
George, S. J., Harper, R. J., Hobbs, R. J. and Tibbett, M.
Agriculture, Ecosystems & Environment 163: 28-36 (2012). ISSN: 0167-8809
http://dx.doi.org/10.1016/j.agee.2012.06.022
Keywords: ecosystem services/ salinity/ soil carbon/ REDD/ reforestation/ watershed management
Abstract: Transformation of the south-western Australian landscape from deep-rooted woody vegetation systems to shallow-rooted annual cropping systems has resulted in the severe loss of biodiversity and this loss has been exacerbated by rising ground waters that have mobilised stored salts causing extensive dry land salinity. Since the original plant communities were mostly perennial and deep rooted, the model for sustainable agriculture and landscape water management invariably includes deep rooted trees. Commercial forestry is however only economical in higher rainfall (>700 mm yr−1) areas whereas much of the area where biodiversity is threatened has lower rainfall (300–700 mm yr−1). Agroforestry may provide the opportunity to develop new agricultural landscapes that interlace ecosystem services such as carbon mitigation via carbon sequestration and biofuels, biodiversity restoration, watershed management while maintaining food production. Active markets are developing for some of these ecosystem services, however a lack of predictive metrics and the regulatory environment are impeding the adoption of several ecosystem services. Nonetheless, a clear opportunity exists for four major issues – the maintenance of food and fibre production, salinisation, biodiversity decline and climate change mitigation – to be managed at a meaningful scale and a new, sustainable agricultural landscape to be developed.
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39. **Transport of salts from disturbed geologic formations**.
Mcworter, D. B. and Rowe, J. W.
Disposal of Residues on Land [Proceedings of the National Conference on Disposal of Residues on Land]**:** 127-132 (1976).
http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9100W6IQ.txt
Keywords: salt transport/ geology/ runoff/ hydrology/ total dissolved solids/ watersheds/ mining/ water quality/ groundwater
Abstract: This paper is a discussion of factors effecting the concentration of inorganic dissolved solids in runoff from watersheds that have been partially disturbed by surface mining. Hydrologic factors, including surface runoff, runoff by interflow, and ground water runoff are combined with the corresponding concentrations

of dissolved solids to provide a quantitative description of observed water quality in an area disturbed by surface mining. The basis for the material in this paper is the observation of the water-quality hydrology on a surface-mined area in northwestern Colorado.

40. **Upper Colorado River Basin Rangeland Salinity Control Project: Watershed Resource Condition Evaluation Phase II Procedure**.
Rasely, R. C., Roberts, T. C. and Pyper, G. P., Colorado River Basin Salinity Forum, (1991).
Keywords: rivers/ rangelands/ salinity/ sediment transport/ erosion control/ conservation practices/ watershed management

41. **Variations in soil dispersivity across a gully head displaying shallow sub-surface pipes, and the role of shallow pipes in rill initiation**.
Faulkner, H., Alexander, R., Teeuw, R. and Zukowskyj, P.
Earth Surface Processes and Landforms 29: 1143-1160 (2004). ISSN: 0197-9337
http://dx.doi.org/10.1002/esp.1109
Keywords: soil crusts/ rills/ infiltration/ gully head
Abstract: A small bifurcating gully head displaying shallow pipe development was surveyed to explore how far three-dimensional patterns of geochemistry and sediment size can be related to hydraulic gradients in the local marl bedrock (Almería, SE Spain).The crust, sub-crust and parent materials were sampled every 20 cm across a 2 m by 3 m grid, and then analysed for dispersive and granulometric characteristics. Spatial patterns of sodium adsoption ratio (SAR) for each layer were plotted separately. In-situ material at depths of 5–10 cm was only weakly dispersive, and the thin (0–2 cm depth) crust is also found to be mostly non-dispersive, paralleling findings from other field sites in Almería. However, the 'signature' relating SAR to electrical conductivity for each layer shows that in places the immediate sub-crust layer (2–5 cm) is highly dispersive. The pattern is not random; rather the SAR of this sub-crust layer follows inferred hydraulic gradients, the dispersive 'hot spots' being located in the most incised part of the small gully, exacerbating the erodibility of that position. Patterns of sediment particle size and sorting do not correlate with inferred hydraulic gradients but surface material is slightly siltier than the sub-crust. Clay fraction increased with depth, and SAR is shown to have a weak inverse relationship to particle size. This association between SAR and the increased clay fractions in the lower layers supports the inference that massive pipe enlargement in the Messinian-Rich Unit is suppressed by sub-surface swelling. Since a reduction in infiltration capacity (fc) with depth can be inferred from these results, infiltrating water must be deflected into the already vulnerable sub-crust layer during rainfall events, explaining the development of shallow pipe forms at preferential depths. It is concluded that calcium replaces sodium in the crust during leaching, leaving a calcic crust, and a sub-crust that is sodic and prone to subsequent pipe enlargement. Rill morphology in these materials also suggests that rills develop from these pipes when pipe roofs collapse (i.e. rill discontinuity; bridges; steep headwalls; and rills with excessively high depth-to-width ratios).
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42. **Vegetation response to contour furrowing**.
Wight, J. R., Neff, E. L. and Soiseth, R. J.
Journal of Range Management 31: 97-101 (1978). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/6799/6409
Keywords: contour furrows/ herbage production/ soil water/ saline soils/ runoff
Abstract: Over an 8-year period, contour furrowing on a panspot range site increased average annual herbage production 165% (527 kg/ha), increased plant available soil water 107%, and reduced total basal cover 73% (from 15.72 to 4.22%). On a saline-upland site, contour furrowing increased available water but had no measurable effect on total herbage production and basal cover. Thickspike and western wheatgrass accounted for most of the increased yields on the contour-furrowed panspot site. High yields on the furrowed plots were due primarily to increased soil water resulting from increased overwinter recharge and reduced summer runoff.
This citation is from the University of Arizona Institutional Repository.

43. **Wind erodibility as influenced by rainfall and soil salinity**.
Lyles, L. and Schrandt, R. L.
Soil Science 114: 367-372 (1972).
http://weru.ksu.edu/new_weru/publications/Andrew_pdf/1210.pdf
Keywords: wind erosion/ soil crusts/ precipitation/ soil salinity
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44. **Wind erosion and soil salinity: An examination of current agricultural practices and government initiatives**.
Calgary Regional Planning Commission [Calgary], Calgary Regional Planning Commission, 36 p. 1989.
Keywords: soil degradation/ wind erosion/ soil salinity
This citation is from AGRICOLA.

45. **Changes in the Water Balance with Land Modification in Southern Australia**.
Dunin, F. X.
Watershed Management on Range and Forest Lands Proceedings of the Fifth Workshop of the U.S./Australia Rangelands Panel, Boise , Idaho June 15-22, 1975, p 157-163, March 1976. 1 fig, 3 tab, 36 ref. (1976).
Keywords: hydrologic disturbance/ land modification/ Australia/ human nonwater activities/ watershed protection
Abstract: Hydrologic disturbance due to land modification in southern Australia, especially in agricultural, mountainous and forested catchments, is studied and interpreted. Loss of topsoil caused reduction of agricultural productivity. Irrigation practices increased salinity of the Murray River, Australia's largest, and resulted in major water supply problems in downstream areas. Consequent salinization of nonirrigated land has been especially damaging to agricultural production in western Australia. The most significant hydrologic effects were due to removal of trees in combination with grazing. Damage has been most pronounced in semi-arid to sub-humid environments, where degeneration has involved both erosion and salting. Early grazing management in arid regions changed overland water flow patterns and thereby, plant communities. In areas of low soil fertility and erratic rainfall, landscape was changed by sequential development of bared areas, soil detachment and crusting, followed by reduced infiltration and increased overland flow. Problems in mountain regions with regular winter snowfall and in rainfed forested areas are discussed. (Jahns-Arizona)
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46. **Channel evolution and hydrologic variations in the Colorado River Basin - Factors influencing sediment and salt loads**.
Gellis, A., Hereford, R., Schumm, S. A. and Hayes, B. R.
Journal of Hydrology 124: 317-344 (1991).
http://dx.doi.org/10.1016/0022-1694(91)90022-A
Keywords: ephemeral-stream processes/ northwestern Colorado/ erosion/ geomorphology
Abstract: Suspended-sediment and dissolved-solid (salt) loads decreased after the early 1940s in the Colorado Plateau portion of the Colorado River basin, although discharge of major rivers - the Colorado, Green and San Juan - did not change significantly. This decline followed a period of high sediment yield caused by arroyo cutting. Reduced sediment loads have previously been explained by a change in sediment sampling procedures or changes in climate, land-use and conservation practices. More recent work has revealed that both decreased sediment production and sediment storage in channels of tributary basins produced the decline of sediment and salt loads. Sediment production and sediment storage are important components of incised-channel evolution, which involves sequential channel deepening, widening and finally floodplain formation. Accordingly, the widespread arroyo incision of the late nineteenth century resulted initially in high sediment loads. Since then, loads have decreased as incised channels (arroyos) have stabilized and begun to aggrade. However, during the 1940s, a period of low peak discharges permitted vegetational colonization of the valley floors, which further reduced sediment loads and promoted channel stabilization. This explanation is supported by experimental studies and field observations. Both geomorphic and hydrologic factors contributed to sediment storage and decreased sediment and salt loads in the upper Colorado River basin.

47. **Dissolved Solids Hazards in the South Platte Basin, Vol. I: Salt Transport in the River**.
Gomez-Ferrer, R. V. and Hendricks, D. W.
Colorado Water Resources Research Institute Completion Report (1983).
http://hdl.handle.net/10217/2988
Keywords: river salinity/ total dissolved solids/ salt mass flows/ irrigation
Abstract: This work demonstrates how river salinity may be characterized, in terms of both time and space variations. Fifteen years of daily and monthly salinity and flow data have been reduced to monthly, seasonal, and annual statistical characterizations for five river stations and three tributary stations for the lower South Platte River. From these characterizations distance profiles were plotted for flow, TDS, and salt mass flows. The distance profiles and measurements of diversion flows, tributary flows, and point source discharges were the basis for a

reach by reach materials balance analysis for four reaches of the South Platte River between Henderson and Julesburg. Return flows and return salt mass flows were computed as residuals. The analysis showed that there is not a salt balance in the lower South Platte River. A net salt loss to the land of 380 tons per day occurs by irrigation. The analysis provided can be the basis for a more comprehensive materials balance model. But the results can be used to estimate the impact of new water resources developments upon the salinity regime of the lower South Platte River.
This citation is from Colorado State University.

48. **Effects of grazing on runoff and sediment yield from desert rangeland at Badger Wash in western Colorado, 1953-1973**.
Lusby, G. C.
US Geological Survey Water-Supply Paper 1532 I, 41 p. (1979).
http://pubs.er.usgs.gov/publication/wsp1532I
Keywords: range management/ grazing management/ hydrology/ runoff/ sediment transport/ soil erosion/ climatic factors
Abstract: Four different systems of livestock management were compared hydrologically during a 20-year study in western Colorado. Complete grazing exclusion resulted in a reduction in runoff of about 20% during the period 1953-65 and an additional 20% during 1966-73. During the same periods sediment yield was reduced by 35 and 28%, respectively, for a total of 63%. Recurrence intervals of annual runoff occurring on three soil types at Badger Wash are provided. The sets of data may be applied to similar soils in areas of like climate and physiography shown on accompanying maps. -from Author
© *Elsevier*

49. **Effects of grazing on the hydrology and biology of the Badger Wash Basin in western Colorado, 1953-66**.
Lusby, G. C., Reid, V. H. and Knipe, O. D.
Geological Survey Water-Supply Paper 1532-D in cooperation with USDA, Forest Service, U.S.D.I., Fish and Wildlife Service, the Bureau of Land Management, and Bureau of Reclamation., 90 p. (1971).
http://pubs.er.usgs.gov/publication/wsp1532D
Keywords: grazing/ hydrology/ watersheds/ runoff/ sediment/ erosion/ livestock exclusion/ vegetation/ small mammals
Abstract: An intensive study of the effect of grazing on the hydrologic and biotic characteristics of small drainage basins on the Colorado Plateau was begun on the fall of 1953. This report presents data obtained during the first 13 years of the proposed 20-years study. For the period of record 1954-66, runoff from grazed watersheds has averaged about 33 acre-feet per square mile per year. Runoff from ungrazed watersheds averaged from 71 to 76 percent of that from grazed watersheds. During the last 6 years of the period, however, ungrazed watersheds produced 69 to 71 percent as much runoff as grazed watersheds. The sediment yield from grazed watershed during the same period was about 3 acre-feet per square mile per year. Sediment yield from ungrazed watersheds ranged from 51 to 75 percent of that from grazed watersheds and averaged 66 percent. The largest change in these relations occurred about 2 years after livestock were excluded from certain watersheds. The causative factors for changes in the runoff and sediment yield relations are not entirely clear. At the end of 13 years, a significant change had occurred in the amount of bare soil and rock, in the ground-cover index, and in the litter and moss of the grazed watersheds. These items remained essentially unchanged on ungrazed watersheds. The changes in ground-cover factors were not of large magnitude and did not occur at the same rate as the changes of runoff and sediment yield. A large part of the difference appears to have been caused by a change in the structure of surface soil, which was brought about by the elimination of trampling by livestock. Deer mice were the most common rodent present on the experimental watersheds, but even their population was not great enough to affect the composition of range vegetation. Deer mice populations remained comparable on grazed and ungrazed watersheds during the study. Other rodents were not present in sufficient numbers to allow their comparison on grazed and ungrazed range. Desert cottontail rabbits and black-tailed jackrabbits were more plentiful in ungrazed watersheds but were not present in large enough numbers to affect range vegetation.

50. **Effects of gully plugs and contour furrows on erosion and sedimentation in Cisco Basin, Utah**.
Gifford, G. F., Thomas, D. B., Coltharp, G. B. and Coltharp, B.
Journal of Range Management
30: 290-292 (1977).
https://journals.uair.arizona.edu/index.php/jrm/article/view/6730/6340
Keywords: erosion control/ sedimentation/ surface runoff/ Utah/ gully erosion/ watershed management/ basins/ soil stabilization/ Colorado River Basin/ contour furrows/ gully plugs/ Cisco Basin (Utah)
Abstract: The effects of contour furrows and gully plugs on erosion and sedimentation within the Cisco Basin, Utah, were evaluated. Soils studied were less than 10 cm deep and had developed from Mancos shale and sandstone. When combined, contour furrows and gully plugs held all runoff and sediment. Contour furrows alone were only able to hold a portion of the runoff and sediment. Expected life of the contour furrows ranges from 6 to 12 years, while that of the gully plugs is from 14 to 33 years. (Castricone-Arizona)
This citation is from the University of Arizona Institutional Repository.

51. **Effects of gully plugs and contour furrows on the soil moisture regime in the Cisco Basin, Utah**.
Gifford, G. F., Hancock, V. B. and Coltharp, G. B.
Journal of Range Management 31: 293-295 (1978). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/6846/6456
Keywords: soil water/ tillage/ furrows/ sod plugs/ runoff/ soil erosion/ erosion control/ soil salinity/ saline soils
Abstract: Soil moisture patterns in and around gully plugs and contour furrows constructed on Mancos shale-derived soils in Cisco Basin, Utah, were studied from December of 1965 through December of 1966. Preliminary studies were initiated during the summer and fall of 1965. Results of monthly measurements indicate increased moisture storage immediately beneath treatment depressions, but minimal lateral movement. Results of this study, and others, suggest that treatments of this type on Mancos shale will function primarily to collect runoff, sediment, and possibly associated salts and that increased vegetal production is not a logical expectation.
This citation is from the University of Arizona Institutional Repository.

52. **Environmental effects of off-road vehicles: Impacts and management in arid regions**.
Webb, R. H. and Wilshire, H. G.
Book. Springer-Verlag. New York (1983).
Keywords: off-road/ off-highway/ compaction/ water erosion/ wind erosion/ vegetation/ ORV/ OHV

53. **Experience in accelerated irreversible desalinization of soils in Golodnaya Steppe**.
Bobchenko, V. E. and Sydko, A. A.
Transactions of the 9th International Congress of Soil Science 1: 443-453 (1968).
Keywords: conservation/ agriculture/ soil salinity
Abstract: Soil research was performed in the Golodnaya Steppe, USSR, to determine effective measures for accelerated irreversible desalinization of the virgin lands now being developed. Soils containing up to 1% toxic salts and having a seepage factor of 2-4 m/day were desalted by drainage and leaching at the rate of 8,200-71,000 cu m/ha (gross). The soils were desalinized to a depth of 0.7-9.5 m during 1-5 mo; the amount of unleached toxic salts within this depth was below the damaging limit. Increasing the leaching rate results in an increase in the amount of water that must be delivered for each consequent unit of salt removal and delays the progress of land reclamation, making capital investments less profitable. Application of very high leaching rates is economically unfeasible. Very low leaching rates are economically unfeasible because they do not provide for sufficient soil desalinization nor for beneficial crop yields. Measures are recommended for preventing secondary salinization of the leached soils and further desalinization in the lower horizons. At high rates, leaching during rice cultivation provides for deep desalinization of soil and quick repayment of capital investments. (USBR)
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54. **Hydrologic impacts of sheep grazing on steep slopes in semiarid rangelands**.
Wilcox, B. P. and Wood, M. K.
Journal of Range Management 41: 303-306 (1988). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8265/7877
Keywords: rangelands/ semi-arid soils/ grazing lands/ hydrogeology/ soil water
Abstract: Infiltration, sediment concentration of runoff and sediment production from lightly grazed and ungrazed semiarid slopes were compared using a band-portable rainfall simulator. The study slope was located in the Guadalupe Mountain of southeastern New Mexico. Average slope steepness was 50%. The objective of this study was to determine the impacts of light grazing by sheep (10 ha/AU) on steep slope infiltrability and sediment production. Infiltrability on the grazed slopes WM 12-1796 lower than on the ungrazed slopes. These results are comparable to what has been reported from moderate slope gradients. Sediment concentration of runoff from the lightly grazed slopes was significantly higher than from the ungrazed slopes only at the end of the dry run (45 min). Sediment production was significantly greater from the grazed slopes for the dry run, but not the wet run. Percentage difference of sediment production between the grazed and ungrazed slopes was well within the range published for moderate slope conditions. These data give no indication that steep slopes (30-70%) in semiarid regions are any more hydrologically sensitive to light grazing than are moderate slopes (<10%).
This citation is from the University of Arizona Institutional Repository.

55. **Hydrologic responses of a montane riparian ecosystem following cattle use**.
Flenniken, M., Mceldowney, R. R., Leininger, W. C., Frasier, G. W. and Trlica, M. J.
Journal of Range Management 54: 567-574 (2001). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/9656/9268
Keywords: riparian areas/ ecosystems/ hydrology/ grazing management/ range management/ rangelands/ watersheds/ runoff
Abstract: Riparian areas link streams with their terrestrial catchments and decrease water pollution by trapping sediments from upland sources before they reach streams or lakes. Livestock grazing in riparian areas is a controversial practice. If not properly managed, cattle can cause degradation to both the riparian zone and adjacent water body. Vegetative, soil microtopographical, microchannel and hydrograph parameters were measured in a montane riparian community in northern Colorado to quantify the effects of cattle on overland flow and runoff characteristics. Treatments were cattle grazing plus trampling, cattle trampling, mowing, and a control. Water was applied to plots (3 m × 10 m) at a rate of 100 mm hr-1 using a rainfall simulator. Concurrently, overland flow was introduced at the upper end of the plots at an equivalent rate of 25 mm hr-1 . A high intensity-short duration grazing treatment was used for the cattle-treated plots. Reduction in vegetation stem density and aboveground biomass by cattle decreased microchannel sinuosity and drainage density. Cattle-treated plots had greater flow velocities and depths in microchannels compared with mowed and control plots. Reduced stem density and aboveground biomass by grazing left fewer obstacles to divert flows, which decreased microchannel sinuosity and drainage density. Flows were concentrated into fewer microchannels with deeper flows. Microchannel characteristics were not significant factors affecting total runoff. Stem density and rainfall intensity were the most important factors in predicting runoff characteristics and total runoff. Results from this study have improved our understanding of flow and runoff processes following cattle use of a riparian ecosystem.
This citation is from the University of Arizona Institutional Repository.

56. **Implications of deep drainage through saline clay for groundwater recharge and sustainable cropping in a semi-arid catchment, Australia**.
Timms, W. A., Young, R. R. and Huth, N.
Hydrology and Earth System Sciences 16: 1203-1219 (2012). ISSN: 1027-5606
http://dx.doi.org/10.5194/hess-16-1203-2012
Keywords: catchment area/ resource management/ sustainable development/ rainfall/ Australia/ Murray-Darling Basin/ freshwater/ clays/ potential evapotranspiration/ soil/ computer programs/ groundwater recharge/catchment basins/ soil properties/ water resources and supplies/ hydrologic analysis/ leaching/ drainage/ river discharge/ vegetation/ runoff/ evapotranspiration/ precipitation/ water balance/ salts/ flood plains

Abstract: The magnitude and timing of deep drainage and salt leaching through clay soils is a critical issue for dryland agriculture in semi-arid regions (2000 mm yr super(-1)) such as parts of Australia's Murray-Darling Basin (MDB). In this rare study, hydrogeological measurements and estimations of the historic water balance of crops grown on overlying Grey Vertosols were combined to estimate the contribution of deep drainage below crop roots to recharge and salinization of shallow groundwater. Soil sampling at two sites on the alluvial flood plain of the Lower Namoi catchment revealed significant peaks in chloride concentrations at 0.8-1.2 m depth under perennial vegetation and at 2.0-2.5 m depth under continuous cropping indicating deep drainage and salt leaching since conversion to cropping. Total salt loads of 91-229 t ha super(-1) NaCl equivalent were measured for perennial vegetation and cropping, with salinity to greater than or equal to 10 m depth that was not detected by shallow soil surveys. Groundwater salinity varied spatially from 910 to 2430 mS m super(-1) at 21 to 37 m depth (N = 5), whereas deeper groundwater was less saline (290 mS m super(-1)) with use restricted to livestock and rural domestic supplies in this area. The Agricultural Production Systems Simulator (APSIM) software package predicted deep drainage of 3.3-9.5 mm yr super(-1) (0.7-2.1% rainfall) based on site records of grain yields, rainfall, salt leaching and soil properties. Predicted deep drainage was highly episodic, dependent on rainfall and antecedent soil water content, and over a 39 yr period was restricted mainly to the record wet winter of 1998. During the study period, groundwater levels were unresponsive to major rainfall events (70 and 190 mm total), and most piezometers at about 18 m depth remained dry. In this area, at this time, recharge appears to be negligible due to low rainfall and large potential evapotranspiration, transient hydrological conditions after changes in land use and a thick clay dominated vadose zone. This is in contrast to regional groundwater modelling that assumes annual recharge of 0.5% of rainfall. Importantly, it was found that leaching from episodic deep drainage could not cause discharge of saline groundwater in the area, since the water table was several meters below the incised river bed.
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57. **Infiltration rates and sediment production following herbicide/fire brush treatments**.
Knight, R. W., Blackburn, W. H. and Scifres, C. J.
Journal of Range Management 36: 154-157 (1983). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7492/7104
Keywords: infiltration (hydrology)/ herbicides/ brush control/ prescribed burning/ sediment transport/ soil transport processes
This citation is from the University of Arizona Institutional Repository.

58. **Influence of a polyacrylamide soil conditioner on runoff generation and soil-erosion - field-tests in Baringo District, Kenya**.
Fox, D. and Bryan, R. B.
Soil Technology 5: 101-119 (1992).
http://dx.doi.org/10.1016/0933-3630(92)90012-P
Keywords: polyacrylamide/ soil conditioners/ soil erosion/ erosion control/ runoff/ infiltration (hydrology)/ disturbed soils
Abstract: Following promising laboratory results the effect of low concentration applications of a polyacrylamide soil conditioner SEPARAN AP30 on soil properties was tested under field conditions in a severely degraded semi-arid region in northern Kenya. Tests of conditioner performance on tilled and undisturbed soils were carried out under simulated rainfall on crusting Eutric or Calcaric Fluvisols at two sites on alluvio-lacustrine flats adjacent to Lake Baringo. Tests were carried out in two series separated by up to six weeks of sunshine and natural rainfall, to determine the longevity and residual effects of conditioner application. Runoff generation and soil loss were significantly reduced on all runoff plots during the first rainfall simulation, but the most dramatic results occurred when conditioner application was combined with raking. This inhibited crust development and virtually eliminated runoff and soil loss, under natural weathering, surface crusts had developed on all plots before the second rainfall simulations. Some residual effects of the conditioner on infiltration rates were still noted, but the residual effect on soil loss was greatly diminished. The tests indicate that low concentration applications of SEPARAN

are not useful on undisturbed soils, but can provide useful temporary reductions in sheet and rill wash hazard when combined with tillage and could be effectively combined with grass re-seeding for more permanent reclamation.

59. **The influence of livestock trampling under intensive rotation grazing on soil hydrologic characteristics**.
Warren, S. D., Thurow, T. L., Blackburn, W. H. and Garza, N. E.
Journal of Range Management 39: 491-495 (1986). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8049/7661
Keywords: grazing management/ disturbed soils/ soil erosion/ trampling damage/ rotational grazing/ range management/ soil compaction
Abstract: Infiltration rate decreased significantly and sediment production increased significantly on a site with a silty clay surface soil devoid of vegetation following periodic trampling typical of intensive rotation grazing systems. The deleterious impact of livestock trampling generally increased as stocking rate increased. Damage was augmented when the soil was moist at the time of trampling. Thirty days of rest were insufficient to allow hydrologic recovery. Soil bulk density, aggregate stability, aggregate size distribution and surface microrelief were related to the soil hydrologic response of the trampling treatments.
This citation is from the University of Arizona Institutional Repository.

60. **Is short-duration grazing the answer?**
Pieper, R. D. and Heitschmidt, R. K.
Journal of Soil and Water Conservation 43: 133-137 (1988). ISSN: 0022-4561
Keywords: grazing management/ grazing intensity/ range management/ water quality/ conservation practices/ soil erosion/ erosion control
This citation is from the Soil and Water Conservation Society.

61. **Overwinter Soil Water Recharge and Herbage Production as Influenced by Contour Furrowing on Eastern Montana Rangelands**.
Neff, E. L. and Wight, J. R.
Journal of Range Management 30: 193-195 (1977).
https://journals.uair.arizona.edu/index.php/jrm/article/view/6703/6313
Keywords: soil water recharge/ contour furrows/ runoff/ snow accumulation/ herbage production
Abstract: Highlight: On fine-textured range sites in southeastern Montana, contour furrowing increased average overwinter soil water recharge 11 mm on a saline-upland range site and 39 mm on a panspot range site. Increased recharge resulted from decreased late fall and early spring runoff and increased snow accumulation. Overwinter recharge was a function of both antecedent soil water and the amount of water available for recharge. Herbage production was significantly (r = 0.89) related to spring soil water content.
This citation is from the University of Arizona Institutional Repository.

62. **Preclearing hydrology of the Western Australia wheatbelt: Target for the future?**
See record 21 in Rangeland Management Practices and Potential Impact on Salinity.

63. **Processes of accelerated pluvial erosion on desert hillslopes modified by vehicular traffic**.
Iverson, R. M.
Earth Surface Processes 5: 369-388 (1980).
http://dx.doi.org/10.1002/esp.3760050407
Keywords: accelerated pluvial erosion/ hillslopes/ off-road vehicles/ deserts/ runoff hydraulics/ sediment transport/ kinematic routing
Abstract: Accelerated pluvial erosion on hillslopes modified by off-road vehicles (ORVs) is analysed using results from 50 rainfall simulation experiments conducted in teh Mojave Desert, California. Sediment yield from 1m2 hillslope plots subjected to intense, 20-minute rainfalls is typically increased 10 to 20-fold following ORV use. Salient effects of vehicle traffic, which reduce infiltration, increase runoff sediment transport efficiency, and enhance gully formation, are further studied by combining simple theoretical relations with experimental data. This analysis helps identify factors controlling erosion on natural desert hillslopes, as well as those used by ORVs. Erosion of natural or vehicle-used desert surfaces is heavily influenced by runoff hydraulics. Calculated Darcy-Weisbach friction factors decrease by an average of 13-fold following vehicular slope modification, whereas runoff Reynolds numbers increase by an average of 5.5 fold. The capacity of overland flow to transport sediment is related to runoff power and

its degree of localization, which usually increase considerably following ORV activity; however, the ability of overland flow to move large grains (competency) is related to a combination of factors not always systematically influenced by ORV use. Kinematic runoff routing, which is used to extrapolate experimental results to longer slope lengths, leads to the suggestion that the hydraulic roughness of desert hillslopes strongly influences their erosional behaviour.
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64. **Range Claypan Soil Improvement: Properties Affecting Their Response to Mechanical Treatment**.
White, E. M. and Gartner, F. R.
Journal of Range Management 34: 116-119 (1981). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7147/6759
Keywords: soil properties/ land treatments/ contour furrows/ claypans
Abstract: Improvement efforts for claypan range sites by mechanical treatment can be grouped into those that increase water infiltration, disrupt the exchangeable-Na-rich claypan layer, mix the claypan layer with other layers, or combinations of treatments. The beneficial effect of a treatment on range productivity depends mainly on the specific soil characteristics or adapting the treatment to the soil. Spacings between contour furrows, ripper teeth, or similar devices probably should coincide with the distance between large natural soil structure boundaries for maximum lasting effects.
This citation is from the University of Arizona Institutional Repository.

65. **Range claypan soil improvement: response from furrowing and ripping in northwestern South Dakota**.
White, E. M., Gartner, F. R. and Butterfield, R.
Journal of Range Management 34: 119-125 (1981). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7148/6760
Keywords: land treatments/ claypans/ contour furrows/ ripping/ infiltration/ herbage production
Abstract: Ripping and furrowing increased water infiltration and herbage production on some claypan range soils for 4 to 13 years. Infiltrating water in the ripped or furrowed soil zones redistributed extractable Na and salt toward the soils between the disturbed soil zones. This distribution of the water probably accelerates natural soil processes and will give long term increased forage production on nonsaline sodic soils.
This citation is from the University of Arizona Institutional Repository.

66. **Range waterspreading as a range improvement practice**.
Pierson, R. K.
Journal of Range Management 8: 155-158 (1955). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/4670/4281
Keywords: waterspreading/ conservation practices/ rangeland management/ forage production/ grazing/ soil salinity/ saline water
Abstract: Range waterspreading is a multiple-purpose conservation practice of limited application due to the specific requirements of land and water. It is a desirable range improvement practice from the standpoint of forage production since highly productive valley lands can be restored to a key position in grazing use. Waterspreading areas must become integral parts of general range management plans and receive intensive management practices to maintain a high level of productivity. As a range improvement practice, waterspreading is a paying proposition in the production of an increased forage supply. To insure success all of the physical factors of the site must be carefully studied before an attempt is made to install a waterspreading system. An important factor is water quality. All too frequently, runoff from western rangeland carries with it a quantity of dissolved salts which, if allowed to drain into normal water courses, would be carried down to larger streams and rivers and ultimately to the sea. When trapped in waterspreading systems, the salts permeate the soil and add to a zone already high in salt content, or are carried back to the surface again by capillarity. The same problems in handling excessive salts in agricultural irrigation are common to range waterspreading, although not in the same degree because of the smaller volume of water applied. If there is a suspicion of high salt content in the water supply for spreading, ultimate failure and monetary loss can be avoided by laboratory analysis of water

quality. Unless soil permeability and internal drainage are especially favorable, water of high salt content should not be used.
This citation is from the University of Arizona Institutional Repository.

67. **Salinity control on BLM-administered public lands in the Colorado River basin: A report to Congress**.
See record 28 in Rangeland Management Practices and Potential Impact on Salinity.

68. **Salt leaching and the effect of gypsum application in a saline-sodic soil**.
Khosla, B. K., Gupta, R. K. and Abrol, I. P.
Agricultural Water Management 2(3): 193-202 (1979). ISSN: 0378-3774
http://dx.doi.org/10.1016/0378-3774(79)90002-7
Keywords: soil salts/ soil salinity/ gypsum/ leaching
Abstract: Field leaching studies in representative mixed Hyperthermic Salic Calciorthids showed that for 80% reduction in profile salinity, 0.4 cm leaching water/cm soil depth was required to be passed through the soil. This corresponded to 1.14 pore volume displacement. From four different predictive models, Burns' model, which is theoretically based and requires knowledge of simple parameters, was found to be highly predictive. Dieleman's empirical relationship also adequately described field leaching data. Desalinization of the profile was accompanied by simultaneous reduction in the SAR of the soil solution. When leached in the presence of gypsum, the SAR was reduced to a greater extent in lower depths which would otherwise have been achieved by passing additional quantities of water. Results have been discussed in view of the possible need or otherwise of amendments during reclamation of soils having excess neutral salts and a high SAR of soil solution (saline-sodic soils).
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69. **Salt-release from suspended sediments in the Colorado River basin**.
Nezafati, H., Bowles, D. S., Riley, J. P. and Rogers, J. R.
Water Forum 1981: 1327-1334 (1981).
Keywords: electrical conductivity/ chemically precipitated rocks/ Price River/ Colorado River basin/ rivers and streams/ watersheds/ suspended materials/ salinity/ evaporites/ sedimentary rocks/ western United States/ sediment/ hydrogeology/ salts
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70. **Snow Trapping by Contour Furrows in Southeastern Montana**.
Neff, E. L.
Journal of Range Management
33: 221--223 (1980).
https://journals.uair.arizona.edu/index.php/jrm/article/view/7053/6665
Keywords: contour furrows/ snow accumulation/ snowmelt/ runoff/ precipitation
Abstract: Contour furrows on fine-textured range sites in southeastern Montana caught an annual average of 22 mm more snow equivalent than nearby nonfurrowed areas. In addition, the furrows held snowmelt onsite in the spring and significantly reduced winter runoff in nearly half of the years of record. Except in years of much below normal winter precipitation, however, the winter runoff from furrowed areas was still more than adequate to fill well- designed stockponds.
This citation is from the University of Arizona Institutional Repository.

71. **Soil and water salinity in Queensland: the prospect of ecological sustainability through the implementation of land clearing policy**.
See record 33 in Rangeland Management Practices and Potential Impact on Salinity.

72. **Soil changes caused by erosion control treatments on a salt desert area**.
See record 34 in Rangeland Management Practices and Potential Impact on Salinity.

73. **Soil chloride and deep drainage responses to land clearing for cropping at seven sites in central Queensland, northern Australia**.
Radford, B. J., Silburn, D. M. and Forster, B. A.
Journal of Hydrology 379: 20-29 (2009). ISSN: 0022-1694
http://dx.doi.org/10.1016/j.jhydrol.2009.09.040
Keywords: dryland cropping/ native vegetation/ cracking clays/ transient chloride mass balance/ Fitzroy Basin/ salinity
Abstract: Summary Soil cores were taken at seven paired sites (native vegetation and adjacent dryland cropping on cracking clay soils)

which had been cropped for 10–65 years in the Fitzroy Basin in central Queensland, northern Australia. Levels of soil chloride (Cl^-) and nitrate nitrogen (NO3–N) were determined in 0.3 m increments to a depth of 5 m where possible. The amounts of Cl^- in the soil (0–1.5 m depth) under native vegetation were generally high (10–23 t ha^{-1} at six of the seven sites). The amounts of Cl^- that had leached below 1.5 m depth during dryland cropping varied from 2.2 to 16.8 t ha^{-1} or 19–91% of the original totals at 0–1.5 m. Leaching of salt from the crop rooting zone in combination with higher rates of deep drainage can lead to outbreaks of soil salinisation but can also increase the soil plant available water capacity (PAWC). NO3–N had also been leached below crop rooting depth at three sites. Such leaching not only contaminates the groundwater but also wastes crop nutrients. The transient chloride mass balance approach was used to determine mean annual rates of deep drainage below crop rooting depth (1.5 m). At all seven sites annual deep drainage was low under native vegetation (0.2–1.7 mm yr^{-1}) but increased under dryland cropping (1.6–27.5 mm yr^{-1}). Drainage losses showed an inverse relationship with plant available water content (PAWC). Drainage losses waste the limited supply of water available for dryland cropping but can be reduced by practising opportunity cropping or by growing ley (temporary) pastures in rotation with annual crops.
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74. **Soil moisture patterns on two chained pinyon-juniper sites in Utah**.
Gifford, G. F. and Shaw, C. B.
Journal of Range Management 26: 436-440 (1973). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/6257/5867
Keywords: soil moisture/ chaining/ microclimates/ vegetation density/ deep seepage
Abstract: Soil moisture patterns were studied under chaining-with-windrowing, chaining-with-debris-in-place, and natural woodland at one site each in both southwestern and southeastern Utah. Results of the study indicate the greatest moisture accumulation occurred under the debris-in-place treatment (as compared to woodland controls), during the first 6 months of each year at Milford and regardless of season at Blanding. The woodland had the least soil moisture throughout most of each year. Most moisture flux took place in the upper 60- to 90-cm of soil profile, with only minor changes occurring at greater depths. Differences in soil moisture patterns have been attributed to changes in microclimates due to chaining, different rooting depths and length of growing season, mulching effect of litter on the debris-in-place treatment, and possible differences in snow accumulation. Variation in vegetation density on the chained treatments did not influence soil moisture patterns. There was no evidence of deep seepage on any chaining treatment at either site.
This citation is from the University of Arizona Institutional Repository.

75. **Solute displacement in a silt loam soil as affected by the method of water application under different evaporation rates**.
Minhas, P. S. and Khosla, B. K.
Agricultural Water Management 12: 63-74 (1986). ISSN: 0378-3774
http://dx.doi.org/10.1016/0378-3774(86)90006-5
Keywords: evaporation rate/ soil transport processes/ salinity/ leaching
Abstract: To study the displacement and redistribution of surface applied salts as affected by continuous and intermittent ponding, three separate experiments were conducted on a silt loam soil during periods of varying atmospheric evaporativity. The USWB class A pan values during the successive study periods averaged 1.52, 7.74 and 4.51 mm/day and a total of 15, 22.5 and 40 cm water was used for leaching, respectively. In the case of intermittent ponding, water was applied at 10-day intervals in equal splits of 7.5 or 10 cm depth. No difference in leaching of chloride was observed when the same amount of water was applied continuously or intermittently during the periods of high (7.74 mm/day) and medium (4.51 mm/day) evaporation rates. However, when evaporation at the surface was prevented or remained low (1.52 mm/day), distinctly greater amounts of chloride were removed from the soil and the salt peak was displaced deeper under intermittent as compared to continuous ponding. Preferential movement of water through macropores in relation to micropores during leaching resulted in low mobility of surface applied chloride relative to that of water.
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76. **Succession of secondary shrubs on Ashe juniper communities after dozing and prescribed burning**.
Rasmussen, G. A. and Wright, H. A.
Journal of Range Management 42: 295-298 (1989). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8385/7997
Keywords: Juniperus ashei/ Rhus lanceolata/ Quercus spp./ soil series/ topography/ prescribed fire/ dozing/ plant succession/ brush control
Abstract: Secondary brush species (found as minor components of the climax community and those from lower seral stages) have increased after most prescribed burns on the Edwards Plateau of Texas. Originally, most of this area was dominated by Ashe juniper (*Juniperus ashei*). Line and belt transects were used to estimate brush canopy cover and density on 4 soil series located on 5 topographical positions in untreated, tree dozed, and tree dozed plus prescribed burn areas. Total canopy cover and density were not correlated with time following dozing (13, 16, or 18 years) or burning (8, 9, 10, 12, 13, or 14 years). Recovery of brush canopy cover to untreated levels was dependent on the topographical location and treatment. Total brush canopy cover was not different (P≤0.05) among untreated, dozed, and dozed plus burned treatments on the Speck soil series occurring on the plateau tops. However, brush canopy cover was reduced by burning on soil series occurring on the sideslopes (Oplin and Brackett variant series) and drainages. Species composition was altered with Ashe juniper being reduced approximately 80% on dozed plus burned areas. Flameleaf sumac did not occur on untreated areas but comprised an average of 38% of the woody cover on all burned areas. Other secondary brush species increased, the amount depending on the topographical position. Future management may have to include spot treatment on upland soil series where secondary brush species quickly increase.
This citation is from the University of Arizona Institutional Repository.

77. **Successional trends in Sonoran Desert abandoned agricultural fields in northern Mexico**.
Castellanos, A. E., Martinez, M. J., Llano, J. M., Halvorson, W. L., Espiricueta, M. and Espejel, I.
Journal of Arid Environments 60: 437-455 (2005). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2004.06.004
Keywords: desert succession/ abandoned fields/ water use efficiency/ nitrogen use efficiency/ photosynthesis/ Sonoran Desert/ salinized fields
Abstract: Excessive ground-water use and saline intrusion to the aquifer led, in less than three decades, to an increase in abandoned agricultural fields at La Costa de Hermosillo, within the Sonoran Desert. Using a chronosequence from years since abandonment, patterns of field succession were developed. Contrary to most desert literature, species replacement was found, both in fields with and without saline intrusion. Seasonal photosynthetic capacity as well as water and nitrogen use efficiencies were different in dominant early and late successional plant species. These ecological findings provided a framework for a general explanation of species dominance and replacement within abandoned agricultural fields in the Sonoran Desert.
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78. **Surface-water salinity in the Gunnison River Basin, Colorado, water years 1989 through 2007**.
See record 37 in Rangeland Management Practices and Potential Impact on Salinity.

79. **Vegetation response to contour furrowing**.
See record 42 in Rangeland Management Practices and Potential Impact on Salinity.

80. **Waterponding: Reclamation technique for scalded duplex soils in western New South Wales rangelands**.
Thompson, R.
Ecological Management & Restoration 9: 170-181 (2008). ISSN: 1442-8903
http://dx.doi.org/10.1111/j.1442-8903.2008.00415.x
Keywords: Chenopod shrubland/ revegetation/ roadgrader construction
Abstract: Summary: Building on previous trials initiated in the 1960s, a demonstration programme involving 18 landholders was established at Nyngan, New South Wales Australia; in the mid-1980s to refine 'waterponding' techniques used to rehabilitate scalded claypans. The waterponding technique involves building horseshoe shaped banks (about 240 m in length) to create ponds of about

0.4 ha each. Each pond retains up to 10 cm of water after rain which leaches soluble salts from the scald surface. This improves the remaining soil structure, inducing surface cracking, better water penetration and allows entrapment of wind-blown seed. Consequently, niches are formed for the germination of this (and any sown) seed and recovery of a range of chenopod native pasture species occurs on the sites, which can be supplemented by direct seeding. What started as a project continues now as a standard rangeland rehabilitation process for reclaiming bare, scalded semi-arid areas of New South Wales and turning them back into biodiverse and productive rangelands. Since 1985, further modifications have been made to the method and the ongoing programme has surveyed, marked out and built approximately 56 700 waterponds within the Marra Creek waterponding district.

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81. **Influence of vegetation cover on sand transport by wind: field studies at Owens Lake, California**.
Lancaster, N. and Baas, A.
Earth Surface Processes and Landforms 23: 69-82 (1998).
http://dx.doi.org/10.1002/(SICI)1096-9837(199801)23:1<69::AID-ESP823>3.0.CO;2-G
Keywords: wind erosion/ sand transport/ vegetation cover/ saltation threshold
Abstract: Field studies conducted at Owens Lake, California, provide direct measurements of sand flux on sand sheets with zero to 20 per cent cover of salt grass. Results from 12 different sand transport events show that aerodynamic roughness length and threshold wind shear velocity increase with vegetation cover as measured by vertically projected cover and roughness density (λ). This results in a negative exponential decrease in sediment flux with increasing vegetation cover such that sand transport is effectively eliminated when the vertically projected cover of salt grass is greater than 15 per cent. A general empirical model for the relation between sand flux and vegetation cover has been derived and can be used to predict the amount of vegetation required to stabilize sand dune areas. © 1998 John Wiley & Sons, Ltd.

82. **Management effects on wind-eroded sediment and plant nutrients**.
Zobeck, T. M., Fryrear, D. W. and Pettit, R. D.
Journal of Soil and Water Conservation 44: 160-163 (1989).
Keywords: wind erosion/ soil erosion/ soil nutrients/ plant micronutrients/ range management/ eolian deposits
Abstract: The following five land management practices were evaluated on a Brownfield fine sand (loamy, mixed, thermo Arenic Aridic Paleustalf) to determine their effects on windblown sediment and plant nutrients: shiner oak (*Quercus havardii*) rangeland with 12,400 kg/ha (11,060 pounds/acre) surface residue, a burned rangeland site with 800 kg/ha (71.5 pounds/acre) residue, a cleaned-till abandoned field with 1,600 kg/ha (1,430 pounds/ acre) residue, a clean-tilled field with 500 kgh (446 pounds/acre) residue, and a herbicide-treated rangeland with 4,400 kg/ha (3,925 pounds/acre) residue. The clean-tilled practice produced the greatest amount of windblown sediment, followed by the burned, abandoned, herbicide, and undisturbed treatments, respectively. The selectivity of the erosion process for certain soil nutrients was evaluated by comparing the nutrient levels in the sediment to that of the original surface. Levels of sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), action exchange capacity, and organic matter for relatively bare treatments generally were lower than for treatments with greater amounts of seduce residue and increased with height above the soil surface. Comparisons of total nutrients or organic matter in the windblown sediment showed great differences among treatments and nutrients. Organic mutter collected on the burned treatment, for example, was 81 times that collected on the abandoned field. Cation exchange capacity of the burned site was 48 times that collected on the abandoned field. These results demonstrate the selective removal of plant nutrients in wind-eroded sediment and show the relative rate of removal to be dependent upon management practice.

83. **Salinity control on BLM-administered public lands in the Colorado River basin: A report to Congress**.
See record 28 in Rangeland Management Practices and Potential Impact on Salinity.

84. **Timing of recharge, and the origin, evolution and distribution of solutes in a hyperarid aquifer system**.
Wood, W. W., Rizk, Z. S. and Alsharhan, A. S.
Developments in Water Science. Abdulrahman, S. A. and Warren, W. W., Elsevier. Volume 50**:** 295-312 (2003).
http://dx.doi.org/10.1016/S0167-5648(03)80026-6
Keywords: aquifers/ recharge/ arid regions/ solute transport
Abstract: Examination of an aquifer system in the Liwa Crescent/Bu Hasa area of the Emirate of Abu Dhabi on the southeastern edge of the Rub al Khali, Arabian sub-continent, provides insight into the timing of ground-water recharge and the origin and evolution of solutes in a

representative hyperarid area. Ground-water flow in the aquifer system is radially outward from the center of two ground-water mounds, corresponding to two 110 m-thick sand deposits. The isotopic data from ancient ground waters from the Liwa Oasis with its unusual “d” (deuterium excess) of approximately -15 indicate that Holocene moisture derived from previously evaporated water on the surface of the Indian Ocean rather than from the Mediterranean/ Arabian Gulf. Such a source is consistent with a summer monsoonal circulation. Hydraulic heads in underlying aquifers are lower than those of the Liwa/Bu Hasa aquifer; thus, there is no advective water or solute input from these lower units. Solute diffusion from underlying aquifers provides a small solute flux, but it is inadequate to account for the observed solute mass, nor is the ionic ratio consistent with this source. There are no laterally adjacent aquifers; thus, there is no influx of solutes from these sources. Dissolution of the aquifer framework provides for only a minor fraction of most of the observed solutes. Most solutes in this aquifer system are derived from atmospheric precipitation. Salts contained in rain were stored on the surface and in the unsaturated zone during the hyperarid time interval between the ends of the Pleistocene recharge event (26,000 years BP) and the beginning of the Holocene recharge (9000 years BP). During the Holocene recharge era (9000 to 6000 years BP), these stored salts were mobilized and transported to the ground water. The initial solute distribution has been slightly modified as the solutes and water were transported along the flow path. As ground water moves away from the apex of the mound, it encounters a series of interdunal sabkhat. Water is evaporated from the sabkhat leaving soluble chloride and nitrate minerals on the surface and retrograde carbonate and sulfate minerals in the unsaturated zone. When recharge occurs through the interdunal sabkhat, which are the only areas of recharge in the aquifer, soluble salts on the surface, modern 14C, and tritium are added to the aquifer, aquifer because the density of the recharged water is greater than the density of the ground water in this nearly homogenous and isotropic aquifer. Relatively insoluble carbonate and sulfate minerals are retained in the unsaturated zone of the interdunal sabkhat, causing a change in the solute ratios downgradient. Only the portion of the aquifer not associated with interdunal sabkhat retains the original solute composition determined by mobilization of stored salts. These findings, although specific to this aquifer, provide a useful model by which to evaluate other aquifer systems in hyperarid environments.

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85. **Effects of Agroforestry-Pasture Associations on Groundwater Level and Salinity**.
Bari, M. A. and Schofield, N. J.
Agroforestry Systems 16(1): 13-31 (1991).
http://dx.doi.org/10.1007/BF00053194
Keywords: stream salinization/ land salinization/ groundwater/ human nonwater activities/ water use/ impaired water quality
Abstract: Stream and land salinization brought about by rising groundwater levels due to the clearing of native forest for agricultural development is a major environmental and resource problem in Western Australia and several other semi-arid regions of the world. One potential approach to reclamation with simultaneous economic benefits is agroforestry. To determine the effects of agroforestry on groundwater level and salinity, two experiments were carried out in Western Australia. In Experiment I a pinus-pasture agroforestry covering 58% of the cleared area with final stem densities of 75-225 stems/ha was successful in lowering a saline groundwater table. Over the period 1979-1989, groundwater levels declined by 1.0 m relative in groundwater levels beneath a nearby pasture site. In Experiment II the eucalyptus-pasture agroforestry covering 57% of farmland at a final density of 150-625 stems/ha was found to successfully lower the yearly minimum groundwater level by 2.0 m relative to a pasture site over seven years. The salinity of the groundwater beneath agroforestry decreased by 9% for Experiment I and 6% for Experiment II, respectively, which was contrary to some early expectations. The design of agroforestry for controlling saline groundwater tables needs further evaluation with respect to species, stem densities and proportion of cleared area planted. (Author's abstract) 55 23 Dec 91
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86. **Hydrologic characteristics of vegetation types as affected by livestock grazing systems, Edwards Plateau, Texas**.
Thurow, T. L., Blackburn, W. H. and Taylor Jr, C. A.
Journal of Range Management 39: 505-509 (1986). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8052/7664
Keywords: grazing management/ range management/ hydrology/ vegetation types/ runoff/ soil erosion
This citation is from the University of Arizona Institutional Repository.

87. **The impact of contour furrowing on chenopod patterned ground at Fowlers Gap, western New South Wales**.
Macdonald, B. C. T. and Melville, M. D.
Journal of Arid Environments 41: 345-357 (1999). ISSN: 0140-1963
http://dx.doi.org/10.1006/jare.1998.0489
Keywords: contour furrowing/ chenopod patterned ground/ salt redistribution/ dispersive soils
Abstract: Patterned ground occurs extensively across the world's arid and semi-arid areas. The Australian chenopod shrublands, typical of the other areas, has been degraded through species change and erosion since the application of European grazing methods and management practices. Contour furrowing was applied to these areas in an attempt to reduce erosion and encourage the establishment of desirable vegetation. Contour furrowing disrupted the natural hydrology and soil chemical mosaic of the patterned ground system. The contour furrows encouraged soil erosion by the concentration of sheet flow into a ‘stream flow’ because of furrow breakthrough. The breakthroughs were a direct consequence of the use of dispersive soil to construct the furrow banks. The application of this rehabilitation technique to other areas of south-eastern Australian is limited due to the widespread occurrence of dispersive soils. Similar problems may be encountered within western Africa.
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88. **Impact of grazing around a watering point on soil status of a semi-arid rangeland in Ethiopia**.
Gebremeskel, K. and Pieterse, P. J.
African Journal of Ecology 45: 72-79 (2007). ISSN: 0141-6707
http://dx.doi.org/10.1111/j.1365-2028.2006.00682.x

Keywords: calcium/ grazing/ issues in sustainable development/ particle size/ organic carbon/ organic phosphorus/ soil/ Ethiopia/ sand/ Ca2+/Mg2+/ exchanging ATPase/ acidity/ Costa Rica/ pH/ cation exchange/ ions/ clay/ water in soils/ zoology/ bases/ hydrogen ion concentration/ silt/ exchange capacity/ livestock/ sodium/ rangelands/ cations/ semiarid environments/ ecosystem and eEcology studies/ Africa/ magnesium/ nitrogen
Abstract: The influence of long-term livestock grazing on the soil status of a semi-arid rangeland was studied along a grazing gradient from a watering point in southern Afar Region of Ethiopia for two seasons. The soil samples were analysed for organic carbon (OC), total nitrogen (N), available phosphorus (P), exchangeable cations (Ca2+, Mg2+, K+ and Na+), acidity (pH), cation exchange capacity, and particle size distribution (clay, silt and sand). No significant differences (P>0.05) were observed for particle size distribution, OC, N, P and K contents along the grazing gradient further than 1500m from the watering point. Ca2+ and Mg2+ were found to be dominant cations particularly in the severely degraded area contributing about 74% to the exchangeable cations. The study has also recognized high concentrations of Na+ and more than 11% exchangeable sodium percentage. Total exchangeable bases significantly declined (P < 0,05) along the grazing gradient and were indicative of the exchange complex of the soil being saturated with Ca2+ and Mg2+ ions. Thus this study concluded that there are soil differences in the grazing gradient caused by impact of grazing, particularly in the severely degraded area.
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89. **Impact of various range improvement practices on watershed protective cover and annual production within the Colorado River Basin**.
Hessary, I. K. and Gifford, G. F.
Journal of Range Management 32: 134-140 (1979).
https://journals.uair.arizona.edu/index.php/jrm/article/view/6918/6528
Keywords: rangeland management/ range improvement practices/ annual production/ gully plugs/ contour furrowing/ pitting/ chaining/ sagebrush control/ pinyon-juniper/ watersheds
Abstract: During 1976 a study of annual production and cover (litter + rock + vegetation) on various range improvement practices was conducted in Utah, Colorado, New Mexico, and Arizona. The range improvement practices studied included gully plugs, contour furrowing, pitting, pinyon-juniper chaining, and various sagebrush control treatments. Results from studies of annual production on treated vs untreated sites indicated that: (a) about 33% of the contour furrowed sites had significant increases in annual production. Best responses were found on loam and clay loam soils, while soils of sandy loam or clay texture indicated a poor response to treatment. Soils classified as typical ustifluvents and ustollic haplargids were most favorable in terms of increased production; (b) annual production on pinyon-juniper chainings was significantly increased across a variety of soil types (growth of trees excluded). The greatest increases in production were measured on sites with loam soils classified as typic haplustolls; (c) neither of the two pitting treatments on a clay and a sandy clay loam site indicated increased annual production; (d) less than 50% of the various sagebrush treatments indicated increased annual production. There appears to be a general trend for best responses on loam soils, though significant decreases in production were also indicated on this type of soil; (e) plowing was the least successful sagebrush treatment studied. Best cover responses on the various range improvement practices were found on contour furrowing treatments on sandy clay loam and loam textured soils and on typic torriorthent or ustic torriorthent soil types. Though significant cover increases due to chaining of pinyon and juniper were noted on 57% of the treatments, on a variety of soil textures and soil types, the increases were uniformly small (tree cover included) and no clear pattern emerged with either soil texture or soil type. Only about 20% of the various sagebrush treatments showed significant increases in cover; 10% indicated decreased cover, and there was no impact on cover on the remaining 70% of the treatments. Pitting treatments in this study had no impact on cover. Age of contour furrow treatments made little difference as to whether there was a significant increase or decrease in either production or cover. Cover data from pinyon-juniper chainings indicate either that significant increases in cover (if they occur) are slightly more dramatic on more recent treatments, or that treatments approximately 11 years old represent conditions most ideal for enhanced cover. The former interpretation is probably more nearly correct. Production data suggests

that pinyon-juniper sites chained since 1964 are not as favorable in terms of increased production as those chained prior to 1964. Age of sagebrush treatment had no impact on significant changes in cover; however, a general trend indicated that production increases are slightly higher for more recent sagebrush ripping and sagebrush chaining treatments than for older ones.
This citation is from the University of Arizona Institutional Repository.

90. **The importance of rapid, disturbance-induced losses in carbon management and sequestration**.
Breshears, D. D. and Allen, C. D.
Global Ecology and Biogeography
11: 1-5 (2002).
http://dx.doi.org/10.1046/j.1466-822X.2002.00274.x
Keywords: carbon management/ carbon sequestration/ disturbance/ forest dieback/ erosion/ fire/ reforestation/ climate change/ *Pinus edulis*/ patterns/ forests/ ecosystems/ vegetation/ responses/ erosion/ storage/ biomass/ Colorado pinyon
Abstract: Management of terrestrial carbon fluxes is being proposed as a means of increasing the amount of carbon sequestered in the terrestrial biosphere. This approach is generally viewed only as an interim strategy for the coming decades while other longer-term strategies are developed and implemented-the most important being the direct reduction of carbon emissions. We are concerned that the potential for rapid, disturbance-induced losses may be much greater than is currently appreciated, especially by the decision-making community. Here we wish to: (1) highlight the complex and threshold-like nature of disturbances-such as fire and drought, as well as the erosion associated with each-that could lead to carbon losses; (2) note the global extent of ecosystems that are at risk of such disturbance-induced carbon losses; and (3) call for increased consideration of and research on the mechanisms by which large, rapid disturbance-induced losses of terrestrial carbon could occur. Our lack of ability as a scientific community to predict such ecosystem dynamics is precluding the effective consideration of these processes into strategies and policies related to carbon management and sequestration. Consequently, scientists need to do more to improve quantification of these potential losses and to integrate them into sound, sustainable policy options.
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91. **Is short-duration grazing the answer?**
See record 60 in Rangeland Management Practices and Potential Impact on Water.

92. **Overwinter Soil Water Recharge and Herbage Production as Influenced by Contour Furrowing on Eastern Montana Rangelands**.
See record 61 in Rangeland Management Practices and Potential Impact on Water.

93. **Phenology of salt desert plants near contour furrows**.
See record 17 in Rangeland Management Practices and Potential Impact on Salinity.

94. **Range waterspreading as a range improvement practice**.
See record 66 in Rangeland Management Practices and Potential Impact on Water.

95. **Responses of three arid zone grass species to varying Na/Ca ratios in saline sand culture**.
Ashraf, M. and Naqvi, M. I.
New Phytologist 119: 285-290 (1991).
ISSN: 1469-8137
http://dx.doi.org/10.1111/j.1469-8137.1991.tb01032.x
Keywords: grasses/ Na/Ca ratio/ Na/K ratio/ sodium chloride
Abstract: The effects on three grass species, *Cenchrus pennisetiformis* Hochst. & Steud., Leptnchloa fusca (L.) Kunth. and *Panicum turgidum* Forssk., of decreasing Ca2+ concentration in a saline growth medium were assessed after 7 weeks growth in sand culture. The different Na/Ca ratios of the salt treatment were 24, 49, 99, and 199, at a constant concentration of 200 mol m−3.*Leptuchloa fusca* produced the highest fresh and dry biomass, and was able to maintain Na+ and Cl− Concentrations in the shoots and roots almost constant at varying external Na/Ca ratios, except that the shoot Na+ concentration increased

significantly at the highest Na/Ca ratio. In *C, pennisetiformis* the shoot Na+ decreased, whereas the shoot Cl− concentration increased at the highest external Na/Ca ratio. But the root Na+ and Cl− concentrations in this species remained unchanged at varying Na/Ca ratios. C. pennisetiformis and *L. fusca* maintained almost constant K+ and Ca2+ concentrations in both shoots and roots at varying Na/Ca ratios. In *P. turgidum* the shoot K+ and shoot and root Ca2+ remained almost unchanged at all Na/Ca ratios, whereas the root K+ concentration decreased significantly but uniformly at the three, higher Na/Ca ratios. No consistent pattern of increase or decrease was observed in the shoot and root Na/K and Na/Ca ratios of all the species. The shoot selectivity (Sk + na) increased consistently in *C pennisetiformis* with the increase in Na/Ca ratios and it decreased in *L. fusca* only at the highest Na/Ca ratio in the growth mediumIt was established that *L. fusca* was tolerant, *C. pennisetiformis* intermediate and P. turgidum relatively sensitive to low Ca2+ concentrations of the saline growth medium.
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96. **Restoring Western Ranges and Wildlands (Vol 1)**.
Monsen, S. B., Stevens, R. and Shaw, N. L., (2004).
http://www.fs.fed.us/rm/pubs/rmrs_gtr136_1.pdf
Keywords: rehabilitation/ revegetation/ plant ecology/ seed/ plant communities/ wildlife habitat/ invasive species/ equipment/ plant materials/ native plants
Abstract: This work, in three volumes, provides background on philosophy, processes, plant materials selection, site preparation, and seed and seeding equipment for revegetating disturbed rangelands, emphasizing use of native species. The 29 chapters include guidelines for planning, conducting, and managing, and contain a compilation of rangeland revegetation research conducted over the last several decades to aid practitioners in reestablishing healthy communities and curbing the spread of invasive species. Volume 1 contains the first 17 chapters plus the index.

97. **Restoring Western Ranges and Wildlands (Vol 2)**.
Monsen, S. B., Stevens, R. and Shaw, N. L., (2004).
http://www.fs.fed.us/rm/pubs/rmrs_gtr136_2.pdf
Keywords: rehabilitation/ revegetation/ plant ecology/ seed/ plant communities/ wildlife habitat/ invasive species/ equipment/ plant materials/ native plants
Abstract: This work, in three volumes, provides background on philosophy, processes, plant materials selection, site preparation, and seed and seeding equipment for revegetating disturbed rangelands, emphasizing use of native species. The 29 chapters include guidelines for planning, conducting, and managing, and contain a compilation of rangeland revegetation research conducted over the last several decades to aid practitioners in reestablishing healthy communities and curbing the spread of invasive species. Volume 2 contains chapters 18-23 plus the index.

98. **Restoring western ranges and wildlands (Vol 3)**.
Monsen, S. B., Stevens, R., Shaw, N. L., Davis, J. N., Goodrich, S. K., Jorgensen, K. R., Lopez, C. F., Mcarthur, E. D., Nelson, D. L., Tiedemann, A. R., Vallentine, J. F., Van Epps, G. A., Welch, B. L., Whisenant, S. G. and Wilson, G. R.
USDA Forest Service - General Technical Report RMRS-GTR, 884 p. (2004).
http://www.fs.fed.us/rm/pubs/rmrs_gtr136_3.html
Keywords: equipment/ invasive species/ native plants/ plant communities/ plant ecology/ plant materials/ rehabilitation/ revegetation/ seed/ wildlife habitat/ native species/ nature conservation/ plant community/ rangelands/ restoration ecology
Abstract: This work, in three volumes, provides background on philosophy, processes, plant materials selection, site preparation, and seed and seeding equipment for revegetating disturbed rangelands, emphasizing use of native species. The 29 chapters include guidelines for planning, conducting, and managing, and contain a compilation of rangeland revegetation research conducted over the last several decades to aid practitioners in reestablishing healthy communities and curbing the spread of invasive species.

99. **Revegetating weed-infested rangeland: what we've learned**.
Jacobs, J. S., Carpinelli, M. F. and Sheley, R. L.
Rangelands 20: 10-15 (2006). ISSN: 0190-0528
https://journals.uair.arizona.edu/index.php/rangelands/article/view/11400/10673

Keywords: revegetation/ plant establishment/ noxious weeds
Abstract: For revegetation of weed-infested rangeland to become more widely applicable to the various rangeland conditions, cost-effective and reliable methods need to be developed. Developing strategies that enhance our ability to cost-effectively establish desired plant communities may provide ranchers and land managers with a sustainable method for managing noxious weed-infested rangeland. Reducing the number of entries onto the land will reduce the cost of revegetation. Combining the factors discussed above to improve the success of establishing desirable species, and applying them in a single pass will be the most cost-effective and reliable way to revegetate rangeland. New equipment has made possible the simultaneous application of herbicides, tillage, and seeding as well as seeding using no-till methods.
This citation is from the University of Arizona Institutional Repository.

100. **Riparian management: the future is in our hands**.
Kaufman, H.
Rangelands 19: 18-19 (2006). ISSN: 0190-0528
https://journals.uair.arizona.edu/index.php/rangelands/article/view/11355/10628
Keywords: riparian areas/ grazing/ range management/ conservation practices
Abstract: Riparian areas need to be managed differently than uplands, and research has shown us that it is difficult to restore the functions and values of these areas' years of damage. If ripanan areas are not well managed the destructive impacts of floods and droughts are alarming. Potential income is reduced since abundant water, shelter and forage translate into marketable value. A grazing system can utilize range management principles and practices and contribute to the productiveness of the landscape and watershed. Grazing strategies enhance livestock production and maintain or improve plant communities. With proper rest and deferment, a good grazing system can offset the impact of cropping and trampling. Deferred rotation, rest rotation and time controlled systems all are good "tools" to put into practice.
This citation is from the University of Arizona Institutional Repository.

101. **Role of nurse shrubs in restoration of an arid rangeland: Effects of microclimate on grass establishment**.
Jankju, M.
Journal of Arid Environments 89: 103-109 (2013). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2012.09.008
Keywords: Agropyron desertorum/ canopy facilitation/ competition/ Iran/ rangelands/ soil moisture
Abstract: A perennial forage grass, *Agropyron desertorum* was sown under the canopies of four shrub species or in open areas to test for facilitation during seedling establishment in an arid rangeland in Karnakh, Northeast Iran. Height, area and volume of shrubs were measured. Microclimate conditions and seedling establishment were assessed three times within two consecutive growing seasons. Near surface light intensity and air temperature were lower under shrubs, which led to initially higher soil moisture and grass establishment under the canopy of some shrub species. The leguminous shrub (*Astragalus gossypinus*) showed facilitation during moderate stress (summer 2009), but shifted to a negative effect during the severe drought (summer 2010). Competition, possibly for light, reduced the establishment of *Agropyron* seedlings under the cushion-like shrub (*Acantholimon prostegium*). *Salsola arbusculiformis* and *Artemisia kopetdaghensis* respectively showed a neutral and a facilitation effect in the first season, but a combined effect of allelopathy and drought led to the high mortality of *Agropyron* seedlings under their canopy. In conclusion in this arid rangeland, shrubs may facilitate establishment of understory plants under moderate drought stress, and for non-resource factors (light and temperature), but these positive effects are suppressed due to competition under severe drought conditions.
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102. **The role of the mineral component in surface stabilization processes of a disturbed desert sandy surface**.
Yair, A. and Verrecchia, E.
Land Degradation & Development 13: 295-306 (2002).
http://dx.doi.org/10.1002/ldr.507
Keywords: sandy desert areas/ topsoil crusts/ crust recovery rate/ surface stabilization/ biotic and mineral components/ biological soil crusts/ western Negev/ Nizzana/ Israel

Abstract: The stabilization of sandy and loamy surfaces in semiarid and and areas by topsoil crusts protecting the soil against wind or runoff erosion is well known. Destruction of such crusts, often by overgrazing, can enhance erosion and desertification. Crust recovery does not depend purely on biotic components of the crust and vegetation. Mineral components in the initial surface stabilization process are often overlooked. The present study focuses on the relative importance of the biotic and mineral components in the process of topsoil crust recovery in a sandy desert area located in the northwestern Negev Desert of Israel. Observations of the initial crust and of the disturbed surface, in the field and under the scanning electron microscope, showed that the mineral components of the crust recovered more quickly than its biotic elements. The implications for the rehabilitation of the disturbed ecosystem are discussed. Copyright (C) 2002 John Wiley Sons, Ltd.

103. **Sagebrush conversion to grassland as affected by precipitation, soil, and cultural practices**.
Shown, L. M., Miller, R. F. and Branson, F. A.
Journal of Range Management 22: 303-311 (1969). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/5724/5334
Keywords: sagebrush/ grasslands/ soil/ precipitation/ halophytes/ vegetation/ management practices
Abstract: The most successful conversions of sagebrush to crested wheatgrass, in areas of the Western United States that receive an average of 8 to 14 inches of precipitation annually, usually occur where the annual precipitation exceeds 10 inches and on soils having medium moisture-holding capacities. Conversion results were intermediate on coarse soils having low moisture-holding capacities and comparatively poor on fine soils having high moisture-holding capacities. Degree of grass establishment varied directly with the big sagebrush vigor-index. Grass production was lower on gravelly sites converted from black sagebrush than on nearby sites converted from big sagebrush. Cheatgrass hindered the establishment of crested wheatgrass in some places. Conversion results were poor on sites where greasewood or shadscale was mixed with sagebrush. These halophytes had usually re-established on the treated sites.
This citation is from the University of Arizona Institutional Repository.

104. **Salinisation as an ecological perturbation to rivers, streams and wetlands of arid and semi-arid regions**.
Bailey, P. C. E., Boon, P. I., Blinn, D. W. and Williams, W. D.
New York, NY, United States (USA), Cambridge University Press, New York, NY. 2006.
Keywords: hydrology/ terrestrial environment/ human activity/ arid environment/ surface water/ semi-arid environment/ rivers and streams/ agriculture/ pollution/ ecosystems/ salinity/ environmental effects/ biota/ irrigation/ case studies/ wetlands/ hydrogeology/ ecology/ environmental geology/ salinization
© *ProQuest*

105. **Salinity and sodicity affect soil respiration and dissolved organic matter dynamics differentially in soils varying in texture**.
Mavi, M. S., Marschner, P., Chittleborough, D. J., Cox, J. W. and Sanderman, J.
Soil Biology and Biochemistry 45: 8-13 (2012). ISSN: 0038-0717
http://dx.doi.org/10.1016/j.soilbio.2011.10.003
Keywords: dissolved organic matter/ salinity/ sodicity/ soil respiration/ soil texture
Abstract: The individual effects of salinity and sodicity on organic matter dynamics are well known but less is known about their interactive effects. We conducted a laboratory incubation experiment to assess soil respiration and dissolved organic matter (DOM) dynamics in response to salinity and sodicity in two soils of different texture. Two non-saline non-sodic soils (a sand and a sandy clay loam) were leached 3–4 times with solutions containing different concentrations of NaCl and CaCl2 to reach almost identical electrical conductivity (EC1:5) in both soils (EC1:5 0.5, 1.3, 2.5 and 4.0 dS m−1 in the sand and EC1:5 0.7, 1.4, 2.5 and 4.0 dS m−1 in the sandy clay loam) combined with two sodium absorption ratios: SAR < 3 and 20. Finely ground wheat straw residue was added (20 g kg−1) as substrate to stimulate microbial activity. Cumulative respiration was more strongly affected by EC than by SAR. It decreased by 8% at EC 1.3 and by 60% at EC 4.0 in the sand, whereas EC had no effect on respiration in the sandy clay loam. The apparent differential sensitivity to EC in the two soils can

be explained by their different water content and therefore, different osmotic potential at the same EC. At almost similar osmotic potential: −2.92 MPa in sand (at EC 1.3) and −2.76 MPa in the sandy clay loam (at EC 4.0) the relative decrease in respiration was similar (8–9%). Sodicity had little effect on cumulative respiration in the soils, but DOC, DON and specific ultra-violet absorbance (SUVA) were significantly higher at SAR 20 than at SAR < 3 in combination with low EC in both soils (EC 0.5 in the sand and EC 0.7 and 1.4 in the sandy clay loam). Therefore, high SAR in combination with low EC is likely to increase the risk of DOC and DON leaching in the salt-affected soils, which may lead to further soil degradation.
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106. **Salinity Balance of the Lower Virgin River Basin, Nevada and Arizona**.
Woessner, W. W., Mifflin, M. D., French, R. H., Elzeftawy, A. and Zimmerman, D. E.
Salinity in Watercourses and Reservoirs. Panelist. Boston, Butterworth Publishers**:** 145-156 (1984).
Keywords: chemical processes/ sources and fate of pollution
Abstract: This 12 month study developed additional hydrologic data for the development of salinity budgets in the Lower Virgin River Valley Nevada and Arizona, a tributary of the Colorado River. Monthly stream gaging at six locations, groundwater monitoring at existing and new sites, water-quality sampling and soil sampling were included. Results indicate a complex hydrologic system with concentration, storage, and transport of salt occurring iin the study area. Water and salt budget analyses indicate a 36% net loss of water and a 34% net loss in salt for a 61 km reach of river. The majority of water loss is attributed to phreatophyte consumptive use. Salt concentration associated with phreatophyte consumptive use exceeded consumptive concentration of salt by agriculture and direct evaporation by 2.6 times. Data indicate that phreatophyte areas play a major role in salt accumulation and storage by consumptively utilizing 2.1 to 3.6 m of water per year. TDS concentrations of 5,800 to 11,000 mg/1 were measured in the shallow groundwater underlying phreatophyte areas. (Author)
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107. **Salinity control on BLM-administered public lands in the Colorado River basin: A report to Congress**.
See record 28 in Rangeland Management Practices and Potential Impact on Salinity.

108. **Seed inoculation with effective root-nodule bacteria enhances revegetation success**.
See record 32 in Rangeland Management Practices and Potential Impact on Salinity.

109. **Self-sustainable reclamation: Shrub and tree establishment on saline mine wastes**.
Osborne, J. M.
International Journal of Surface Mining, Reclamation and Environment 10: 91-95 (1996).
ISSN: 1389-5265
Keywords: abandoned mines/ database systems/ ecosystems/ gold mines/ industrial wastes/ plants (botany)/ sampling/ acacias/ chenopods/ eucalypts/ ground cover/ saline mine wastes/ seeding/ self sustainable reclamation/ revegetation/ mine spoil/ reclamation/ saline soil/ vegetation/ Australia
Abstract: Mining ceased in 1991 at the Westonia open-cut goldmine, 320 km east of Perth, Western Australia. The early May 1990 seeding of 40 ha of dump surfaces used a suite of species local to the area, and additional selected salt tolerant varieties. No fertilizer was applied. Subsequently stratified random sampling assessed the revegetation at twice yearly intervals. In 1995 two different sampling strategies were required. The chosen samplings were repeatable and accurate, and cost, labor and time effective. Seeding success was evaluated. Eucalypts and tall shrubs were prevalent and chenopods provided ground cover. Densities of eucalypts approximated 625 per hectare, with individuals to 4 m not uncommon. Acacias (wattles) and other woody perennial shrubs and trees were present. Saltbushes were prevalent. An extensive chenopod ground cover included *Atriplex semibaccata*, *Enchylaena tomentosa* and *Maireana brevifolia*. With this appropriate data base prediction of longer term ecosystem development can be made.
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110. **Soil organic matter and its lignin component in surface horizons of salt-affected soils of the Argentinian Pampa**.
Peinemann, N., Guggenberger, G. and Zech, W.
CATENA 60: 113-128 (2005). ISSN: 0341-8162
http://dx.doi.org/10.1016/j.catena.2004.11.008
Keywords: lignin/ mollisols/ salt-affected soils/ soil organic matter/ particle size fractions
Abstract: Salt-affected soils differ in their chemical properties to all other soils. Sodicity and salinity may affect the soil organic matter component of these soils. In a field experiment, we investigated organic matter decomposition in nonsaline nonsodic Aquic Argiudoll, a nonsaline sodic Typic Natraquoll, nonsaline nonsodic Petrocalcic Paleudoll and a saline sodic Typic Natralboll in the Pampa Deprimida, Argentina. The objectives were to identify the degree of stabilization of organic matter by association with mineral particles in these soils and to follow in particular the fate of lignin in these soils. We measured organic carbon, total nitrogen and the extent of lignin alteration with soil depth and in various particle size fractions. The salt-affected soils contained much less organic carbon and nitrogen in their mollic epipedons than the nonsaline nonsodic soils, and bioturbation into deeper layers was restrained. In the salt-affected soils most of the organic matter was in sand-sized particles. Retarded degradation of plant residues was indicated by the pattern of lignin-derived phenols, suggesting less alteration of lignin in the salt-affected soils than in the nonsaline nonsodic soils. We suggest that this results from the effects of high pH, high sodicity, and high salinity on the microorganisms and their enzymatic activities. The high pH and high concentrations of monovalent cations decreased formation of solid organo-mineral complexes. We conclude that in the salt-affected soils oxidatively altered organic compounds are susceptible to losses in dissolved or colloidal forms, because these compounds are not stabilized against leaching and mineralization by chemical bonding to soil minerals.
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111. **Soil salinity: A neglected factor in plant ecology and biogeography**.
Bui, E. N.
Journal of Arid Environments 92: 14-25 (2013). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2012.12.014
Keywords: Acacia/ evolutionary ecology/ halophytes/ non-halophytes/ speciation
Abstract: This paper argues that soil salinity needs to be more broadly acknowledged as a driving factor in plant ecology—not only in the ecology of halophytes—in order to understand and make more accurate predictions for the impact of environmental change on biodiversity and vegetation patterns throughout the semi-arid world. It summarizes recent research on soil salinity and plant distributions in semi-arid environments throughout the world: there is empirical as well as experimental evidence that soil salinity, even at low levels, is an abiotic stress factor that influences vegetation patterns and diversification. Lines of evidence demonstrating salinity's potential influence as a selective agent in East Africa and North America are presented. The paper then synthesizes recent results from spatial ecology, plant and insect systematics and behavioral ecology, focusing on Australia, that support a role for salinity in evolutionary ecology of Acacia. On a shorter time scale, soil salinity may play a role in weed invasion and woody vegetation encroachment in Australia.
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112. **Soil sodicity as a result of periodical drought**.
Van Der Zee, S. E., Shah, S. H., Van Uffelen, C. G., Raats, P. A. and Dal Ferro, N.
Agricultural Water Management 97: 41-49 (2010). ISSN: 0378-3774
http://dx.doi.org/10.1016/j.agwat.2009.08.009
Keywords: dry-wet cycles/ root zone model/ salinity/ sodicity/ water management/ salt accumulation/ leaching/ ecohydrology
Abstract: Soil sodicity development is a process that depends nonlinearly on both salt concentration and composition of soil water. In particular in hot climates, soil water composition is subject to temporal variation due to dry–wet cycles. To investigate the effect of such cycles on soil salinity and sodicity, a simple root zone model is developed that accounts for annual salt accumulation and leaching periods. Cation exchange is simplified to considering only Ca/Na exchange, using the Gapon exchange equation. The resulting salt and Ca/Na-balances are solved for a series of dry/wet cycles with a standard numerical approach. Due to the nonlinearities in the Gapon equation, the fluctuations of soil salinity that may be induced, e.g. by fluctuating soil water content, affect sodicity development. Even for the case that salinity is in a periodic steady state, where salt

concentrations do not increase on the long term, sodicity may still grow as a function of time from year to year. For the longer term, sodicity, as quantified by Exchangeable Sodium Percentage (ESP), approaches a maximum value that depends on drought and inflowing water quality, but not on soil cation exchange capacity. Analytical approaches for the salinity and sodicity developing under such fluctuating regimes appear to be in good agreement with numerical approximations and are very useful for checking numerical results and anticipating changes in practical situations.
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113. **Soil-plant factors in early browning of Russian wildrye on Natrustoll Soils**.
Bowman, R. A., Mueller, D. M. and Mcginnies, W. J.
Journal of Range Management 37: 225-228 (1984). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7707/7319
Keywords: saline soils/ drought/ forage/ soil-water-plant relationships
Abstract: The occurrence of early browning in selected areas of a 1979-established Russian wildrye (*Elymus junceus* Fisch.) plot led to a comparison of soil-plant-water relationships in the brown senescing areas, and in adjacent green healthy areas. Although the green areas exhibited better nutrient status and less salinity-sodicity associated problems than the brown areas, the main problem and cause for this premature browning appeared to be water related.
This citation is from the University of Arizona Institutional Repository.

114. **Tall wheat grass (*Thinopyrum ponticum*) and puccinellia (*Puccinellia ciliata*) may not be the answer for all saline sites: A case study from the Central Western Slopes of New South Wales**.
Semple, W. S., Koen, T. B. and Dowling, P. M.
Australian journal of agricultural research 59: 814-823 (2008). ISSN: 0004-9409
http://dx.doi.org/10.1071/AR07298
Keywords: tall wheat grass/ *Thinopyrum ponticum*/ puccinellia/ *Puccinellia ciliata*/ saline sites/ revegetation/ grazing
Abstract: Emergence and survival of *Thinopyrum ponticum* cv. Dundas, *Puccinellia ciliata* cv. Meneman, and *Trifolium fragiferum* cv. Palestine were observed over three seasons (2004-06) on part of a salinised area in Central Western New South Wales. Grid sampling of topsoils in August 2003 indicated that the site was acidic (mean pHwater 6.05), sodic (exchangeable sodium percentage 29), and saline (estimated ECe 18 dS/m). The site comprised a mosaic of low-salinity (ECe ~ 6 dS/m) vegetated patches and high-salinity (ECe ~ 30 dS/m) bare patches where EC was highly variable seasonally (exceeding 100 dS/m) and spatially. Despite suboptimal rainfall, emergence of the grasses was satisfactory on bare patches in all seasons but *T. fragiferum* failed to emerge in 2004 and was omitted from subsequent sowings. Various methods of 'engineering' the bare patches, viz. ditching, mounding, straw mulching, liming, or hand weeding, failed to promote optimum growth of the grasses, although survival was generally enhanced in treatments that included a shallow ditch. Results of the experiments, and observations elsewhere on the salinised area (where some patches supported optimal performance of the three species), suggested that high salinity was the main reason for poor performance on the bare patches. It was concluded that comprehensive site definition, both spatial and temporal, is important before attempting revegetation. Nevertheless the response of *T. ponticum* and *P. ciliata* in ditches will be limited on high-salinity sites. In addition, it was observed that surface disturbance and reduced grazing promoted establishment and growth of pre-existing species, particularly *Cynodon dactylon* and *Lolium rigidum*. There are many salinised sites in the Central West of NSW where neither P. ciliata nor T. ponticum has performed well, nor would be expected to do so, and where management of native and naturalised species already present may provide the best option for enhancing ground cover and herbage production. © CSIRO 2008.
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115. **Temporal evolution of salts in Mediterranean soils transect under different climatic conditions**.
Zwikel, S., Lavee, H. and Sarah, P.
CATENA 70: 282-295 (2007). ISSN: 0341-8162
http://dx.doi.org/10.1016/j.catena.2006.09.004
Keywords: electrical conductivity/ microenvironment/ temporal dynamics/ ion concentrations/ climatic transect

Abstract: The research was conducted in Israel at three sites along a south–north axis, characterized by increasing annual rainfall, from 310 mm at site LAV in the south through 600 mm at site MAT (600), to 800 mm at site EIN in the north. At each site soil samples were taken during several seasons (September 2001 through April 2003), in three dominant microenvironments at 0–2 cm and 5–10 cm. The following microenvironments were selected at LAV and MAT: “Under Shrub” (US), “Between Shrubs” (BS), and “Under Rock fragments” (UR). At EIN the selected microenvironments were US, BS, and “Under Tree” (UT). In each soil sample, electrical conductivity (EC), pH, and concentrations of several ions were determined. The objective was to analyze the effects of soil microenvironments and climatic conditions on the temporal dynamics of salt concentrations. In all microenvironments at all sites the minimal values of EC were found in the rainy season (January or April), and the maximal values in the dry season (September). In the rainy season the temporal variability of EC in the topsoil was regulated by: (1) clay, which restricted the leaching of salts from the topsoil when EC was low; and (2) surface features (microenvironment), when EC was high. In the UT, US, and UR microenvironments the rainy season could be divided into two periods with respect to their effect on salt movement in the topsoil: at the beginning of the rainy season (September–January) the reduction in EC was relatively moderate, especially with regard to ions involved in biotic activity (Mg++ and K+), whereas, late in the rainy season (January–April) there was enhanced reduction in EC. In contrast, in BS the regulation of salt movement was weak at all sites. Hence, in this microenvironment the salts concentration (mainly Na+ and Cl−) responded rapidly to changes in rain amount and soil moisture and temperature. In the dry season (April–September) the temporal variation in EC varied not only between microenvironments but also between sites. In US, where local surface features were similar at all sites (the same shrub), the rise in EC was maximal at LAV (mainly Ca++ and Na+), and gradually diminished toward EIN. Thus, the contribution of regional sources to the salts added to the soil diminished toward the humid site, EIN, where the EC hardly changed in any microenvironment. In BS and UR microenvironments the rise in EC (mainly in Ca++, Na+, and K+) was greatest at site MAT, and decreased toward LAV and EIN. It seems that this pattern was affected also by changes in local biotic activity.
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116. **Vegetation restoration of secondary bare saline-alkali patches in the Songnen plain, China**.
Jiang, S. C., He, N. P., Wu, L. and Zhou, D. W. *Applied Vegetation Science* 13: 47-55 (2010). ISSN: 1402-2001
http://dx.doi.org/10.1111/j.1654-109X.2009.01048.x
Keywords: grasslands/ restoration/ safe sites/ saline-alkaline patches/ seed bank/ seed movement/ *Leymus chinensis*/ Puccinellia
Abstract: Questions: What factors limit vegetation restoration of secondary bare saline-alkaline patches (BSAP) in the Songnen grassland of northeast China? Is there any adaptive approach to promote revegetation in the shortest time possible and at a low cost? Location: Northeast China. Methods: Considering the climate, soil saline-alkalization and available seed sources, a new approach was adopted to restore vegetation in BSAP, which were formed by the degradation of typical *Leymus chinensis* grasslands owing to long-term overgrazing. The experimental treatments included no treatment (CK), fencing (F), fencing+inserting cornstalks (FS), fencing+inserting cornstalks+sowing L. chinensis (FSL) and fencing+inserting cornstalks+sowing *Puccinellia chinampoensis* (FSP). The assumptions behind inserting cornstalks were not only that they would create safe sites for initial revegetation but also that they would enhance seed input by trapping and containing the seeds from seed movement on the BSAP surface. Results: Seed bank shortage was an important factor limiting initial revegetation in BSAP; seed movement on the BSAP surface could provide the necessary seed source if it were contained by effective measures. Vegetation at the sites FS, FSL and FSP was restored well in terms of the above-ground biomass and coverage. Inserted cornstalks acted as safe sites that enhanced the plant survival rate in BSAP; they also enhanced the ability to contain seed movement, thus providing a seed source for initial revegetation. Along with initial revegetation, tussocks around cornstalks can provide better safe sites, which in turn can accelerate subsequent vegetation restoration in BSAP. Conclusions: The approach

entails the strategic use of diverse seed sources and the construction of safe sites with agricultural byproducts (cornstalks); therefore, it is a low-cost method and can be used on a widespread scale. The results provide vigorous support in favor of vegetation restoration in BSAP and severely degraded grasslands in the region. In practice, this approach can be used in degraded ecosystems with compacted soil surfaces (including arid and salt-affected soils) to promote revegetation in various regions. © 2009 International Association for Vegetation Science.
© *Wiley Online Library*

117. **Accelerated Salt Transport Method for Managing Ground Water Quality**.
Helweg, O. J. and Labadie, J. W.
JAWRA Journal of the American Water Resources Association 12: 681-694 (1976). ISSN: 1752-1688
http://dx.doi.org/10.1111/j.1752-1688.1976.tb02740.x
Keywords: groundwater/ water quality/ saline water/ water salinization/ models
Abstract: This paper briefly reviews the problem of ground water degradation from irrigation and present approaches to controlling ground water quality. As an alternative to these approaches, a management scheme called the Accelerated Salt TRANsport (ASTRAN) method is proposed as being a feasible solution to the problem of salt build-up in irrigated areas. A management algorithm for implementing the ASTRAN method is described. Results from modeling studies indicate that the ASTRAN method is cost-effective and encourages conjunctive use of ground water and surface water.
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118. **Adsorption and desorption of boron in column studies as related to pH: Results and model predictions**.
Suarez, D. L., Wood, J. D. and Taber, P. E.
Vadose Zone Journal 11 (2012). ISSN: 1539-1663
http://dx.doi.org/10.2136/vzj2011.0073
Keywords: adsorption characteristic/ agricultural drainage water/ brackish groundwater/ column experiments/ column study/ concentration ranges/ constant capacitance model/ elevated concentrations/ experimental data/ irrigation waters/ model constants/ model prediction/ municipal wastewaters/ pH-dependent/ root zone/ soil property/ soil solutions/ solution composition/ Southern California/ surface area/ transport models/ adsorption/ boron/ desorption/ experiments/ forecasting/ geologic models/ groundwater/ irrigation/ leaching/ soil moisture/ wastewater disposal/ wastewater treatment/ water supply/ soil pollution/ arid region/ brackish water/ concentration (composition)/ groundwater pollution/ numerical model/ pH/ pollutant transport/ rhizosphere/ soil column/ soil drainage/ solute transport/ toxicity/ wastewater/ California/ United States
Abstract: Reuse of agricultural drainage waters, treated municipal wastewaters, and brackish groundwaters is often impaired by elevated concentrations of B. Boron is an element with a narrow concentration range between deficiency and toxicity for plants. Knowledge of the B concentrations in soil solution and transport of B out of the root zone is essential for management of wastewaters. Prediction of B concentrations in the root zone requires consideration of soil adsorption and desorption of B, which are dependent on soil properties and solution composition, especially pH. We examine B transport in soil by first applying a 0.08-mmol L _1 B solution to three arid-land soils from southern California and subsequently leaching the soils with a low B solution. The experiment was conducted with irrigation water at pH 6.0 and 9.0. The data showed that transport was highly pH dependent. Results from the column experiments were generally well predicted using the UNSATCHEM transport model with the B subroutine that includes the constant capacitance model and prediction of the model constants for each soil based on the specific soil properties. Use of a single set of average constants for all soils in combination with a calculated surface area provided a less satisfactory fit to the experimental data, especially at elevated pH. These results indicate that B transport can be predicted without the need for time-consuming and soil-specific determinations of B adsorption characteristics if we utilize predictive relations to predict the CCM constants from individual soil properties. © Soil Science Society of America.
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119. **Analysis of the Characteristics of Soil and Groundwater Salinity in the Lower Reaches of Heihe River**.
Liu, W., Wang, T., Su, Y. H., Feng, Q., Si, J. H., Zhang, Y. W. and Chang, Z. Q.
Journal of Glaciology and Geocryology 27: 898-905 (2005). ISSN: 1000-0240
Keywords: desertification/ water sampling/ ecosystems/ water analysis/ groundwater quality/ groundwater pollution/ groundwater hydrology/ land resources/ soil/ soil salinity/ salinity/ glaciology/ streamflow and runoff/ deltas/ topography/ rivers/ groundwater salinity/ freshwater pollution/ salinization/ salts/ salinity of

groundwater/ surface-groundwater relations/ groundwater/ chemical analysis/ evolution
Abstract: Using field investigations and chemical analyses (including 405 soil samples and 101 water samples), the evolution of soil salt with groundwater quality and the location change in the lower reaches of Heihe River were made clear. The soil is coarse, and the salt content is high with high surface concentration in Ejin delta. In the study area, land desertification and land salinization is serious, land resources decrease rapidly, and ecosystem environment deteriorates seriously. Soil salinity has a funnel distribution in the vertical section and it became complicated with topography changing; however, its changing trend is similar to the groundwater quality. The salinity of groundwater is usually high, varying from 800 mg times L super(-1) to 3000 mg times L super(-1). The main water chemical types are HCO sub(3) times SO sub(4)-Na, Cl times SO sub(4)-Na(Ca), HCO sub(3) times Cl-Na (Ca)SO sub(4) times Cl-Na and SO sub(4) times Cl-Na(Ca-Mg). Analyses of the samples from two longitudinal profiles (a--a' and b--b') show that the salinity of ground-water is close related with the distance to the river course. The far to the river course is, the high the salinity is, and the vice versa.
© *ProQuest*

120. **Assessing Ground-Water Recharge in the Arid and Semi-Arid Southwestern United States**.
Stonestrom, D. A., Constantz, J. E., Ferre, T. P., Flint, A. L., Flint, L. E., Leake, S. A., Prudic, D. E., Scanlon, B. R. and Walvoord, M. A.
GSA Denver Annual Meeting, Denver CO, Geological Society of America (2007).
Keywords: groundwater recharge/ arid regions/ semi-arid zones/ geomorphology/ surveys/ climatic factors/ saline water/ water table/ alluvial soils/ hydrology/ models
Abstract: The quantification of ground-water recharge in arid settings is inherently difficult due to the generally low amount of recharge, its spatially and temporally spotty nature, and the absence of techniques for directly measuring fluxes entering the saturated zone from the unsaturated zone. Deep water tables in arid alluvial basins correspond to thick unsaturated zones that produce up to millennial time lags between changes in hydrologic conditions at the land surface and subsequent changes in recharge to underlying ground water. Recent advances in physical, chemical, isotopic, and modeling techniques have fostered new types of recharge assessments. Chemical and isotopic techniques include an increasing variety of environmental tracers that are useful and robust. Physically based techniques include the use of heat as a tracer and computationally intensive geophysical tools for characterizing hydrologic conditions in the unsaturated zone. Modeling-based techniques include high-resolution geospatially distributed water-budget calculations using geographic information systems (GIS). Application of these techniques to arid and semi-arid settings in the southwestern United States reveals distinct patterns of recharge corresponding to tectono-geomorphic setting, climatic and vegetative history, and land use. Analysis of recharge patterns shows that large expanses of alluvial basin floors are drying out under current climatic conditions, with little to no recharge to underlying ground water. Ground-water recharge occurs mainly beneath (1) upland catchments in which thin soils overlie permeable bedrock, (2) ephemeral channels in which flow may average only several hours per year, and (3) active agricultural areas.
This citation is from the Geological Society of America.

121. **Chemical and Isotopic Constraints on the Origin of Wadi El-Tarfa Ground Water, Eastern Desert, Egypt**.
Sultan, M., Sturchio, N. C., Gheith, H., Hady, Y. A. and El Anbeawy, M.
Ground Water 38: 743-751 (2000). ISSN: 0017-467X
http://info.ngwa.org/gwol/pdf/pdf/002570669.PDF
Keywords: water resources and supplies/ agriculture/ deserts/ Egypt/ evaporation/ water resources/ radioactive isotopes/ salinization/ streams (in natural channels)/ transpiration/ arid lands/ chemical processes/ salinity/ arid regions/ deserts/ wadi/ radioisotope/ groundwater/ chemical composition
Abstract: We evaluated the use of the renewable ground water resources of the Eastern Desert to develop sustainable agriculture in Upper Egypt, an alternative that could alleviate some of Egypt's dependence on water from the Nile River. Ground water from shallow aquifers in the Eastern Desert of Egypt, near the intersection of Wadi El-Tarfa and the Nile River, was analyzed for chemical compositions, stable isotope ratios, and tritium activities. The ground water has a

range in total dissolved solids of 300 to 5000 mg/L. Values of delta D and delta super(18)O range from -10 to +34 ppt and -2 to +5.2 ppt, respectively, and defines a line having a slope of 5.7 that intersects the meteoric water line at about delta D = -15 ppt on a plot of delta D versus delta super(18)O. These findings indicate that the water might have been derived by a combination of evaporation of and salt addition to regional precipitation. Only one sample could have been derived directly by evaporation and transpiration of modern Nile River water. Salinization of the ground water could have occurred through dissolution of marine aerosol dry fallout, carbonate minerals, gypsum, and other trace evaporitic minerals at and near the ground surface. Tritium activities ranged from 0.04 to 12.9 TU (tritium units), indicating that all but one of the samples were derived at least partly from precipitation that occurred within the last 45 years. These data indicate that Nubian Aquifer paleowater is not a significant component of the shallow aquifers of this portion of the Eastern Desert. The most likely source of this ground water is sporadic flash flood events yielding locally voluminous recharge that accumulates in coarse sediments and fractured rock beneath alluvial channels. The magnitude of this renewable ground water resource and its potential for supporting sustainable agriculture require further investigation.
© *ProQuest*

122. **Combined effects of groundwater and aeolian processes in the formation of the northernmost closed saline depressions of Europe: north-east Spain**.
Sánchez, J. A., Pérez, A., Coloma, P. and Martínez-Gil, J.
Hydrological Processes 12: 813-820 (1998).
ISSN: 1099-1085
http://dx.doi.org/10.1002/(SICI)1099-1085(19980430)12:5<813::AID-HYP629>3.0.CO;2-P
Keywords: groundwater/ eolian processes/ closed saline depression/ mathematical models/ Spain
Abstract: A genetic and evolutionary model is established for saline depressions in continental areas. These depressions are located in arid or subarid areas, and are developed on low permeability geological mediums (K<10 mm/day) with a lack of streams reaching the small lakes. The phenomenon of evaporation is fundamental, since it is the basic requirement for the presence or absence of a free water surface in the lake, and also for depression of the phreatic surface, which causes inflow of groundwater towards the lake. With these conditions, the proposed model includes the following stages: (i) initiation of the close depression; (ii) deepening of the depression; (iii) formation of the lake basin and the end of the deepening; and (iv) levelling and lateral extension of the lake basin. The combined effects of groundwater flows and aeolian action offer a coherent explanation for the origin and evolution both of the closed depressions found in the Ebro Valley, and of the salt lakes that subsequently form. The processes described form morphologies of oval shape with the main axis parallel to the direction of the wind, flat floors and evaporitic sedimentation, although they act on geological materials with different lithologies. © 1998 John Wiley & Sons, Ltd.

123. **A conceptual framework for ground-water solute-transport studies with emphasis on physical mechanisms of solute movement**.
Reilly, T. E., Franke, O. L., Buxton, H. T. and And Bennett, G. D.
Water-Resources Investigation Report, Reston, Virginia, U. S. Geological Survey, 44 p. (1987).
http://pubs.usgs.gov/wri/wri874191/pdf/wrir_87-4191.pdf
Keywords: groundwater/ solute transport/ advection/ dispersion
Abstract: Analysis of solute transport in ground-water systems involves a complex, multi-discipline study that requires intensive and costly investigation. This report examines the physical mechanisms of solute transport, advection and dispersion, and explains how they relate to one another and the scale of study. A step-by-step framework for conducting a study of the physical mechanisms is given that encourages the use of simulation to help understand the ground-water system under study. This framework is intended to aid both first-time project leaders of solute-transport studies who already have considerable experience in ground-water flow studies and technically oriented administrators .

124. **Defining the climatic signal in stream salinity trends using the Interdecadal Pacific Oscillation and its rate of change**.
Mcneil, V. H. and Cox, M. E.
Hydrology and Earth System Sciences 11: 1295-1307 (2007). ISSN: 1027-5606
http://dx.doi.org/10.5194/hess-11-1295-2007
Keywords: climatology/ hydrogeology/ land use
Abstract: The impact of landuse on stream salinity is currently difficult to separate from the effect of climate, as the decadal scale climatic cycles in groundwater and stream hydrology have similar wavelengths to the landuse pattern. These hydrological cycles determine the stream salinity through accumulation or release of salt in the landscape. Widespread patterns apparent in stream salinity are discussed, and a link is demonstrated between stream salinity, groundwater levels and global climatic indicators. The Interdecadal Pacific Oscillation (IPO) has previously been investigated as a contributory climatic indicator for hydrological and related time series in the Southern Hemisphere. This study presents an approach which explores the rate of change in the IPO, in addition to its value, to define an indicator for the climate component of ambient shallow groundwater levels and corresponding stream salinity. Composite time series of groundwater level and stream salinity are compiled using an extensive but irregular database covering a wide geographical area. These are modelled with respect to the IPO and its rate of change to derive control time series. An example is given of how a stream salinity trend changes when the decadal climatic influence is removed.
This citation is from the European Geosciences Union.

125. **Detailed study of selenium and selected elements in water, bottom sediment, and biota associated with irrigation drainage in the Middle Green River Basin, Utah 1988-90**.
Stephens, D. W., Waddell, B., Peltz, A. and Miller, J. B.
USGS Water-Resources Investigations Report 92-4084, 1992. 164p (1992).
http://pubs.usgs.gov/wri/1992/4084/report.pdf
Keywords: bioaccumulation/ drainage water/ selenium/ water pollution effects/ water pollution sources/ ducks/ irrigation/ water birds/ waterfowl/ wetlands/ wildlife habitat
Abstract: Studies completed at Stewart Lake Waterfowl Management Area, lower Ashley Creek, Ouray National Wildlife Refuge, and Pariette Wetlands, Utah identified several areas where selenium was adversely affecting water quality and creating a hazard to wildlife. The source of contamination at Stewart Lake is drainwater and shallow groundwater from soils derived from Mancos Shale. Median concentrations of selenium in all drainwater discharged to Stewart Lake exceeded the State standard of 5 microg/L established for wildlife protection. Selenium concentrations in all biological tissues sampled at Stewart Lake Waterfowl Management Area were large compared to concentrations in biota from most other sites in the middle Green River basin. Selenium concentrations in Ashley Creek upstream of the City of Vernal generally were less than 1 microg/L but 12 miles downstream averaged 73 microg/L. The source of the contamination was believed to be from inflows of shallow groundwater and surface water originating as seepage from a sewage-lagoon system that flows through Mancos Shale and mobilizes selenium. Waterfowl from the area contained selenium concentrations as large as 27.2 microg/g in muscle tissue, and an eared grebe egg contained 71 microg/g. Selenium contamination of ponds at Ouray National Wildlife Refuge was limited to a small area on the western part of the refuge and was apparently due to seepage of shallow groundwater into waterfowl ponds. Geometric mean concentrations of selenium in plants, invertebrates, bird eggs, and fish from the North and South Roadside Ponds were larger than concentrations known to cause reproductive failure in mallards. (USGS)

126. **Dissolved Solids in Basin-Fill Aquifers and Streams in the Southwestern United States**.
Anning, D. W., Bauch, N. J., Gerner, S. J., Flynn, M. E., Hamlin, S. N., Moore, S. J., Schaefer, D. H., Anderholm, S. K. and Spangler, L. E.
Scientific Investigations Report, National Water-quality Assessment Program, 168 p. (2006).
http://pubs.usgs.gov/sir/2006/5315/
Keywords: total dissolved solids/ water quality/ aquifers/ rivers/ water salinization/ models
Abstract: The U.S. Geological Survey National Water-Quality Assessment Program performed a regional study in the Southwestern United States (Southwest) to describe the status and trends of dissolved solids in basin-fill aquifers and streams and to determine the natural and

human factors that affect dissolved solids. Basin-fill aquifers, which include the Rio Grande aquifer system, Basin and Range basin-fill aquifers, and California Coastal Basin aquifers, are the most extensively used ground-water supplies in the Southwest. Rivers, such as the Colorado, the Rio Grande, and their tributaries, are also important water supplies, as are several smaller river systems that drain internally within the Southwest, or drain externally to the Pacific Ocean in southern California. The study included four components that characterize (1) the spatial distribution of dissolved-solids concentrations in basin-fill aquifers, and dissolved-solids concentrations, loads, and yields in streams; (2) natural and human factors that affect dissolved-solids concentrations; (3) major sources and areas of accumulation of dissolved solids; and (4) trends in dissolved-solids concentrations over time in basin-fill aquifers and streams, and the relation of trends to natural or human factors. Dissolved-solids concentrations of ground water in the basin-fill aquifers of the Southwest ranged from less than 500 milligrams per liter near basin margins where ground water is recharged from nearby mountains to more than 10,000 milligrams per liter in topographically low areas of some basins or in areas adjacent to specific streams or rivers in the Basin and Range and Rio Grande aquifer systems. The area of the basin-fill aquifer systems with dissolved-solids concentrations less than or equal to 500 milligrams per liter was about 57 percent for the Rio Grande aquifer system, 63 percent for the Basin and Range basin-fill aquifers, and 44 percent for the California Coastal Basin aquifers. At least 70 percent of the area of these three basin-fill aquifer systems had dissolved-solids concentrations less than or equal to 1,000 milligrams per liter. Dissolved solids in streams were described on the basis of median daily concentration, median annual load, and median annual yield data for 420 surface-water-quality monitoring sites. The time period with dissolved-solids data for individual sites varied but was at least 10 or more years between 1974 and 2003. Median daily dissolved-solids concentrations vary substantially among the sites in the Southwest, ranging between 22 and 13,800 milligrams per liter, and also vary between different sites on the same stream. Median daily concentrations generally increased in a downstream direction for sites on the Rio Grande, Colorado River, Yampa River, White River, Green River, San Juan River, Gila River, Bear River, and Sevier River. Median annual dissolved-solids loads ranged from 60 tons per year for a site on Elk Creek, a headwater tributary to the Colorado River, to 7.86 million tons per year at Colorado River below Hoover Dam, Arizona-Nevada. Typically, streams with the highest flows have the highest dissolved-solids loads. Median annual loads for sites on these rivers generally increased in the downstream direction, except where streamflow decreased substantially due to diversions and (or) streambed infiltration, typically in the downstream part of the river system. Median annual yields ranged from 0.69 to 7,510 tons per year per square mile, and the mean for all 420 sites was 125 tons per year per square mile. Most (104 of 112) sites with median annual yields greater than 100 tons per year per square mile were in the Colorado River basin upstream from Lees Ferry and in the Bear and Great Salt Lake hydrologic subregions. A conceptual model was developed for the effects of natural and human factors on dissolved-solids concentrations in basin-fill aquifers and streams. Factors affecting concentrations in streamflow of upland mountain areas include amount of low-concentration runoff in the stream; presence of sedimentary rocks that are less resistant to the solvent action of water, especially evaporite deposits; streamflow storage and mixing processes in reservoirs; evapotranspiration; and transbasin diversions that result in the removal of high-quality water that would otherwise serve to help dilute high-concentration water sources in the originating basin. Streams eventually flow out of the upland mountain areas and into lowland areas that have flatter terrain and contain large basin-fill aquifers. Ground-water recharge of the basin-fill aquifers along the basin margin by streamflow infiltration, or by subsurface flow from adjacent bedrock highland aquifers, typically has low dissolved-solids concentrations in comparison to ground-water in other parts of the aquifer. Dissolved-solids concentrations in ground-water typically increase along flowpaths through basin-fill aquifers as a result of geochemical reactions with the aquifer matrix, dissolution of disseminated salts and massive evaporite deposits, and evapotranspiration by natural vegetation or by agricultural crops. Dissolved-solids concentrations also can change as a result of mixing two or more subsurface waters; recharge from irrigation seepage, septic tank seepage, and percolation ponds or streambeds that infiltrate imported water or treated municipal

wastewater; or seawater intrusion (in coastal areas). Dissolved-solids concentrations in streams also change along their paths through lowland areas due to evapotranspiration or mixing with ground water, irrigation-return flows, or releases from municipal wastewater-treatment plants. In lowland areas, the enhancement or restriction of surface-water and ground-water outflow affects the accumulation of dissolved solids in water supplies. Natural drainage or artificial drainage by canals or pipelines can enhance the outflow of water containing dissolved solids, thereby diminishing the accumulation of salts. Restriction of outflow through water use, or through natural features like topographic barriers that prevent surface outflow, restricts the outflow of water, thereby promoting the accumulation of salts. The salts generally accumulate in areas with high evapotranspiration, a process that increases dissolved-solids concentrations. Significant dissolved-solids source and accumulation areas were determined by using a mass-balance analysis of the contributions and losses of dissolved solids for river systems in hydrologic accounting units of the Southwest. Contributions to river systems in each hydrologic accounting unit included inflows, internal deliveries, and imports; and losses included outflows, internal accumulation, and exports. These six terms were quantified by using predictions from a spatially-referenced regression model of contaminant transport on watershed attributes (SPARROW).

127. **Dryland management for salinity control**.
Van Schilfgaarde, J.
Agricultural Water Management
4: 383-391 (1981).
http://dx.doi.org/10.1016/0378-3774(81)90059-7
Keywords: salinity control/ groundwater flow/ aquifers/ geology/ watersheds/ saline water/ vegetation/ recharge areas/ saline seeps/ precipitation/ management practices
Abstract: The objective of managing the lands in a watershed to maintain or enhance a dependable water yield of low salinity differs fundamentally from that of enhancing agricultural production in situ. The challenge is to devise strategies compatible with both. Vegetative management to increase evapotranspiration reduces salt emissions; it also reduces water yield and, if achieved by forestation, agricultural production. However, U.S. experience indicates that crop selection to increase water use in recharge areas is an effective practice to ameliorate downslope saline seeps. It appears the physico-chemical principles that control salt and water flow through geologic systems, and the effects of vegetation thereon, are well established. This is true, at least, for systems where the predominant salt is NaCl derived from deposition in rainfall. The mathematical tools to make use of these principles are also adequate. The data base, however, frequently is not sufficient to describe the system, nor is our ability to make the necessary field measurements at a reasonable cost. Aside from economic considerations, potential solutions for dryland salinity problems must be related to the specific site conditions. They may include interception drainage, drainage of water from perched water tables, reduction of hydrostatic pressure in artesian systems, as well as soil and crop management systems. The viability of these (or other) solutions can only be assessed after adequate delineation of the site conditions, including identification of the recharge area, description of the subsurface conditions with evaluation of the hydraulic properties of the aquifer materials traversed by the flux, and sufficient information to derive the flow paths. In addition, the time dependence of the flow system must be considered. Whereas flow problems have most often been solved in terms of potential distributions, it will be helpful to pay more explicit attention to velocity fields and transit times. Examples of specific situations, real or imagined, will be used to illustrate the points made above. A parallel will be drawn with similar problems under irrigated agriculture.
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128. **Dryland salinity in south east Australia: Which scenario makes more sense?**
See record 8 in Rangeland Management Practices and Potential Impact on Salinity.

129. **Dryland salinity processes within the discharge zone of a local groundwater system, southeastern Australia**.
Bennetts, D. A., Webb, J. A., Mccaskill, M. and Zollinger, R.
Hydrogeology Journal 15: 1197-1210 (2007).
http://dx.doi.org/10.1007/s10040-007-0212-y

Keywords: arid zones/ groundwater/ saline water/ soil salinization/ water salinization/ high water table/ evaporation/ Australia
Abstract: Detailed study of a localised saline discharge zone in southeastern Australia shows that the salinisation is mostly due to the shallow water table (<1–2 m from the surface). Direct evaporation, particularly in summer, leads to extremely high soil–water salinities at the surface, even though the underlying groundwater is moderately fresh. Groundwater discharge is localised at a break of slope, where the water table intersects the surface, and where the transition from permeable sands to clay-rich sediments inhibits lateral groundwater flow. Higher salt concentrations build up in the clays because of the long residence times during which soil-waters are exposed to evapotranspiration and the reduced potential for salts to be flushed from the sediments. As a result the saline discharge area does not correspond to the part of the site with the largest salt store. Results of the study demonstrate that for dryland salinisation to occur, the groundwater beneath the discharge zone need not be saline, and the presence of a large salt store does not necessarily lead to problems of dryland salinisation if, as in the clay-rich sediments at the site, the salt lies below the pasture root zone. Furthermore, mobilisation of salt stores within low permeability sediments by rising groundwater may be minor.

130. **Dual water flow pattern in the unsaturated zone under a gypsum-amended soil**.
Gvirtzman, H., Magaritz, M. and Nadler, A.
Journal of Soil Science 41: 177-187 (1990). ISSN: 1365-2389
http://dx.doi.org/10.1111/j.1365-2389.1990.tb00055.x
Keywords: soil treatment/ gypsum/ saline water/ saline soils/ unsaturated flow
Abstract: Sediment samples were obtained from boreholes down to c. 20 m in a gypsum-treated, saline-water irrigated soil and from nearby uncultivated fields at two locations (Nir Oz and Nahal Oz). Measurements of tritium concentrations in the soil solution enabled the determination of water flow rates in the unsaturated zone. Two types of flow, fast and slow, were identified in the profiles. The slow component, the ‘piston-flow type’ in the sandy loess section in Nir Oz and in the clayey loess section of Nahal Oz, had a vertical velocity of 0.16 and 0.23 m a^{-1}, respectively. The faster component typically transported the solution through fractures and other preferred paths. The percentage of the slow component in the sandy and in the clayey loess was 40% and 60% respectively. A previous prediction of delayed transport of salts was verified and is related to the interaction between chemical composition of irrigation water and the agro technical practices of gypsum application.
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131. **Dynamics of Floodwater Infiltration and Groundwater Recharge Under Ephemeral Channels in Arid Regions**.
Tatarsky, B., Dahan, O. and Enzel, Y.
Eos, Transactions, American Geophysical Union 88: Abstract H33B-02 (2007). ISSN: 0096-3941
Keywords: aquifers/ Namibia/ Kuiseb R./ groundwater quality/ groundwater storage/ Spain/ arid environment/ water table/ Israel/ boreholes/ groundwater level/ water levels/ network design/ groundwater recharge/ percolation/ floods/ wetting/ South Africa/ floodwater/ monitoring systems/ groundwater flow/ vadose waters/ runoff/ monitoring and analysis of water and wastes/ channels/ fronts/ aquifer recharge/ water management/ infiltration/ TSD distribution/ water masses/ alluvial aquifers/ groundwater
Abstract: Shallow alluvial aquifers underneath ephemeral streams are often the only reliable source of water that can sustain human habitation in arid environments (e.g. Arava Valley, Israel; Rio Andarax, Spain; Kuiseb River, Namibia). The main source of replenishment of these alluvial aquifers is recharge from floodwater infiltration. Accordingly, effective management of surface water and groundwater in arid regions requires a better understanding of the processes controlling floodwater infiltration and recharge of alluvial aquifers. This study focuses on understanding the dynamic process of floodwater infiltration from ephemeral channels while implementing innovative methods specifically designed to quantify the recharge fluxes. The monitoring system provides real-time continuous measurements of the hydraulic conditions in all three domains involved in the recharge process: (a) the flood, (b) water-content variations along the unsaturated profile, (c) the groundwater response to the recharge event. Water-content variations along the unsaturated profile were monitored using flexible TDR (FTDR) probes

installed along slanted boreholes underneath the stream channel. Water levels and salinity of both the flood and the groundwater were measured simultaneously. Two study sites were selected for this work: the Buffels River, South Africa and the Kuiseb River, Namibia. The monitoring stations installed at those sites recorded several flood events during 2005/2006. Data collected during this period revealed the dynamic process in which floodwater percolates through the vadose zone and recharges the groundwater. Each flood initiated an infiltration event expressed by wetting of the vadose zone and a rise in the water table. The sequential wetting of the vadose zone allowed direct calculations of the wetting-front propagation velocities and percolation fluxes from land surface down to the groundwater. With the arrival of the wetting front to the water table, groundwater began to rise, indicating an increase in groundwater storage in response to the recharge event. Water fluxes were calculated using several independent methods: (a) combining the calculated wetting-front propagation velocity with the change in moisture profile, (b) the rate at which the water table rises as an indication of the percolation rate, and (c) the final increase in groundwater storage through the measured change in groundwater levels. Interestingly, the calculations performed for all of the floods yielded corresponding flux values of approximately 1 cm/h. Aquifer dimensions, as well as total recharge estimations, were also derived from the data. Salt-transport dynamics at each site and the positive influence of the flood events on groundwater quality were revealed from the EC measurements.
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132. **Effects of land processes on the salinity of the upper Colorado River Basin: Final project report**.
Hawkins, R. H., Gifford, G. F. and Jurinak, J. J., Logan, Utah, Utah State University, 196 p. (1977).
http://archive.org/details/effectsoflandpro00hawk
Keywords: water quality/ Colorado River Watershed (Colo.-Mexico)/ stream salinity

133. **Elucidating Salination Mechanisms by Stable Isotope Tracing of Water Sources**.
Gat, J. R.
Brackish Water as a Factor in Development, International Symposium January 5-10, 1975, Beer-Sheva, Israel, Ben-Gurion University of the Negev: 15-23 (1975).
Keywords: use of water of impaired quality/ identification of pollutants/ sources and fate of pollution
Abstract: Stable isotope characterization, along with more conventional chemical methods, is helpful in elucidating salinization mechanisms that operate in brackish water sources. Brackish waters and brines appear in the meteoric water cycle through such processes as dissolution of rocks and evaporites, salt retention and concentration by shale ultrafilters, salt concentration in residues of (surface) evaporation processes and admixtures of nonmeteoric saline waters such as seawater, paleobrines and possibly magmatic exhalations. One indicator of salinity origin is the abundance of oxygen 18 and deuterium in saline water sources compared with the isotopic composition of local or regional cyclic waters. The expected pattern involves conservation of the isotopic composition in the process of dissolution of anhydrous evaporites; heavy isotope species enrichment by surface evaporation processes, with a theoretically predictable correlation between the degree of enrichment of oxygen 18 and deuterium; and a different enrichment pattern for ultrafiltration process residues. Seawater's distinctive isotope composition can be traced to its mixtures with meteoric waters. Isotope characteristics associated with the different pathways of salinization and its mechanisms are outlined. Studies include those on salinity in a coastal aquifer, in arid zone hydrology and in groundwaters. (Jahns-Arizona)
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134. **Estimation of groundwater evaporation and salt flux from Owens Lake, California, USA**.
Tyler, S. W., Kranz, S., Parlange, M. B., Albertson, J., Katul, G. G., Cochran, G. F., Lyles, B. A. and Holder, G.
Journal of Hydrology 200: 110-135 (1997).
http://www.nicholas.duke.edu/people/faculty/katul/jhydrology.pdf
Keywords: groundwater evaporation/ salt flux/ eddy correlation/ microlysimeters/ chloride profiles/ dust
Abstract: Groundwater evaporation and subsequent precipitation of soluble salts at Owens Lake in eastern California have created one of the single largest sources of airborne dust in the USA, yet the evaporation and salt

flux have not been fully quantified. In this study, we compare eddy correlation, microlysimeters and solute profiling methods to determine their validity and sensitivity in playa environments. These techniques are often used to estimate evaporative losses, yet have not been critically compared at one field site to judge their relative effectiveness and accuracy. Results suggest that eddy correlation methods are the most widely applicable for the variety of conditions found on large playa lakes. Chloride profiling is shown to be highly sensitive to thermal and density driven fluxes in the near surface and, as a result, appears to underestimate yearly groundwater evaporation. Yearly mean groundwater evaporation from the playa surface estimated from the three study areas was found to range from 88 to 104 mm year-1, whereas mean evaporation from the brine-covered areas was 872 mm year-1. Uncertainties on these mean rates were estimated to be 625%, based on comparisons between eddy correlation and lysimeter estimates. On a yearly basis, evaporation accounts for approximately 47 x 106 m3 of water loss from the playa surface and openwater areas of the lake. Over the playa area, as much as 7.5 x 108 kg (7.5 x 105 t) of salt are annually concentrated by evaporation at or near the playa surface, much of which appears to be lost during dust storms in the area. © 1997 Elsevier Science B.V.

135. **Evaluation of the storage of diffuse sources of salinity in the Upper Colorado River Basin**.
Laronne, J. B.
Colorado Water Resources Research Institute Completion Report, Fort Collins, Colorado, Colorado Water Resources Research Institute, Colorado State University, 111 p. (1977).
http://hdl.handle.net/10217/2636
Keywords: salinity/ Colorado River/ watersheds
Abstract: Specific electrical conductance (EC) was found to correlate highly with the total dissolved solids concentration of aqueous solutions derived from mixtures of distilled water and sediment samples collected in the Mancos Shale lowlands of the Upper Colorado River Basin. The effects of suspended sediment presence, turbulence and particle sized on the EC of partially equilibrated mixtures appeared negligible. The mixing time necessary to approach equilibrium decreased with an increase of salt content (of the dissolving sediment) and with a decrease of sediment concentration, and the time span required for equilibrium ranged from a few minutes to several days. Results from the experiments on the amount of dissolution and dissolution rates upon dilution indicate that the true salt load from diffuse sources of salinity may be much larger than presently assumed. Chemical analyses of samples from a single low magnitude flow event in West Salt Creek show that stormflow salinity is considerable influenced by the soluble mineral content of bed and lower bank materials. Results also confirm that major areas of diffuse sources of salinity in the Upper Colorado River Basin are also major sediment contributors. Hence, gullying will significantly increase the sediment and salt load of channels in saline alluvium and in Mancos Shale bedrock.

136. **Evolution of groundwater in the Tyrrell catchment, south-central Murray Basin, Victoria, Australia**.
Petrides, B., Cartwright, I. and Weaver, T. R.
Hydrogeology Journal 14: 1522-1543 (2006).
http://dx.doi.org/10.1007/s10040-006-0057-9
Keywords: groundwater/ rivers/ watershed management/ aquifers/ saline water/ rain/ water salinization/ hydrogeology
Abstract: The Tyrell catchment lies on the western margin of the Riverine Province in the south-central Murray Basin, one of Australia's most important groundwater resources. Groundwater from the shallow, unconfined Pliocene Sands aquifer and the underlying Renmark Group aquifer is saline (total dissolved solids up to 150,000 mg/L) and is Na-ClMg type. There is no systematic change in salinity along hydraulic gradients implying that the aquifers are hydraulically connected and mixing during vertical flow is important. Stable isotopes (18 O+ 2 H) and Cl/Br ratios indicate that groundwater is entirely of meteoric origin and salts in this system have largely been derived by evapotranspiration of rainfall with only minor halite dissolution, rock weathering (mainly feldspar dissolution), and ion exchange between Na and Mg on clays. Similarity in chemistry of all groundwater in the catchment implies relative consistency in processes over time, independent of any climatic variation. Groundwater in both the Pliocene Sands and Renmark Group aquifers yield ages of up to 25 ka. The Tyrrell Catchment is arid to semi-arid and has low topography. This has resulted in relatively low recharge rates and hydraulic gradients that have resulted in long groundwater residence times.

137. **Examination of a non-point source loading function for the Mancos shale wildlands of the Price River Basin, Utah**.
Ponce, S. L.,
Utah State University, 177 p. (1975).
Keywords: mineral waters/ saline water/ salinity

138. **Field measurements of wind and water transport for contaminant mobility: Comparisons and contrasts among semiarid grassland, shrubland, and forest ecosystems**.
Breshears, D. D., Whicker, J. J., Johansen, M. P. and Pinder, J. E.
Health Physics 84: S155-S155 (2003).
Keywords: wind erosion/ eolian deposits/ grasslands/ rangelands/ soil transport processes/ erosion control/ shrubland/ forests/ ecosystems/ soil pollution

139. **The geochemistry and isotope hydrology of the southern Mexicali Valley in the area of the Cerro Prieto, Baja California (Mexico) geothermal field**.
Portugal, E., Izquierdo, G., Truesdell, A. and Alvarez, J.
Journal of Hydrology 313: 132-148 (2005).
ISSN: 0022-1694
http://dx.doi.org/10.1016/j.jhydrol.2005.02.027
Keywords: silicates/ electrical conductivity/ terrestrial environment/ X-ray diffraction data/ temperature/ Colorado River/ California/ sedimentary rocks/ mineral composition/ movement/ discharge/ pH/ North America/ agriculture/ models/ recharge/ Tertiary/ Mexico/ transmissivity/ Baja California Mexico/ United States/ oxygen/ isotopes/ salinity/ stable isotopes/ ground water/ Cenozoic/ water-rock interaction/ geochemistry/ Mexicali Valley/ Salton Sea/ chemically precipitated rocks/ isotope ratios/ arid environment/ smectite/ O-18/O-16/ hydrochemistry/ evaporites/ Miocene/ clay minerals/ Cerro Prieto Field/ aquifers/ geothermal energy/ geothermal fields/ evaporation/ saturation/ hydrogen/ Neogene/ infiltration/ hydrochemistry/ hydrogeology/ sheet silicates
Abstract: Groundwaters from the phreatic aquifer within and surrounding of the Cerro Prieto geothermal field were analyzed geochemically and isotopically in order to establish a hydrodynamic model of the study zone, which is located in the Mexicali Valley between 655,000-685,000m E-W and 3,605,000-3,576,000m N-S relative to UTM coordinates. Based on their chemical composition three types of water were recognized: chloride, sulfate and bicarbonate. However four groups of water were identified on a statistical multi-variable method of cluster analysis (A-D). The average temperature is 25 degrees C; with a few exceptions in the south where temperature can be as high as 47 degrees C. Stable isotope ratios for some waters plot close to the world meteoric line, corresponding to the original unaltered waters of the zone. The hydrogeochemistry varies in relation to three principal processes: evaporation, infiltration of water used in agriculture and rock interaction by reaction with evaporitic deposits. Major quartz, calcite and plagioclase and minor smectite, kaolinite, halite, sylvite and gypsum were identified by X-ray diffraction in lacustrine sediments of the central part of the zone. Chemical modeling indicates saturation with respect to calcite and undersaturation with respect to gypsum. By incorporating chemical and isotope data into geological and isopotential well information, a hydrodynamic model has been postulated. In this hydrodynamic model the water (A) enters the study zone from the east and it is originally of the old Colorado River water. The water samples on which the model is based were draw from agricultural wells that intersected two aquifers, a shallow and a deep one, representing the recharge to the zone. The salinity of the deep aquifer water (B) is lower than that of the shallow aquifer water (C) and so is the stable isotope ratio. The difference is thought to be due to dissolution of evaporates, evaporation and possible infiltration of spent agriculture water. Both waters then pass through lacustrine sediments and gain in salinity and become isotopically heavier mainly by evaporation in a stagnate flow. They eventually emerge as a saline water (D) in the central part of the study zone. This saline water is the one that mixes with thermal fluid discharges from the geothermal reservoir in the south.
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140. **Global impacts of conversions from natural to agricultural ecosystems on water resources: Quantity versus quality**.
Scanlon, B. R., Jolly, I., Sophocleous, M. and Zhang, L.
Water Resources Research 43: W03437 (2007).
ISSN: 0043-1397

http://dx.doi.org/10.1029/2006WR005486
Keywords: aquifers/ discharge (fluid mechanics)/ environmental impact/ evapotranspiration/ leaching/ stream flow/ water quality/ global impacts/ salinization/ water table/ water analysis/ agricultural ecosystem/ global change/ hydrological change/ irrigation systems/ land use change/ recharge/ streamflow/ sustainability/ water resource/ China/ India/ United States
Abstract: [1] Past land use changes have greatly impacted global water resources, with often opposing effects on water quantity and quality. Increases in rain-fed cropland (460%) and pastureland (560%) during the past 300 years from forest and grasslands decreased evapotranspiration and increased recharge (two orders of magnitude) and streamflow (one order of magnitude). However, increased water quantity degraded water quality by mobilization of salts, salinization caused by shallow water tables, and fertilizer leaching into underlying aquifers that discharge to streams. Since the 1950s, irrigated agriculture has expanded globally by 174%, accounting for ~ 90% of global freshwater consumption. Irrigation based on surface water reduced streamflow and raised water tables resulting in waterlogging in many areas (China, India, and United States). Marked increases in groundwater-fed irrigation in the last few decades in these areas has lowered water tables (≤1 m/yr) and reduced streamflow. Degradation of water quality in irrigated areas has resulted from processes similar to those in rain-fed agriculture: salt mobilization, salinization in waterlogged areas, and fertilizer leaching. Strategies for remediating water resource problems related to agriculture often have opposing effects on water quantity and quality. Long time lags (decades to centuries) between land use changes and system response (e.g., recharge, streamflow, and water quality), particularly in semiarid regions, mean that the full impact of land use changes has not been realized in many areas and remediation to reverse impacts will also take a long time. Future land use changes should consider potential impacts on water resources, particularly trade-offs between water, salt, and nutrient balances, to develop sustainable water resources to meet human and ecosystem needs. Copyright 2007 by the American Geophysical Union.
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141. **Groundwater chemistry and dryland salinity: a case study from Central Tableland, NSW, Australia**.
Zaman, T. M. and Al, B. D.
International salinity forum: Managing saline soils and water: science, technology and social issues, Riverside, California, USA (2005).
Keywords: argillaceous rocks/ arid lands/ basalts/ calcite/ calcium carbonate/ catchment hydrology/ geology/ hydrological factors/ ion exchange/ limestone/ magnesium carbonate/ rain/ saline soils/ salinity/ sedimentary materials/ shale/ silica/ water quality/ watershed management/ weathering/ dacite/ ground water/ rainfall/ rhyolite/ sodium salts/ water chemistry/ water composition and quality/ Australia/ New South Wales
Abstract: The Mulyan Creek Catchment (MCC) is located in the Central Tablelands of NSW, Australia, is approximately 270 km west of Sydney and occupies an area of 350 Km2. Groundwater chemistry in the catchment has been examined in order to assess the hydrogeological processes influencing dryland salinity. A strong relationship was found between the local geology and the major salts that ultimately control water quality and dryland salinity. Calcium, magnesium, sodium and chloride were found to be major elements of different salts. Calcium and magnesium carbonates mainly came from weathering and dissolution, and calcite precipitation of limestone, which is dominant in the northeastern part of the catchment. Sedimentary siltstone and blackshale, widespread in middle and southeastern parts of the catchment, produced silica through weathering. Dacite and basalt might have contributed in calcium as well. Some of the sodium and possibly most of the chloride were originated from the seawater and carried in by rainfall. Rhyolite and dacite have also contributed some of sodium and silica. Apart from the geology, reverse ion exchange and simple ion exchange have also influenced the water chemistry and subsequent dryland salinity.
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142. **Ground-water contribution to the salinity of the Upper Colorado River Basin**.
Warner, J. W., Heimes, F. J. and Middelburg, R. F.
USGS Water-Resources Investigations Report, U.S. Geological Survey, 113 p. (1985).
http://pubs.er.usgs.gov/publication/wri844198

Keywords: groundwater/ water salinization/ surveys/ hydrogeology/ watersheds/ saline water/ mineralogy
Abstract: A reconnaissance level study was conducted to estimate the ground-water contribution to the salinity of streamflow in the Upper Colorado River Basin. Salt-load estimates were derived from a mass balance using measurements of the quantity and quality of base flow. Ground-water inflow was considered to represent the bulk of the streamflow during the winter months of low flow. A one-time sampling of the base flow of streams in the Upper Colorado River Basin was conducted in December 1977 and January 1978. Data on discharge and specific conductance and samples for chemical analysis were collected at 142 sites in the Upper Colorado River Basin upstream from the confluence of the Colorado and Green Rivers. Available data were used for other areas in the Upper Colorado River Basin. In some of these areas, data were obtained from local and regional studies. Elsewhere, data were obtained from records from streamflow-gaging stations operated by the U.S. Geological Survey. The study area was divided into two major regions; the Green River basin (referred to here as the Green River region) and the Colorado River basin upstream from the confluence with the Green River (referred to here as the Colorado River region). These two regions were divided into nine subregions. The annual salt load contributed to streams by ground water in these subregions ranged from 30 to 93 percent. In general, the salt load contributed by ground water was larger in the Colorado River region than in the Green River region. The Colorado River region had an overall average ground-water salt-load contribution of 69 percent of the total compared with 38 percent for the Green River region. The estimated total base-flow salt load of the Upper Colorado River Basin above the confluence of the Colorado and Green Rivers was 3.8 million tons per year. This is about 55 percent of the total annual salt load. Diffuse ground-water discharge to streams accounts for most of the base-flow salt load. However, significant increases in the salt load along fairly short reaches in certain locations result from the surface-water solution of salts in the Upper Cretaceous shales, mostly the Mancos Shale; ground-water discharge from highly saline formations, such as the Paradox Member of the Hermosa Formation of Pennsylvanian age; and from point sources, such as the highly saline mineral springs near Glenwood Springs, Colo., and Dotsero, Colo.

143. **Groundwater investigation of SO4(2-) diffusion from a Cretaceous Shale hillslope: upper Colorado River Basin**.
Duffy, C. J., Jurinak, J. J., Korom, S. and Corey, P.
Technical Completion Report. USGS Office of Water Research and Technology, 160 p. (1989).
Keywords: Colorado River Basin/ slopes/ hydrology/ salinity/ solute transport/ shale/ groundwater quality/ advection/ diffusion/ dispersion/ shallow aquifers/ water pollution sources/ path of pollutants/ saline soils/ model studies
Abstract: This research examines the role of advection, diffusion, and dispersion in the generation and transport of groundwater salinity from hillslopes to streams of the Upper Colorado River Basin. The study coordinated field experiments and theoretical-computer experiments to gain insight into the way that subsurface salinity fronts are mobilized and transported from hillslopes of the region, and to better understand the mechanics of the groundwater system within surficial deposits which generate the observed accumulation of salinity in the Colorado River system. The field situation is that excess irrigation water from snowmelt runoff infiltrates, generates a shallow saturated zone and ultimately produces stream salinization as return flow. The following two mechanisms are proposed: (1) The formation of a shallow aquifer and accelerated displacement of salts from alluvial sediments on the lower portion of hillslopes. This displacement is a natural consequence of excess irrigation and canal seepage. (2) The diffusion of saline pore fluids from a low permeability marine shale which underlies the shallow aquifer. Since the marine, Mancos Shale, underlies most of the irrigated land of the basin, the potential for diffusive salt loading from this formation constitutes a major nonpoint source of downstream salinity.

144. **Groundwater quality in the semi-arid region of the Chahardouly basin, West Iran**.
Tizro, A. T. and Voudouris, K. S.
Hydrological Processes 22: 3066-3078 (2008).
ISSN: 0885-6087
http://dx.doi.org/10.1002/hyp.6893
Keywords: aquifers/ bicarbonates/ calcium/ catchment hydrology/ electrical conductivity/ evaporation/ geology/ groundwater/ rain/ saline water/ salinity/ semi-arid climate/ semi-arid zones/ sodium/ suspended solids/ water balance/ water quality/ watersheds/ wells/ catchment areas/ rainfall/ salt water/ water chemistry/ water composition and quality/ Middle East/ developing countries/ Iran
Abstract: Chahardouly basin is located in the western part of Iran and is characterized by semi-arid climatic conditions and scarcity in water resources. The main aquifer systems are developed within alluvial deposits. The availability of groundwater is rather erratic owing to the occurrence of hard rock formation and a saline zone in some parts of the area. The aquifer systems of the area show signs of depletion, which have taken place in recent years due to a decline in water levels. Groundwater samples collected from shallow and deep wells were analysed to examine the quality characteristics of groundwater. The major ion chemistry of groundwater is dominated by Ca2+ and HCO3-, while higher values of total dissolved solids (TDS) in groundwater are associated with high concentrations of all major ions. An increase in salinity is recorded in the down-gradient part of the basin. The occurrence of saline groundwater, as witnessed by the high electrical conductivity (EC), may be attributed to the long residence time of water and the dissolution of minerals, as well as evaporation of rainfall and irrigation return flow. Based on SAR values and sodium content (%Na), salinity appears to be responsible for the poor groundwater quality, rendering most of the samples not suitable for irrigation use.
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145. **Groundwater salinisation mechanisms in arid and semi arid regions of Australia**.
Evans, R. E.
Abstracts with Programs - Geological Society of America 30: 203-203 (1998). ISSN: 0016-7592
Keywords: water/ water quality/ migration/ terrestrial environment/ recycling/ Australasia/ arid environment/ surface water/ semi-arid environment/ pumping/ unsaturated zone/ mechanism/ atmospheric precipitation/ salinity/ vegetation/ aquifers/ groundwater/ irrigation/ water table/ recharge/ levels/ hydrogeology/ Australia/ salinization
Abstract: A range of different mechanisms exist in arid and semi arid Australia to produce an increase in the salinity of groundwater--so called, groundwater salinisation (these are in no way related to or associated with conventional sea water intrusion). Groundwater salinisation is where there is a relatively rapid increase in salinity--in time ranging from years to centuries. This is often caused by some relatively modern process, typically European farming practices. The major mechanisms are: 1. Increased Recharge: The clearing of deep rooted native vegetation (principally trees) over large parts of Australia and replacement with shallow rooted grasses has resulted in a major increase in recharge. Thick unsaturated zones also exist which have high salt storages, often at a depth of 2 to 4 metres, within the root zone of the original native vegetation. The increased vertical recharge mobilises the salt stored in the unsaturated zone which is flushed down to the water table resulting in increased groundwater salinity. 2. Recycling: The pumping of groundwater to the surface for irrigation causes a gradual increase in the salinity of the groundwater by recycling. In this case, the irrigated pasture, trees or crops use the "fresh" water leaving the salt in the groundwater to be flushed downwards to the aquifer by both excess irrigation water and by rain water. 3. Migration: Pumping good quality groundwater which is surrounded, vertically and horizontally, by adjacent poor quality groundwater causes the irrigation of the poor groundwater and results in quality degradation of the pumped groundwater. This degradation can be relatively rapid, in the order of only a few years. 4. Water Table Rise: Water table rise can cause salt previously stored in the unsaturated zone to be mixed in the aquifer resulting in a salinity increase. 5. Other: Increased flow of saline groundwater into good quality groundwater as a consequence of higher pressures in the saline aquifers. Importing salt in surface water which is used for irrigation and which then recharges the groundwater. Understanding the mechanisms for groundwater salinisation is essential to enable strategies to be developed to counter this potentially major long term degradation process.
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146. **Ground-water salinity problems related to irrigation in the Colorado River basin**.
El-Ashry, M. T.
Ground Water 18: 37-45 (1980).
http://dx.doi.org/10.1111/j.1745-6584.1980.tb03369.x
Keywords: salinity/ groundwater/ irrigation/ Colorado River Basin/ saline water/ salts/ water quality/ water quality control/ leaching/ aquifers/ irrigation water/ irrigation practices/ irrigation operation and maintenance/ irrigation effects/ agriculture
Abstract: The groundwater system in many of the irrigated areas of the Colorado River Basin is derived almost entirely from deep percolation of irrigation water and seepage from irrigation conveyance and tailwater collection systems. Salt pickup rates from irrigated soils in the basin vary in the different areas. Among the high salt pickup areas is the Grand Valley in western Colorado, estimated at 8 tons/acre/year. Water entering the groundwater supply from irrigation practices in the valley amounts to about 145,000 acre-feet/year and contributes about 690,000 tons/year to the salt load of the Colorado River. Samples of base-flow water from the weathered Mancos Shale aquifer in the valley vary in salinity from about 1,500 to about 9,000 mg/l with a mean of 4,100 mg/l; while water samples from alluvial aquifers range from 305 to 124,000 mg/l with a mean of about 11,500 mg/l. Base-flow returning to the river in the drains and washes has concentrations that average about 4,200 mg/l. Water losses and quantities of irrigation return flows can be reduced by improving farm irrigation efficiencies and by partial or complete lining of canals, laterals, and ditches. Increasing on-farm irrigation efficiency through system improvements and irrigation scheduling is the most cost-effective measure. However, achievement of higher efficiencies will require changes in water laws to encourage conservation and revised water pricing policies that discourage waste. (Sims-ISWS)
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147. **Groundwater–surface water interactions in a large semi-arid floodplain: implications for salinity management**.
Lamontagne, S., Leaney, F. W. and Herczeg, A. L.
Hydrological Processes 19: 3063-3080 (2005).
ISSN: 1099-1085
http://dx.doi.org/10.1002/hyp.5832
Keywords: Murray River/ salinity/ environmental tracers/ floodplain/ groundwater-surface water interactions
Abstract: Flow regulation and water diversion for irrigation have considerably impacted the exchange of surface water between the Murray River and its floodplains. However, the way in which river regulation has impacted groundwater–surface water interactions is not completely understood, especially in regards to the salinization and accompanying vegetation dieback currently occurring in many of the floodplains. Groundwater–surface water interactions were studied over a 2 year period in the riparian area of a large floodplain (Hattah–Kulkyne, Victoria) using a combination of piezometric surface monitoring and environmental tracers (Cl−, δ2H, and δ18O). Despite being located in a local and regional groundwater discharge zone, the Murray River is a losing stream under low flow conditions at Hattah–Kulkyne. The discharge zone for local groundwater, regional groundwater and bank recharge is in the floodplain within ~1 km of the river and is probably driven by high rates of transpiration by the riparian Eucalyptus camaldulensis woodland. Environmental tracers data suggest that the origin of groundwater is principally bank recharge in the riparian zone and a combination of diffuse rainfall recharge and localized floodwater recharge elsewhere in the floodplain. Although the Murray River was losing under low flows, bank discharge occurred during some flood recession periods. The way in which the water table responded to changes in river level was a function of the type of stream bank present, with point bars providing a better connection to the alluvial aquifer than the more common clay-lined banks. Understanding the spatial variability in the hydraulic connection with the river channel and in vertical recharge following inundations will be critical to design effective salinity remediation strategies for large semi-arid floodplains. Copyright © 2005 John Wiley & Sons, Ltd.

148. **Historical BLM Mancos Shale management in NW CO**.
See record 11 in Rangeland Management Practices and Potential Impact on Salinity.

149. **Hydrochemical processes in an arid region of Europe (Almeria, SE Spain)**.
Sanchez Martos, F., Pulido Bosch, A. and Calaforra, J. M.
Applied Geochemistry 14: 735-745 (1999).
ISSN: 0883-2927
http://dx.doi.org/10.1016/S0883-2927(98)00094-8
Keywords: electrical conductivity/ magnesium/ terrestrial environment/ Spain/ halogens/ Andarax River basin/ salinity/ salt water/ temperature/ groundwater/ sedimentary rocks/ sampling/ geochemistry/ pH/ processes/ chlorine/ Andarax River valley/ alkaline earth metals/ sulfate ion/ arid environment/ human activity/ lithium/ alkali metals/ Tabernas Gully/ hydrochemistry/ aquifers/ metals/ hydrochemistry/ boron/ carbonate rocks
Abstract: In the Lower Andarax river basin, three aquifer units have been defined, namely the carbonate, the deep and the detrital aquifers, which between them contain a wide variety of water types. Identification of hydrogeochemical processes has been performed by studying a series of ionic ratios, comprising the principal constituents of groundwaters with high concentrations together with B and Li (Cl vs SO (sub 4), Cl vs Mg, Cl vs Li, B vs Li). Among the processes detected the circulation of groundwaters with high concentrations of SO (sub 4) was found to have significant effects. Moreover, in the coastal region, naturally occurring processes related to the flushing of saline waters from sediments of marine origin occur in conjunction with others, clearly of human origin, that are related to saltwater intrusion. A further factor is the entry, from overlying deposits of waters with a high saline content; this salinity is related to the flushing of sediments of marine origin. The use of B and Li together enables waters in which salinity is related to sea-water to be distinguished from others in which salinity is related to evaporitic layers or to thermal areas. The concentration of Li is directly related to water T, whereas that of B is greater in the most saline sectors, of gypsiferous and/or sea-water origin.
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150. **Hydrogeochemical processes in arid and semi-arid regions; focus on North Africa**.
Edmunds, W. M. and Simmers, I.
International Contributions to Hydrogeology 23: 251-287 (2003). ISSN: 0936-3912
Keywords: Nile Valley/ terrestrial environment/ isotopes/ halogens/ semi-arid environment/ unsaturated zone/ tritium/ groundwater/ hydrologic cycle/ radioactive isotopes/ water-rock interaction/ Senegal/ chloride ion/ Louga Senegal/ geochemistry/ Surt Basin/ Wadi Hawad/ hydrology/ chlorine/ concentration/ rainfall/ paleohydrology/ arid environment/ Cl-36/ Libya/ Sudan/ hydrochemistry/ hydrogen/ Africa/ Botswana/ hydrogeology/ Kalahari Desert/ salinization/ Sahel
Abstract: Hydrogeochemical processes in arid and semi-arid zones are described, following the pathway of water through the hydrological cycle from rainfall via the unsaturated zone to groundwater. Detailed studies using a combination of chemical and isotopic techniques are recommended to understand the evolution of groundwater quality in arid regions, especially since it is important to be able to distinguish modern recharge from widespread palaeowaters recharged under much wetter climate conditions. Once the groundwater system is properly understood it is possible to monitor changes with simple tools such as Cl, NO (sub 3) and SEC. The range of methods available for investigation of hydrochemical processes are reviewed, and are illustrated with various examples from the north African and Sahel region of Africa. The chemical and isotopic information in the unsaturated zone may be used to estimate recharge and the build-up of salinity. In the saturated zone the evolution of groundwater chemistry may be understood by following hydrochemical changes along flow lines, especially in confined aquifers. A case study from Wadi Hawad in central Sudan is used to explain the links between surface and groundwater quality using a combination of isotopic and chemical studies, which clearly distinguish areas of modern recharge and the identity of palaeowaters.
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151. **Hydrological connectivity of soil pipes determined by ground-penetrating radar tracer detection**.
Holden, J.
Earth Surface Processes and Landforms 29: 437-442 (2004). ISSN: 1096-9837
http://dx.doi.org/10.1002/esp.1039
Keywords: ground-penetrating radar/ soil pipes/ peat/ uplands/ runoff/ tracers/ subsurface hydrology/ pipeflow

Abstract: Soil pipes are common and important features of many catchments, particularly in semi-arid and humid areas, and can contribute a large proportion of runoff to river systems. They may also significantly influence catchment sediment and solute yield. However, there are often problems in finding and defining soil pipe networks which are located deep below the surface. Ground-penetrating radar (GPR) has been used for non-destructive identification and mapping of soil pipes in blanket peat catchments. While GPR can identify subsurface cavities, it cannot alone determine hydrological connectivity between one cavity and another. This paper presents results from an experiment to test the ability of GPR to establish hydrological connectivity between pipes through use of a tracer solution. Sodium chloride was injected into pipe cavities previously detected by the radar. The GPR was placed downslope of the injection points and positioned on the ground directly above detected soil pipes. The resultant radargrams showed significant changes in reflectance from some cavities and no change from others. Pipe waters were sampled in order to check the radar results. Changes in electrical conductivity of the pipe water could be detected by the GPR, without data post-processing, when background levels were increased by more than approximately twofold. It was thus possible to rapidly determine hydrological connectivity of soil pipes within dense pipe networks across hillslopes without ground disturbance. It was also possible to remotely measure travel times through pipe systems; the passing of the salt wave below the GPR produced an easily detectable signal on the radargram which required no post-processing. The technique should allow remote sensing of water sources and sinks for soil pipes below the surface. The improved understanding of flowpath connectivity will be important for understanding water delivery, solutional and particulate denudation, and hydrological and geomorphological model development. Copyright © 2004 John Wiley & Sons, Ltd.

152. **Hydrosalinity fluxes in a small scale catchment of the Berg river (South Africa)**.
Jovanovic, N. Z., Bugan, R. D., Frantz, G., De Clercq, W. and Fey, M.
9th International Conference on Modelling, Monitoring and Management of Water Pollution, Water Pollution 2008, Stellenbosch, South Africa (2008).
http://dx.doi.org/10.2495/WP080591
Keywords: Berg River/ dryland salinity/ hydrosalinity fluxes/ runoff/ South Africa/ throughflow/ catchment/ flux measurement/ salinity/ salinization/ semi-arid regions/ soil water
Abstract: The occurrence of dryland salinity is widespread throughout semi-arid regions of the world. The sources of salts may be either rock weathering or rain deposition. Clearing of natural scrubland to make way for cultivated crops and pastures may also change the water balance, trigger salt mobilization and increase the salinity of water resources. These processes are suspected to be the main cause for salinization of the Berg river catchment (South Africa). The objective of this study was to determine the hydrosalinity fluxes associated with overland and subsurface (vadose zone) flow for different soils and land uses. For this purpose, the following data were collected during 2006 in a typical small scale catchment (~40 ha) located near the town of Riebeek West: weather data, hydrological and water quality measurements, soil water contents and chemistry. The climate of the area is Mediterranean with winter rainfall of about 350 mm a -1. The chemical speciation of water and soil solution in the catchment is conservative, with Na + and Cl - being the dominant ions. Soil water and salt contents varied seasonally. Due to the typical low intensity of rainfall, the fluxes of salts during individual runoff events were steady. Fluctuations in salinity due to local processes were buffered at a catchment scale. Uncultivated (bare) soil produced more runoff and higher salinity compared to pasture land. Overland flow varied between 3 and 18% of rainfall, mobilizing up to 24 g m -2 of salts during 2006, depending on soil properties, slopes, rainfall intensity and duration, and antecedent moisture conditions. Subsurface fluxes of water and salts were estimated with the HYDRUS-2D model. Management practices at farm scale are required in order to reduce salt mobilization and salinization at catchment scale.
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153. **Identification of sources of ground-water salinization using geochemical techniques**.
Richter, B. C. and Kreitler, C. W., U.S. Environmental Protection Agency, (1991).
http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=30000HXE.txt

Keywords: groundwater/ water salinization/ geochemistry/ water quality
Abstract: This report deals with salt-water sources that commonly mix and deteriorate fresh ground water. It reviews characteristics of salt-water sources and geochemical techniques that can be used to identify these sources after mixing has occurred. The report is designed to assist investigators of salt-water problems in a step-by-step fashion. Seven major sources of salt water are distinguished: (1) Natural saline ground water, (2) Halite solution, (3) Sea-water intrusion, (4) Oil-and gas-field brines, (5) Agricultural effluents, (6) Saline seep, and (7) Road salting. The geographic distribution of these, sources was mapped individually and together, illustrating which ones are potential sources at any given area in the United States. In separate sections, each potential source is then discussed in detail regarding physical and chemical characteristics, examples of known techniques for identification of mixtures between fresh water and that source, and known occurrences by state. Individual geochemical parameters that are used within these techniques are presented in a separate section, followed by a discussion concerning where and how to obtain them. Also provided is a description of basic graphical and statistical methods that are used frequently in salt-water studies. An extensive list of references for further study concludes this report.

154. **Impact of land use and land cover change on groundwater recharge and quality in the southwestern US**.
Scanlon, B. R., Reedy, R. C., Stonestrom, D. A., Prudic, D. E. and Dennehy, K. F.
Global Change Biology 11: 1577-1593 (2005).
ISSN: 1354-1013
http://dx.doi.org/10.1111/j.1365-2486.2005.01026.x
Keywords: agriculture/ drylands/ ecohydrology/ global change/ groundwater contamination/ groundwater recharge/ irrigation/ land cover/ land use/ nitrate/ nitrogen/ water resources/ groundwater pollution/ land use change/ recharge/ North America/ United States
Abstract: Humans have exerted large-scale changes on the terrestrial biosphere, primarily through agriculture; however, the impacts of such changes on the hydrologic cycle are poorly understood. The purpose of this study was to test the hypothesis that the conversion of natural rangeland ecosystems to agricultural ecosystems impacts the subsurface portion of the hydrologic cycle by changing groundwater recharge and flushing salts to underlying aquifers. The hypothesis was examined through point and areal studies investigating the effects of land use/land cover (LU/LC) changes on groundwater recharge and solute transport in the Amargosa Desert (AD) in Nevada and in the High Plains (HP) in Texas, US. Studies use the fact that matric (pore-water-pressure) potential and environmental-tracer profiles in thick unsaturated zones archive past changes in recharging fluxes. Results show that recharge is related to LU/LC as follows: Discharge through evapotranspiration (i.e., no recharge; upward fluxes <0.1 mm yr-1) in natural rangeland ecosystems (low matric potentials; high chloride and nitrate concentrations); moderate-to-high recharge in irrigated agricultural ecosystems (high matric potentials; low-to-moderate chloride and nitrate concentrations) (AD recharge: ~130-640 mm yr-1); and moderate recharge in nonirrigated (dryland) agricultural ecosystems (high matric potentials; low chloride and nitrate concentrations, and increasing groundwater levels) (HP recharge: ~9-32 mm yr-1). Replacement of rangeland with agriculture changed flow directions from upward (discharge) to downward (recharge). Recent replacement of rangeland with irrigated ecosystems was documented through downward displacement of chloride and nitrate fronts. Thick unsaturated zones contain a reservoir of salts that are readily mobilized under increased recharge related to LU/LC changes, potentially degrading groundwater quality. Sustainable land use requires quantitative knowledge of the linkages between ecosystem change, recharge, and groundwater quality. © 2005 Blackwell Publishing Ltd.
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155. **Impacts of climate change on groundwater recharge and salinization of groundwater resources in Senegal**.
Faye, S., Diaw, M., Ndoye, S., Malou, R. and Faye, A.
IAHS-AISH Publication 334: 163-173 (2009).
ISSN: 0144-7815
Keywords: oxygen/ salt-water intrusion/ isotopes/ salinity/ climate change/ stable isotopes/ groundwater/ Senegal/ drainage basins/ estuarine environment/ environmental geology/ Saloum Delta/ annual variations/ Dakar, Senegal/ isotope ratios/ surface water/

O-18/O-16/ Casamance Delta/ aquifers/ West Africa/ water table/ fluctuations/ recharge/ hydrogen/ Africa/ hydrogeology/ shallow aquifers/ water resources/ salinization/ Senegal River

Abstract: Climate variability and climate change affect groundwater resources through changes in the timing and magnitude of recharge, the interaction between groundwater and surface waters, and water withdrawals. Evaluation of these impacts is essential for long-term water resource management, especially in semi-arid regions where the availability of resources is often the key to economic development. In Senegal, hypersalinity occurs upstream in tidal estuaries with salinisation of groundwater in shallow aquifers up to 200 km inland. Recent studies on several aquifers (Senegal River Delta System, North Coast Littoral, Saloum Delta and the Casamance Delta) reveal high sensitivities to climate variability and climate change. Hydrochemical evidence together with numerical and analytical models informs regional groundwater recharge and flow. Sensitivity analyses involving reductions of 10-25% in mean annual recharge reveal only minor changes in the seasonality of water-table fluctuations. In the North Coast Littoral and Saloum Delta systems, changes (-1.2 to -3 m water table lowering) are more pronounced in the high water-level zone (corresponding to the high altitude zone) where recharge mostly occurs; whereas values are negligible to nil in the lower water-level region. In the Casamance catchment and the Senegal River catchments, recharge regimes deduced from the water-table fluctuation method and isotopic signatures suggest that climate change will impact these systems, but the magnitude of these impacts will vary under different geomorphological settings.
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156. **Impacts of climate changes on water resources in Africa with emphasis on groundwater**.
Al-Gamal, S. and Dodo, A. K.
Journal of Environmental Hydrology 17 (2009).
Keywords: aquifers/ resource management/ water availability/ rainfall/ climatic changes/ water resources/ watersheds/ groundwater/ hydrology/ water demand/ temperature effects/ marine/ groundwater recharge/ temperature/ drying/ precipitation/ tidal surges/ sea level/ geohydrology/ evaluation process/ groundwater/ runoff/ sea level changes

Abstract: Climate change is likely to impact groundwater resources, either directly, e.g. via changing precipitation patterns, or indirectly, e.g. through the interaction of changing precipitation patterns with changing land-use practices and water demand. These changes may affect both groundwater quantity and quality. Climate change will affect groundwater recharge rates and groundwater levels. Any decrease in groundwater recharge will exacerbate the effect of sea-level rise in coastal areas. In inland aquifers, a decrease in groundwater recharge can lead to saltwater intrusion from underlying saline aquifers, and increased evapotranspiration in semi-arid and arid regions may lead to the salinization of shallow aquifers. In Africa, climate change and variability have the potential to impose additional pressures on water availability, water accessibility and water demand. A 1 degree C increase in temperature could change runoff by 10%, assuming that precipitation levels remain constant. If such an annual decrease in runoff were to occur, the impacts could be equivalent to the loss of one large dam per year in a given watershed. Temperature and precipitation in the African Sahel are negatively correlated - seasonal warming was accompanied by late 20th century drying.
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157. **Impacts of stream-aquifer connectedness on bank infiltration, seepage, and solute transport during semi-arid flooding**.
Desilets, S. L., Ferré, T. P. and Troch, P. A.
2007 American Geophysical Union Fall Meeting, San Francisco, CA (2007).
Keywords: water table depth/ ecosystems/ water table/ seepage/ freshwater/ environmental factors/ streams/ solutes/ floods/ water depth/ water treatment and distribution/ seepage/ vadose water/ rivers/ runoff/ underground services and water use/ tracking/ water balance/ root zone/ river banks/ infiltration rate/ numerical simulations/ solute transport/ flooding/ infiltration

Abstract: Transient storage of flood water in stream banks during high flow conditions plays a unique role in semi-arid environments. In ephemeral streams, water infiltrated during flood events is a significant component of the water balance, is essential for sustaining low flows, and plays a critical role in sustaining a riparian habitat. This work examines the role of steam-aquifer connectedness in affecting differences of

floodwater distribution in the stream banks. We consider a range of vadose zone depths from closely-connected streams, common to humid areas, to increasingly disconnected streams, common to semi-arid areas. Specifically, we address the question of how stream-aquifer connectedness affects infiltration rate, quantity of seepage, and distribution of solutes. We use the variable saturation code HYDRUS 2-D to simulate transient flow and solute transport. These simulations show a significant change in water distribution for a short change (5 m) in water table depth. In particular, during flooding, cumulative infiltration increases sharply with increasing depth of the water table. During recession, total bank seepage decreases sharply with increasing depth of the water table. Capture zones determined from particle tracking show that only a small area that extends laterally above and below the base of the stream contributes to seepage. Solute transport in connected systems is predominantly horizontal through the shallow root zone. However, for thick vadose zones, a small fraction of solutes in the area of the root zone will be affected by infiltrating water, and those that are mobilized will move predominantly toward the water table, rather than back toward the stream. The maximum transitional depth between humid-like connected behaviors and those in a disconnected system is only 5 m. This implies that riverine ecosystems under pressure from various water demands can expect significant changes in water distribution in the root zone area for even modest lowering of the water table.
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158. **Implication of groundwater fluctuation on the seasonal salt dynamic in the Harran Plain, south-eastern Turkey**.
Çullu, M. A., AydemiR, S., QadiR, M., Almaca, A., Öztürkmen, A. R., BiLgiÇ, A. and Ağca, N.
Irrigation and Drainage 59: 465-476 (2010).
ISSN: 1531-0361
http://dx.doi.org/10.1002/ird.507
Keywords: groundwater fluctuation/ salt movement/ irrigated soils/ salinization/ water management/ Turkey
Abstract: Inefficient farm-level water management aggravates groundwater fluctuation and salt accumulation particularly in arid and semi-arid irrigated agriculture. Inappropriate water management practices in the Harran Plain are a good example. A study was carried out to investigate the effect of groundwater fluctuation on the seasonal salt dynamic in four widespread soil series in the Harran Plain with different natural drainage, south-eastern Turkey. Four profiles were excavated and soil samples were collected seasonally up to 100 cm depth with 10 cm intervals. Similarly, irrigation and groundwater samples were collected from the fields where soil sampling was carried out. Significant seasonal variations in the salt dynamic were observed with the fluctuation levels of the groundwater. Total salt content at 1 m soil depth remained constant during the year, however salt fluctuation throughout the root zone in the growing season exceeded the threshold values of corn, wheat and cotton, commonly grown crops in the region, of 1.7, 6.0 and 7.7 dS m^{-1}, respectively. However, soils with less water fluctuation showed lower salt accumulation in the root zone from May to October. Results also confirmed that soils can be non-saline, but groundwater salinity, which may not be point specific, requires special attention. Copyright © 2009 John Wiley & Sons, Ltd.

159. **Implications of deep drainage through saline clay for groundwater recharge and sustainable cropping in a semi-arid catchment, Australia**.
See record 56 in Rangeland Management Practices and Potential Impact on Water.

160. **Infiltration from an impoundment for coal-bed natural gas, Powder River Basin, Wyoming: Evolution of water and sediment chemistry**.
Healy, R. W., Rice, C. A., Bartos, T. T. and Mckinley, M. P.
Water Resources Research 44 (2008).
http://dx.doi.org/10.1029/2007WR006396
Keywords: gypsum/ impoundments/ total dissolved solids
Abstract: Development of coal-bed natural gas (CBNG) in the Powder River Basin, Wyoming, has increased substantially in recent years. Among environmental concerns associated with this development is the fate of groundwater removed with the gas. A preferred water-management option is storage in surface impoundments. As of January 2007, permits for more than 4000 impoundments had been issued within Wyoming. A study was conducted on changes in water and sediment chemistry as

water from an impoundment infiltrated the subsurface. Sediment cores were collected prior to operation of the impoundment and after its closure and reclamation. Suction lysimeters were used to collect water samples from beneath the impoundment. Large amounts of chloride (12,300 kg) and nitrate (13,500 kg as N), most of which accumulated naturally in the sediments over thousands of years, were released into groundwater by infiltrating water. Nitrate was more readily flushed from the sediments than chloride. If sediments at other impoundment locations contain similar amounts of chloride and nitrate, impoundments already permitted could release over 48,106 kg of chloride and 52,106 kg of nitrate into groundwater in the basin. A solute plume with total dissolved solid (TDS) concentrations at times exceeding 100,000 mg/L was created in the subsurface. TDS concentrations in the plume were substantially greater than those in the CBNG water (about 2.300 mg/L) and in the ambient shallow groundwater (about 8000 mg/L). Sulfate, sodium, and magnesium are the dominant ions in the plume. The elevated concentrations are attributed to cation-exchange-enhanced gypsum dissolution. As gypsum dissolves, calcium goes into solution and is exchanged for sodium and magnesium on clays. Removal of calcium from solution allows further gypsum dissolution.
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161. **Integrated modeling of flow and transport processes in salt-affected soil**.
Van Genuchten, M. T. and Simunek, J.
International Salinity Forum. Managing Saline Soils and Water: Science, Technology, and Soil Issues, Riverside CA (2005).
Keywords: models/ soil erosion/ saline soils/ computer software/ hydrogeology/ soil transport processes

162. **Inventories and mobilization of unsaturated zone sulfate, fluoride, and chloride related to land use change in semiarid regions, southwestern United States and Australia**.
Scanlon, B. R., Stonestrom, D. A., Reedy, R. C., Leaney, F. W., Gates, J. and Cresswell, R. G.
Water Resources Research 45: W00A18 (2009).
http://dx.doi.org/10.1029/2008WR006963
Keywords: surveys/ groundwater/ saline water/ semi-arid zones/ land use/ soil salinity/ saline soils/ water quality/ sulfates/ fluorides/ chlorides
Abstract: Unsaturated zone salt reservoirs are potentially mobilized by increased groundwater recharge as semiarid lands are cultivated. This study explores the amounts of pore water sulfate and fluoride relative to chloride in unsaturated zone profiles, evaluates their sources, estimates mobilization due to past land use change, and assesses the impacts on groundwater quality. Inventories of water-extractable chloride, sulfate, and fluoride were determined from borehole samples of soils and sediments collected beneath natural ecosystems (N = 4), non-irrigated ("rain-fed") croplands (N = 18), and irrigated croplands (N = 6) in the southwestern United States and in the Murray Basin, Australia. Natural ecosystems contain generally large sulfate inventories (7,800–120,000 kg/ha) and lower fluoride inventories (630–3,900 kg/ha) relative to chloride inventories (6,600–41,000 kg/ha). Order-of-magnitude higher chloride concentrations in precipitation and generally longer accumulation times result in much larger chloride inventories in the Murray Basin than in the southwestern United States. Atmospheric deposition during the current dry interglacial climatic regime accounts for most of the measured sulfate in both U.S. and Australian regions. Fluoride inventories are greater than can be accounted for by atmospheric deposition in most cases, suggesting that fluoride may accumulate across glacial/interglacial climatic cycles. Chemical modeling indicates that fluorite controls fluoride mobility and suggests that water-extractable fluoride may include some fluoride from mineral dissolution. Increased groundwater drainage/recharge following land use change readily mobilized chloride. Sulfate displacement fronts matched or lagged chloride fronts by up to 4 m. In contrast, fluoride mobilization was minimal in all regions. Understanding linkages between salt inventories, increased recharge, and groundwater quality is important for quantifying impacts of anthropogenic activities on groundwater quality and is required for remediating salinity problems.
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163. **Ionic composition of vadose zone water in an arid region**.
Rice, R. C., Bowman, R. S. and Bouwer, H.
Ground Water 27: 813-822 (1989). ISSN: 0017-467X
http://dx.doi.org/10.1111/j.1745-6584.1989.tb01045.x
Keywords: soil/ electrical conductivity/ terrestrial environment/ geophysical surveys/ arid environment/ unsaturated zone/ Salt River valley/ salinity/ ions/ hydrochemistry/ groundwater/ Arizona/ runoff/ hydrogeology/ chemical composition/ geochemistry
Abstract: The ionic composition of water in the vadose zone of the Salt River Valley in south central Arizona was studied for three different water regimes: desert, irrigated, and flooded by urban runoff. The desert area exhibited high salinity in the top 10 m, probably due to concentration of salts over several years. Below 15 m the salinity decreased with depth and approached the salinity of the native groundwater. For the irrigated area the chemical composition of the soil water was similar to that of the applied water but concentrations were higher. The irrigation efficiency calculated from the salinities of the irrigation and soil water was 78%. The average NO3 concentration from five of six sites was 100 mg/L, but was as high as 24,000 mg/L at another. Soil water from the urban runoff site had an electrical conductivity that was about three times less than that from the irrigated site, showing the effect of leaching with rain water. The observed salt distributions in the vadose zone were reasonably correlated to land use at the sites sampled. (Author 's abstract)
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164. **Major ion chemistry of groundwater in the extreme arid region northwest China**.
Si, J., Feng, Q., Wen, X., Su, Y., Xi, H. and Chang, Z.
Environmental Geology (Berlin) 57: 1079-1087 (2009). ISSN: 0943-0105
http://dx.doi.org/10.1007/s00254-008-1394-x
Keywords: water quality/ electrical conductivity/ magnesium/ terrestrial environment/ halogens/ dolostone/ salinity/ drinking water/ ions/ groundwater/ statistical distribution/ sedimentary rocks/ major elements/ cesium/ water-rock interaction/ chloride ion/ Ejina Basin/ discharge/ chemical composition/ geochemistry/ environmental geology/ China/ Inner Mongolia/ chlorine/ alkaline earth metals/ carbonate ion/ sulfate ion/ arid environment/ alkali metals/ magnesite/ pollution/ hydrochemistry/ weathering/ calcite/ dissolved materials/ saturation/ metals/ hydrochemistry/ acidification/ carbonate rocks/ carbonates
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165. **Management of Dryland Saline Seeps**.
Halvorson, A. D. and Richardson, J. L.
Wallender, W. W. and Tanji, K. K.,
ASCE**:** 561-589 (2012).
http://www.ars.usda.gov/SP2UserFiles/Place/54070000/1990-1999documents/224%201990%20Halvorson%20ASCE%20Man%20&%20Report.pdf
Keywords: arid lands/ salinity/ water quality
Abstract: Covers the identification, diagnosis, control and reclamation of dryland saline seeps. Saline seeps result from a combination of geologic, climatic, hydrologic, and cultural (land-use) conditions.

166. **Mancos shale literature review on the Colorado Plateau**.
Lebron, I., Chandler, D. and Jackson, L., Bureau of Land Management, Moab, UT, 71 p. (2005).
http://archive.org/details/mancosshaleliter4226lebr
Keywords: salinity/ selenium/ geochemistry/ soil/ erosion/ sedimentation/ disturbance/ dust/ reclamation/ restoration/ vegetation/ soil crusts/ invasive species
Abstract: The main focus of the literature review project was to identify available information directly related to research in the Mancos Shale on the Colorado Plateau. The literature review was further focused on salinity and disturbance effects to the Mancos, in an effort to get relevant information into the hands of regional land manager's dealing with an array of management issues on Mancos landscapes. In some instances it was difficult to determine which of the 800+ citations should go into the hardcopy reference, and which should be relegated to the CD ROM version. It was clear that any research that dealt specifically with the Mancos Shale should go into the hard copy. The majority of these citations deal with salinity and geochemistry, and to a lesser degree the others deal principally with erosion or sedimentation. Since one of the objectives of the project was to identify research related to disturbance, dust issues and reclamation associated with the Mancos, and our review identified only minimal

references for this type of research directly on the Mancos, it was decided to include additional citations that deal with disturbance, dust and reclamation in other arid western US areas, principally in the Mojave Desert. Not placed in the hard copy report were multiple citations dealing with salinity and selenium related to agricultural lands on the Mancos since this review is focused primarily on natural landscape management issues. Additionally the hard copy list of citations does not include multiple geologic references and mineral assessment reports where the Mancos was involved however, these citations were placed on the CD ROM.

167. **A method for determining salt sources in surface waters**.
Shirinian-Orlando, A. A. and Uchrin, C. G.
Journal of the American Water Resources Association 36: 749-757 (2000).
http://dx.doi.org/10.1111/j.1752-1688.2000.tb04303.x
Keywords: salinization/ secondary soil salinization/ groundwater/ surface water/ TDS
Abstract: This paper presents a method for determining the causes of salinization of surface waters, in this case the upper Colorado River and its tributaries. The analysis, which includes a combination of statistical analysis and graphical methods, indicates that among the sources of salt (e.g., saline ground water discharge into surface waters and storm runoff both surface and shallow subsurface, and washing minerals into surface waters) the major contributor is saline ground water, which discharges into the river and streams. Data also points to salt plume intrusion into the river and streams from sources of salt in the aquifers.
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168. **Modeling Transport of Subsurface Salinity from a Mancos Shale Hillslope**.
Azimi-Zonooz, A. and Duffy, C. J.
Ground Water 31: 972-981 (1993).
http://info.ngwa.org/gwol/pdf/932659793.PDF
Keywords: subsurface salinity/ salinity control/ dispersive transport/ advective transport/ diffusive transport/ salinity measurement/ groundwater flow/ stream flow/ seepage/ percolation (fluids)/ shale/ mass transfer
Abstract: In the Upper Colorado River Basin, irrigated agriculture is associated with increasing stream salinity. In areas targeted for control of salinity transport to streams, as much as 90% of stream salinity has been estimated to originate from ground water flowing through salt-bearing stratum. Primary salt sources are the marine shales and the shale residuum that underlie the soils throughout much of the basin. Shallow subsurface flow systems, created by seepage from canals and deep percolation of irrigation water, are believed to be the primary agents leaching the salts from underlying shale deposits and carrying them to streams. This study attempts to determine the relative importance of advective, dispersive, and diffusive salt transport processes from the alluvium covered, shale hillslopes of the region. The results of various irrigation management schemes for appraising the possibility of controlling salt loading to streams are presented.

169. **Modelling of salt movement in the root zone**.
Meddahi, M. E., Mallants, D., Feyen, J. and Vereecken, H.
Science du sol (france) 31: 59-76 (1993).
Keywords: saline soils/ irrigation/ root zone/ salinity/ salts/ soil transport processes/ models/ arid zones/ semi-arid zones
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170. **On the connection between surface exposed fractures, atmospheric conditions and groundwater salinization in arid environment**.
Weisbrod, N., Dragila, M., Kamai, T., Pillersdorf, M., Cooper, C. and Anonymous
Abstracts with Programs - Geological Society of America (2006).
Keywords: terrestrial environment/ mechanism/ unsaturated zone/ groundwater/ temperature/ controls/ fractures/ transport/ thickness/ diurnal variations/ processes/ experimental studies/ numerical models/ arid environment/ matrix/ rates/ convection/ measurement/ water table/ evaporation/ dissolved materials/ infiltration/ hydrogeology/ salinization
Abstract: This research investigated a possible mechanism for groundwater salinization via surface-exposed fractures, and the effect that these fractures have on estimates of arid land evaporative losses. Groundwaters overlain by thick vadose zones of low permeability are generally thought to be protected from typical surface salinization problems. However, a fracture venting process could effectively shorten the protective thickness of the vadose

zone. If salts accumulated within the fractures are dissolved during infiltration events, these dissolved salts might reach the groundwater. Essentially, this mechanism could draw the contaminant salts from the matrix to the fracture surface by capillarity, and from there rapidly to the water table, effectively circumventing the natural barrier the matrix is presumed to provide. Intermediate-scale experimental measurements of evaporation from fractures were performed using a specially designed apparatus located in a climate control room. The experiments showed significant salt accumulation along fracture surfaces due to evaporation, and a reduction in long-term evaporation rate caused by salt accumulation. Evaporation rates were found to be strongly dependent on atmospheric temperature, with highest evaporation rates during cold nights when convective conditions within the fracture develop. Field measurements carried out inside a surface exposed fracture in the Negev Desert of Israel demonstrated that "convective conditions" occurs naturally and during large portions of the year. Numerical methods were used to establish the limits of the convective process and explore a greater number of parameters. The mechanism for convective venting of moist air from fractures driven by diurnal changes in atmospheric temperature was investigated by experimental and numerical methods. The mechanism was shown to have a significant potential to concentrate and transport salt and contaminants, and to enhance evaporative losses from the landscape.
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171. **On the Problem of Salt Diffusion in the Zone of Aeration**.
Ogilvy, N.
Water in the Unsaturated Zone, Vol II. Proceedings of the Wageningen Symposium, The Netherlands, June 19-25, 1966., International Association of Scientific Hydrology (1966).
Keywords: chemical processes/ water in soils/ infiltration/ salt flows
Abstract: With small amounts of infiltration which are generally observed in arid regions in the zone of aeration an ascending salt flow counteracts a descending convection salt transfer by infiltrating water. At distance from the solid walls of the rock skeleton exceeding the mean free path of translation of particles, diffusion in free interstitial water is similar to that in large solution volumes. In bound water, translation jumps of the particles occur with different frequency. Therefore, the diffusion coefficient in bound water may greatly differ from the corresponding free water coefficient. In rocks, the solute transfer in bound water is proportional to the rock's specific surface and the thickness of the bound water film. In sands, the solutes are mainly transferred in free water, while in clays they move primarily within the bound water. The diffusion phenomena in the zone of aeration of arid regions account for the processes of carbonate cementation of this zone, for the appearance of gypsum crusts in it and also for the observed relations between occurrence of ombrophytes and the groundwater salinity. (KNAPP-USGS)
© *ProQuest*

172. **Potential impact of convective fracture venting on salt-crust buildup and ground-water salinization in arid environments**.
Weisbrod, N. and Dragila, M. I.
Journal of Arid Environments 65: 386-399 (2006). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2005.07.011
Keywords: salinization/ fractures/ evaporation/ thermal convection/ efflorescent crusts/ arid land
Abstract: We present a conceptual model by which surface-exposed fractures could be the main source of aquifer salinization under arid conditions. Fractures in thick vadose zones of low permeability are considered the major conduit for aquifer recharge in arid and semi-arid lands. Evaporation of pore water from within fractures is hypothesized to be enhanced by convective air circulation within the fracture that vents moisture to the atmosphere. This phenomenon also enhances lateral movement of pore water from the adjacent matrix towards the fracture opening. Subsequent evaporation results in salt precipitation within the fracture that can be conducted to the aquifer during the rainy season. The proposed model suggests that most of the water vapor loss from fractures is driven by an inversion in the thermal gradient of the adjacent matrix during the cold nights rather than the hot days. This conceptual model is investigated theoretically and tested in a series of preliminary experimental studies.
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173. **Preliminary identification of Price River Basin salt pickup and transport processes**.
Riley, J. P., Bowles, D. S., Chadwick, D. G. and Grenney, W. J.
JAWRA Journal of the American Water Resources Association 15: 984-995 (1979).
ISSN: 1752-1688
http://dx.doi.org/10.1111/j.1752-1688.1979.tb01077.x
Keywords: channel erosion/ efflorescence/ erosion/ hydrologic models/ salinity/ sediment transport/ simulation
Abstract: The Price River is a significant contributor of salt to the Colorado River. Relatively pristine waters leaving the upper elevations of the basin degenerate into highly saline waters entering the Green River. The primary reason for this deterioration is the contact of the water with the Mancos shale, a marine deposit underlying most of the central basin. This paper presents the structure of an evolving model of the salt pick-up and transport processes in the Price River basin. The initial purpose of the model is to aid in the identification of the natural and man-modified hydro-salinity-sediment system of the basin, based on data collection and analysis in the field and the laboratory. This identification procedure will result in both a better qualitative understanding of the important physiochemical processes, and in a mathematical description of these processes. When the identification stage is complete, the model will be used as a management tool for such purposes as examining various strategies for reducing salt loads in the Price River and in other similar rivers.
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174. **Quantification of salt dust pathways from a groundwater-fed lake: Implications for salt budgets and dust emission rates**.
Zlotnik, V. A., Ong, J. B., Lenters, J. D., Schmieder, J. and Fritz, S. C.
Journal of Geophysical Research: Earth Surface 117 (2012).
http://dx.doi.org/10.1029/2011JF002107
Keywords: crusts/ emission rates/ groundwater/ lakes/ salt dust/ substrates
Abstract: Emissions of salt dust from the shores of saline lakes significantly impact lake chemistry, air quality, transportation, human health, and climate. Quantitative methods for assessing these emissions, however, are still in the developmental stage. We investigate salt pathways from groundwater to dust using an approach that takes advantage of opportune conditions at a groundwater-fed, saline lake in the Nebraska Sand Hills region. The mass of salt in the lakeshore surface crust and soil was measured, as well as in the dust on the surrounding dune field. These data, together with information on the lake hydrology, show that dust emission is an important mechanism controlling lake salinity, even though a mere fraction of the salt crust is deflated each year under extant climatic conditions. Wind data collected at the lake site indicate high wind speeds capable of dust mobilization. Therefore, the physical and chemical bonding of salts in the crust is offered as the primary limiting factor for dust emission rates.
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175. **A review of groundwater–surface water interactions in arid/semi-arid wetlands and the consequences of salinity for wetland ecology**.
Jolly, I. D., Mcewan, K. L. and Holland, K. L.
Ecohydrology 1: 43-58 (2008). ISSN: 1936-0592
http://dx.doi.org/10.1002/eco.6
Keywords: salinity/ ecology/ groundwater-surface water interactions/ wetlands
Abstract: In arid/semi-arid environments, where rainfall is seasonal, highly variable and significantly less than the evaporation rate, groundwater discharge can be a major component of the water and salt balance of a wetland, and hence a major determinant of wetland ecology. Under natural conditions, wetlands in arid/semi-arid zones occasionally experience periods of higher salinity as a consequence of the high evaporative conditions and the variability of inflows which provide dilution and flushing of the stored salt. However, due to the impacts of human population pressure and the associated changes in land use, surface water regulation, and water resource depletion, wetlands in arid/semi-arid environments are now often experiencing extended periods of high salinity. This article reviews the current knowledge of the role that groundwater–surface water (GW–SW) interactions play in the ecology of arid/semi-arid wetlands. The key findings of the review are as follows: * 1.GW–SW interactions in wetlands are highly dynamic, both temporally and spatially. Groundwater that is low in salinity has a beneficial impact on wetland ecology which can be diminished in dry periods when groundwater

levels, and hence, inflows to wetlands are reduced or even cease. Conversely, if groundwater is saline, and inflows increase due to raised groundwater levels caused by factors such as land use change and river regulation, then this may have a detrimental impact on the ecology of a wetland and its surrounding areas. * 2.GW–SW interactions in wetlands are mostly controlled by factors such as differences in head between the wetland surface water and groundwater, the local geomorphology of the wetland (in particular, the texture and chemistry of the wetland bed and banks), and the wetland and groundwater flow geometry. The GW–SW regime can be broadly classified into three types of flow regimes: (i) recharge—wetland loses surface water to the underlying aquifer; (ii) discharge—wetland gains water from the underlying aquifer; or (iii) flow-through—wetland gains water from the groundwater in some locations and loses it in others. However, it is important to note that individual wetlands may temporally change from one type to another depending on how the surface water levels in the wetland and the underlying groundwater levels change over time in response to climate, land use, and management. * 3.The salinity in wetlands of arid/semi-arid environments will vary naturally due to high evaporative conditions, sporadic rainfall, groundwater inflows, and freshening after rains or floods. However, wetlands are often at particular risk of secondary salinity because their generally lower elevation in the landscape exposes them to increased saline groundwater inflows caused by rising water tables. Terminal wetlands are potentially at higher risk than flow-through systems as there is no salt removal mechanism. * 4.Secondary salinity can impact on wetland biota through changes in both salinity and water regime, which result from the hydrological and hydrogeological changes associated with secondary salinity. Whilst there have been some detailed studies of these interactions for some Australian riparian tree species, the combined effects on aquatic biodiversity are only just beginning to be elucidated, and are therefore, a future research need. * 5.Rainfall/flow-pulses, which are a well-recognized control on ecological function in arid/semi-arid areas, also play an important, though indirect, role through their impact on wetland salinity. Freshwater pulses can be the primary means by which salt stored in both the water column and the underlying sediments are flushed from wetlands. Conversely, increased runoff is also a commonly observed consequence of secondary salinity, and so, wetlands can experience increased surface water inflows that are higher in salinity than under natural conditions. Moreover, changes in rainfall/flow-pulse regimes can have a significant impact on wetland GW–SW interactions. It is possible that in some instances groundwater inflow to a wetland may become so heavy that it could become a major component of the water balance, and hence, mask the role of natural pulsing regimes. However, if the groundwater is low in salinity, this may provide an ecological benefit in arid/semi-arid areas by assisting in maintaining water in wetlands that become aquatic refugia between flow-pulses. * 6.There has been almost no modelling of GW–SW interactions in arid/semi-arid wetlands with respect to water fluxes, let alone salinity or ecology. There is a clear need to develop modelling capabilities for the movement of salt to, from, and within wetlands to provide temporal predictions of wetland salinity which can be used to assess ecosystem outcomes. * 7.There has been a concerted effort in Australia to collect and collate data on the salinity tolerance/sensitivity of freshwater aquatic biota and riparian vegetation. There are many shortcomings and knowledge gaps in these data, a fact recognized by many of the authors of this work. Particularly notable is that there is very little time-series data, which is a serious issue because wetland salinities are often highly temporally variable. There is also a concern that many of the data are from very controlled laboratory experiments, which may not represent the highly variable and unpredictable conditions experienced in the field. In light of these, and many other shortcomings identified, our view is that the data currently available are a useful guide but must be used with some caution. Copyright © 2008 John Wiley & Sons, Ltd.

176. **River basin salinity management via the ASTRAN method: I. Model development**.
Khan, I. A. and Labadie, J. W.
Journal of Hydrology 42: 301-321 (1979). ISSN: 0022-1694
http://dx.doi.org/10.1016/0022-1694(79)90053-2
Keywords: soil salinity/ models/ watersheds/ river basins/ salt transport
Abstract: A new salinity management strategy for irrigated stream-aquifer systems, called the accelerated salt transport (ASTRAN) method, is described. It is based on the idea that the

generally slow salt transport naturally occurring in the saturated zone of a groundwater basin can be augmented by using well pumpage on irrigated lands downstream of the well source. This controls excessive buildup of salts in the groundwater in any one area. An optimizing or screening model is developed for optimal basin-wide application of the ASTRAN method. Since the optimization problem is large-scale, it is proved that an efficient, sequential algorithm will yield optimal basin-wide solutions, under certain assumptions. A hierarchical algorithm links the optimizing model with quantity-quality simulation models of both the unsaturated and saturated zones in order to predict concentrations of important ions under ASTRAN management. A companion paper (Part II) describes the application of the ASTRAN method to a case study.
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177. **Role and contribution of environmental tracers for study of sources and processes of groundwater salinization**.
Hyurtsever, Y., Peters, N. E. and Coudrain-Ribstein, A.
Hydrochemistry. proceedings of an international symposium of the fifth scientific assembly of the International association of hydrological sciences (IAHS), Rabat, Morocco, 23 April to 3 May 1997: 3-12 (1997).
Keywords: salt formations/ mineralization/ geochemistry/ groundwater/ radioactive tracers/ radiolabeling
Abstract: Quality degradation of groundwater resources, particularly inarid and semi-arid regions, due to rising salinity is an increasingly encountered problem. The cause of groundwater salinization in these water-scarce regions is, in many cases, stress imposed on the system by (over)exploitation inducing sea-water encroachment in coastal aquifers; irrigation water applications; mixing of freshwater with saline formation waters (often underlying the upper freshwater aquifers) or leaching of salt formations causing increased mineralization. Use of natural isotopes for studying the sources and processes involved in groundwater salinization, for verification of site-specific dynamic models of salt water intrusion and identification of the geochemical evolution of groundwater is reviewed in the paper. Results of selected case studies conducted by the IAEA, particularly in arid and semi-arid regions, are included as examples.
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178. **The Role of Ground Water in Arid/Semiarid Ecosystems, Northwest China**.
Cui, Y. and Shao, J.
Ground Water 43: 471-477 (2005). ISSN: 1745-6584
http://dx.doi.org/10.1111/j.1745-6584.2005.0063.x
Keywords: groundwater/ hydrology/ water quality/ soil salinization/ desertification/ semi-arid zones/ water table/ ecosystems
Abstract: Ground water plays an important role in water supply and the ecology of arid to semiarid areas such as Northwest China, where the landscape is fragile due to frequent drought in the past few decades. This paper discusses the role of ground water in these ecosystems, including the effect of condensation water and water table depth on the growth of plants and degree of soil salinity. The paper also discusses the controlling process for land desertification and soil salinization in Northwest China. Water table depth is a key factor controlling the water balance, ground water flow, and salt transport in the vadose zone. The suitable water table depth for vegetation growth, which can prevent land desertification and soil salinization, is within a range of 2 to 4 m; the optimal depth is ~3 m. As examples, changes in ecosystems owing to water resources development in Tarim and Manas basins, Xinjiang, China, are discussed.
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179. **Role of solute-transport models in the analysis of groundwater salinity problems in agricultural areas**.
Konikow, L. F.
Agricultural Water Management 4: 187-205 (1981). ISSN: 0378-3774
http://dx.doi.org/10.1016/0378-3774(81)90050-0
Keywords: salinity/ soil transport processes/ groundwater
Abstract: Undesirable salinity increases occur in both groundwater and surface water and are commonly related to agricultural practices. Groundwater recharge from precipitation or irrigation will transport and disperse residual salts concentrated by evapotranspiration, salts leached from soil and aquifer materials, as well

as some dissolved fertilizers and pesticides. Where stream salinity is affected by agricultural practices, the increases in salt load usually are attributable mostly to a groundwater component of flow. Thus, efforts to predict, manage, or control stream salinity increases should consider the role of groundwater in salt transport. Two examples of groundwater salinity problems in Colorado, U.S.A., illustrate that a model which simulates accurately the transport and dispersion of solutes in flowing groundwater can be (1) a valuable investigative tool to help understand the processes and parameters controlling the movement and fate of the salt, and (2) a valuable management tool for predicting responses and optimizing the development and use of the total water resource.
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180. **Salinity investigations of Mancos landforms and springs in the upper Colorado River Basin**.
Deyo, A. E.
Davis, California, University of California, Davis. Davis, CA, United States. PhD., 184 p. (1984).
Keywords: dissolved salts/ geology/ salt transport/ groundwater/ springs/ salt efflorescence/ erosion/ management practices
Abstract: This investigation was aimed at assessment of the potential contribution of dissolved mineral salts to the Colorado River by representative watersheds in the Upper Colorado River Basin. The Mancos, Sego and Mount Garfield formations, which were formed in the late Cretaceous Mancos Sea, are identified as important contributions of soluble salts. The occurrence of springs within the study area is highly localized, resulting in significant differences in water quality and discharge between nearly identical watersheds. In some areas the springs reach salinity levels of 80dSm-1. It was determined that the predominance of the salts leave the watershed by ground water flow through buried stream channels. Salt efflorescences associated with Mancos springs, contain ten different Ca, Na, and Mg sulfate evaporite species. Four additional evaporites were identified associated with the Sego and Mount Garfield springs. The hydrated sulfates of Na and Mg, as very labile salts, are subject to change in response to relatively minor changes in temperature and moisture. The Mancos landforms are interrelated by an erosional cycle that is initiated by a lowering of the local base level. During the cycle, previously stable non-saline pediment surfaces are initially dissected to form steeply sloping saline badlands. As the local relief decreases through erosion, soils form, surface salinity decreases and the rate of erosion decreases. Erosion and leaching continue until the landscape becomes graded to the local base level, forming a new planation or pediment surface with electrical conductivity levels 1/20 that of the sloping Mancos badlands. To decrease the salinity contributions from the wildlands requires a multi-level approach. It is proposed that: 1) good quality ground water be intercepted and used locally or transported past highly saline areas; 2) saline ground water, which reaches as high as 80 dSm-1, be intercepted and transported to evaporation ponds; and 3) erosion resulting in sediment and salt production be controlled through use of gully plugs and sediment retention dams, reversing the present dissection of the pediments. This program would decrease erosion, sediments yield and salt yield while increasing wildland water and vegetation.
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181. **Salinity trends in surface waters of the Upper Colorado River Basin, Colorado**.
Bauch, N. J. and Spahr, N. E.
Journal of Environmental Quality 27: 640-655 (1998).
Keywords: total dissolved solids/ saline water/ Colorado River/ watersheds/ watershed management
Abstract: Dissolved-solids data collected in the Upper Colorado River Basin upstream from Cameo, Colorado, and in the Gunnison River Basin were analyzed for trends in flow-adjusted dissolved-solids concentrations and loads for water years 1970 to 1993, 1980 to 1993, and 1986 to 1993. Trend results for flow-adjusted periodic dissolved-solids concentrations for the Colorado River Basin upstream from Cameo, CO, generally were downward or no trend was indicated. Trends in flow-adjusted monthly and annual dissolved-solids loads primarily were downward or absent. These trend results partly agree with the downward trends reported by a previous investigation for the Colorado River near Cameo site. In the Gunnison River Basin, trends in flow-adjusted dissolved-solids concentrations and loads were not detected for more than one-half of the site/analysis-period combinations. Of the trends that were present, most indicated decreases in concentrations and loads rather than increases. In both the

Colorado River Basin upstream from Cameo, CO, and the Gunnison River Basin, trends in flow-adjusted dissolved-solids concentrations and flow-adjusted monthly and annual dissolved-solids loads may be affected by a variety of factors. These include channel evolution and hydrologic variation, water quality and flow rate of groundwater discharges and springs, sample size and period of record of dissolved-solids data, and changes in land use in the basin.
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182. **Salt Accumulation and Flushing in Unsaturated Fractures in an Arid Environment**.
Weisbrod, N., Nativ, R., Adar, E. M. and Ronen, D.
Ground Water 38: 452-461 (2000). ISSN: 0017-467X
http://dx.doi.org/10.1111/j.1745-6584.2000.tb00232.x
Keywords: water resources and supplies/ geochemistry of sediments/ precipitation (atmospheric)/ soil contamination/ irrigation/ Israel/ Negev Desert/ salinization/ precipitation/ arid lands/ salts/ solutes/ salinity/ arid regions/ percolation/ pollution (soil)/ infiltration/ groundwater
Abstract: Salt precipitation and dissolution in fractured chalk was investigated through flow experiments in both the laboratory and the field (in the Negev Desert, Israel). In the laboratory, a flow-cell experimental setup was used to simulate intermittent infiltration and drying periods along coated and uncoated fracture surfaces. Three infiltration events, lasting 24, 8, and 8 hours, were carried out with long drying periods of 82 and 44 days between them. In the field, two flow experiments were conducted through a single fracture. Water was percolated from land surface through a discrete fracture into a compartmental sampler. The duration of the two field experiments was 5 and 119 hours, respectively, with a drying period of seven months between them. The percolating outflows in both the laboratory and field experiments were collected and analyzed for electrical conductivity. The electrical conductivity of the outflows and its temporal variations during the experiments suggest that evaporation triggered capillary forces that mobilized water and solutes from the bulk matrix toward the fracture surface. As the water evaporated, the solutes precipitated on the fracture surface. The precipitated soluble salts were dissolved during the first few hours of the subsequent flow event that followed the drying period. This mechanism, enhanced in arid environments, may result in the transport of salts that accumulate in the upper few meters of the unsaturated zone to the ground water, bypassing the low-permeability matrix. The calculated amount of solutes transported by back-diffusion from the chalk matrix (190 g) could not account for the large (1200 g) amount of salts released from the fracture void during the experiments.
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183. **Salt loading from efflorescence and suspended sediments in the Price River basin**.
Bowles, D. S., Nezafati, H., Bhasker, R. K., Riley, J. P. and Wagenet, R. J.
Water Resources Planning Series, Logan, Utah, Utah Water Research Laboratory, Utah State University, 142 p. (1982).
http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1584&context=water_rep
Keywords: salt loading/ soil erosion/ sediment/ salt transport/ runoff/ salt efflorescence
This citation is from Utah State University.

184. **Salt Loads in an Intermittent Prairie Stream: Sage Creek Hydrogeologic Basin, Northern Montana**.
Miller, K. J.
Report of Investigation. Montana Bureau of Mines and Geology, 27 p. (2004).
http://leg.mt.gov/content/Committees/Interim/2007_2008/water_policy/staffmemos/casestudies.pdf
Keywords: rivers/ water salinization/ runoff/ groundwater/ ephemeral streams/ seepage/ hydrogeology
Abstract: The Sage Creek watershed, in Liberty and Hill Counties in north-central Montana, is geologically and hydrologically typical of many basins drained by intermittent streams in the semi-arid Northern Great Plains of the United States. Sage Creek supports a variety of uses such as stock watering, irrigation, and habitat for aquatic biota. The prevalent land use in the watershed is the production of dryland small grain crops. Most of the drinking water used on farmsteads is derived from ground water. Ground-water discharge to Sage Creek controls water quality over the long term and causes the presence of perennial pools in the stream

channel. Mean total dissolved solids (TDS) concentrations of the three most commonly used aquifers in the watershed—Quaternary deposits (inclusive of alluvium, glacial outwash, inwash, and till), the Judith River Formation, and the Eagle/Virgelle Formation—were 1,500 milligrams per liter (mg/L), 2,780 mg/L, and 1,350 mg/L, respectively. In areas where farming-induced dryland salinity processes have caused elevated salt concentrations in shallow ground water, TDS concentrations greater than 8,000 mg/L have been noted in Quaternary deposits. Potentiometric contours, the presence of perennial pools in the stream channel, saline seeps in the stream channel, color infrared photography, and water-quality information indicate that ground water from Quaternary deposits and the Judith River Formation is discharging along the stream channel. The discharge rate of ground water from Quaternary deposits in a 31-mi stream reach was estimated at 5.8 cubic feet per second (cfs), or about 0.2 cfs per stream mile. But the net loss of moisture along Sage Creek (10–13 in precipitation/year vs. 40–41 in evaporation/year) causes non-flowing conditions and drives the evapoconcentration of salts and elevated TDS concentrations in perennial pools and stream sediments. Total salt loads in ground water in Quaternary deposits along a 31-mi reach of Sage Creek averaged 550,000 lbs per stream mile per year for 1994–2001. Salts that accumulate in the stream channel after ground water evaporates are flushed downstream by infrequent, high-discharge, low-duration runoff events. Streamflow occurring in 1999 and 2002 ranged from 1 cfs to about 36 cfs. In June 2002 a 25-yr flood occurred in Sage Creek, with estimated peak flows in excess of 6,100 cfs. Reducing salt loads to Sage Creek and other streams requires the implementation of land uses (Best Management Practices) that reduce or eliminate ground-water discharge to the watercourse. One of the most effective methods for reducing the quantity of ground-water discharge is by growing deep-rooted alfalfa in selected recharge areas (Holzer, 1996). If this, or another effective alternative cropping system, were to be implemented on a watershed-wide basis for a sufficient length of time, the major anthropogenic mechanism for salt transport from salinized ground water to surface water would be destroyed. Suggested achievable targets to improve water quality to pre-farming levels could be measured by (1) percentage reduction in overall acreage of summer fallow in the entire watershed, perhaps starting with 10% in 10 years, or (2) percentage lowering of water levels in shallow ground water that results from implementing Best Management Practices, perhaps 10% watershed-wide in 10 to 15 yr.

185. **Salt Transport by the South Platte River in Northeast Colorado**.
Gomez-Ferrer, R., Hendricks, D. W. and Turner, C. D.
Journal of the American Water Resources Association 19: 183–190 (1983).
http://dx.doi.org/10.1111/j.1752-1688.1983.tb05312.x
Keywords: salt balance/ salinity/ salt load/ irrigation/ total dissolved solids/ leaching
Abstract: The salinity of the lower South Platte River in Colorado is characterized by plotting the average annual flow, total dissolved solids, and salt mass flow against distance along the stream. The plots show that salts are being leached from the irrigated lands above Greeley and are being deposited on the irrigated lands below Greeley. The salt deposition on the lower lands will result in their salination. The plots show also that fall and winter stream flows carry most of the salt loads. These fall and winter flows are stored in off stream reservoirs for use during the irrigation season. Therefore these salts are transferred to the lower irrigated lands where they accumulate. The salt balance for these lands can be improved by permitting the fall and winter flows to leave the basin, or by providing adequate land drainage coupled with supplemental irrigation water.
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186. **Salt transport in the Bremer Hills, SA: report for NAP South Australian salt mapping and management**.
Cox, J., Mcewan, K., Davies, P., Smitt, C., Herczeg, A. and Walker, G.
Technical Report, Australia, CSIRO Land and Water, (2002).
http://nrmonline.nrm.gov.au/catalog/mql:701
Keywords: groundwater/ salinity/ highlands/ transport/ trends/ data collection/ land use/ pipes/ sampling/ magnesium
Abstract: This report is a draft progress report on salt storage and transport in the Bremer Hills, South Australia. The general objective of this project is to determine the relationships between geology, geomorphology, groundwater and stream salinity in the Bremer Hills. The principal

objective of the proposed work is to determine the salt storages and transport processes, which result in salinity in the Bremer hills. The project integrates and builds on existing data (e.g. piezometer water levels and quality, chloride profiles, and geophysics) from sub-catchment studies within or adjacent to the Bremer or Barker streams. Thus the first stage of the project was to review (and possibly re-assess) the existing data and identify where salt is stored within the landscape. Analysis of existing surface and groundwater data helped with the selection of stream locations and piezometers for sampling for chemical analysis to help determine the source of salt. Groundwater behaviour will be modeled using flowtube to help interpret how salt is mobilised to the streams (and this work has commenced).

187. **Simultaneous transport of water and solutes under transient unsaturated flow conditions - A case study**.
Purandara, B. K., Varadarajan, N. and Venkatesh, B.
Journal of Earth System Science 117: 477-487 (2008). ISSN: 0253-4126
http://dx.doi.org/10.1007/s12040-008-0047-5
Keywords: agriculture/ climatic zones/ dam control/ earth sciences/ groundwater quality/ infiltration/ salinization of soil/ soil salinity/ irrigation
Abstract: The imbalance between incoming and outgoing salt causes salinization of soils and sub-soils that result in increasing the salinity of stream-flows and agriculture land. This salinization is a serious environmental hazard particularly in semi-arid and arid lands. In order to estimate the magnitude of the hazard posed by salinity, it is important to understand and identify the processes that control salt movement from the soil surface through the root zone to the ground water and stream flows. In the present study, Malaprabha sub-basin (up to dam site) has been selected which has two distinct climatic zones, sub-humid (upstream of Khanapur) and semi-arid region (downstream of Khanapur). In the upstream, both surface and ground waters are used for irrigation, whereas in the downstream mostly groundwater is used. Both soils and ground waters are more saline in downstream parts of the study area. In this study we characterized the soil salinity and groundwater quality in both areas. An attempt is also made to model the distribution of potassium concentration in the soil profile in response to varying irrigation conditions using the SWIM (Soil-Water Infiltration and Movement) model. Fair agreement was obtained between predicted and measured results indicating the applicability of the model.
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188. **Soil water and salinity in response to water deliveries and the relationship with plant growth at the lower reaches of Heihe River, Northwestern China**.
Yu, T., Feng, Q., Liu, W., Si, J., Xi, H. and Chen, L.
Shengtai Xuebao/ Acta Ecologica Sinica 32: 7009-7017 (2012). ISSN: 1000-0933
http://dx.doi.org/10.5846/stxb201110101484
Keywords: ecological water deliveries/ Heihe River/ plant growth/ response process/ soil-water salinity content/ coniferous tree/ decadal variation/ growth rate/ oasis/ plant communities/ river discharge/ salinity/ self thinning/ socioeconomic impact/ soil depth/ soil moisture/ soil water/ China/ Gansu Prov./ Hei River
Abstract: The Heihe River is the second longest inland river in China. The eco-environmental problems of the oasis in the lower reaches of Heihe River have markedly deteriorated over the past several decades because of the comprehensive effects of a number of factors. These factors include the continuous decrease in the discharge water of the Heihe River, human and animal population growth, increase of socio-economic activities, and climate warming. Water deliveries have been conducted by the Heihe River Bureau since 2000 to address the existing eco-environmental problems. Several scientific and realistic issues concerning this significant artificial water delivery project include the response process and mechanism of the eco-environment involving vegetation restoration and reconstruction brought about by water deliveries in the lower reaches of Heihe River. The responses of soil water and salinity variation to water deliveries were presented based on the investigation of soil and plant plots in 2001 and 2010. This paper aimed to evaluate the variance in the soil moisture and soil-soluble salt content before and after water deliveries in the lower reaches of Heihe River. The relationship between soil moisture, as well as soil-soluble salt content, and vegetation growth variables was also determined. The results indicated that the soil moisture content (SMC) increased at different depths after water deliveries in Heihe River. The

rate of increase varied with the different types of communities and could be arranged in the following order: *Populus euphratica>Tamarix chinensis*>Herbal. Moreover, the soil-soluble salt content (SSC) increased after water deliveries at different depths because of the strong evaporation effects. The rate of increase could be arranged in following the order: *Sophora alopecuroides>T. chinensis>Haloxylon ammodendron>P. euphratica*. In addition, it could be found in the conversion of soil salinity type from slightly saline soil dominated by HCO3- and Na+ to medium and intense saline soil mainly dominated by SO4 2-, Cl- and Ca2+. The average density and crown, with *P. euphratica* community as an example, increased with increasing SMC of less than 6%, in which these values ranged from 40 m2 to 70 m2 and 0.5 plants per 100 m2 to 5 plants per 100 m2 at an SMC of more than 6%, respectively. Similarly, the average density ranged from 0.5 plants per 100 m2 to 5 plants per 100 m2 with an SSC of more than 6%. However, the average crown did not decrease with an SSC of more than 6%. Therefore, we conclude that the "self thinning" process of the *P. euphratica* community, rather than the salt, caused stress to the plant growth.
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189. **Spatial and temporal variability of water salinity in an ephemeral, arid-zone river, central Australia**.
Costelloe, J. F., Grayson, R. B., Mcmahon, T. A. and Argent, R. M.
Hydrological Processes 19: 3147-3166 (2005).
ISSN: 0885-6087
http://dx.doi.org/10.1002/hyp.5837
Keywords: arid environment/ ephemeral streams/ salinity/ solute transport/ spatial variation/ temporal variation/ arid zones/ ephemeral rivers/ salinity modeling/ salinity processes
Abstract: This study describes the spatial and temporal variability of water salinity of the Neales-Peake, an ephemeral river system in the arid Lake Eyre basin of central Australia. Saline to hypersaline waterholes occur in the lower reaches of the Neales-Peake catchment and lie downstream of subcatchments containing artesian mound springs. Flood pulses are fresh in the upper reaches of the rivers (<200 mgl -1). In the salt-affected reaches, flood pulses become increasingly saline during their recession. It is hypothesized that leakage from the Great Artesian Basin deposits salt at the surface. This salt is then transported by infrequent runoff events into the main river system over long periods of time. The bank:/floodplain store downstream of salt-affected catchments contains high salt concentrations, and this salt is mobilized during the flow recession when bank/floodplain storage discharges into the channel. The salinity of the recession increases as the percentage of flow derived from this storage increases. A simple conceptual model was developed for investigating the salt movement processes during flow events. The model structure for transport of water and salt in the Neales-Peake catchment generated similar spatial and temporal patterns of salt distribution in the floodplain/bank storage and water flow as observed during flow events in 2000-02. However, more field-data collection and modelling are required for improved calibration and description of salt transport and storage processes, particularly with regard to the number of stores required to represent the salt distribution in the upper zone of the soil profile.
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190. **Spatial Variability of Groundwater Recharge in a Semiarid Region**.
Cook, P. G., Walker, G. R. and Jolly, I. D.
Journal of Hydrology 111: 195-212 (1989).
http://dx.doi.org/10.1016/0022-1694(89)90260-6
Keywords: salt load/ aquifers/ data acquisition/ groundwater/ Cl/ western Murray basin/ Australia
Abstract: Chloride profiles and electromagnetic techniques were used to estimate rates of groundwater recharge in the Western Murray Basin, southern Australia. The use of electromagnetic techniques allowed large numbers of estimates to be made in a relatively short period of time, thus permitting statistical analysis of the spatial variability. Recharge rates appear to be approximately log-normally distributed, in accordance with published results of infiltration rate and hydraulic conductivity. The spatial structure is defined approximately by a spherical semivariogram. The results derived were applied to a study of groundwater salinization. Based on the estimated recharge distribution, predictions of future recharge and salt loads to the aquifer were made. The increase in groundwater salinity resulting from the flux of salt to the water table will depend on the rate of movement of the groundwater and

the amount of mixing with deeper groundwaters. The importance of considering spatial variability in recharge studies can be seen by comparing mean recharge and salt fluxes to the groundwater predicted using areal averages with those predicted after considering spatial variability. Large spatial variability results in the effects of clearing beginning to be seen much sooner, due to the effect of the high-recharge sites, but with the full impact delayed, because of the low-recharge sites. Lower spatial variability results in a much more sudden impact. (Rochester-PTT)
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191. **Studies on water movement and solute transport in arid regions**.
Yu, Z. and Hu, B.
Journal of Hydrology 275: 139-140 (2003).
ISSN: 0022-1694
http://dx.doi.org/10.1016/S0022-1694(03)00040-4
Keywords: solute transport/ precipitation rates/ evapotransporation
Abstract: Low precipitation rates and high evapotransporation rates commonly result in low rates of water movement and thick vadose zones in arid regions. Arid regions have been considered as favorable sites for storage of nuclear wastes and other contaminants. Understanding groundwater recharge, water movement and solute transport in these regions is crucial for the rational management of water resources, preservation of subsurface water quality, optimization of irrigation and drainage efficiency, safe and economic extraction of subsurface mineral and energy resources, subsurface storage of energy and waste, and perhaps prediction of global climate change. In the last several decades, important studies have been conducted in this area and much progress has been made. However, owing to the complexity of the media, such as the complex fracture system and large heterogeneity of the various hydraulic properties, and limited available field data, groundwater recharge, flow and solute transport in the complex subsurface environments have not been fully understood. To meet the demands of accurate prediction of flow and transport processes for various environmental projects, development of more efficient and accurate measurement methods and more appropriate modeling approaches is imperative. A systematic summary of the current study results and existing problems in this area will guide scientists in new research directions. This special issue brings together selected papers from the 2000 meeting of the Geological Society of America (GSA), session T91, 'Studies on Water Movement and Solute Transport in Arid Regions', convened by Z. Yu and Bill X. Hu.
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192. **Study of salinity production from wildlands of Price River Basin, Utah**.
Lin, A.
Salinity in Watercourses and Reservoirs. Proceedings of the 1983 International Symposium on State-of-the-Art Control of Salinity July 13-15, 1983, Salt Lake City, Utah, Salt Lake City, UT, Butterworth (1983).
Keywords: salinity/ water pollution sources/ Price River/ Utah/ erosion/ sedimentation/ saline water/ overland flow/ mathematical studies/ Universal Soil Loss Equation/ shale/ soil erosion/ rainfall/ snowmelt
Abstract: The importance of hillslope erosion in sediment and salinity production of the Price River Basin, Utah is confirmed. In investigating hillslope erosion processes, it is necessary to consider (1) the difference between the ' first event ' and the others in a running sequence, and (2) the separation of mass wasting, if it exists, from overland flow processes. The Universal Soil Loss Equation (USLE) could be useful in western wildland if the coverage factor is properly calibrated. Additionally, to use USLE effectively for individual events, it should be applied to runoff source areas. In-channel solute pick-up could be important where Mancos Shale is exposed. For a fixed amount of exposure of Mancos Shale in a watershed, there should be an upper limit for the salt encrustation along the exposed part. It is postulated that given sufficient time for salt crust to mature, the amount of in-channel solute pick-up for a ' first event ' is more or less a fixed quantity. Thunderstorms in the summer and fall produce an estimated 11% of total salt load in the basin. There is no data to assess salt production generated from erosion associated with spring snowmelt runoff. (Lantz-PTT)

193. **Successional trends in Sonoran Desert abandoned agricultural fields in northern Mexico**.
See record 77 in Rangeland Management Practices and Potential Impact on Water.

194. **Surface-water salinity in the Gunnison River Basin, Colorado, water years 1989 through 2007**.
See record 37 in Rangeland Management Practices and Potential Impact on Salinity.

195. **Timing of recharge, and the origin, evolution and distribution of solutes in a hyperarid aquifer system**.
See record 84 in Rangeland Management Practices and Potential Impact on Water.

196. **Towards sustainable development of the environmentally degraded arid rivers of China; a case study from Tarim River**.
Feng, Q., Endo, K. N. and Cheng, G. D.
Environmental Geology (Berlin) 41: 229-238 (2001). ISSN: 0943-0105
Keywords: eolian features/ water quality/ degradation/ biomass/ water management/ desertification/ ecosystems/ Xinjiang Prov./ environmental analysis/ deserts/ groundwater/ carbon/ ecology/ organic carbon/ discharge/ environmental geology/ China/ protection/ hydrology/ rainfall/ surface water/ pollution/ Tian Mountains/ Tarim Basin/ Taklimakan Desert/ water table/ planning/ runoff/ sustainable development/ water resources/ land use/ salinization
© *ProQuest*

197. **Tracking salinity sources to Texas streams; examples from West Texas and the Texas Gulf Coastal Plain**.
Nance, H. S.
Transactions - Gulf Coast Association of Geological Societies 56: 675-693 (2006). ISSN: 0533-6562
http://www.beg.utexas.edu/starr/PDF/Nance/Nance_Tracking_salinity.pdf
Keywords: United States/ electrical conductivity/ sea water/ halogens/ rivers and streams/ Petronila Creek/ petroleum/ salinity/ solution/ groundwater/ observations/ Colorado River/ sedimentary rocks/ levels/ chloride ion/ mixing/ gypsum/ Great Plains/ discharge/ geochemistry/ Southern Great Plains/ hydrology/ chlorine/ North America/ chemically precipitated rocks/ sulfate ion/ sulfates/ Paleozoic/ surface water/ West Texas/ Texas/ Gulf Coastal Plain/ evaporites/ hydrochemistry/ Permian/ dissolved materials/ brines/ hydrochemistry/ hydrogeology/ hydraulic conductivity/ water wells
Abstract: Upper Colorado River (West Texas) and Petronila Creek (Texas Coastal Plain) salinities exceed state regulatory standards. For a recent study, airborne conductivity surveys located points of saline influx. Hydrochemical analyses defined salinity trends and potential sources. Both streams comprise Na-Cl hydrochemical facies and are near hydrocarbon production operations. Upper Colorado River salinity decreases downstream overall (8,430-1,540 mg/L total dissolved solids [TDS], during this study) with local trend reversals. Stream-proximal shallow Permian groundwaters are sulfate enriched from evaporite dissolution. Stream-water chloride predominance is mitigated downstream by sulfate-enriched base flow. Anomalous chloride increases along the stream path correlate with proximity to anomalously saline water wells and oil fields. Conservative (Br/Cl) mixing models suggest hydraulic connection between saline wells, deep-basin brines, and saline streams. Petronila Creek salinity increases downstream (233-15,180 mg/L TDS). The highest salinity (28,100 mg/L) in the study area is observed in a tributary ditch that previously was used for oil-field brine discharge. Conservative mixing models suggest that either Tertiary-age oil-field brine or seawater might constitute the source of salinity. However, boron and chloride data suggest that oil-field brine is probably the source. Sulfate (relative to chloride) is more concentrated in surface water than is expected from evaporation of oil-field brine or seawater and probably reflects soil-gypsum dissolution.
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198. **Transit sources of salinity loading in the San Rafael River, upper Colorado River Basin, Utah**.
Hadley, H. K., University of Utah, 168 p. (2012).
Keywords: rivers/ water salinization/ soil transport processes/ runoff
Abstract: The research objective of this study is to develop and implement a scientific methodology comprised of integrating soil and water field measures and geographic information system (GIS) analysis in order to determine the major transit mode of salt loading to the San Rafael River in central Utah. Major transit modes in a watershed are either a surface-water runoff process or a ground-water inflow to the stream process. Salinity studies conducted to date have investigated process research questions of salt movement largely

through a sole discipline of hydrology or terrestrial science (soils and landforms), but have not fully integrated hydrology with soils. None have attempted to create a methodology to determine above-ground versus below-ground, salt-transit loading in the watersheds of the upper Colorado River basin. Quantification of annual salt loads (tons/year) in the San Rafael River range from a long-term average of 202,810, to this study's period (2001-2006) of 63,510, to an instantaneous (water year 2004) baseflow-only load of approximately 50,200. Thus, the 2004 ground-water salt load (baseflow) was approximately 80% of the study period average annual total load, or about 25% of the long-term average (202,810 tons/yr). GIS zonal analysis ranking of the salt-loading floodplains show that ground-water contributing areas have a high co-incidence of gypsum-rich, clay-poor rocks coupled with higher precipitation zones. Surface-water runoff tends to occur in more clay-rich soils. This scientific methodology to determine the major transit mode and quantity of salt loading in a watershed can be applied to salinity-control management on public land throughout the upper Colorado River Basin. The knowledge gained from implementing this methodology goes into planning and on-the-ground projects that focus mainly on surface-runoff erosion control.
This citation is from Univeristy of Utah.

199. **Transport of salts in soils and subsoils**.
Bresler, E.
Agricultural Water Management 4: 35-62 (1981).
ISSN: 0378-3774
http://dx.doi.org/10.1016/0378-3774(81)90043-3
Keywords: movement/ salts in soil/ soil/ soil transport processes
Abstract: Factors affecting transport of salts in saturated-unsaturated dryland soils are reviewed. Simultaneous movement of water and salts occurring in homogeneous soils is discussed first. Governing equations describing combined diffusion-convection transient transport and miscible displacement of salts, as well as nonsteady water flow are given. Effects of salinity on soil water transmission rates are described. The governing equations and boundary conditions appropriate to three processes of the dryland hydrologic cycle: infiltration, redistribution, and evaporation, are formulated in a manner suitable for mathematical modeling. Numerical solutions are obtained. One-dimensional, vertical profiles of non-interactive salts are described for homogeneous, bare, fallow soil. Effects of physico-chemical interactions between solution and soil matrix on transport of interactive anions and cations are incorporated. Vegetation factors and their effects on salt dynamics and distribution are also considered. Consideration of salt transport in saturated-unsaturated heterogeneous fields concludes the paper. Statistics of field profile concentration and salt dynamics in field scales are given.
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200. **Using noble gases to investigate mountain-front recharge**.
Manning, A. H. and Solomon, D. K.
Journal of Hydrology 275: 194-207 (2003).
ISSN: 0022-1694
http://dx.doi.org/10.1016/S0022-1694(03)00043-X
Keywords: groundwater/ mountains/ noble gases/ recharge/ temperature/ tracers
Abstract: Mountain-front recharge is a major component of recharge to inter-mountain basin-fill aquifers. The two components of mountain-front recharge are (1) subsurface inflow from the mountain block (subsurface inflow), and (2) infiltration from perennial and ephemeral streams near the mountain front (stream seepage). The magnitude of subsurface inflow is of central importance in source protection planning for basin-fill aquifers and in some water rights disputes, yet existing estimates carry large uncertainties. Stable isotope ratios can indicate the magnitude of mountain-front recharge relative to other components, but are generally incapable of distinguishing subsurface inflow from stream seepage. Noble gases provide an effective tool for determining the relative significance of subsurface inflow, specifically. Dissolved noble gas concentrations allow for the determination of recharge temperature, which is correlated with recharge elevation. The nature of this correlation cannot be assumed, however, and must be derived for the study area. The method is applied to the Salt Lake Valley Principal Aquifer in northern Utah to demonstrate its utility. Samples from 16 springs and mine tunnels in the adjacent Wasatch Mountains indicate that recharge temperature decreases with elevation at about the same rate as the mean annual air temperature, but is on average about 2 °C cooler. Samples from 27 valley production wells yield recharge elevations ranging from the valley elevation (about 1500 m)

to mid-mountain elevation (about 2500 m). Only six of the wells have recharge elevations less than 1800 m. Recharge elevations consistently greater than 2000 m in the southeastern part of the basin indicate that subsurface inflow constitutes most of the total recharge in this area.
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201. **Variations in soil dispersivity across a gully head displaying shallow sub-surface pipes, and the role of shallow pipes in rill initiation**.
See record 41 in Rangeland Management Practices and Potential Impact on Salinity.

202. **Vegetation communities on the shores of a salt lake in semi-arid Western Australia**.
Barrett, G.
Journal of Arid Environments 67: 77-89 (2006).
ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2006.01.016
Keywords: salt lakes/ Halosarcia/ Frankenia/ lake shores/ eolian deposition/ saline ground-water/ vegetation communities
Abstract: The vegetation communities of the eastern and southern shores of Lake Lefroy, a large salt lake near Kambalda, Western Australia, were studied. The aim of the studies was to explore the relationship between the distribution of vegetation along salt lake shores in relation to soil conditions and the depth to ground-water. Four distinct lake shore types were investigated and two-way indicator species analysis (TWINSPAN) was used to classify the vegetation communities occurring on the lake shores. Seven vegetation communities, with a total of 50 vascular plant species, were identified. More than half of the species recorded were herbs. Those communities occurring on highly saline soils close to the shallow hypersaline ground-water-table included the halophytic genera Halosarcia and Frankenia. Communities on less saline soils and at greater elevations were more diverse. It was concluded that depth to ground-water and soil texture were likely to be key factors in determining the distribution of vegetation communities along the shores. The findings of the study have implications for the design of rehabilitation programmes for shores disturbed by mining activity.
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203. **Water Quality Challenge: Using New Technology to Track Tectonic Salinity Sources to Surface and Ground Water**.
Crossey, L. J., Sherson, L. R., Jochems, A. P., Harding, J. J., Woolsey, E. E., Karlstrom, K. E., Ali, A. M., Erson, M. A., Halihan, T. and Dahm, C. N.
GSA Rocky Mountain Section - 64th Annual Meeting (9–11 May 2012), Albuquerque NM, Geological Society of America (2012).
Keywords: water quality/ saline water/ water salinization/ groundwater/ tectonics/ saltwater intrusion/ hydrology/ seepage/ aquifers/ hydrogeology
Abstract: In the arid Southwest, saline surface water and brackish groundwater pose particular problems in water quality for water management. The contribution of deep groundwaters to near-surface hydrologic systems (streams and shallow unconfined aquifers) is often overlooked. Quantitative forecasting of the effects of climate change (diminishing surface flows) on water quality depends on our understanding of these deep inputs. The Jemez and Rio Salado watersheds in northern New Mexico are classic examples of arid-region salinization due in part to tectonic inputs (deep fluids emerging along fault conduits). These hydrologic systems are important both to local constituencies (including a mix of private, tribal and public lands) as well as regional managers because of their contribution to the middle Rio Grande system, and as recharge components to Sandoval County and the northwestern part of the Albuquerque groundwater basin. Under base flow conditions deep groundwater inputs to the Jemez along fault pathways result in high salinity and arsenic contents. Climate change scenarios predicting reduced snowpack and changes in runoff timing, linked to a solute loading/discharge model, highlight serious water quality concerns for the Jemez. Three sets of data are presented to demonstrate how a quantitative loading model for particular solutes of concern (in this case, sulfate and arsenic) can be integrated with climate change scenarios. (1) Traditional ‘campaign’ water sampling over the 2006-2012 water years along a 60 km reach of the Jemez shows that during low flow the salinity, sulfate concentration, and arsenic concentration all exceed designated use limits. (2) The deployment of continuous sensors for temperature, salinity, pH, and dissolved oxygen in the Jemez in 2010-2012 provides information on coupling of discharge, temperature, dissolved

oxygen, pH and specific conductance at a highly resolved timescale. (3) Preliminary results from two geophysical surveys (both a Distributed Temperature Sensor (DTS) deployment in the Rio Salado and an ERI survey across the Nacimiento fault indicate diffuse leakage from the fault system into the shallow alluvial aquifer). Combined, these results indicate the need for a wider application of environmental sensors in hydrologic systems to inform water management decisions.

This citation is from the Geological Society of America.

Transport Processes: Surface Water

204. **1980-82 salinity status report: Results of Bureau of Land Management studies on public lands in the Upper Colorado River Basin**.
Jackson, W. L., Bentley, R. G. and Fisher, S., Denver, Colorado, U.S. Bureau of Land Management, 54 p. (1984).
Keywords: soil/ salts/ Colorado River Watershed (Colo.-Mexico)/ rivers/ watersheds/ saline water/ salinity/ water salinization/ conservation practices/ government programs and projects/ environmental policy/ rangelands/ range management/ water management

205. **Aeolian additions: The downwind effects on soil and vegetation in Owens Valley [paper/poster]**.
Quick, D. J., Reheis, M. C., Stewart, B. W. and Chadwick, O. A.
Kearney Foundation of Soil Science: Understanding and Managing Soil-Ecosystem Functions Across Spatial and Temporal Scales. 2006-2011 Mission, Davis, CA, University of California, Davis, 14 p. (2002).
http://www.wmrs.edu/projects/cerec/pdfs/QuickCEREC.pdf
Keywords: eolian deposits/ dust storms/ sediment transport/ vegetation cover/ wind erosion/ playas/ alluvial soils/ rain/ soil salinity
Abstract: We present results from an ongoing study of soil-ecosystem responses to dust flux from Owens Lake Playa in Owens Valley over the past century. Our goal has been to document the spatial impact of the dust by explicitly considering distance from the playa and the contrast between the chemistry and mineralogy of the playa derived dust and the background, regional dust rain that has impacted the soils at least during the Holocene. We have sampled soils along a transect running from north to south along the valley axis to compare accumulation of salts and fine-grained minerals both with respect to dust trap samples collected by the US Geological Survey and with respect to distance from the playa source for the dust. These sampled soils are from sites selected on alluvial fan deposits emanating from the Sierra Nevada Batholith granites. We know that there is a distinct contrast in trace element chemistry, Sr isotopic composition and particle size among the granitic parent material, the playa sediments and the regional dust rain. These contrasts will allow us to develop quantitative estimates of not only the role of salts and fines in the soil profiles and in plant leaf chemistry but also to assign fractions of contribution from different sources. Early results do demonstrate a higher level of salts in soils adjacent to the playa, as well as a clear Sr signature from the playa. Our results will move the analysis of the prodigious dust clouds that are thought to impact human health to an analysis of their impact on the ecosystems of Owens Valley. An evaluation of the severity of that impact is a critical step toward assessing management decisions related to Owens Lake Playa as well as other similar dust sources such as the Salton Sea that may become desiccated in the future. [linked to poster]
This citation is from the White Mountain Research Center.

206. **Aggregate stability and seal formation as affected by drops impact energy and soil amendments**.
Shainberg, I., Levy, G. J., Rengasamy, P. and Frenkel, H.
Soil Science 154: 113-119 (1992).
Keywords: water quality/ electrolyte concentration/ infiltration rate/ crusts/ formation/ clay
Abstract: In soils exposed to rain, aggregate disintegration is the first process which leads to seal formation. The objective of this study was to evaluate the relative importance of aggregate stability in seal formation. The effects of raindrops' impact energy, exchangeable sodium percentage (ESP), electrolyte concentration in the applied water, and addition of an anionic polyacrylamide (PAM) on aggregate stability and seal formation were studied on three smectitic cultivated soils from Israel using laboratory drip-type rain simulators. Aggregate slaking took place much faster than seal formation; only 9 mm of rain were needed to disintegrate the aggregates compared with >40 mm of rain needed for seal formation. Soil ESP enhanced aggregates' breakdown at the upper ESP range, whereas the effect of ESP on seal formation was at the lower ESP range. Electrolyte concentration in the applied water had no affect on aggregate disintegration but affected the rate and final infiltration rate of the seals formed. Adding PAM to the soil improved aggregate

stability and increased the permeability of the seal. Aggregate breakdown was suggested as the first step in seal formation, to be followed by surface compaction and clay dispersion.
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207. **Analysis of the Variation Characteristics of Soil Moisture and Soil Salinity --Take Arou Pasture in the Upper Reaches of Heihe River for an Example**.
Wang, W. Z., Wu, Y. R., Jin, R., Wang, J. and Che, T.
Journal of Glaciology and Geocryology 31: 268-274 (2009). ISSN: 1000-0240
Keywords: rivers/ moisture/ salinity variations/ freezing-thawing cycles/ freezing/ pastures/ evaporation/ evapotranspiration/ soil salinity/ salts/ Qinghai Prov./ salinity/ transportation/ streamflow and runoff/ China/ soil moisture/ accumulation/ saline soils
Abstract: Freezing and thawing cycle of soil is a unique mechanism of soil salinization, which controls the soil salinity accumulation in spring. In the process of freezing-thawing, with the change of soil profile structure, three layers are formed. They are frozen layer, similar frozen layer and non-frozen layer. In this paper, the Arou pasture in the upper reaches of the Heihe River is taken for an example to study the variation characteristics of moisture and salt transportation. Arou pasture in the Qilian Mountains is a seasonal frozen area located in the high-cold region in Northwest China. Owing to the freezing-thawing cycle, most parts of Arou pasture experience a special water and soil salinity transportation mechanisms: Moisture and salt move up to the freezing layer in the freezing time, making soil salinity content increase continuously, whereas in the thawing time moisture and salt move to the surface intensively due to evaporation. These lead to an intense salinity accumulation in the surface soil, which trigger the rising of salinity twice.
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208. **Assessment of erosion rates from microphyte-dominated calcareous soils under rain-impacted flow**.
Eldridge, D. J. and Kinnell, P. I. A.
Australian Journal of Soil Research 35: 475-489 (1997).
http://dx.doi.org/10.1071/S9607
Keywords: microphytes/ cryptogamic crusts/ water erosion/ microphytic crusts/ lichens/ bryophytes/ erosion processes/ semi-arid rangelands/ degraded semi-arid woodland/ cryptogam cover/ surface condition/ rangelands/ Australia/ fire/ monoliths/ crusts/ runoff
Abstract: Intact soil monoliths with surfaces of varying microphytic crust cover were collected from a calcareous earth soil in semi-arid belah-rosewood woodland near Wentworth in south-western New South Wales. Monoliths were tested for their susceptibility to erosion by rain-impacted flow using a laboratory rainfall simulator. The erosive stress applied to each surface was controlled by varying the flow depth between 4 and 8 mm whilst maintaining a flow velocity of 25 mm/s using 2.7 mm raindrops falling 11.2 m at average rainfall intensities of 65 mm/h. Increasing the cover of microphytic crusts on the surface resulted in a significant (P = 0.001) reduction in sediment concentration. A linear model incorporating percentage cover and distribution of cover accounted for 46% of the variance in soil erosion. A significant relationship was also found between the coarse fraction (>0.053 mm) and crust cover (P = 0.012) at the dmm depth. Management practices such as overgrazing, trampling, and fire, which reduce the cover of crusts in this landscape, will lead to increased erosion hazard.
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209. **Assessment of sediment yield by splash erosion on a semiarid soil with varying cryptogam cover**.
Eldridge, D. J. and Greene, R. S. B.
Journal of Arid Environments 26: 221-232 (1994).
http://dx.doi.org/10.1006/jare.1994.1025
Keywords: raindrop impact/ surface crust/ woodland/ water/ fire/ rangelands/ flow
Abstract: Cryptogams are a group of non-vascular plants including algae, lichens, mosses, liverworts and fungi which form crusts when associated with surface soils. A series of experiments were undertaken to investigate the role of cryptogams in erosion processes on a red earth soil in semi-arid eastern Australia. Under 20 min of simulated rainfall at an intensity of 45 mm h-1, the presence of cryptogams significantly reduced both the total amount of material that was eroded by splash and the rate of removal from a semi-arid red earth soil. As cryptogam cover increased, there was an exponential decline in total splash erosion and an increase in the proportion of coarse material in the sediment. The results indicate that, under

natural rainfall conditions, there is a continual transfer of fine material and adsorbed nutrients away from areas of low cryptogam cover. The application of these results to the management of soils with cryptogamic surfaces is briefly discussed.
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210. **Biological soil crusts: Ecology and management**.
Belnap, J., Kalteneker, J. H., Rosentreter, R., Williams, J., Leonard, S. and Eldridge, D. Technical Reference. U.S. Bureau of Land Management, Denver CO, U. S. Bureau of Land Management, 110 p. (2001).
http://www.blm.gov/nstc/library/pdf/CrustManual.pdf
Keywords: soil crusts/ erosion control/ soil erosion/ soil ecology/ rangeland soils/ hydrology/ nutrient cycles
Abstract: This technical reference presents a review of current scientific knowledge on the ecology of biological soil crusts, then integrates this information into a discussion on monitoring and management of arid and semiarid lands in the western United States. The document begins with a discussion on the composition, structure, and distribution of biological crusts relative to environmental factors such as climate and soil characteristics. This information is then synthesized into guidelines on development of monitoring strategies as well as site-specific management prescriptions regarding livestock, recreation, and other multiple-use activities. The material is presented from a practical and applied management perspective and is summerized in numerous tables and figures.

211. **Chemical Characteristics of a Desert Stream in Flash Flood**.
Fisher, S. G. and Minckley, W. L.
Journal of Arid Environments 1: 25-33 (1978).
Keywords: chemical processes/ identification of pollutants/ control of water on the surface
Abstract: Flash flooding, a common hydrologic phenomenon in arid regions has profound physical and biological influences upon receiving systems such as reservoirs. While numerous accounts document the profound effects of desert flash floods upon human settlements, many of which are located upon alluvial fans and debris cones of steep mountains, there is little data available on the transport characteristics of a flash flooding desert stream. This paper reports upon the water chemistry of a single flash flooding event on Sycamore Creek, Arizona, and discusses implications of flash flooding on water resources in desert regions. Water samples were taken before, during and for 2 days after a flash flood event on Sept. 26, 1976. Sample were subsequently analyzed for conductivity, nitrate, phosphate, iron, suspended sediments, organic particulate matter and total alkalinity. Results indicated that particulate materials increase to exceedingly high concentrations during flooding, peaking at the leading edge of the initial flood wave. Total dissolved substances, however, decline regularly during flooding, due to the dilution effect and fail to respond to minor increase in discharge. Some dissolved constituents such as nitrate and phosphate are found to increase with flooding and this suggests that leaching provides a major source of these nutrients. Because of the short-lived nature of these floods, peak discharges seldom exceed 25 percent of the normal flood peaks for the U.S. in general, and flows of less than 10 times the median discharge account for only 7 percent of the total runoff in Sycamore Creek in particular. It is suggested that analysis of flood waters in the Southwestern desert be concentrated on only those peak flows of 10 times the median charge. (Tickes-Arizona).
© *ProQuest*

212. **Colorado River Ecology and Dam Management: Proceedings of a Symposium May 24-25, 1990 Santa Fe, New Mexico**.
Committee to Review the Glen Canyon Environmental Studies, Water Science Technology Board and Commission on Geosciences Environment and Resources Colorado River Ecology and Dam Management Symposium, Santa Fe, NM, National Research Council, National Acadamies Press (1991).
http://www.nap.edu/openbook.php?record_id=1832&page=R1
Keywords: rivers/ saline water/ hydrology/ dams (hydrology)/ hydroelectric power/ water reservoirs/ water salinization/ environmental policy/ government programs and projects
Abstract: This book contains 11 papers that review the extant information about the Colorado River from an ecosystem perspective and serve as the basis for discussion of the use of ecosystem/earth science information for river management and dam operations. It also

contains a synopsis of the committee's findings and recommendations to the Bureau of Reclamation as the agency seeks to change its direction to the management of natural resources.

213. **Concentrated flow erodibility for physically based erosion models: Temporal variability in disturbed and undisturbed rangelands**.
Al-Hamdan, O. Z., Pierson, F. B., Nearing, M. A., Williams, C. J., Stone, J. J., Kormos, P. R., Boll, J. and Weltz, M. A.
Water Resources Research 48: W07504 (2012).
ISSN: 1944-7973
http://dx.doi.org/10.1029/2011WR011464
Keywords: rangelands/ erosion control/ soil erosion/ runoff/ overland flow/ hydrology/ disturbed soils/ temporal variation
Abstract: Current physically based overland flow erosion models for rangeland application do not separate disturbed and undisturbed conditions in modeling concentrated flow erosion. In this study, concentrated flow simulations on disturbed and undisturbed rangelands were used to estimate the erodibility and to evaluate the performance of linear and power law equations that describe the relationship between erosion rate and several hydraulic parameters. None of the hydraulic parameters consistently predicted the detachment capacity well for all sites, however, stream power performed better than most of other hydraulic parameters. Using power law functions did not improve the detachment relation with respect to that of the linear function. Concentrated flow erodibility increased significantly when a site was exposed to a disturbance such as fire or tree encroachment into sagebrush steppe. This study showed that burning increases erosion by amplifying the erosive power of overland flow through removing obstacles and by changing the soil properties affecting erodibility itself. However, the magnitude of fire impact varied among sites due to inherent differences in site characteristics and variability in burn severity. In most cases we observed concentrated flow erodibility had a high value at overland flow initiation and then started to decline with time due to reduction of sediment availability. Thus we developed an empirical function to predict erodibility variation within a runoff event as a function of cumulative unit discharge. Empirical equations were also developed to predict erodibility variation with time postdisturbance as a function of readily available vegetation cover and surface soil texture data.
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214. **Desert Winds: Monitoring Wind-Related Surface Processes in Arizona, New Mexico, and California**.
Breed, C. S. and Reheis, M. C.
U.S. Geological Survey Professional Paper no. 1598, 158 p. (1999).
http://pubs.usgs.gov/pp/p1598/
Keywords: deserts/ arid lands/ wind erosion/ soil erosion/ eolian deposits/ soil transport processes/ disturbed soils/ measuring devices/ erosion control

215. **Detailed study of selenium and selected elements in water, bottom sediment, and biota associated with irrigation drainage in the Middle Green River Basin, Utah 1988-90**.
See record 125 in Subsurface Transport Processes.

216. **Determination of the wind speed threshold for the emission of desert dust using satellite remote sensing in the thermal infrared**.
Chomette, O., Legrand, M. and Marticorena, B.
Journal of Geophysical Research-Atmospheres 104: 31207-31215 (1999).
http://dx.doi.org/10.1029/1999JD900756
Keywords: erosion/ meteorology and atmospheric dynamics/ land-atmosphere interactions/ paleoclimatology/ sedimentation/ troposphere composition and chemistry/ Infrared Difference Dust Index (IDDI)
Abstract: The Infrared Difference Dust Index (IDDI), derived from images obtained from the Meteosat 10.5- to 12.5-mu m channel, describes the dust distribution over the Saharan-Sahelian region. This IDDI, associated with the 10-m wind speed re-analyses from the European Centre for Medium-Range Weather Forecasts (ECMWF), reveals whether or not the observed dust is associated with emission from an underlying source. This result allows one to determine the wind speed thresholds for dust emission from targets located in the western, central, and eastern Saharan-Sahelian region, by means of satellite remote sensing. Threshold values

determined for seven targets are presented. A comparison is carried out between such values and direct determinations obtained through the description of the soil texture and surface roughness of these targets. The agreement between these quite independent determinations is conclusive, with an average difference of 0.3 m s(-1) and a rms difference of 0.35 m s(-1).
© *Wiley Online Library*

217. **Dissolution potential of surficial Mancos Shale and alluvium**.
Laronne, J. B. and Schumm, S. A.
Fort Collins, Colo., Colorado State Univ., 144 p. (1977).
Keywords: salinity/ Colorado River Basin/ Mancos Shale/ salts/ sulfates/ dissolved solids/ alluvium/ sediment/ dilution/ salt source/ salt deposits/ water chemistry/ conductivity/ water quality
Abstract: The objectives were to determine the salt content of Mancos Shale and associated alluvium and the release mechanisms of salt from these deposits. When mixed with distilled water, the time necessary to approach equilibrium decreased with an increase of salt content and with a decrease of sediment concentration, and the time span required for equilibrium ranged from a few minutes to several days. The chemical quality of the aqueous mixtures was of the Ca2+-MG2+-Na1+-SO42--HCO31- type. Sodium and magnesium hydrated sulfates appeared to dissolve faster than gypsum or calcite and the relative abundance of Na1+, Mg2+ and SO42- decreased with increased dilution. There is a large inherent variability in the salt content of sampled sediments. Soluble mineral content of Mancos Shale from hillslopes (2 percent) is significantly larger than that of terrace alluvium (0.62-0.29 percent) and bed materials (0.93-0.81 percent) of North Miller and West Salt Creeks respectively. The most saline deposits (10 percent) are efflorescent bed crusts. Terrace and bed materials in narrow valleys where shallow alluvium overlies shale are highly saline (1.6 percent) and show an increase in salt content with depth. The results also show that major areas of diffuse sources of salts are also the major sediment contributors in the Upper Colorado River Basin.

218. **Drag coefficients, roughness length and zero-plane displacement height as disturbed by artificial standing vegetation**.
See record 7 in Rangeland Management Practices and Potential Impact on Salinity.

219. **Drought and grazing: II. Effects on runoff and water quality**.
Emmerich, W. E. and Heitschmidt, R. K.
Journal of Range Management 55: 229-234 (2002).
https://journals.uair.arizona.edu/index.php/jrm/article/view/9712
Keywords: erosion/ sediment yield/ nutrient transport/ Great Plains/ vegetation/ seasonal variation/ cover
Abstract: Understanding the interacting effects of drought and grazing on runoff, erosion, and nutrient transport is essential for improved rangeland management. Research was conducted at the Fort Keogh Livestock and Range Research Laboratory located near Miles City, Mont. using 12, non-weighing lysimeters for 3 years. During years I and 3, no drought treatment was imposed. For year 2, one half of the lysimeters were covered to implement a drought treatment. The 3 grazing treatments were ungrazed, grazed during but not after drought, and grazed during and after drought. Runoff, sediment yield, and an array of nutrients in the runoff water were measured from the lysimeters. First year base line data with no grazing or drought treatments applied indicated no significant differences among lysimeters. Below normal precipitation occurred during year 2, resulting in no runoff from the drought treatment and negated the "nondrought" control. This prevented a direct assessment of the interaction among the drought and grazing treatments for this year. The drought treatment did produce significant reductions in water, sediment, and nutrient yield. No grazing impact was observed during year 2. The third year with more normal precipitation, there was a trend toward increased runoff, sediment, and nutrient yield from the second year drought treatment lysimeters. In the third year, both grazing treatments showed significantly greater runoff, sediment, and nutrient yield than the ungrazed treatment. Runoff and sediment yield tended to increase from the combination of drought and grazing treatments. The observed increases in runoff and sediment and reduced water quality from the drought and grazing treatments were

measured against controls and when compared to the natural variability and water quality standards, they were concluded to be minimal.
This citation is from the University of Arizona Institutional Repository.

220. **Dryland management for salinity control**.
See record 127 in Subsurface Transport Processes.

221. **Dryland salinity in south east Australia: Which scenario makes more sense?**
See record 8 in Rangeland Management Practices and Potential Impact on Salinity.

222. **Dust deposition downwind of Owens (dry) Lake, 1991-1994: Preliminary findings**.
Reheis, M. C.
Journal of Geophysical Research 102: 25999-26008 (1995).
http://dx.doi.org/10.1029/97JD01967
Keywords: dust storms/ eolian deposits/ wind erosion/ playas/ saline soils/ soil salinization/ vegetation
Abstract: Salt-rich dust derived from the Owens Lake playa is deposited in significant quantities to distances of at least 40 km north and south of the playa. Semiannual measurements from 1991 to 1994 of dust deposition rates (dust flux) and composition 2 m above the ground at seven sites in Owens Valley show that (1) dust in Owens Valley is derived mainly from the playa, although areas closer to the sites can also be sources; (2) south of the playa, dust flux is higher in the winter than in the summer, but north of the playa, dust flux is about the same or slightly lower in the winter; (3) on the playa, interannual variation in dust flux is large (factors of 5–10 during the 3 years), but at downwind sites, the variation is much smaller; (4) the dust typically has total soluble salt content as high as 30%, generally much higher than that of dust elsewhere in southern Nevada and California; and (5) to a distance of at least 40 km south of the playa, soluble salt flux is significantly higher than regional rates. The dust flux measurements indicate that significant quantities of salt-rich dust are probably being added to the soils in the region around Owens Lake playa; these dust additions may affect soil pH and vegetation.
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223. **Dust emission from wet and dry playas in the Mojave desert, USA**.
Reynolds, R. L., Yount, J. C. and Reheis, M.
Earth Surface Processes and Landforms 32: 1811−1827 (2007).
http://dx.doi.org/10.1002/esp.1515
Keywords: playas/ dust storms/ eolian deposits/ wind erosion/ soil erosion/ water table/ rain/ groundwater/ saline sodic soils
Abstract: The interactions between playa hydrology and playa-surface sediments are important factors that control the type and amount of dust emitted from playas as a result of wind erosion. The production of evaporite minerals during evaporative loss of near-surface ground water results in both the creation and maintenance of several centimeters or more of loose sediment on and near the surfaces of wet playas. Observations that characterize the texture, mineralogic composition and hardness of playa surfaces at Franklin Lake, Soda Lake and West Cronese Lake playas in the Mojave Desert (California), along with imaging of dust emission using automated digital photography, indicate that these kinds of surface sediment are highly susceptible to dust emission. The surfaces of wet playas are dynamic - surface texture and sediment availability to wind erosion change rapidly, primarily in response to fluctuations in water-table depth, rainfall and rates of evaporation. In contrast, dry playas are characterized by ground water at depth. Consequently, dry playas commonly have hard surfaces that produce little or no dust if undisturbed except for transient silt and clay deposited on surfaces by wind and water. Although not the dominant type of global dust, salt-rich dusts from wet playas may be important with respect to radiative properties of dust plumes, atmospheric chemistry, windborne nutrients and human health.
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224. **Ecology of dust**.
Field, J. P., Belnap, J., Breshears, D. D., Neff, J. C., Okin, G. S., Whicker, J. J., Painter, T. H., Ravi, S., Reheis, M. C. and Reynolds, R. L.
Frontiers in Ecology and the Environment 8: 423-430 (2010).
http://dx.doi.org/10.1890/090050
Keywords: dust storms/ wind erosion/ soil erosion/ eolian deposits/ runoff/ ecology/ rangelands
Abstract: Wind erosion and associated dust emissions play a fundamental role in many

ecological processes and provide important biogeochemical connectivity at scales ranging from individual plants up to the entire globe. Yet, most ecological studies do not explicitly consider dust-driven processes, perhaps because most relevant research on aeolian (wind-driven) processes has been presented in a geosciences rather than an ecological context. To bridge this disciplinary gap, we provide a general overview of the ecological importance of dust, examine complex interactions between wind erosion and ecosystem dynamics from the scale of plants and surrounding space to regional and global scales, and highlight specific examples of how disturbance affects these interactions and their consequences. It is likely that changes in climate and intensification of land use will lead to increased dust production from many drylands. To address these issues, environmental scientists, land managers, and policy makers need to consider wind erosion and dust emissions more explicitly in resource management decisions.
This citation is from the Ecological Society of America.

225. **The effect of erosion on solute pickup from Mancos Shale hillslopes, Colorado, USA**.
Laronne, J. B. and Shen, H. W.
Journal of Hydrology 59: 189-207 (1982).
http://dx.doi.org/10.1016/0022-1694(82)90011-7
Keywords: soil erosion/ solute transport/ Mancos Shale/ Colorado/ shales/ runoff/ rainfall-runoff relationships/ salinity/ surface runoff/ sediment yield/ rill erosion
Abstract: Sediment concentration has been shown to be statistically related to solute concentration. A causal relationship is demonstrated between these water quality variables. Solute concentration, which for a constant discharge is linearly related to solute production, increases with increases in sediment yield during rilling and rill entrenchment due to dissolution of transported sediment particles. Moreover, solute release increased as the power per unit width of surface area increased, thereby causally explaining the high correlation between runoff salinity and slope inclination. The regression between these two variables may be used as a tool to assess salinity hazard. The proportions of solute yield derived entirely from contact with the soil surface or from dissolution of transported sediment have not been determined. It is assumed that a significantly larger proportion of solute yield from Mancos Shale hillslopes originates from transported sediment than that demonstrated herein. Direct runoff rather than rainfall induced runoff was generated on the studied hillslopes.

226. **Effect of Low Levels of Exchangeable Sodium and Applied Phosphogypsum on the Infiltration Rate of Various Soils**.
Kazman, Z., Shainberg, I. and Gal, M.
Soil Science 135(3): 184-192 (1983).
Keywords: water quality control/ arable soils/ erosion/ runoff
Abstract: The arable soils in the arid and semiarid regions of Israel contain 2 to 6% exchangeable sodium in the upper layer. Considerable amounts of runoff and erosion from these soils, measured during rainstorms, have been associated with aggregate dispersion and crust formation at the soil surface. The effect of exchangeable sodium percentage (ESP) on the infiltration rate (IR) and crust formation of four soils, varying in their texture , mineralogy, and CaCO3 content was studied, using distilled water (EC approximately .05 mmho/cm) in a rain simulator. The IR of the four soils was very sensitive to low levels of ESP (5), whereas the hydraulic conductivity (HC) of these soils was less sensitive. The presence of lime in the soils was effective in preventing HC decreases due to low levels of exchangeable Na. Conversely, lime was not effective in maintaining the IR of the calcareous soils. Phosphogypsum prevented the sharp drop in IR of the soils at all levels of ESP. The mechanical impact of the raindrops, the low concentration of electrolytes in the rain and in the surface soil solution, and the relative freedom for particle movement at the soil surface, accounts for the higher susceptibility of the soil surface to exchangeable Na. The high rate of dissolution of phosphogypsum, leading to the presence of electrolytes in the surface soil solution, accounts for the effectiveness of phosphogypsum in maintaining the high IR. The effect of low levels of ESP and the soil solution concentration of the IR of soils suggests that crust formation in soils is due to two mechanisms: a physical dispersion of soil aggregates caused by the mechanical impact of the raindrops; and a chemical dispersion caused by the soil ESP and the low electrolyte concentration in the applied water. (Moore-IVI)
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227. **The effect of soil salinity and sodicity on soil erodibility, sediment transport and downstream water quality**.
Ghadiri, H., Hussein, J., Dordipour, A. E. and Rose, C.
ISCO 2004, 13th International Soil Conservation Organisation Conference - Conserving Soil and Water for Society: Sharing Solutions, Brisbane, Australia (2004).
http://tucson.ars.ag.gov/isco/isco13/PAPERS%20F-L/GHADIRI.pdf
Keywords: soil erosion/ erosion control/ soil salinity/ saline soils/ soil sodicity/ sodic soils/ soil conservation/ soil stabilization/ rain/ runoff/ soil treatment
Abstract: There is an abundance of literature on many aspects of soil salinity and sodicity, and the impact of increased salt and sodium on properties, behaviour, management and productivity of soils. However the impact of sodicity on erosion and soil erodibility and sediment transport has received less attention. The aim of this study was to investigate the effects of changing soil salinity and sodicity of two Queensland soils on their erodibilities and erosion losses under simulated rainfall. Erosion measurements were carried out on the two soils in the 1 x 6 m flume of Griffith University's large rainfall simulation facility (GUTSR), with and without sodium treatments. Sediment loss increased for both sodium-treated soils with the Redlands soil showing an eight-fold increase. Mea n aggregate/particle size of the eroded sediment decreased with increased sodicity. High sodium concentration thus contributed to the weakening of soil aggregates and their dispersion under the raindrop impact. Electrical conductivity and salt concentration of the runoff decreased exponentially with time from sodium-treated soils.
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228. **Effects of fire and environmental variables on plant structure and composition in grazed salt desert shrublands of the Great Basin (USA)**.
Haubensak, K., D'antonio, C. and Wixon, D.
Journal of Arid Environments 73: 643-650 (2009). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2008.12.020
Keywords: cheatgrass/ fire/ grasses/fire cycle/ Great Basin/ invasion/ non-native grasses/ post-fire recovery/ shrub recruitment
Abstract: Fire in shrub-dominated portions of the Great Basin, largely fueled by non-native annuals such as *Bromus tectorum*, has become an important structuring force altering vegetation composition and soil characteristics. The extent to which fire affects native species in drier portions of the Great Basin, termed salt desert, is poorly documented. We conducted a survey of grazed salt desert habitat in northwestern Nevada 5 years after wildfires burned 650,000 ha, with the goal of investigating community response to fire and factors correlating with post-fire recovery. We found that recruitment of a dominant shrub, *Artemisia spinescens*, is severely restricted following fire: it occurred in only 2 of the 24 burned sites. The co-dominant shrub, *Atriplex confertifolia*, occurred in most burned sites although on average its percent cover was one-third lower than adjacent unburned sites. Biotic soil crust cover was four times lower, and non-native species cover 5 times higher, in burned sites compared to unburned. Ordination analyses confirmed differences among plant communities in burned versus unburned sites, with environmental variables soil conductivity, plant litter, soil potassium (K+) and pH explaining 38% of the variance in community composition. However, we found no environmental predictors of recovery for native species in burned sites. Future recruitment is likely to be further limited, as fire frequency in the salt desert is expected to increase with invasion by non-native annual grasses and with global climate change.
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229. **Effects of land processes on the salinity of the upper Colorado River Basin: Final project report**.
See record 132 in Subsurface Transport Processes.

230. **Effects of soil degradation on infiltration rates in grazed semiarid rangelands of northeastern Patagonia, Argentina**.
Chartier, M. P., Rostagno, C. M. and Pazos, G. E.
Journal of Arid Environments 75: 656-661 (2011). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2011.02.007
Keywords: rangelands/ soil degradation/ infiltration (hydrology)/ grazing lands/ semi-arid zones/ runoff/ soil erosion
Abstract: In grazed semiarid ecosystems, considerable spatial variability in soil infiltration exists as a result of vegetation and soil

patchiness. Despite widespread recognition that important interactions and feedbacks occur between vegetation, runoff and erosion, currently there is only limited quantitative information on the control mechanisms that lead to differences in infiltration from different vegetation types. In this paper, we determine (i) the relationship between vegetation and soil surface characteristics and (ii) the soil infiltration rate by using rainfall simulations on runoff plots (0.60 × 1.67 m) in three plant communities of northeastern Patagonia: grass (GS), degraded grass with scattered shrubs (DGS), and degraded shrub steppes (DSS). Our results clearly indicate that vegetation and soil infiltration are closely coupled. Total infiltration was significantly higher in the GS (69.6 mm) compared with the DGS and DSS (42.9 and 28.5 mm, respectively). In the GS, soil infiltration rate declined more slowly than the others communities, reaching a terminal infiltration rate significantly greater (57.7 mm) than those of DGS and DSS (25.7 and 12.9 mm, respectively). The high rate of water losses via overland-flow may limit the possibilities for grass seedling emergence and establishment and favor the persistent dominance of shrubs.
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231. **Elementary processes of soil–water interaction and thresholds in soil surface dynamics: A review**.
Greene, R. S. B. and Hairsine, P. B.
Earth Surface Processes and Landforms 29: 1077-1091 (2004). ISSN: 0197-9337
http://dx.doi.org/10.1002/esp.1103
Keywords: swelling/ slaking/ clay dispersion/ cover/ aggregate stability/ surface crusts/ sealing
Abstract: Elementary processes of soil–water interaction and the thresholds to these processes are important to understand as they control a range of phenomena that occur at the soil surface. In particular processes involved with wetting by rainfall that lead to particle breakdown are critical. This breakdown causes soil detachment and crust formation, which are both key elements in erosion. This paper reviews the range of approaches that have been taken in describing the processes associated with the wetting of a soil surface by rainfall. It assembles the studies that emphasize soil physics, soil chemistry, and erosion mechanics in a framework to enable a balanced consideration of important processes and management strategies to control erosion for a particular situation. In particular it discusses the factors associated with the two basic processes of soil structural breakdown, i.e. slaking and dispersion, and how these processes are critical in particle detachment, transport and surface crust formation. Besides the balance between the exchangeable cation composition and electrolyte concentration (measured as the sodium adsorption ratio (SAR) and total cation concentration (TCC) respectively) of the soil, the importance of energy input and soil organic matter content in controlling clay dispersion is emphasized. Based on the balance between these factors, the soil can be in one of three different regions, i.e. a dispersed region, an inoculated region and one where the resilience of the soil is variable. The implications of each of these regions to soil erosion management are briefly outlined, as are the critical roles that soil cover levels and organic matter have in controlling erosion. Finally, the relationship between various laboratory measures of aggregate stability, and corresponding field erosion characteristics, is discussed. Copyright © 2004 John Wiley & Sons, Ltd.

232. **Environmental tracers applied to quantifying causes of salinity in arid-region rivers; results from the Rio Grande Basin, Southwestern USA**.
Phillips, F. M., Mills, S., Hendrickx, J. M. H. and Hogan, J.
Developments in Water Science 50: 327-334 (2003). ISSN: 0167-5648
http://cierzo.sahra.arizona.edu/research/TA2/images/Riosalinity.pdf
Keywords: oxygen/ isotopes/ halogens/ New Mexico/ stable isotopes/ groundwater/ irrigation/ tracers/ deuterium/ Rio Grande valley/ Cl-Br/ geochemistry/ Rio Grande River/ hydrology/ chlorine/ isotope ratios/ O-18/O-16/ southwestern United States/ bromine/ hydrochemistry/ evapotranspiration/ Mexico/ dissolved materials/ hydrogen/ hydrochemistry/ hydrogeology/ Colorado/ salinization
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233. **Eolian factor in the process of modern salt accumulation in western Dzungaria, China**.
Abuduwaili, J. and Mu, G. J.
Eurasian Soil Science 39: 367−376 (2006).
http://dx.doi.org/10.1134/S106422930604003X

Keywords: salinity/ eolian deposits/ soil transport processes/ dust storms/ playa soils
Abstract: In the Ebinur region of Western Dzungaria, strong wind flows from Dzungarian Gate predetermine the widespread development of deflation processes. As a result of human-induced desiccation of Lake Ebinur, a new source of the loose material—the dry lake bed—has formed, which has intensified dust storms in this region. Annual dynamics of the frequency and intensity of dust storms and the amount and chemical composition of salts in the eolian material deposited in the area have been studied. The frequency of dust storms and the intensity of dust and salt deposition regularly decrease with an increase in the distance from the dry lake bottom (playa). The amount of dust deposition ranges from 600 (near the lake) to 70 (100–200 km from the lake) g/m2/a. The amount of salts precipitating with dust is mainly from 14 to 27 g/m2/a the maximum registered amount of salt deposition is 77 g/m2/a. As shown in our study, the farther from the lake, the higher the portion of sulfate and calcium and the smaller the portion of chloride and sodium ions in the composition of salts.

234. **Eolian transport, saline lake basins, and groundwater solutes**.
Wood, W. W. and Sanford, W. E.
Water Resources Research 31: 3121-3129 (1995). ISSN: 0043-1397
http://dx.doi.org/10.1029/95WR02572
Keywords: eolian transport/ arid basin/ chloride/ groundwater/ groundwater quality/ mass transport/ saline lake/ solute concentration
Abstract: Eolian processes associated with saline lakes are shown to be important in determining solute concentration in groundwater in arid and semiarid areas. Steady state mass balance analyses of chloride in the groundwater at Double Lakes, a saline lake basin in the southern High Plains of Texas, United States, suggest that approximately 4.5 X 10(5) kg of chloride is removed from the relatively small (4.7 km2) basin floor each year by deflation. Transport of salts from the lake was confirmed over a short term (2 years) by strategically placed dust collectors. The eolian transport process provides an explanation of the degraded groundwater quality associated with the 30-40 saline lake basins on the southern half of the southern High Plains of Texas and New Mexico and in many other arid and semiarid areas. -from Authors
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235. **Evaluation of the storage of diffuse sources of salinity in the Upper Colorado River Basin**.
See record 135 in Subsurface Transport Processes.

236. **Evaporite mineral species in Mancos Shale and salt efflorescence, Upper Colorado River basin**.
Whittig, L. D., Deyo, A. E. and Tanji, K. K.
Soil Science Society of America Journal 46: 645-651 (1982). ISSN: 0361-5995
Keywords: bloedite/ chemically precipitated rocks/ Colorado/ Colorado River basin/ composition/ Cretaceous/ epsomite/ evaporites/ gypsum/ hexahydrite/ kieserite/ loewite/ Mancos Shale/ Mesozoic/ mineral composition/ mirabilite/ pentahydrite/ salinity/ sedimentary rocks/ soil surveys/ soils/ starkeyite/ sulfates/ surveys/ thenardite/ United States/ Upper Cretaceous/ Utah/ water quality/ watersheds/ X-ray diffraction analysis
Abstract: Evaporite mineral species associated with Late Cretaceous marine sedimentary formations in a selected region of the Upper Colorado River Basin were identified by x-ray diffraction analysis. Mancos Shale, a major contributor of dissolved mineral salts to the Colorado River and several of its tributaries in the Upper Basin, contains abundant gypsum as the only detectable evaporite mineral. Salt efflorescence associated with the Mancos Shale, however, contains variable quantities of Ca, Na, and Mg sulfate evaporite species, including gypsum (CaSO4 o 2H2O), epsomite (Mg2SO4 o 10H2O), hexahydrite (MgSO4 o 6H2O), pentahydrite (MgSO4 o 5H2O), starkeyite (leonhardtite) (MgSO4 4H2O), kieserite (MgSO4 H2O), loewite [Na4Mg2(SO4)4 o 5H2O], bloedite [Na2Mg(SO4)2 o 4H2O],mirabilite (NaSO4 o 10H2O), and thenardite [Na2SO4). The hydrated sulfates of Na and Mg, as very labile salts, are subject to change in response to relatively minor changes in temperature and moisture status. Dominant evaporite mineral species associated with a few localized seeps and springs emanating from the Late

Cretaceous Mount Garfleld formation of the Mesaverde group, overlying the Mancos Shale, include soda (Na2CO3 10H2O), trona (Na2CO3 NaHCO3 2H2O), nahcolite (NaHCO,), and halite (NaCI). Origin of the evaporite mineral species and their significance in relation to salt loading of the Colorado River are discussed.
This citation is from the Soil Science Society of America.

237. **Examination of a non-point source loading function for the Mancos shale wildlands of the Price River Basin, Utah**.
See record 137 in Subsurface Transport Processes.

238. **Experimental study on the susceptibility of crusted surfaces to wind erosion: A comparison of the strength properties of biotic and salt crusts**.
Langston, G. and Mckenna Neuman, C.
Geomorphology 72: 40-53 (2005).
http://dx.doi.org/10.1016/j.geomorph.2005.05.003
Keywords: soil crusts/ wind erosion/ eolian deposits/ soil erosion/ saline soils
Abstract: Penetrometry has been employed in a number of studies investigating the strength of crusted sediments as related to their stability to particle impact in aeolian systems. Despite the early success of this procedure, questions remain concerning the effect of the angle of penetration, the role of fatigue, and the relative importance of the ultimate strength as compared to the elasticity of the crust. This paper reports on a series of penetrometer and wind tunnel experiments that consider these effects in the context of both salt and biotic crusts. The results demonstrate that the angle of penetration is not important but the density of penetrations is. The decreased strength observed with high densities of penetration, repeated loading, and continual impact in wind tunnel experiments provides further confirmation that sedimentary crusts progressively become weaker during mass transport events. The elasticity of the surface appears to be at least as important to consider as the ultimate strength. Although much stronger, the salt crusts were found to break down and erode sooner than biotic crusts in wind tunnel studies. The notable elasticity of biotic crusts appears to afford them some protection against abrasion. D 2005 Elsevier B.V. All rights reserved.
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239. **Field measurements of wind and water transport for contaminant mobility: Comparisons and contrasts among semiarid grassland, shrubland, and forest ecosystems**.
See record 138 in Subsurface Transport Processes.

240. **Floating brine crusts, reduction of evaporation and possible replacement of fresh water to control dust from Owens Lake bed, California**.
Groenveld, D. P., Huntington, J. L. and Barz, D. D.
Journal of Hydrology 392: 211-218 (2010).
ISSN: 0022-1694
http://dx.doi.org/10.1016/j.jhydrol.2010.08.010
Keywords: brine/ evaporation/ saline playas/ saltcrust/ static chamber
Abstract: Owens Lake, California, a saline terminal lake desiccated after diversion of its water source, was formerly the single largest anthropogenic source of fugitive dust in North America. Over 100 billion m-3 yr-1 of fresh water are projected to be used for mandated dust control in over 100 km2 of constructed basins required to be wetted to curtail emissions. An extensive evaporite deposit is located at the lake's topographic low and adjacent to the dust control basins. Because this deposit is non-dust-emissive, it was investigated as a potential replacement for the fresh water used in dust control. The deposit consists of precipitated layers of sodium carbonate and sulfate bathed by, and covered with brine dominated by sodium chloride perennially covered with floating salt crust. Evaporation (E) rates through this crust were measured using a static chamber during the period of highest evaporative demand, late June and early July, 2009. Annualized total E from these measurements was significantly below average annual precipitation, thus ensuring that such salt deposits naturally remain wet throughout the year, despite the arid

climate. Because it remains wetted, the evaporite deposit may therefore have the potential to replace fresh water to achieve dust control at near zero water use. (c)2010 Published by Elsevier B.V.
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241. **Global impacts of conversions from natural to agricultural ecosystems on water resources: Quantity versus quality**.
See record 140 in Subsurface Transport Processes.

242. **Global variability of daily total suspended solids and their fluxes in rivers**.
Meybeck, M., Laroche, L., Dürr, H. H. and Syvitski, J. P. M.
Global and Planetary Change 39: 65-93 (2003).
ISSN: 0921-8181
http://dx.doi.org/10.1016/S0921-8181(03)00018-3
Keywords: sediment concentration/ sediment flux/ river regimes/ global scale/ time variability
Abstract: The daily variability of river suspended sediment concentration (Cs) and related yield (Y) is studied at 60 global stations. The data set covers natural conditions (e.g. pre-reservoir data), ranging from the humid tropics to subarctic and arid regions, located in all types of relief (yearly runoff q* from 0.1 to 55 l s−1 km−2). Basin area ranges from 64 km2 to 3.2 million km2. Survey lengths range from 1 to 20 years with a median of 3 years. Median values (Cs50, q50, Y50) and discharge-weighted averages for Cs* and Y* range from 5 to 29 000 mg l−1 and 10 to 5000 kg km−2 day−1, respectively. A set of indicators of variability are proposed for sediment concentration, water and sediment discharges including mean to median ratios (Cs*/Cs50, Y*/Y50), the percentage of sediment flux discharged in 2% of time (Ms2), the percentage of time necessary to carry half of the sediment flux (Ts50), and quantiles of Cs, q and Y distributions corresponding to the discharge-weighted averages. Since most of the sediment flux is discharged in less than 25% of the time, “truncated rating curves” metrics are proposed between the Cs vs. q relationship for periods of high flux. Temporal variability decreases with increasing basin size, lake abundance, and is higher for basins influenced by glaciermelt and snowmelt. The least variable sediment flux regimes are noted for the Mississippi at its mouth, the Rhone Lacustre, the St. Lawrence and the Somme, a medium-sized French phreatic river. The most variable flux regimes were for small- to medium-sized basins (i.e. <1000 to 10 000 km2) such as steep Andean Bolivian basins, Thai basins, the Eel (CA) and Walla Walla (OR) rivers. A proposed global scale typology is based on six classes key variability indicators.
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243. **Historical BLM Mancos Shale management in NW CO**.
See record 11 in Rangeland Management Practices and Potential Impact on Salinity.

244. **Hydrology of Salt Wells Creek--A Plains Stream in Southwestern Wyoming**.
Delong, L. L., Collier, K. R., Zimmerman, E. A. and Lowham, H. W.
USGS Water-Resources Investigations Report, Cheyenne, Wyoming, U.S. Geological Survey, 52 p. (1982).
http://pubs.er.usgs.gov/publication/wri8162
Keywords: mineral development/ hydrology/ runoff/ intermittent streams/ dissolved solids/ sediment/ stream channel erosion
Abstract: Development of energy minerals in plains areas of Wyoming is expanding rapidly. Such development may affect water resources and hydrologic relations of the plains; however, little information exists concerning hydrologic processes for these areas. This report summarizes results of a hydrologic study made during 1975-78 of Salt Wells creek, a drainage area of about 500 square miles located southeast of Rock Springs, Wyoming. The area is typical of arid and semiarid plains areas in southwestern Wyoming where mineral development is occurring. Salt Wells Creek is predominately an intermittent stream. Numerous springs in the headwaters cause small perennial flows in some upstream tributaries, but evaporation, freezeup, and seepage deplete these flows so that the middle and lower reaches of the main channel have only intermittent flows. The intermittent nature of streamflow affects water quality. It was observed that a flushing of dissolved solids and suspended sediment occurs during the first flows of a runoff event. A striking feature of the stream is its deeply incised channel. The downcutting is attributed to the cumulative effects of: (1) a change in the relative climate, amounts of annual precipitation occurring as rain

and snow, (2) change in base level due to downstream channelization, and (3) changes in land use. Because of the incision, erosion is now expanding to include intervening tributaries. (USGS)

245. **The impact of climate change on geomorphology and desertification along a Mediterranean-arid transect**.
Lavee, H., Imeson, A. C. and Sarah, P.
Land Degradation & Development 9: 407-422 (1998). ISSN: 1085-3278
http://www.agronomia.uchile.cl/web/manuel_casanova/desertificaci%F3n/lavee%201998.pdf
Keywords: desertification/ rainfall/ arid lands/ climatic changes/ environmental impact/ mechanical change/ natural change/ Israel/ ecosystem disturbance/ environmental protection/ permeability/ geomorphology/ soil properties/ infiltration
Abstract: From the perspective of geomorphology, three important aspects of climate should be considered if conditions become more arid: (a) any decrease that might occur in the annual rainfall amount; (b) the duration of rainfall events; and (c) any increase in the intervals between rainfall events. These, together with increasing temperature, lead to less available water, less biomass and soil organic matter content and hence to a decrease in aggregate size and stability. As a consequence, the soil permeability decreases, soils develop surface crusts and infiltration rates decrease dramatically. Such changes in vegetation cover and soil structure lead to an increase in overland flow and in the erosion of the fertile topsoil layer. Positive feedback mechanisms may reinforce these effects and lead to desertification. This paper considers the results of field investigations into the spatial variability of a number of 'quick response' variables at two scales: the regional and the plot scales. Concerning the regional scale spatial variability, results of experimental field work conducted along a climatic transect, from the Mediterranean climate to the arid zone in Israel, show that: (1) organic matter content, and aggregate size and stability decrease with aridity, while the sodium adsorption ratio and the runoff coefficient increase; and (2) the rate of change of these variables along the climatic transect is non-linear. A steplike threshold exists at the semiarid area, which sharply separates the Mediterranean climate and arid ecogeomorphic systems. This means that only a relatively small climatic change would be needed to shift the borders between these two systems. As many regions of Mediterranean climate lie adjacent to semiarid areas, they are threatened by desertification in the event of climate change. Concerning spatial variability at the plot scale, different patterns of overland flow generation and continuity characterize hillslopes under different climatic conditions. While in the Mediterranean climate area infiltration is the dominant process all over the hillslope, in the arid area overland flow predominates. In contrast to the uniform distribution of processes in these two zones, a mosaic-like pattern, consisting of locally 'arid' water contributing and 'moist' water accepting patches is typical of the transitional semiarid area. Such pattern is strengthened by fires or grazing which are characteristic of this area. The development of such mosaic pattern enables most rainfall to be retained on hillslopes. Changes in the spatial pattern of contributing versus accepting water areas can be used as an indicator of desertification and applied to developing rehabilitation strategies.
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246. **Impact of debris dams on hyporheic interaction along a semi-arid stream**.
Lautz, L. K., Siegel, D. I. and Bauer, R. L.
Hydrological Processes 20: 183-196 (2006). ISSN: 0885-6087
http://dx.doi.org/10.1002/hyp.5910
Keywords: hyporheic zone/ OTIS-P/ solute transport/ tracer test/ transient storage/ chlorine compounds/ debris/ stream flow/ substrates/ surface water/ watersheds/ debris dams/ dams/ streamflow/ tracers/ woody debris
Abstract: Hyporheic exchange increases the potential for solute retention in streams by slowing downstream transport and increasing solute contact with the substrate. Hyporheic exchange may be a major mechanism to remove nutrients in semi-arid watersheds, where livestock have damaged stream riparian zones and contributed nutrients to stream channels. Debris dams, such as beaver dams and anthropogenic log dams, may increase hyporheic interactions by slowing stream water velocity, increasing flow complexity and diverting water to the subsurface. Here, we report the results of chloride tracer injection experiments done to evaluate hyporheic interaction along a 320 in reach of Red Canyon Creek, a second order stream in the semi-arid Wind River Range

of Wyoming. The study site is part of a rangeland watershed managed by The Nature Conservancy of Wyoming, and used as a hydrologic field site by the University of Missouri Branson Geologic Field Station. The creek reach we investigated has debris dams and tight meanders that hypothetically should enhance hyporheic interaction. Breakthrough curves of chloride measured during the field experiment were modelled with OTIS-P, a one-dimensional, surface-water, solute-transport model from which we extracted the storage exchange rate α and cross-sectional area of the storage zone AS, for hyporheic exchange. Along gaining reaches of the stream reach, short-term hyporheic interactions associated with debris dams were comparable to those associated with severe meanders. In contrast, along the non-gaining reach, stream water was diverted to the subsurface by debris dams and captured by large-scale near-stream flow paths. Overall, hyporheic exchange rates along Red Canyon Creek during snowmelt recession equal or exceed exchange rates observed during baseflow at other streams. Copyright © 2005 John Wiley & Sons, Ltd.

247. **Impact of flooding on modelling salt transport processes to streams**.
Jolly, I. D., Narayan, K. A., Armstrong, D. and Walker, G. R.
Environmental Modelling and Software 13: 87-104 (1998). ISSN: 1364-8152
http://dx.doi.org/10.1016/s1364-8152(98)00003-6
Keywords: flood/ modeling/ salts/ transport processes
Abstract: The development of many of the world's arid and semi-arid regions has resulted in the salinisation of land and water resources. In these areas, soils and groundwaters are often naturally saline and any disturbance of the delicate hydrological balance results in mobilisation of the stored salt. The salt transport mechanisms are often highly complex, the understanding of which necessitates the use of computer modelling in combination with field studies. In this paper the transport of salt between groundwater and streams on the Chowilla floodplain in south-eastern Australia was modelled and compared with available field data. The large salinity contrast between the fresh stream and floodwater and the saline groundwater results in density-dependent flow behaviour, and hence necessitated the use of a variable density flow and solute transport model (SUTRA). The model was applied in cross-section over a 6.1-km-long transect across the floodplain. Time varying boundary conditions were employed at the locations of three streams on the transect to simulate the interaction between the rising and falling streams and the adjacent aquifer during and after floods. The model was used to assess the importance of overbank floods in the transport of salt to floodplain streams by carrying out simulations under various recharge scenarios. The simulations showed that the mixing of floodwater and groundwater within the bank storage adjacent to the streams could predict the observed short-term (<12 months) salt load recessions. In order to predict the observed long-term (12-24 months) salt load recessions, the inclusion of localised recharge during overbank floods is required, as hypothesised by previous field-based studies.
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248. **Important factors influencing water infiltration and sediment production on arid lands in New Mexico**.
Wood, J. C., Wood, M. K. and Tromble, J. M.
Journal of Arid Environments 12: 111-118 (1987). ISSN: 0140-1963
http://jornada.nmsu.edu/bibliography/322.pdf
Keywords: soil water/ infiltration (hydrology)/ arid lands/ soil water/ sediment erosion/ soil transport processes
Abstract: Factors influencing infiltration rates and sediment production were evaluated on representative study areas of four watersheds in New Mexico under various land management practices. Multiple regression analysis was used to determine the most important factors influencing infiltration and sediment production. Factors found important were soil texture, soil organic matter, soil bulk density, plant cover, biomass production, time to runoff, and time to ponding. Of all variables studied, total ground cover was considered to be the most important single variable influencing infiltration and sediment production.

249. **In situ measurements of moisture and salt movement in freezing soils**.
Gray, D. M. and Granger, R. J.
Canadian Journal of Earth Sciences 23: 696-704 (1986). ISSN: 0008-4077
http://dx.doi.org/10.1139/e86-069

Keywords: saline soils/ soil transport processes/ soil salinization/ models/ rangelands/ soil water/ frozen soils
Abstract: The paper presents the results of field studies on the movement of moisture and salts during freezing of Prairie soils. It is shown that large fluxes of water can migrate to the freezing front and move upward into the frozen soil above. The fluxes are largest in light-textured soils (e.g., silt loam) having a water table at shallow depth. However, substantial amounts of soil moisture may also move in silty clay, silty clay loam, and clay soils under dryland farming provided there is sufficient water present to support capillary flow. The dynamics of soil moisture transfer under natural conditions as a result of freezing involves movement of water in both vapor and liquid phases. In the shallow surface layer of soil, to a depth of 300-400 mm, vapor flow predominates; in the depth below, water usually moves primarily as a liquid. It is demonstrated that the accumulation of ice with time increases because of the downward movement of the freezing front and the upward movement of water into the frozen soil above. In a silt loam with large fluxes, the ice content of the frozen zone rapidly reaches a level (80-85% pore saturation) where measurable migration ceases. Conversely, in a silty clay the movement of moisture into the frozen soil is observed to continue throughout most of the freezing period, and the ice content reaches 93 % pore saturation. The greater movement in the finer grained soil is attributed to a higher freezing-point depression, a larger number of capillary pores, and a higher concentration of soluble salts in the liquid films. A close association is observed between changes in the ice content and electrical conductivity of a silt loam after freezing. In a silty clay the agreement is less clear, probably the result of the exchange of ions between the migrating liquid water and the clay particles. Maximum amounts of exchangeable ions moving into a 1 m depth of soil by the freezing action are estimated to be 11.9 t/ha in a silt loam and 15.7 t/ha in a silty clay loam. Data showing the redistribution of water and salts during thawing are also presented and discussed.

250. **Infiltration from an impoundment for coal-bed natural gas, Powder River Basin, Wyoming: Evolution of water and sediment chemistry**.
See record 160 in Subsurface Transport Processes.

251. **Infiltration through three contrasting biological soil crusts in patterned landscapes in the Negev, Israel**.
Eldridge, D. J., Zaady, E. and Shachak, M.
CATENA 40: 323-336 (2000).
http://dx.doi.org/10.1016/S0341-8162(00)00082-5
Keywords: soil crusting/ soil patterning/ infiltration/ Negev Desert/ vegetation patchiness/ desertification/ microbiotic crusts/ microphytic crusts
Abstract: We examined the role of soil crusts in infiltration processes in three contrasting environments in the Northern, Central, and Central-Western Negev, Israel. The removal of a thin cyanobacterial-dominant crust from a sandy dune at Nizzana in the Central-Western Negev and of a well-developed lichen-dominant and a cyanobacterial-dominant crust from a loess-covered hillslope at Sayeret Shaked in the Northern Negev resulted in three to fivefold increases in sorptivity and steady-state infiltration under both pending and tension. The removal of a depositional crust colonised by cyanobacteria from a loess floodplain at Sede Zin in the Central Negev resulted in an increased infiltration under tension, but had no significant effect under pending. We attribute the lack of effect under pending to exposure of surface silts to water, which resulted in the clogging of matrix pores and surface sealing. The removal of the crusts in all three landscapes influences resource flows, particularly the redistribution of runoff water, which is essential for the maintenance of desert soil surface patterning. It would also have marked effects on germination, establishment and survival of vascular plants and soil biota, leading ultimately to desertification. (C) 2000 Elsevier Science B.V. All rights reserved.

252. **Influence of abiotic and biotic factors in measuring and modeling soil erosion on rangelands: state of knowledge**.
Weltz, M. A., Kidwell, M. R. and Fox, H. D.
Journal of Range Management 51: 482-495 (1998).
https://journals.uair.arizona.edu/index.php/jrm/article/view/9344/8956
Keywords: sediment yield/ interrill erosion/ rill erosion/ erosion/ modeling/ sediment/ watersheds/ plant communities/ ecology/ soil loss/ USLE/ RUSLE/ WEPP
Abstract: The first standardized soil erosion prediction equation used on rangelands was the Universal Soil Loss Equation (USLE). The Revised Universal Soil Loss Equation (RUSLE) was developed to address deficiencies in the USLE by accounting for temporal changes in soil erodibility and plant factors which were not originally considered. Improvements were also made to the rainfall, length, slope, and management practice factors of the original USLE model. The Water Erosion Prediction Project (WEPP) model was developed to estimate soil erosion from single events, long-term soil loss from hillslopes, and sediment yield from small watersheds. Temporal changes in biomass, soil erodibility, and land management practices, and to a limited extent, spatial distribution of soil, vegetation, and land use are addressed in the WEPP model. To apply new process-based erosion prediction technology, basic research must be conducted to better model the interactions and feedback mechanisms of plant communities and landscape ecology. Thresholds at which accelerated soil erosion results in unstable plant communities must be identified. Research is needed to determine the confidence limits for erosion predictions generated by simulation models so that the probability of meeting specified soil loss values (kg ha-1 yr-1) for given management systems can be calculated at specific significance levels. As the technology for modeling soil erosion on rangelands has improved, limitations with the techniques of parameter estimation have been encountered. Improvements in model parameterization techniques and national databases that incorporate vegetation and soil variability are required before existing erosion prediction models can be implemented.
This citation is from the University of Arizona Institutional Repository.

253. **Integrated modeling of flow and transport processes in salt-affected soil**.
See record 161 in Subsurface Transport Processes.

254. **Interrelationships between plant functional types and soil moisture heterogeneity for semiarid landscapes within the grassland/forest continuum: a unified conceptual model**.
Breshears, D. D. and Barnes, F. J.
Landscape Ecology 14: 465-478 (1999).
http://dx.doi.org/10.1023/A:1008040327508
Keywords: catastrophe theory/ desertification/ grasslands/forest continuum/ savanna/ shrubland/ woodland/ soil moisture heterogeneity/ plant/ community composition/ plant functional types/ Walter's two-layer/ hypothesis/ pinyon-juniper woodlands/ water balance/ vegetation systems/ patagonian/ steppe/ spatial pattern/ rooting depth/ arid savanna/ New Mexico/ dynamics/ grass
Abstract: In semiarid landscapes, the ratio of herbaceous to woody plant biomass is a major determinant of ecosystem properties. This ratio depends to a large extent on the amount and spatial distribution of soil moisture that is available to plants, and these variables, in turn, are determined primarily by climate and land use. Current conceptual models for determining the ratio of herbaceous to woody plant biomass in semiarid plant communities are based either on differences in soil moisture with depth (vertical heterogeneity) from one site to another (Walter's two-layer model) or on differences in soil moisture between canopy and intercanopy patches at the same site (horizontal heterogeneity) that result from disturbances associated with land use (Schlesinger et al.'s model of desertification). We developed a model that unifies these two perspectives by relaxing two assumptions of Walter's two-layer model. First, our model recognizes that soil moisture varies horizontally between canopy and intercanopy patches, not only due to land-use disturbance, a general assumption of the Schlesinger et al. model, but also due to the physical nature of the canopy itself. Second, while retaining the general assumption of Walter that woody plants obtain moisture from deeper soil layers than do herbaceous plants, our model recognizes the existence of two types of woody plants: those that extract a substantial proportion of their moisture from deeper layers and those that extract mainly from shallower layers. By

modifying the two-layer hypothesis to include four soil compartments and distinguishing between shallow- and deeper-rooted woody species, our model integrates three key concepts in semiarid ecology: (1) the proportion of woody cover increases as moisture in the deeper soil layers increases (Walter's two-layer hypothesis for coexistence of herbaceous and woody plants); (2) land use practices that cause a reduction in herbaceous vegetation and compaction of intercanopy soils lead to a long-term increase in the proportion of woody plants (Schlesinger et al.'s concept, or more generally, that at a given site multiple variations in the proportions of herbaceous and woody plant biomass are possible); and (3) changes in the ratios of herbaceous to woody plant biomass exhibit complex behavior (changes can happen quickly and are not directly reversible without intensive management). This integration of concepts results because rather than assuming a simple, one-way dependence of plant functional types on soil moisture heterogeneity, our model assumes an interdependence between the two: soil moisture heterogeneity constrains the composition of the plant community, which in turn modifies soil moisture heterogeneity. The four-compartment model that we propose enables, for the first time, an integrated picture of both dimensions of soil moisture heterogeneity - horizontal and vertical - and of the interdependence between soil moisture heterogeneity and the proportions of the plant functional types that make up a given plant community. This unified conceptual model can be applied to provide insight into the individual and the combined effects of climate and land use on semiarid plant communities within the grassland/forest continuum, which vary in the proportions of canopy and intercanopy patches.

255. **Inventories and mobilization of unsaturated zone sulfate, fluoride, and chloride related to land use change in semiarid regions, southwestern United States and Australia**.
See record 162 in Subsurface Transport Processes.

256. **Mancos shale literature review on the Colorado Plateau**.
See record 166 in Subsurface Transport Processes.

257. **Mancos shale-associated alluvium**.
Laronne, J. B.
Earth Surface Processes and Landforms 6: 541-552 (1981). ISSN: 1096-9837
http://dx.doi.org/10.1002/esp.3290060604
Keywords: laboratory simulations/ dissolution kinetics/ shales and alluvium/ salinity/ arid regions
Abstract: Inquiry into the dissolution kinetics of naturally occurring geologic materials, rather than individual mineral species, has been relatively neglected. This is especially true of surface processes, the realm of surface water hydrology and geomorphology. This paper focuses attention at a laboratory study of the rate of such complex reactions. Functions defining the dissolution rates of saline (0.1–20 per cent salt content) Mancos Shale-associated alluvium in distilled water follow varying patterns. Dissolution is characterized by an initial (<5 min) high rate constant, by a following phase (20 min-57 h) where rates are reduced drastically, and by a final period of encroachment to equilibrium. Initial dissolution rates increase with increase in salt content and sediment: water ratio. The time necessary to approach equilibrium is, however, found to be directly proportional to the sediment; water ratio. The concentration of Na+, Mg2+, Ca2+, SC2−4 and HCO−3, and the relative abundance of Ca2+ and HCO−3 increase continuously with contact time, indicating that the hydrated sodium and magnesium sulphate minerals provide most of the initial solutes, though not necessarily most of the total solute bulk. The results obtained in this study indicate that the high initial dissolution rate of soluble minerals from alluvium, and particularly from shales in contact with aqueous solutions, is too short-lived to account for most of the solutes occurring in heavily sediment-laden surface flow. Excluding input from slower, usually supersaturated subsurface flow, dissolution from sediment in transport should be a major source of solutes in originally undersaturated and kinetically unequilibrated surface water in semiarid and arid regions.
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258. **Microbiotic crust control of runoff generation on sand dunes in the Negev Desert**.
Kidron, G. J., Yair, A., Vonshak, A. and Abeliovich, A.
Water Resources Research 39: 1108 (2003).
http://dx.doi.org/10.1029/2002WR001561

Keywords: microbiotic crusts/ chlorophyll/ carbohydrate/ runoff/ sand dunes/ Negev Desert/ biological soil crusts/ longitudinal dunes/ bounding/ surfaces/ Israel
Abstract: [1] The general belief that dune sands in arid regions are not likely to generate runoff and that runoff necessitates wet conditions is examined. Runoff generation was measured within an arid dune field in the western Negev Desert, Israel, during 1990 - 1994 on 16 plots (1.2-6.6 m(2)), constructed along a continuum of crust-covered crust. The relationships between chlorophyll a and carbohydrates of the microbiotic crust and runoff yield were studied. Whereas chlorophyll a (15-45 mg m(-2)) and carbohydrates (4.9-17.6 g m(-2)) of the cyanobacterial crusts showed positive linear relationships with runoff coefficients, a significant reduction in runoff yield was obtained once the moss-dominated crust (with 53 - 54.5 mg m(-2) chlorophyll a and 28.5 - 28.9 g m(-2) of carbohydrates), which inhabited the wettest habitat within the dune field, was also included in the analysis. Contrary to previous assumptions that an increase in runoff generation occurs on arid and semiarid sand dunes in wet climates, wet climates may lead to the establishment of moss-dominated crusts that in turn decrease runoff yield.
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259. **Microbiotic crusts and ecosystem processes**.
Evans, R. D. and Johansen, J. R.
Critical Reviews in Plant Sciences 18: 183-225 (1999).
http://dx.doi.org/10.1080/07352689991309199
Keywords: arid lands/ biodiversity/ carbon cycling/ ecosystem stability/ land use change/ nitrogen cycling
Abstract: Microbiotic crusts are biological soil crusts composed of lichens, cyanobacteria, algae, mosses, and fungi. The biodiversity of these crusts is poorly understood; several cosmopolitan species dominate in most areas, but many species are confined to one or a few sites. Nitrogen fixation by organisms within the crust can be the dominant source of nitrogen input into many ecosystems, although rates of nitrogen input are limited by water availability, temperature, and nitrogen loss from the crust. Photosynthetic rates of the microbiotic crust can be 50% of those observed for higher plants, but the contribution of crusts to carbon cycling is not known. The microbiotic crust binds soil particles together, and this significantly increases soil surface stability and resistance to erosion. Greenhouse studies have found that crusts can enhance seed germination, seedling survivorship, and plant nutrient status, but further experiments are needed under field conditions. Crusts are extremely susceptible to surface disturbance and fire, and disruption of crusts can decrease soil fertility and stability resulting in lower nutrient availability for vascular plants and significant soil loss from the ecosystem.

260. **Microbiotic Soil Crusts - a Review of Their Roles in Soil and Ecological Processes in the Rangelands of Australia**.
Eldridge, D. J. and Greene, R. S. B.
Australian Journal of Soil Research 32: 389-415 (1994).
http://dx.doi.org/10.1071/SR9940389
Keywords: microbiotic crusts/ microbiota/ cryptogamic crusts/ semi-arid rangelands/ soil crusts/ moss/ lichens/ cyanobacteria/ degraded semi-arid woodland/ arid chenopod shrubland/ eastern Australia/ raindrop impact/ pinyon-juniper/ sandy area/ surface crust/ deserts/ fire/ vegetation
Abstract: Microbiotic crusts are assemblages of non-vascular plants (mosses, liverworts, algae, lichens, fungi, bacteria and cyanobacteria) which form intimate associations with surface soils. They play a major role in infiltration processes through changes to soil physico-chemical properties, and through their influence on soil surface roughness. Whilst some research suggests that they may restrict infiltration, Australian experience is that they are generally associated with enhanced infiltration. Unlike physical soil crusts, microbiotic crusts stabilize the soil against water and wind erosion, increasing landscape stability, particularly in areas of low vascular plant cover. Microbiotic crusts are thus useful indicators of soil surface condition, and cyanobacteria in the crusts fix nitrogen which may be utilized by developing vascular plant seedlings. Little is known, however, about how they interact with vascular plants and soil invertebrates. Their role in rangeland ecosystems has received renewed attention over the past few years with an increasing interest in ecologically sustainable development of arid and semi-arid grazing systems. In this review we discuss the characteristics and distribution of microbiotic crusts in the rangelands of Australia, their roles

in soil and ecological processes and the impacts of fire and grazing. Finally we propose a new system for classifying crusts into functional groups and identify areas requiring further investigation.
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261. **Microphytic crust influence on interrill erosion and infiltration capacity**.
Williams, J. D., Dobrowolski, J. P. and West, N. E.
Transactions of the ASAE 38: 139-146 (1995).
http://1.usa.gov/14lc8L4
Keywords: raindrop impact/ soil stability/ microphytic crusts/ cryptobiotic crusts/ microbiotic crusts/ aridland processes/ soil-water content/ semi-arid woodland/ cryptogam cover/ sandy area/ vegetation/ rainfall/ Negev Desert/ field/ land
Abstract: Microphytic crusts form at the soil surface in arid and semiarid rangelands. They bind soil particles together and purportedly influence hydrologic and stability responses to rainfall. We tested this influence in a designed rainfall simulation experiment conducted on a sandy loam site in Capitol Reef National Park, Utah, that had been protected from livestock and human traffic for two to three years. Treatments consisted of microphytic crust conditions: 1) living and undisturbed (control); 2) chemically killed to determine structural influence (chemically killed), and mechanically removed from the soil surface (scalped) to approximate conditions of absence. Microphytic crusts in control and chemically killed treatments significantly reduced (alpha less than or equal to 0.05) time to pending and time to runoff, apparently due to structural and textural differences at the soil/air interface. Interrill erosion was greatest in the chemically killed treatment and lowest in the control treatment Interrill erosion in the scalped treatment was significantly greater than in the control treatment at 45 and 90 min. Microphytic crusts did not significantly influence the infiltration capacity. We attribute these responses to textural differences and structural support contributed to the soil by the microphytes. In the control treatment living microphytes' greatest contribution was to the stabilization of the soil particles at the soil surface. Microphytic crusts' ability to contribute to soil stability should be considered in development of management plans.

262. **Mineral soil surface crusts and wind and water erosion**.
Singer, M. J. and Shainberg, I.
Earth Surface Processes and Landforms 29: 1065-1075 (2004). ISSN: 0197-9337
http://dx.doi.org/10.1002/esp.1102
Keywords: soil crusts/ soil erosion/ mineralogy/ wind erosion/ eolian deposits/ runoff/ overland flow/ hydrology/ soil water
Abstract: The first few millimetres of soil largely control the soil's response to the eroding forces of wind and water. The tendency of soils to form surface seals and crusts influences the processes of wind and water erosion differently. For wind, dry particle size distribution and particle organization determine the shear strength and threshold wind velocity necessary to initiate particle movement. In loams and clay loams, seals and crusts decrease roughness but increase surface soil strength, generally decreasing wind erosion. Conversely, in sand and sandy loams, loose erodible sandy material may either deposit on the crust and is subject to erosion or it may disrupt the crust, accelerating the erosion process. For water erosion, particle size distribution and structure determine infiltration rate, time to ponding, and energy required for soil particle detachment. Seals and crusts tend to decrease infiltration rate and time to ponding thus increasing overland flow and soil erosion. This paper briefly reviews how permanent and time-dependent soil properties influence surface seals and crusts and how these affect soil erosion by wind and water. The tendency of a soil to form a seal and crust depends to some degree on the time-dependent property of soil structural stability, which tends to increase with increasing clay content and smectitic mineralogy which are permanent properties. These permanent properties and their effect on structure are variable depending on dynamic properties of exchangeable sodium percentage and soil solution electrical conductivity. Antecedent water content prior to irrigation or rainfall, rate of wetting before an erosive event and aging, the time between wetting and an erosive event, greatly influence the response of soil structure to raindrop impact. The effect of these dynamic processes is further influenced by the static and dynamic properties of the soil. Weak structure will be less influenced by wetting rate than will a soil with strong structure. Process-based models of wind and

water erosion need to consider the details of the interactions between soil static and dynamic properties and the dynamic processes that occur prior to erosive events. Copyright © 2004 John Wiley & Sons, Ltd.

263. **Modelling the effects of land use changes on runoff and soil erosion in two Mediterranean catchments with active gullies (South of Spain)**.
Martinez-Murillo, J. F., Lopez-Vicente, M., Poesen, J. and Ruiz-Sinoga, J. D.
Landform Analysis 17: 99-104 (2011).
https://lirias.kuleuven.be/handle/123456789/350589
Keywords: gully erosion/ land use/ RMMF model/ runoff/ soil erosion
Abstract: This study investigates the effects of land use changes between 1956 and 2006 on runoff and soil erosion in two Mediterranean catchments (South Spain) with active gullies, by applying the RMMF Model and by comparing the erosion channel network from both years. Results underline the complexity of soil erosion dynamics in gullied catchments where a general increase in soil erosion due to land use changes can occur simultaneously with a decrease in erosion rates within the gully system.
This citation is from Katholieke Universiteit Leuven.

264. **Moisture distributions and wetting rates of soils at experimental fields in the Netherlands, France, Sweden and Germany**.
Dekker, L. W., Ritsema, C. J., Wendroth, O., Jarvis, N., Oostindie, K., Pohl, W., Larsson, M. and Gaudet, J. P.
Journal of Hydrology 215: 4-22 (1999).
http://dx.doi.org/10.1016/S0022-1694(98)00258-3
Keywords: dry bulk density/ drying temperature/ irregular wetting/ soil water content/ water repellency/ wetting rate
Abstract: The variability of soil water content over short distances was studied at seven experimental fields, located in southern Sweden, eastern Germany, southern France, and in the Netherlands. The soils all in use as arable land, are a sandy soil, a stony sandy soil, a loamy sand, a sandy loam, and three clay soils. Samples with a volume of 100 cm(3) were taken at close intervals in trenches at several depths to determine potential water repellency and soil water content. When dry, the topsoils of the Mellby site in Sweden (loamy sand) and the Vredepeel site in the Netherlands (sandy soil) are water repellent, whereas the soils at the other five sites are wettable, according to the water drop penetration time (WDPT) test. The variation in water content within short distances was high at most depths at all sites, with differences of 7 to 18 vol% within a horizontal distance of only centimeters to decimeters. Drier as well as wetter soil areas were visualized by contour plots of the soil water content distributions in the transects. Large differences in wetting capacity between samples taken in the topsoil and in the subsoil at several sites were assessed by measurements of the wetting rate. In many cases, subsoil samples wetted faster than topsoil samples. The severity of water repellency of sandy samples from the Vredepeel site increased remarkably at oven temperatures above 65 degrees C, The wetting rates of dried samples from this soil were also evidently influenced by the oven temperature; samples dried at 25 degrees C wetted immediately and reached soil water contents of 23 to 32 vol% within one hour, whereas samples dried above 85 degrees C hardly wetted during 72 hours, as a result of the increased water repellency at higher drying temperatures. (C) 1999 Elsevier Science B.V. All rights reserved.

265. **Non-point salt loading in a semi-arid watershed**.
White, R. B. and Hawkins, R. H.
Symposium on Watershed Management (21-23 July 1980) (1980).
Keywords: salts/ stream flow/ erosion/ watersheds/ salt loading/ runoff
Abstract: Salt production from small ephemeral channels in the Price River Basin of east-central Utah was studied using artificial inputs in order to better define the general sources of non-point salinity within the basin. An attempt was made to determine those factors which have the greatest effect on salt release. Salinity in channelized surface runoff was found to be closely related to accompanying channel erosion. A simple linear relationship covered most of the cases studied. The coefficients were found to be site related and associated with measurable soil chemical and physical properties. Refs.

266. **On the Problem of Salt Diffusion in the Zone of Aeration**.
See record 171 in Subsurface Transport Processes.

267. **Phenology of salt desert plants near contour furrows**.
See record 17 in Rangeland Management Practices and Potential Impact on Salinity.

268. **Potential of Water and Salt Yields From Surface Runoff on Public Lands in the Price River Basin**.
See record 20 in Rangeland Management Practices and Potential Impact on Salinity.

269. **The potential roles of biological soil crusts in dryland hydrologic cycles**.
Belknap, J.
Hydrological Processes 20: 3159-3178 (2006).
http://dx.doi.org/10.1002/hyp.6325
Keywords: arid/ deserts/ infiltration/ microbiotic crusts/ runoff/ semi-arid/ water cycles/ water erosion
Abstract: Biological soil crusts (BSCs) are the dominant living cover in many drylands of the world. They possess many features that can influence different aspects of local hydrologic cycles, including soil porosity, absorptivity, roughness, aggregate stability, texture, pore formation, and water retention. The influence of biological soil crusts on these factors depends on their internal and external structure, which varies with climate, soil, and disturbance history. This paper presents the different types of biological soil crusts, discusses how crust type likely influences various aspects of the hydrologic cycle, and reviews what is known and not known about the influence of biological crusts on sediment production and water infiltration versus runoff in various drylands around the world. Most studies examining the effect of biological soil crusts on local hydrology are done by comparing undisturbed sites with those recently disturbed by the researchers. Unfortunately, this greatly complicates interpretation of the results. Applied disturbances alter many soil features such as soil texture, roughness, aggregate stability, physical crusting, porosity, and bulk density in ways that would not necessarily be the same if crusts were not naturally present. Combined, these studies show little agreement on how biological crusts affect water infiltration or runoff. However, when studies are separated by biological crust type and utilize naturally occurring differences among these types, results indicate that biological crusts in hyperarid regions reduce infiltration and increase runoff, have mixed effects in arid regions, and increase infiltration and reduce runoff in semiarid cool and cold drylands. However, more studies are needed before broad generalizations can be made on how biological crusts affect infiltration and runoff. We especially need studies that control for sub-surface soil features such as bulk density, micro- and macropores, and biological crust structure. Unlike the mixed effects of biological crusts on infiltration and runoff among regions, almost all studies show that biological crusts reduce sediment production, regardless of crust or dryland type. Published in 2006 by John Wiley & Sons, Ltd.

270. **Preclearing hydrology of the Western Australia wheatbelt: Target for the future?**
See record 21 in Rangeland Management Practices and Potential Impact on Salinity.

271. **Prediction of bed-load transport by desert flash floods**.
Reid, I., Powell, D. M. and Laronne, J. B.
Journal of Hydraulic Engineering 122: 170-173 (1996).
http://dx.doi.org/10.1061/(ASCE)0733-9429(1996)122:3(170)
Keywords: sediment transport/ gravel rivers/ bedload/ rates
Abstract: A number of predictive bed-load sediment transport equations are rated against a unique set of field data collected by automatic slot samplers during flash floods in a desert wadi. The Meyer-Peter and Muller equation is shown to perform well, providing a median ratio of calculated to observed (C/O) bed-load flux of 1.18. The Bagnold equation is shown to underpredict considerably, with a median C/O of 0.44. The Parker equation performs better, though it still underpredicts with a median C/O of 0.78. The apparent success of the Meyer-Peter and Muller formula is attributed to the ready supply of sediment to the channel system in desert and semidesert environments. This ensures that the channel bed remains unarmored, in contrast to supply-limited, armored, perennial rivers of humid zones. It also ensures that bed-load flux responds to changing hydraulic conditions in a comparatively simple fashion.

272. **Preliminary identification of Price River Basin salt pickup and transport processes**.
See record 173 in Subsurface Transport Processes.

273. **Price River, San Rafael River, and Muddy Creek TMDLs for total dissolved solids West Colorado watershed management unit, Utah**.
Montague, K. and Inc, M. F. G.
Report, Utah Division of Water Quality, 159 p. (2004).
http://www.waterquality.utah.gov/TMDL/West_Colorado_TMDL.pdf
Keywords: rivers/ total dissolved solids/ watershed management/ water quality
Abstract: This TMDL study has been prepared for the Price River, San Rafael River, and Muddy Creek watersheds. These three watersheds encompass a large portion of the West Colorado Watershed Management Unit located in east-central Utah. Water quality assessments completed by the Utah Department of Environmental Quality, Division of Water Quality (DEQ) in 1997 resulted in several stream segments in these watersheds being listed on the Utah's 303 (d) list for impaired waters in 2000. The DEQ determined that primarily due to high concentrations of total dissolved solids (TDS) several portions and/or tributaries of the Price River its headwaters and the Green River are non-supporting or partially supporting of their agricultural use classifications. Additionally, for certain smaller river sections, pH, dissolved oxygen (DO), and dissolved iron (Fe) are also cited as causing impairment. The water quality assessment performed by the DEQ, which was also supported by water quality sampling performed by the Emery County Water Conservancy District (EWCD), also revealed that agricultural use classifications are not being supported in several stream segments in the San Rafael and Muddy Creek watersheds as a result of high concentrations of TDS in these waters. The impaired stream segments in the watershed are listed in Table 1-1. Section 303 (d) of the Clean Water Act requires states to identify waterbodies not currently meeting water quality standards after technology-based controls are in place. Consequently, states are required to have TMDLs established in order to attain water quality standards for impaired waters. The TMDL establishes allowable loadings for pollutants for a given waterbody. Although pH, dissolved oxygen (DO), and iron (Fe) have also been cited as causing water quality impairments in the Price River and one tributary (see Table 1-1), the focus of this TMDL study is TDS. As described in Section 3.1 of this report, analyses of available data indicate that there are no impairments attributable to DO and pH (Toole 2003). This section of the report describes the purposes of this TMDL study, the watersheds studied, and the associated water quality impairments. Section 2 of this report describes the applicable water quality standards and the establishment of target sites and a TMDL endpoint. Section 3 discusses the assessment of the current water quality in the watersheds and impairment analysis. Section 4 addresses the sources of TDS loading in the watersheds. Section 5 describes the methods that were used to establish TDS loading capacity, and Section 6 describes the TMDL allocations required to meet established TMDL endpoints.

274. **Pulsed redistribution of a contaminant following forest fire: Cesium-137 in runoff**.
Johansen, M. P., Hakonson, T. E., Whicker, F. W. and Breshears, D. D.
Journal of Environmental Quality 32: 2150-2157 (2003).
http://dx.doi.org/10.2134/jeq2003.2150
Keywords: ponderosa pine hillslope/ spatial variation/ New Mexico/ cs-137/ soil/ sediment/ wildfire/ erosion/ restoration/ watersheds
Abstract: Of the natural processes that concentrate dispersed environmental contaminants, landscape fire stands out as having potential to rapidly concentrate contaminants and accelerate their redistribution. This study used rainfall simulation methods to quantify changes in concentration of a widely dispersed environmental contaminant (global fallout Cs-137) in soils and surface water runoff following a major forest fire at Los Alamos, New Mexico, USA. The Cs-137 concentrations at the ground surface increased up to 40 times higher in ash deposits and three times higher for the topmost 50 mm of soil compared with pre-fire soils. Average redistribution rates were about one order of magnitude greater for burned plots, 5.96 KBq ha(-1) mm(-1) rainfall, compared with unburned plots, 0.55 KBq ha(-1) mm(-1) rainfall. The greatest surface water transport of Cs-137, 11.6 KBq ha(-1) mm(-1), occurred at the plot with the greatest amount of ground cover removal (80% bare soil) following fire. Concentration. increases of Cs-137 occurred

during surface water erosion, resulting in enrichment of Cs-137 levels in sediments by factors of 1.4 to 2.9 compared with parent soils. The elevated concentrations in runoff declined rapidly with time and cumulative precipitation occurrence and approached pre-fire levels after approximately 240 mm of rainfall. Our results provide evidence of order-of-magnitude concentration increases of a fallout radionuclide as a result of forest fire and rapid transport of radionuclides following fire that may have important implications for a wide range of geophysical, ecosystem, fire management, and risk-based issues.
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275. **Quaternary Soils and Dust Deposition in Southern Nevada and California**.
Reheis, M. C. and Goodmacher, J. C.
GSA Bulletin 107: 1003-1022 (1995).
http://dx.doi.org/10.1130/0016-7606(1995)107<1003:QSADDI>2.3.CO;2
Keywords: dust storms/ wind erosion/ soil erosion/ eolian deposits/ climatic factors/ sediment transport/ arid regions/ playas/ soil formation
Abstract: Eolian dust constitutes much of the pedogenic material in late Pleistocene and Holocene soils of many arid regions of the world. Comparison of the compositions and influx rates of modern dust with the eolian component of dated soils at 24 sites in southern Nevada and California yields information on (1) the composition and influx rate of dust in late Pleistocene and Holocene soils, (2) paleoclimate and its effects on the genesis of aridic soils, especially with regard to dustfall events, (3) the timing and relative contribution of dust from playa sources versus alluvial source, and (4) the effects of accumulation of dust in soil horizons.
This citation is from the Geological Society of America.

276. **Rainfall interception by selected plants in the Chihuahuan Desert**.
Wood, M. K., Jones, T. L. and Vera-Cruz, M. T.
Journal of Range Management 51: 91-96 (1998). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/9286/8898
Keywords: rain/ arid lands/ deserts/ hydrogeology/ soil water/ xerophytes
Abstract: Water budget modeling usually requires quantification of all possible processes of the hydrologic cycle. This includes rainfall interception. The purpose of this study was to estimate the potential amounts of water transferred back to the atmosphere from interception for some common plants found in the Chihuahuan desert. Fifty plants of many sizes representing 10 common species of the Chihuahuan Desert were chosen for evaluation. Plants were submerged in a 2 X 2 m tank filled with water. After submersion, the plants were weighed, and the difference in weight was recorded as the maximum water storage capacity of the plant's canopy. Plants were also measured for maximum and minimum crown dieter (cm), height (cm), green weight (g) at time of submersion, and oven-dry weight (g). The forb, grass, and shrub species had different variables included in the prediction equations. Dry and green weight were the 2 variables which appear to have the strongest relationship with the amount of water intercepted for all species. Of the 7 grass species evaluated, dry and green weight were part of all equations, and height was included in only 2 equations.
This citation is from the University of Arizona Institutional Repository.

277. **Rainfall-Runoff Modeling of Ungauged Catchments**.
Blöschl, G.
Encyclopedia of Hydrological Sciences, John Wiley and Sons, Ltd**:** 305 (2006).
http://dx.doi.org/10.1002/0470848944.hsa140
Keywords: calibration/ catchment attributes/ field data/ hydrological similarity/ model parameters/ physically based model/ regionalization/ remote sensing/ soft data/ upscaling
Abstract: Catchments where no runoff data are available are termed ungauged catchments. For these catchments, the parameters of rainfall-runoff models cannot be obtained by the calibration on runoff data and hence need to be obtained by other methods. Model parameters that require calibration are usually transposed from similar gauged catchments. This article reviews concepts for identifying hydrologic similarity as well as methods for transposing the parameters of both event models and explicit soil moisture accounting (ESMA) models. Model parameters that are physically based are usually measured or inferred from other data within the ungauged catchment of interest. This article summarizes the most important methods and discusses the issues of using point scale field data in rainfall-runoff models. Alternatives to

runoff data for model calibration are suggested. The value of soft data and qualitative field observations is emphasized.
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278. **Rangeland experiments to parameterize the water erosion prediction project model - vegetation canopy cover effects**.
Simanton, J. R., Weltz, M. A. and Larsen, H. D.
Journal of Range Management 44:
276-282 (1991).
https://journals.uair.arizona.edu/index.php/jrm/article/download/8603/8215
Keywords: soil loss/ infiltration/ runoff/ interception losses/ rainfall/ simulation/ infiltration/ variability/ rates
Abstract: The Water Erosion Prediction Project (WEPP) is a new water erosion prediction technology being developed by the USDA-Agricultural Research Service to replace the Universal Soil Loss Equation. Rangeland field experiments were designed to parameterize the WEPP rangeland erosion model. Included in the field experiments were plot treatments designed to separate direct from indirect effects of vegetation canopy on runoff and soil erosion. Nine rangeland sites from a wide range of soil and vegetation types were evaluated using rainfall simulation techniques. Natural versus clipped treatment surface characteristics and runoff and erosion responses were compared using regression analyses. These analyses showed that there were no significant differences between natural and clipped plot surface characteristics, runoff ratios, final infiltration rates, or initial rainfall abstractions. Erosion rates were different between treatments with the clipped plots having slightly less erosion than the natural plots. Results indicated that, under the rainfall conditions simulated, canopy cover was not directly contributing to initial abstractions through rainfall interception loss or significantly affecting runoff or erosion.
This citation is from the University of Arizona Institutional Repository.

279. **A review of groundwater–surface water interactions in arid/semi-arid wetlands and the consequences of salinity for wetland ecology**.
See record 175 in Subsurface Transport Processes.

280. **Role of rill development in salt loading from hillslopes**.
Sunday, G. K., Colorado State University; MS Thesis, Fall 1979 (117 p.), (1979).
Keywords: Colorado River/ salinity/ rill erosion/ soil erosion/ Hortons law/ drainage/ shales/ weathering/ deterioration/ rainfall-runoff relationships/ overland flow/ slopes/ Colorado
Abstract: A field study, a computer simulation, and flow velocity experiments were used to identify the major contributing factors in salt loading of the Colorado River from hillslopes above the river. The field study of artificially induced runoff over Mancos shale was conducted on sites with little vegetation located north of the Grand Junction, Colorado, airport and in the West Salt Creek Basin near Mack, Colorado. The longitudinal slopes ranged from 7 to 41 degrees with lengths of from 40 to 225 feet. Two sources of water were used: (1) direct runoff applied from a perforated pipe, and (2) runoff from a rain sprinkler system. Rill formation was recorded with careful field notes and movie films. Results show a well-defined relationship between salinity of runoff and slope for direct runoff. Major factors in salt loading were identified as (1) amount of runoff, (2) suspended sediment concentrations associated with rill flow, (3) degree of slope, (4) salt potential of the soil, and (5) method of introduction of flow. In the study of rill development by computer simulation, a hypothetical drainage area is represented by a square (100 x 100) matrix, and rill patterns are generated by a series of moves between adjacent points in the matrix. Drainage patterns resulting from the simulation are checked against Horton's laws of drainage composition. In a laboratory control situation, three loading factors were studied: (1) increased flow velocities, (2) different layers of Mancos shale (unweathered and weathered), and (3) particle size of shale. Unweathered shales were found to yield more salt than weathered shales if equally exposed surface area is considered. (Seigler-IPA)

281. **Role of sediment in non-point source salt loading within the upper Colorado River Basin: combined completion report**.
Shen, H. W.
Fort Collins, Colorado, Colorado Water Resources Research Institute, 213 p. (1981).
http://hdl.handle.net/10217/2689
Keywords: stream salinity/ Colorado River Watershed (Colo.-Mexico)/ suspended sediment

Abstract: The Colorado River Basin is the main water resource for the entire Southwest, providing water for irrigation, industry, power, municipal needs and recreation. A critical shortage of water and a deterioration of water quality plague this vital resource. The most serious water quality problem in the basin is salinity and the continued increase in salinity over the last century (U.S. Bureau of Reclamation, 1972). The Colorado River Basin is divided into the Upper and Lower Basins by the Colorado River Compact of 1922 (U.S. Congressional Record, 1928). The physical dividing point is Lees Ferry, Arizona (Fig. 1.1).
This citation is from Colorado State University.

282. **Runoff and runon areas in a patterned chenopod shrubland, arid western New South Wales, Australia: characteristics and origin**.
Dunkerley, D. L. and Brown, K. J.
Journal of Arid Environments 30: 41-55 (1995). ISSN: 0140-1963
http://dx.doi.org/10.1016/S0140-1963(95)80037-9
Keywords: New South Wales/ desert chenopod shrubland/ surface runoff/ run on
Abstract: Strongly developed vegetation banding in desert chenopod shrubland occurs on hillslopes having gradients of as little as 0·5 degrees and displays a stepped microrelief of about 10 cm. Surface runoff is shed from the bare surfaces in rainstorms of as little as 4–5 mm, and infiltrates readily within the vegetated bands. The banding thus functions as an efficient system for water redistribution, the landscape being divided into multiple bare runoff (water source) and vegetated runon (water sink) zones. Patterns of stone distribution across a study hillslope suggest that the vegetation banding is at least Holocene in age. The patterned shrublands thus represent an enduring component of this arid rangeland environment, and one whose unusual microhydrology should be preserved by informed management.
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283. **Runoff and water quality from three soil landform units on Mancos Shale**.
Jackson, W. L. and Julander, R. P.
Water Resources Bulletin 18: 995-1001 (1982).
http://dx.doi.org/10.1111/j.1752-1688.1982.tb00107.x
Keywords: sediment transport/ erosion/ saline water/ Utah/ sediment concentration/ sediment control/ sediment load/ sedimentary rocks/ Mancos Shale/ shales/ runoff/ Price River/ rainfall-runoff relationships/ suspended sediment/ infiltration/ channel scour/ soil creep/ rill erosion/ water pollution sources/ water quality control
Abstract: Simulated rainfall was applied to three landforms underlain by Mancos shale in the Price River Basin, Utah, to determine the relative yields of water, sediment, and salt from this saline sedimentary formation. The three types of soil were: (1) soil A-shale pediment/recent alluvium, (2) soil D-shale pediment/recent alluvium, and (3) soil A and weathered shale dissected Mancos shale uplands. Final infiltration rates on residual shale derived soils were 0.13-0.50 cm per hour. No runoff was generated on cracked soils derived from aeolian deposits. A steep dissected Mancos shale upland produced 180 times the suspended sediment concentrations and 68 times the EC (indicating salinity) compared to a low relief shale pediment and recent alluvial surface. Rilling was responsible for 80% of the sediment produced on the steep dissected shale's. Channel scour and soil creep were also significant contributors to sediment. An estimated 1.35 million g per ha per year of sediment is produced by the steep dissected shale uplands. Sediment plugs were effective in trapping sediments on a local basis to improve quality of water for stock ponds and irrigation canals.
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284. **Runoff water quality from varying land uses in southeastern Arizona**.
Schreiber, H. A. and Renard, K. G.
Journal of Range Management 31: 274-279 (1978). ISSN: 0022-409X
http://dx.doi.org/10.2307/3897600
Keywords: arid zones/ composition/ grazing/ land use/ rangeland soils/ rangelands/ runoff/ runoff water/ soil/ soil types (ecological)/ soil water categories/ urbanization/ water quality/ water resources/ arid regions/ pasturing/ range pastures/ water composition and quality/ southwestern United States/ Afghanistan/ Arizona
Abstract: Surface runoff waters from three kinds of activity on rangeland in southeastern Arizona were examined for suspended solids and some indicator chemical constituents. Ungrazed

brush-covered rangeland was compared with recently subdivided rangeland which was originally and still partly brush-covered but recently disturbed by man's urbanizing influence. Water quality indicators showed the urbanized watersheds had poorer water quality. Comparisons between the two brush-covered watersheds and a third--grass-covered and grazed--were made only on the runoff water's dissolved constituents. Despite the grazing activity, the waters were of better quality on the grass-covered and grazed watershed. A contrast in the geology between the grass and brush areas suggested that mineral sources affected qualitative changes in the dissolved solids. Calcareous soils produced waters higher in Ca and total dissolved solids and lower in other cations. Phosphate in runoff averaged higher from the grass-covered, noncalcareous area than from the brush-covered calcareous watershed. It is hypothesized that the phosphate originated from soil sources, rather than from grazing activity. Nitrate levels were comparable in runoff from all the nonurban areas, but increased in runoff from the semiurban area. Thus, the nonagricultural activities associated with a housing development were more detrimental to water quality than those activities of undisturbed or grazed rangelands.
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285. **Saline dust storms and their ecological impacts in arid regions**.
Abuduwaili, J., Liu, D. W. and Wu, G. Y.
Journal of Arid Land 2: 144−150 (2010).
http://dx.doi.org/10.3724/SP.J.1227.2010.00144
Keywords: dust storms/ playa soils/ eolian deposits/ arid regions/ salinity/ saline soils/ soil salinization/ water salinization
Abstract: In many arid and semiarid regions, saline playas represent a significant source of unconsolidated sediments available for aeolian transport, and severe saline dust storms occur frequently due to human disturbance. In this study, saline dust storms are reviewed systematically from the aspects of concept, general characteristics, conditions of occurrence, distribution and ecological impact. Our researches showed that saline dust storms are a kind of chemical dust storm originating in dry lake beds in arid and semiarid regions; large areas of unconsolidated saline playa sediments and frequent strong winds are the basic factors to saline dust storm occurrence; there are differentiation characteristics in deposition flux and chemical composition with wind-blown distance during saline dust storm diffusion; and saline dust storm diffusion to some extent increases glacier melt and results in soil salinization in arid regions. An understanding of saline dust storms is important to guide disaster prevention and ecological rehabilitation.
This citation is from the Science Press (China).

286. **Salinity in watercourses and reservoirs**.
French, R. H.
International Symposium on State-of-the-Art Control of Salinity, Salt Lake City, Utah, Butterworth (1983).
Keywords: salinity/ Colorado River/ watersheds/ reservoirs/ rivers

287. **Salinity investigations of Mancos landforms and springs in the upper Colorado River Basin**.
See record 180 in Subsurface Transport Processes.

288. **Salinity trends in surface waters of the Upper Colorado River Basin, Colorado**.
See record 181 in Subsurface Transport Processes.

289. **Salt crust development in paddy fields owing to soil evaporation and drainage: Contribution of chloride and deuterium profile analysis**.
Grünberger, O., Macaigne, P., Michelot, J.-L., Hartmann, C. and Sukchan, S.
Journal of Hydrology 348: 110-123 (2008).
ISSN: 0022-1694
http://dx.doi.org/10.1016/j.jhydrol.2007.09.039
Keywords: evaporation/ saline soils/ deuterium/ chloride profiles
Abstract: In Northeast Thailand lowlands with shallow saline watertable, rainfed paddy fields often present high salt concentration in the dry season, forming patches or spots of salt crusts on the soil surface. In this context, the mechanisms implied in salt concentration during dry season were studied by establishing salt budget with evaporation and drainage estimates inside and outside a saline patch. Drainage was estimated by Hydrus-1D modelling constrained by an hydrodynamic characterization and the profile of water contents at the end of dry season. Evaporation rates at the end of the dry

season were computed by interpreting natural detailed profiles of deuterium (D) and chloride (Cl) contents. Because of the drastic diminution of hydraulic conductivity at saturation with depth and the decrease of groundwater level at the end of the cropping season, simulated hydrological balance with Hydrus-1D pointed out zero cumulated fluxes for depths of 39.5 cm (outside the saline patch) and 37.5 cm (inside the saline patch). Therefore, all the chloride accumulated in the very upper layers during dry season comes from the chloride that was present in the 0–39.5 cm layers before the beginning of the drying. Inside the saline patch, the tentative Cl budget is coherent with the hypothesis of saturation of the profile by aquifer saline water during the flooding. Evaporation rates computed from the diffusion of chloride and deuterium at the end of the drying season, when the aquifer level was 1.4 m deep, range between 0.121 and 0.378 mm d^{-1}. This does not sustain the assumption of a considerable salinity contribution from the aquifer during the dry season. Moreover, evaporation estimates based on Cl and D diffusion equilibrium showed depleted rates (38–63%) inside the saline patch due to salt accumulation in the first 12 cm of the soil. In the vapour transfer layer, estimated evaporation rate based on the vapour movement of D was in the same order of magnitude than computed rate assuming liquid Cl diffusion. This coincidence is attributed to the liquid fluxes that occurred during the expansion of the vapour transfer layer during the progression of the evaporation front.
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290. **Salt loading from efflorescence and suspended sediments in the Price River basin**.
See record 183 in Subsurface Transport Processes.

291. **Salt Loads in an Intermittent Prairie Stream: Sage Creek Hydrogeologic Basin, Northern Montana**.
See record 184 in Subsurface Transport Processes.

292. **Salt Transport by the South Platte River in Northeast Colorado**.
See record 185 in Subsurface Transport Processes.

293. **Salt Transport in Heavy Clay Soil**.
Van Hoorn, J. W.
Proceedings of the ISSS Symposium on Water and Solute Movement in Heavy Clay Soils, International Institute for Land Reclamation and Improvement The Netherlands. ILRI Publication 37. p 229-240, 4 fig, 6 tab, 4 ref. (1984).
http://www2.alterra.wur.nl/Internet/webdocs/ilri-publicaties/publicaties/Pub37/pub37-h8.pdf
Keywords: chemical processes/ water in soils/ sources and fate of pollution
Abstract: Salt movement is linked together with water movement which depends on the hydraulic conductivity of a soil profile and its structure. In heavy clay soils one can usually distinguish a top layer with a rather high hydraulic conductivity consisting of the tilled layer in arable land or the turf layer in grassland, below which the hydraulic conductivity is much lower and often decreases with depth. In basin clay soils in river areas and in marine clay soils, one may encounter at a depth of about 1 m again a layer having a moderate to high hydraulic conductivity and consisting of clay with iron concretions, organic matter, peat or soil material with a coarser texture. The discharge of water in such soil profiles depends on the ratio between the rainfall (or irrigation) rate and the infiltration rate of the second layer of low permeability. Salt transport is discussed with respect to: (1) salt movement from soil aggregates to large pores; (2) leaching by the application of irrigation water; and (3) resalinization of the top layer by capillary rise. A model for predicting desalinization is also presented. (Lantz-PTT)
© *ProQuest*

294. **Salt transport in the Bremer Hills, SA: report for NAP South Australian salt mapping and management**.
See record 186 in Subsurface Transport Processes.

295. **Salt Uptake in Natural Channels Traversing Mancos Shales in the Price River Basin, Utah**.
Riley, J. P., Chadwick, D. G., Dixon, L. S., James, L. D., Grenney, W. J. and Israelsen, E. K.
Reports. Utah Water Research Laboratory, 204 p. (1982).
http://digitalcommons.usu.edu/water_rep/123

Keywords: watersheds/ models/ saline water/ water salinization/ soil transport processes/ runoff/ hydrogeology
Abstract: The report examines possible sources of dissolved salts in the Price River basin. Ephemeral and intermittent streams contributed dissolved salts and are the focus of the study. Seven subwatersheds and the Price River at Heiner are investigated to examine the effects of existing watershed characteristics on runoff and dissolved salts production. Alternately, the report examines the effects of specific land treatments on surface runoff quantity and quality. Various instrumentation techniques are evaluated to help improve future data collected capabilities in intermittent channels. The examination of the data reveals various trends that might be considered for further investigation in subsequent studies.
This citation is from Utah State University.

296. **Salt-release from suspended sediments in the Colorado River basin**.
See record 69 in Rangeland Management Practices and Potential Impact on Water.

297. **Sediment movement and filtration in a riparian meadow following cattle use**.
Mceldowney, R. R., Flenniken, M., Frasier, G. W., Trlica, M. J. and Leininger, W. C.
Journal of Range Management 55: 367-373 (2002). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/9730/9342
Keywords: livestock/ grazing/ sediment/ riparian areas/ overland flow
Abstract: Improper livestock grazing practices in western U.S. riparian areas may reduce the nutrient and pollutant removal function of riparian communities, resulting in degradation of surface water quality. Short duration-high intensity cattle use in 3 × 10 m plots was evaluated in a montane riparian meadow in northern Colorado to quantify livestock effects on sediment movement and filtration under simulated rainfall (approx 100 mm hour-1)$ plus overland flow (approx 25 mm hour-1) conditions. Four treatments: 1) control, 2) mowed to 10 cm stubble height, 3) trampled by cattle, and 4) cattle grazed plus trampled (grazed) were evaluated. Sixty kg of sediment was introduced to overland flow in each plot. Sediment movement was evaluated using sediment traps positioned in microchannels and on vegetation islands at 5 distances downslope from the upper end of the plots and by sediment front advancement. Most sediment deposition occurred within the first meter downslope from application. About 90% of the applied sediment was filtered from runoff within 10 m in the control and mowed treatments, while approximately 84 and 77% of the applied sediment was trapped in the trampled and grazed treatment plots, respectively. The primary variables that influenced sediment filtration were stem density and surface random roughness. Stem density was the most influential variable that affected sediment filtration. Cattle grazing reduced the stem density by 40%. Monitoring of stem density should aid land managers in regulating cattle use of riparian communities and facilitate the protection of surface water quality from sediment in overland flow.
This citation is from the University of Arizona Institutional Repository.

298. **Sensitivity of playa windblown-dust emissions to climatic and anthropogenic change**.
Pelletier, J. D.
Journal of Arid Environments 66: 62-75 (2006). http://dx.doi.org/10.1016/j.jaridenv.2005.10.010
Keywords: unsaturated flow/ modeling/ saltation/ playas
Abstract: Windblown dust is a significant component of atmospheric PM (particulate matter) in arid regions worldwide, with adverse effects on human health and visibility. In the future, windblown-dust emissions are likely to increase if water tables drop as a result of climatic or anthropogenic changes. To manage this hazard, air-quality managers need quantitative models that predict the impact of climatic and anthropogenic change on dust emissions. To meet this need, we constructed a process-based numerical model that includes Richards' equation for vertical moisture flow in the unsaturated zone, Chepil's model for the effect of surface soil moisture on threshold wind speed, and the saltation equation, which also predicts the rate of dust emission from the surface to within a multiplicative factor. This model is solved analytically for a Weibull distribution of wind speeds under steady-state moisture conditions, providing a single predictive equation for the long-term average saltation flux based on local meteorological and hydrological parameters. The model equations are used to predict the increase in saltation flux and dust

emissions resulting from the dessication of a wet playa by climatic change, stream diversion, or groundwater withdrawal. The model is calibrated using CLIM-MET station data collected near Soda (dry) Lake, California. The model results identify a critical range of water-table depths between 3 and 10 m (depending on hydrological parameters) in which small increases in water-table depth cause large, nonlinear increases in windblown-dust emissions. For water tables deeper than 10 m, dust emissions are close to their maximum value and are largely independent of water-table depth. This analysis highlights the importance of preserving the hydrological balance of wet playas in order to minimize windblown-dust emissions. Future climatic changes may also influence dust emissions through changes in the mean or variability of wind speeds. For representative model parameters, 10% increases in the mean and variability of wind speeds, for example, are predicted to increase dust emissions by 80% and 20% within this model framework.
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299. **Shear Stress Partitioning of Overland Flow on Disturbed and Undisturbed Rangelands**.
Al-Hamdan, O. Z., Pierson, F. B., Nearing, M. A., Stone, J. J., Williams, C. J., Kormos, P. R., Boll, J. and Weltz, M. A.
International Symposium on Erosion and Landscape Evolution, Anchorage, AK, ASABE (2011).
Keywords: fire impact/ overland flow/ rangelands/ shear stress partitioning/ soil erosion
Abstract: Physically-based hillslope erosion models commonly estimate soil detachment and transport capacity based on overland flow shear stress applied to soil aggregates. However, vegetation and rock cover counteract the shear stress of overland flow where they occur. Accordingly, partitioning of total shear stress into components exerted on soil, vegetation, and rock cover is a key element for the erosion models. The objective of this study is to estimate the components of shear stress of overland flow on disturbed and undisturbed rangelands using field experimental data. In addition, this study investigates the vegetation cover limit at which the soil shear stress component is substantially reduced, limiting the erosion rate. The soil shear stress component was estimated based on the assumption that the ratio of soil shear stress to the total shear stress is equal to the ratio of hydraulic friction factor of soil to the friction factor of the composite surface. The total friction factor of the composite surface was estimated using empirical equations developed based on field experimental data over diverse rangeland landscapes within the Great Basin Region, United States. This equation logarithmically correlates the composite surface friction to the vegetation cover (plant base and plant litter) and rock cover components. Moreover, the hydraulic friction factor of each cover element was estimated based on its parameter in that equation. The soil hydraulic friction portion was assumed to be the logarithmic difference between the total friction and the friction of the cover elements. The result of this assumption was used to develop empirical equations that predict the ratio of soil shear stress to the total shear stress of concentrated flow and sheet flow in terms of bare soil fraction of total area. The predicting equation of total friction factor was improved by adding the slope and the flow discharge variables. The predicting equations of soil shear stress as a function of bare soil fraction did not change significantly when changing the assumption of a rectangular shape of cross section to a parabolic shape. The developed shear stress partitioning equations in this study are applicable across a wide span of ecological sites, soils, slopes, and vegetation and ground cover conditions and can be used by physically-based rangeland hydrology and erosion models. The results from the developed equations show that shear stress exerted on soil grains is significantly higher when bare soil exceeds 60% of the total surface area, while reduced significantly when bare soil area is less than 25% or when the plant base cover exceeds 20%. These percentages could be used as relative measures of hydrologic recovery for disturbed rangelands or triggers that indicate that a site is crossing a threshold where soil erosion might accelerate due to the high soil shear stress.
This citation is from the American Society of Agricultural and Biological Engineers.

300. **Snow Trapping by Contour Furrows in Southeastern Montana**.
See record 70 in Rangeland Management Practices and Potential Impact on Water.

301. **Soil erosion and conservation in Australia**.
Edwards, K.
New York, NY, United States (USA), Cambridge University Press, New York, NY. 1993.
Keywords: fertilizers/ degradation/ erosion/ desertification/ conservation/ Australia/ soil erosion/ soil/ environmental geology/ saline composition/ productivity/ yields/ surface water/ regional planning/ agriculture/ pollution/ water erosion/ nutrients/ natural resources/ erosion control/ land management/ rural environment/ policy/ economics/ land use/ salinization
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302. **Soil erosion effects on productivity in rangeland environments: where is the research? in western United States**.
Gifford, G. F. and Whitehead, J. M.
Journal of Range Management 35: 801-802 (1982).
https://journals.uair.arizona.edu/index.php/jrm/article/view/7450/7062
Keywords: soil erosion/ site productivity/ plant-soil complex/
Abstract: The importance of erosion on rangelands has been recognized for many years. However, the impact of erosion on site productivity (choose your own index of productivity) has not been quantified to any extent for any rangeland plant-soil complex in the western United States. It is hoped that researchers over the next few years will shift their efforts to this neglected yet very important information void.
This citation is from the University of Arizona Institutional Repository.

303. **Soil hydrology is independent of microphytic crust cover: Further evidence from a wooded semiarid Australian rangeland**.
Eldridge, D. J., Tozer, M. E. and Slangen, S.
Arid Soil Research and Rehabilitation 11: 113-126 (1997).
http://dx/doi.org/10.1080/15324989709381465
Keywords: cyanobacteria/ infiltration/ lichens/ microphytic crusts/ moss/ semi-arid/ rangelands/ eastern Australia/ surface condition/ sandy area/ woodland/ runoff/ Negev Desert/ infiltration/ bryophytes/ erosion/ Israel
Abstract: Rainfall simulation experiments were performed on 25 plots of varying microphytic crust cover in a wooded semiarid rangeland in eastern Australia. Under a rainfall intensity of 45 mm h(-1), steady-state infiltration ranged from 5 mm h(-1) to 41 mm h(-1), but there was no effect of cover on this or any of the other soil hydrological variables measured. When disturbed plots with low cover (<15% cover) were excluded from the analyses, significant increases in time to pending were associated with increases in crust cover. Despite some significant relationships, however, crust cover was an insignificant predictor of soil hydrological status at this site. We attribute this to the well-structured nature of the soils at the site, which have not been subjected to grazing by domestic animals for almost 20 years. The results support earlier work suggesting that in the short term, crust cover is only an important moderator of soil hydrology when soils are degraded.

304. **Soil Movement and Surface Roughness on Wyoming Rangelands**.
Fisser, H. G., Rose, B. and Johnson, C.
Watershed Management in the Eighties: Proceedings of the Symposium held in conjunction with the ASCE Convention; Denver, CO, USA, Denver, CO, USA, ASCE (1985).
Keywords: regional planning/ land use/ soil erosion/ livestock grazing effects/ semi-arid ecosystems/ shrub control treatments/ watersheds
Abstract: Soil movement and surface roughness parameters were evaluated as a function of response to livestock grazing and semiarid shrub control treatments. Repeated elevation of a measurement of erosion transects referenced to permanent metal rods provided spatial and temporal data. Statistical analyses included't' and 'F' tests and multivariate analysis of variance. Influences of the grazing and shrub control treatments and interrelations with climate, soils, topography, and ground cover were investigated. Quantitative analysis was utilized to identify minimal grazing and shrub control effects responsible for significant soil movement and surface roughness differences among and within sites and sampling periods. Management implications regarding livestock grazing and shrub control are discussed. The results are readily applicable to semiarid ecosystems of sagebrush-grass and saltbush rangelands of the intermountain west.
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305. **Soil physical and physico-chemical variability induced by *Atriplex nummularia***.
Sharma, M. L.
Journal of Range Management 26: 426-430 (1973). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/6254/5864
Keywords: soil heterogeneity/ saltbush/ salinity
Abstract: Spatial variability in two soils supporting 10-year old stands of saltbush (*Atriplex nummularia*) was examined by evaluating various soil physical and physico-chemical properties under and between the plants. The differences in soil properties between these two positions were mostly significant for the surface layer (0-7.5 cm) but only in a few cases for the 7.5-15 cm layer. No differences were observed below this depth. Presence of *A. nummularia* resulted in increased electrolyte concentration, higher sodium adsorption ratio, and higher levels of exchangeable sodium and organic matter in the surface soil. Standard laboratory measurements showed that these physico-chemical changes induced a significant deterioration in the structure of the surface soil under the plants as indicated by reduced aggregate stability, poorer drainage, and lowered hydraulic conductivity. Field studies suggested that the bulk density of the surface soil was reduced under the plants but that water penetration and storage in the profile after rains remained unaffected. Probable reasons for these effects are discussed.
This citation is from the University of Arizona Institutional Repository.

306. **Soil water and salinity in response to water deliveries and the relationship with plant growth at the lower reaches of Heihe River, Northwestern China**.
See record 188 in Subsurface Transport Processes.

307. **Soil, vegetation, and hydrologic responses to grazing management at Fort Stanton, New Mexico**.
Gamougoun, N. D., Smith, R. P., Wood, M. K. and Pieper, R. D.
Journal of Range Management 37: 538-541 (1984). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7783/7395
Keywords: grazing management/ rangelands/ range management/ land restoration/ hydrology/ vegetation types
Abstract: The purpose of this study was to evaluate vegetation, soils, infiltration rates, and sediment production as they relate to livestock exclusion, continuous heavy grazing, continuous moderate grazing, and rotation grazing on a homogeneous plant-soil complex. The exclusion of livestock resulted in infiltration rates significantly higher than when the pastures were grazed in any system. No differences were found between heavily and moderately stocked pastures. This was attributed to organic matter additions from forbs that replaced grasses when the area was heavily grazed. The rotation treatment had infiltration rates that were lower than the exclosures or continuous grazing treatments. Sediment production from interrill erosion was similar in all treatments except when the livestock were concentrated into a fourth of the rotation system's area, which resulted in higher sediment levels.
This citation is from the University of Arizona Institutional Repository.

308. **Soil-water characteristic curves of high-TDS and suitability of fitting models**.
Li, X., Zhou, J., Jin, M. and Liu, Y.
Nongye Gongcheng Xuebao/Transactions of the Chinese Society of Agricultural Engineering 28: 135-141 (2012).
http://dx.doi.org/10.3969/j.issn.1002-6819.2012.13.022
Keywords: arid areas/ arid regions/ best model/ curve fitting/ drying process/ fitting model/ geologic models/ large pore size/ log-normal/ models/ moisture/ normal distribution/ optimum model/ pore size/ RETC/ research results/ salinity/ salt transport/ soil hydraulics/ soil moisture/ soil suction/ soil treatments/ soil water/ soil water content/ soil-water characteristic curve/ soils/ specific water capacity/ statistics/ unsaturated hydraulic conductivity/ water/ water columns/ water retention
Abstract: Four soil treatments with different TDS water (freshwater, 30, 100 and 250 g/L) were prepared and their soil-water characteristic curves of drying processes were obtained based on the measured soil water content and soil hydraulic pressure. The results showed that the specific water capacities of these treatments was similar in the whole drying process with partly different. However, compared with the freshwater and the water with TDS of 30 g/L,

scenarios of the higher TDS (100 and 250 g/L) water possessed a remarkably weaker ability of the water retention. Further analysis indicated that four scenarios had different soil-water characteristic curves in the different TDS background. During the variation of soil suction of the four treatments, which ranged from 0 to 100 kPa water column, median pore size of soil dealt by 30 g/L-water, small pore size of soil dealt by 100 g/L-water and large pore size of soil dealt by 250 g/L-water diminished. RETC software and mathematical statistics method were adopted for getting the optimum model that described soil-water characteristic curves of the four dealt soils. For the treatments with freshwater, 30 g/L-water, 100 g/L-water and 250 g/L-water, the optimum models were van Genuchten-Mualem model, Dual-porosity-Mualem model, Log normal distribution-Mualem model and Dual-porosity-Mualem model, respectively, and Mualem model was the best one to describe the unsaturated hydraulic conductivity of the all soils. On the other hand, it's difficult to explain the inherent mechanism of the best model for different TDS. The research results are useful for analysis of soil water and salt transport under high-TDS condition in arid areas.
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309. **Soluble mineral content in surficial alluvium and associated Mancos Shale**.
Laronne, J. B. and Schumm, S. A.
Water Resources Bulletin 18: 27-35 (1982).
http://dx.doi.org/10.1111/j.1752-1688.1982.tb04524.x
Keywords: arid regions/ semi-arid zones/ alluvial soils/ minerals/ total dissolved solids/ soil mineralogy
Abstract: Most arid and semiarid regions experience problems resulting from high salt content in soils and from high solute concentrations in runoff. The rate of salt pickup under varying hydrologic conditions depends on net dissolution and sediment removal rates and on soluble mineral content and its spatial and temporal variations. The Mancos Shale terrain is a source of considerable solute contribution to the Colorado River. The spatial variability of soluble mineral content in weathered Mancos Shale and its associated alluvium was studied in an effort to understand the mechanism of salt production and to determine the source of salinity. Soluble mineral content was found to be highly variable in the alluvium and in associated surficial Mancos Shale. However, it was possible to identify lithomorphological units based on the soluble mineral content. Study results show that crusts are leached in deep alluvial fills, and that they have somewhat lower soluble mineral contents than underlying Mancos Shale on hillslopes. The crusts were found to be saline, sometimes efflorescent, in shale bedrock channels or where channels abut against the shale. Soluble mineral content increases in alluvium with decrease in depth of alluvial fill, does not vary significantly with depth in deep alluvial fills, and increases with depth in shallow fills. Soluble mineral content trends identified by this study can be used in the development of mathematical models and land management programs in areas of the Colorado River basin experiencing salinity problems. (Carroll-FRC)
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310. **Soluble salts dynamics in the soil under different climatic conditions**.
Pariente, S.
CATENA 43: 307-321 (2001). ISSN: 0341-8162
http://dx.doi.org/10.1016/S0341-8162(00)00130-2
Keywords: soluble salts concentration/ temporal variation/ land degradation/ Mediterranean climate/ semi-arid climate/ arid climate
Abstract: The dynamics of soluble salts concentration in the soil was investigated at seven research stations in Israel that represent four climatic regions: Mediterranean, semi-arid, mildly arid and arid. Measurements were taken in different seasons from soils that were developed on hillslopes, which are consisted of hard calcareous rocks. The relationship between the soluble salts content and rainfall was found to be non-linear. An abiotic threshold, which is characterized by a sharp change in the soluble salts content, exists around 200 mm isohyet: sites that receive less than 200 mm rainfall are characterized by significantly high soluble salts content whereas sites that receive more than 200 mm are characterized by very low soluble salts content. Each side of this abiotic threshold expresses typical behavior that can be defined as “environmental signature”. At the “dry” side of the threshold temporal heterogeneity, rate of change, potential of change and differences between layers are higher than those at the “wet” side of the threshold.
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311. **Solute transport by rivers in arid environments; an overview**.
Walling, D. E. and Webb, B. W.
Journal of Water Resources 5: 800-822 (1986).
Keywords: solute transport/ hydrology/ water quality/ concentration/ terrestrial environment/ stream transport/ arid environment/ suspended materials/ ions/ hydrochemistry/ fluctuations/ critical load/ dissolved materials/ transport/ runoff/ sediment yield/ drainage basins/ sediments/ hydrogeology/ seasonal variations/ chemical composition/ discharge/ geochemistry/ environmental geology
Abstract: Data assembled from rivers in Arab countries and in other arid areas emphasise the distinctive nature of solute transport in the arid environment. Concentrations of total dissolved solids and individual ions are higher in the arid than in other morphoclimatic zones. However, low runoff totals more than offset the occurrence of high concentrations, and dissolved loads in arid areas are amongst the lowest in the world and are substantially exceeded by suspended sediment yields. Water composition is also very distinctive in the arid environment, cation and anion chemistry being dominated by Na and by C1 and SO (sub 4) respectively, but significant spatial variations in water chemistry also occur between and within arid regions. Temporal variability in total and individual dissolved solids content is marked for streams in the arid environment and solute concentrations very on a seasonal basis and in response to fluctuations in discharge. However, considerable complexity characterises solute transport processes in the arid zone and in Arab countries which would repay further investigation in the future.
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312. **Spatial and temporal variability of water salinity in an ephemeral, arid-zone river, central Australia**.
See record 189 in Subsurface Transport Processes.

313. **Spatio-temporal patterns and covariance structures of soil water status in two northeast German field sites**.
Wendroth, O., Pohl, W., Koszinski, S., Rogasik, H., Ritsema, C. J. and Nielsen, D. R.
Journal of Hydrology 215: 38-58 (1999).
http://dx.doi.org/10.1016/S0022-1694(98)00260-1
Keywords: soil water pressure head/ variogram analysis/ spatio-temporal pattern/ nested sampling
Abstract: Spatio-temporal patterns of soil moisture status highly affect the heterogeneity of soil water and solute transport and leaching of chemicals to the groundwater. In order to quantify and describe spatial variability of ecologically highly relevant spatial and temporal processes Linked to soil moisture at the land surface, the spatio-temporal covariance structure and the reasons for its change in time need to be identified. Therefore, soil water pressure head was monitored in two surface horizons between April and November 1995 at two field sites with a shallow ground water table, a sandy loam and a heavy clay soil in north-east Germany. For the 10- and the 30-cm depth of the sandy loam soil and for the 30-cm depth of the heavy clay soil the variance of soil water pressure head h (on log basis) was large under wet conditions. With decreasing soil water pressure head the variance of log(10)(-h) decreased to a critical value, for which a spatial correlation structure disappeared. With further drying, the variance of log(10)(-h) increased again, and a spatial range of correlation existed. During drying, temporally stable variation patterns developed at both field sites. The change of variance of log(10)(-h) which is probably associated with changing degree of heterogeneity of flow conditions validates the findings of Roth (1995) obtained from stochastic flow model calculations. In general, the temporal correlation length was better defined than that of spatial correlation. At both depths, correlation lengths of the sandy loam were larger than those of the heavy clay soil. Random spatial variation of log(10)(-h) occurred under conditions when the hydraulic gradient was close to zero. With our experimental design we could identify (i) temporal persistence of spatial patterns and correlation ranges of soil water status that can be used for representativity studies, (ii) the within-site variation of land surface moisture status, and (iii) a basis for description of spatial processes of effective soil properties that are linked to soil water status at the land surface. (C) 1999 Elsevier Science B.V. All rights reserved.

314. **Storm runoff and water quality on three ephemeral washes in the Price River Basin, Utah**.
Lin, A., Jackson, W. L. and Knoop, K. D.
Journal of Soil and Water Conservation 39: 211-214 (1984).
Keywords: Price River Basin/ Utah/ storm runoff/ salinity/ water quality/ erosion control/ sediment transport/ Colorado River/ watershed management/ dissolved solids/ runoff control
Abstract: Eighteen late-summer runoff events were monitored in 1981 on three small watersheds in the Price River Basin, Utah. Average concentrations of total solids from a single storm ranged from 2.783 mg/1 on Coal Creek to 267,680 mg/1 on Wattis Branch. The largest discharge of total dissolved solids, 47 mg, was on Wattis Branch. Average single-storm concentrations of total dissolved solids ranged from 181 mg/1 on Coal Creek to 7,680 mg/1 on Wattis Branch. Particularly high concentrations of total solids and total dissolved solids occurred in runoff on all three watersheds during the first monitored storm following a long, dry period, suggesting a flushing of accumulated sediments and salts. Average storm total solids and total dissolved solids concentrations corresponded to surface soil-loss potential as indexed by universal soil loss equation parameters.
This citation is from the Soil and Water Conservation Society.

315. **Studies of salt and water movement in the Bol Guini Polder, Chad Republic**.
Dieleman, P. J. and De Ridder, N. A.
Journal of Hydrology 1: 311-343 (1963). ISSN: 0022-1694
http://dx.doi.org/10.1016/0022-1694(63)90021-0
Keywords: groundwater flow/ salinity/ lakes/ seepage
Abstract: Hydrogeological investigations of an area on the northern shore of Lake Chad revealed an intricate pattern of groundwater flow from the direction of the lake towards and into low-lying cuvettes or polders. The seepage flow is sufficient to balance the consumptive use of crops, but the quality of the seepage water is such that the polders are threatened with complete salinization. In this article methods of investigation of the hydrological conditions are discussed and the gradual development of salinity in the cultivated areas is analysed.
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316. **Studies on water movement and solute transport in arid regions**.
See record 191 in Subsurface Transport Processes.

317. **A study of runoff and water quality associated with the wildlands of the Price River Basin, Utah**.
Riley, J. P., Salt Lake City, Utah, Unitex Corporation, 138 p. (1982).
http://ia700809.us.archive.org/34/items/studyofrunoff7895rile/studyofrunoff7895rile.pdf
Keywords: runoff/ Utah/ Price River Watershed/ salinity/ water quality
Abstract: This report is organized in two parts; each part is self-contained and may be read independently. Part I: Storm runoff and water quality in selected ephemeral streams of the Price River Basin, Utah. Part II: Baseflow runoff and water quality in selected streams of the Price River basin, Utah.

318. **Study of salinity production from wildlands of Price River Basin, Utah**.
See record 192 in Subsurface Transport Processes.

319. **Study of the interactions between salinity, soil erosion, and pollutant transport on three Queensland soils**.
Ghadiri, H., Hussein, J. and Rose, C. W.
Australian Journal of Soil Research 45: 404-404 (2007).
http://dx.doi.org/10.1071/SR07038
Keywords: soil salinity/ soil sodicity/ runoff/ sediment transport/ soil erosion/ soil aggregates/ soil slaking/ water quality/ rain/ hydrology/ saline sodic soils
Abstract: The effects of salinity and sodicity on soil erosion, sediment transport, and runoff water quality were studied under the simulated rainfall using 3 soils whose salinity and sodicity were artificially raised. Soil type and salt treatment both affected sediment loss, with a significant interaction between the 2 factors. The salt treatment decreased aggregate stability, reduced aggregate mean weight diameters, and increased sediment loss for all soils, but the soil with the most stable aggregates (Redlands) showed the highest impact. The initial treatment resulted in a sharp rise in the electrical conductivity (EC) and exchangeable sodium percentage (ESP) of all 3 soils but these

increases were much higher in the sandy Toohey soil than the 2 clay soils. Electrical conductivities of all 3 treated soils decreased during the rainfall events, but the Toohey soil showed the largest decrease. The ESP of the treated Toohey soil decreased rapidly during the rainfall event due to its coarse texture, rapid renewal of its pore water, and the accessibility of its exchange sites by ions in the solution. The EC of the treated Redlands clay was reduced and its ESP increased during the rainfall events, which resulted in the weakening of its stable aggregates and increased erosion. Sodium adsorption ratio and EC of runoff water from treated soils decreased rapidly with rainfall duration for all 3 soils, but runoff from Toohey showed the largest decrease. The interaction between increased salinity-sodicity and erosion thus appears to be heavily dependent on soil texture, degree of aggregation, and aggregate stability, the 3 determinant factors for soil porosity and pore-size distribution. The results indicate that large sediment and salt losses can occur in runoff from saline-sodic soils, even at low slopes and from apparently stable soils, with major downstream water quality consequences.
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320. **Surface features of the Salt Basin of Lancaster County, Nebraska**.
Joeckel, R. M. and Clement, B. A.
CATENA 34: 243-275 (1999). ISSN: 0341-8162
http://dx.doi.org/10.1016/S0341-8162(98)00114-3
Keywords: salts/ halite/ soil/ groundwater/ Nebraska
Abstract: The Salt Basin of Lancaster County, Nebraska is distinguished by the presence of ephemeral to semi-permanent saline wetlands, salt flats, surface accumulations of salt, zones of bacterial sulfate reduction in wetland soils and stream sediments, and soil cryptogam layers. Salt flat soils are unique in the region and have laminated surface horizons, which probably result from a combination of soil crusting, salt crusting, and microbial binding of grains, with vesicular horizons characteristic of desert soils directly underneath. Soil-surface salt accumulations are dominated by halite (NaCl) and contain minor amounts of thenardite (Na2SO4); they range in morphology from thin, powdery, and very transient efflorescences to thicker, more persistent, soil-cementing crusts. The salt crusts form by the upward wicking of Na+- and Cl−-dominated groundwaters and their subsequent surface evaporation. Although it has been largely ignored by geologists for over a century, the Salt Basin can now be viewed as an unusual occurrence of inland sebkhas.
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321. **Surface runoff and its effect on diffuse salt production from Mancos Shale members**.
Ponce, S. L., Hawkins, R. H., Jurinak, J. J., Gifford, G. F. and Riley, J. R.
Watershed Management (1975).
Keywords: surface runoff/ soil chemical properties/ salinity/ shales/ geologic formations/ vegetation effects/ alkalinity/ water quality/ Utah/ Colorado River Basin/ alluvium/ soil types/ precipitation (atmospheric)/ rainfall-runoff relationships/ electrical conductance/ Price River Basin
Abstract: A study was done within the Price River Basin, one of the major sources of salinity to the Colorado River, located in East-Central Utah. Results indicated that alluvial deposits very near the channel of a perennial stream tend to yield runoff water of high salinity. The Blue Gate and Mancos undivided Shale members are the prime salt producers in the Basin. No simple relation was found between soil salinity and salinity of the runoff water over the soil. A slight correlation was noted between geologic type and the ratio of surface runoff to precipitation, while hydrologic soil-complex numbers showed no distinct separation between types. Strong linear relations exist between electrical conductivity and Ca(++) and SO4 (--) while poor correlations exist between the ratio of surface runoff to precipitation and surface runoff to total solids for runoff from the Mancos members.
This citation is from the American Society of Civil Engineers.

322. **Surface-water salinity in the Gunnison River Basin, Colorado, water years 1989 through 2007**.
See record 37 in Rangeland Management Practices and Potential Impact on Salinity.

323. **Timing of recharge, and the origin, evolution and distribution of solutes in a hyperarid aquifer system**.
See record 84 in Rangeland Management Practices and Potential Impact on Water.

324. **Towards sustainable development of the environmentally degraded arid rivers of China; a case study from Tarim River**.
See record 194 in Subsurface Transport Processes.

325. **Tracer-based studies of soil water movement in semi-arid forests of New Mexico**.
Newman, B. D., Campbell, A. R. and Wilcox, B. P.
Journal of Hydrology 196(1-4): 251-270 (1997).
http://dx.doi.org/10.1016/S0022-1694(96)03320-3
Keywords: soil transport processes/ evaporation/ hydrologic variables/ plant cover/ arid regions/ radioactive tracers
Abstract: The related issues of water movement and contaminant transport in arid and semi-arid environments have generated considerable interest and concern in the last few decades. Essential to understanding these issues is knowledge of how water moves through the soils that form the uppermost part of the vadose zone. The use of tracers, both natural and artificially introduced, is proving to be an effective method for gaining such knowledge in dry regions, where investigation by other means is difficult. In this study, natural stable-isotope and chloride tracers were used to investigate water movement in the soils of a pinon-juniper woodland and of a ponderosa pine forest on the Pajarito Plateau in northern New Mexico. The objectives were to (1) estimate and compare near-surface flux rates and evaluate the importance of evaporation in the two communities, and (2) determine to what extent differences in flux rates and evaporation are due to differences in plant cover and/or soil hydraulic properties. The results of this study will aid in evaluating the potential for contaminant mobility in semi-arid systems such as the Pajarito Plateau and, in addition, will increase understanding of nutrient distributions and plant water use in semi-arid environments. The stable-isotope data indicate a similarity between the pinon-juniper and ponderosa communities with respect to evaporation: in both, it is restricted mainly to the upper 10 cm of soil. Chloride profiles from the two communities, on the other hand, show a distinct difference with respect to downward fluxes: in the ponderosa pine forest, these fluxes ([approximate]0.02 cm year-1) are an order of magnitude lower than those in the pinon-juniper woodland ([approximate]0.2 cm year-1), even though total precipitation is about 4 cm year-1 higher in the ponderosa pine forest. This difference, however, appears to be related not to plant cover, but to differences in soil hydraulic properties. The soils of the ponderosa pine forest contain clay-rich B horizons that appear to restrict downward movement of water through the soil matrix, whereas the soils of the pinon-juniper community have B horizons much lower in clay content. The effect of differing soil properties on water movement suggests that contaminant distributions will vary across the Pajarito Plateau. The data on soil water ages support this hypothesis: they indicate that water (and, thus, contaminants) moves through the soil matrix in less than a decade in some areas, whereas in other areas, water takes hundreds of years to pass through the entire soil profile.
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326. **Tracking salinity sources to Texas streams; examples from West Texas and the Texas Gulf Coastal Plain**.
See record 197 in Subsurface Transport Processes.

327. **Trampling of microphytic crusts on calcareous soils, and its impact on erosion under rain-impacted flow**.
Eldridge, D. J.
CATENA 33: 221-239 (1998). ISSN: 0341-8162
http://dx.doi.org/10.1016/S0341-8162(98)00075-7
Keywords: microphytic crusts/ trampling/ soil crusts/ lichens/ micromorphology/ water erosion
Abstract: Twenty five intact soil monoliths dominated by microphytic crusts were tested for their susceptibility to erosion by raindrop-impacted flow transport after subjecting them to simulated sheep trampling. Using a sheep's hoof, five levels of trampling representing stocking rates ranging from nil to 1.6 sheep ha(-1), were imposed on the monoliths. An erosive stress was applied to each surface using a simulated rainfall intensity of 65 mm h(-1) (2.7 mm raindrops).. surface flow depths of 4 mm and 8 mm with a flow velocity of 25 mm s(-1). There was a significant effect of trampling on erodibility (P = 0.003), and trampling explained 33% of the variability in erodibility. Only the severe trampling treatment had significantly higher erodibility compared with the other

treatments. Compared to the control, severe trampling resulted in a significant decline in the area of the surface covered by micro-depressions and attached microphytic crust, and concomitant increases in loose, detached microphytic crusts, coarse lag gravel and bare soil. The results were supported by micromorphological examination which revealed that trampling and subsequent rainfall simulation resulted in considerable surface sealing and sorting of sediments, loss of fine material and deposition of coarse material in micro-depressions. (C) 1998 Published by Elsevier Science B.V.

328. **Transit sources of salinity loading in the San Rafael River, upper Colorado River Basin, Utah**.
See record 198 in Subsurface Transport Processes.

329. **Transport of salts in soils and subsoils**.
See record 199 in Subsurface Transport Processes.

330. **Two causes for runoff initiation on microbiotic crusts: Hydrophobicity and pore clogging**.
Kidron, G. J., Yaalon, D. H. and Vonshak, A.
Soil Science 164: 18-27 (1999).
Keywords: hydrophobicity/ Negev Desert/ microbiotic crusts/ water repellency/ surface runoff/ infiltration
Abstract: Hydrophobicity and pore clogging are suggested as two mechanisms responsible for generating runoff over microbiotic crusts overlying dune sand, Although natural microbiotic crusts in the Hallamish dune field (Negev Desert, Israel) did not show any hydrophobicity, that was not the case with natural crusts subjected to long periods of continuous wetness in the lab. Monoalgal crusts, grown in the lab, also showed high hydrophobicity when dry. The hydrophobicity vanished, however, once the surface was wetted. Runoff on monoalgal lab-grown crusts was obtained when (i) the dry crust exhibited hydrophobic properties and (ii) the wetted crust no longer showed water repellence. Although runoff generation caused by hydrophobicity is expected, it is suggested that runoff initiation when the crusts do not exhibit any hydrophobicity stems from the high water absorption and swelling of the exopolysaccharide cyanobacterial sheaths causing pore clogging. The multi-layered structure of the crust and filament migration to the surface may enhance pore clogging. The experiments and their interpretation are supported by reinterpretation of published data.
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331. **UNSATCHEM 3.1: Computer Model for Prediction of Water and Multicomponent Solute Transport**.
Suarez, D. L.
International salinity forum - managing saline soils and water: science, technology and social issues. Poster Presentation Abstracts, Riverside Convention Center, Riverside, California, USA, 25-28 April 2005, Riverside, CA (2005).
Keywords: adsorption/ boron/ calcite/ carbon dioxide/ computer software/ hydraulic potential/ ion transport/ mathematical models/ movement in soil/ rhizosphere/ soil chemistry/ soil water movement/ solutes/ trace elements/ transport processes/ microelements/ soil transport processes/ transport processes in soil systems
Abstract: The previously developed computer model UNSATCHEM has been upgraded with several new capabilities. The model contains capability to predict B adsorption and transport based with prediction of the constant capacitance constants from generally available soil properties, a calcite kinetic model that considers the effect of dissolved organic carbon, as well as a clay organic matter mixing model to predict cation selectivity constants. Several existing features are still unique, such as prediction of C02 concentrations in the root zone, consideration of the effects of soil chemistry on hydraulic properties and inclusion of a kinetic model to describe calcite dissolution and precipitation.
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332. **Variations in soil dispersivity across a gully head displaying shallow sub-surface pipes, and the role of shallow pipes in rill initiation**.
See record 41 in Rangeland Management Practices and Potential Impact on Salinity.

333. **Vegetation communities on the shores of a salt lake in semi-arid Western Australia**.
See record 202 in Subsurface Transport Processes.

334. **Very high-rates of bedload sediment transport by ephemeral desert rivers**.
Laronne, J. B. and Reid, I.
Nature 366: 148-150 (1993).
http://dx.doi.org/10.1038/366148a0
Keywords: gravel-bed streams/ suspended sediment/ size distribution/ dynamics/ floods
Abstract: Geomorphologists have thought for some time that rates of sediment transfer might differ markedly in ephemeral and perennial rivers, and have used this idea to explain both the changing character of sedimentary successions and the morphology of rivers in sub-humid or semi-arid areas that have experienced significant shifts in climate during the Quaternary period. But until now there has been a lack of suitable field data to confirm this suggestion, mainly because floods in arid zones are infrequent and unpredictable. Here we present bedload sediment transport data for an ephemeral river in Israel, which show it to be, on average, as much as 400 times more efficient at transporting coarse material than its perennial counterparts in humid zones. This suggests that existing predictive sediment transport equations, developed and calibrated exclusively with data obtained in perennial rivers, are inadequate for application to rivers in arid environments. It also suggests that areas that are at risk of shifting from sub-humid to semi-arid conditions as a result of prospective global changes in climate may suffer severe sedimentation problems.
© *Nature*

335. **Viewpoint: Sustainability of pinon-juniper ecosystems: A unifying perspective of soil erosion thresholds**.
Davenport, D. W., Breshears, D. D., Wilcox, B. P. and Allen, C. D.
Journal of Range Management 51: 231-240 (1998). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/9306/8918
Keywords: erosion/ pinyon-juniper ecosystems/ erosion potential
Abstract: Many piñon-juniper ecosystems in the western U.S. are subject to accelerated erosion while others are undergoing little or no erosion. Controversy has developed over whether invading or encroaching piñon and juniper species are inherently harmful to rangeland ecosystems. We developed a conceptual model of soil erosion in piñon-juniper ecosystems that is consistent with both sides of the controversy and suggests that the diverse perspectives on this issue arise from threshold effects operating under very different site conditions. Soil erosion rate can be viewed as a function of (1) site erosion potential (SEP), determined by climate, geomorphology and soil erodibility; and (2) ground cover. Site erosion potential and cover act synergistically to determine soil erosion rates, as evident even from simple USLE predictions of erosion. In piñon-juniper ecosystems with high SEP, the erosion rate is highly sensitive to ground cover and can cross a threshold so that erosion increases dramatically in response to a small decrease in cover. The sensitivity of erosion rate to SEP and cover can be visualized as a cusp catastrophe surface on which changes may occur rapidly and irreversibly. The mechanisms associated with a rapid shift from low to high erosion rate can be illustrated using percolation theory to incorporate spatial, temporal, and scale-dependent patterns of water storage capacity on a hillslope. Percolation theory demonstrates how hillslope runoff can undergo a threshold response to a minor change in storage capacity. Our conceptual model suggests that piñon and juniper contribute to accelerated erosion only under a limited range of site conditions which, however, may exist over large areas.
This citation is from the University of Arizona Institutional Repository.

336. **Water Quality Challenge: Using New Technology to Track Tectonic Salinity Sources to Surface and Ground Water**.
See record 203 in Subsurface Transport Processes.

337. **Widespread natural perchlorate in unsaturated zones of the southwest United States**.
Rao, B., Anderson, T. A., Orris, G. J., Rainwater, K. A., Rajagopalan, S., Sandvig, R. M., Scanlon, B. R., Stonestrom, D. A., Walvoord, M. A. and Jackson, W. A.
Environmental science & technology 41: 4522-4528 (2007).
http://dx.doi.org/10.1021/es062853i
Keywords: geologic sediments/ geologic sediments/ perchloric acid/ perchloric acid/ chemical analysis/ soil pollutants/ soil pollutants/ southwestern United States
Abstract: A substantial reservoir (up to 1 kg ha(-1)) of natural perchlorate is present in diverse unsaturated zones of the arid and semi-arid

southwestern United States. The perchlorate co-occurs with meteoric chloride that has accumulated in these soils throughout the Holocene [0 to 10-15 ka (thousand years ago)] and possibly longer periods. Previously, natural perchlorate widely believed to be limited to the Atacama Desert, now appears widespread in steppe-to-desert ecoregions. The perchlorate reservoir becomes sufficiently large to affect groundwater when recharge from irrigation or climate change flushes accumulated salts from the unsaturated zone. This new source may help explain increasing reports of perchlorate in dry region agricultural products and should be considered when evaluating overall source contributions.
© *Thomson Reuters*

338. **Wind and water erosion and transport in semi-arid shrubland, grassland and forest ecosystems: quantifying dominance of horizontal wind-driven transport**.
Breshears, D. D., Whicker, J. J., Mathew, P. J. and Pinder, J. E.
Earth Surface Processes and Landforms 28: 1189-1209 (2003). ISSN: 0197-9337
http://dx.doi.org//10.1002/esp.1034
Keywords: wind erosion/ water erosion/ ecosystems
Abstract: Soil erosion is an important process in dryland ecosystems, yet measurements and comparisons of wind and water erosion within and among such ecosystems are lacking. Here we compare wind erosion and transport field measurements with water erosion and transport from rainfall-simulation for three different semi-arid ecosystems: a shrubland near Carlsbad, New Mexico; a grassland near Denver, Colorado; and a forest near Los Alamos, New Mexico. In addition to comparing erosion loss from an area, we propose a framework for comparing horizontal mass transport of wind- and water-driven materials as a metric for local soil redistribution. Median erosion rates from wind for vertical mass flux measurements (g m-2 d-1) were 1.5 x 10-2 for the shrubland, 8.3 x 10-3 for the grassland, and 9.1 x 10-3 for the forest. Wind-driven transport from horizontal mass flux measurements was greatest in the shrubland (15.0 g m-2 d-1) followed by the grassland (1.5 g m-2 d-1) and the forest sites (0.17 g m-2 d-1). Annual projections accounting for longer-term site meteorology suggest that wind erosion exceeds water erosion at the shrubland by c. 33 times and by c. five times at the forest, but not the grassland site, where the high clay content of the soils contributed to greater amounts of water erosion: water erosion exceeded wind erosion by about three times. Horizontal transport by wind was greater than that by water for all three systems, overwhelmingly so in the shrubland (factor of c. 2200). Our results, which include some of the only wind erosion measurements to date for semi-arid grasslands and forests, provide a basis for hypothesizing trends in wind and water erosion among ecosystems, highlight the importance of wind erosion and transport in semi-arid ecosystems, and have implications for land surface geomorphology, contaminant transport, and ecosystem biogeochemistry.
© *Wiley Online Library*

339. **Wind effects on water and salt loss in playa lakes**.
Torgersen, T.
Journal of Hydrology 74: 137-149 (1984).
http://dx.doi.org/10.1016/0022-1694(84)90145-8
Keywords: playa lakes/ wind stress/ lake salinity/ infiltration
Abstract: The theory behind wind stress induced setup of water surface slope on a playa lake is reviewed. Due to the low gradient of the bottom in most playa lakes (1–20 cm km−1), the advance and retreat of lake waters due to wind stress can expose or cover many square kilometers. It is even possible for the surface slope to exceed the bottom slope and thereby create a “roving” lake. Such water movements can transport lake water over undersaturated “shore” sediments and water can therefore infiltrate and be lost without an increase in lake salinity. This case is demonstrated with data from Lake George, New South Wales, Australia. Such wind effects need to be examined for their relation to the diagenesis of sediments, the composition of the bitterns, and the salt budget of playa lakes.

340. **Wind erodibility as influenced by rainfall and soil salinity**.
See record 43 in Rangeland Management Practices and Potential Impact on Salinity.

341. **Wind erosion losses as related to plant silhouette and soil cover**.
Bilbro, J. D. and Fryrear, D. W.
Agronomy Journal 86: 550-553 (1994).
Keywords: wind erosion/ eolian deposits/ soil erosion/ models
Abstract: Wind erosion adversely affects soils, plants, animals, equipment, the environment, and people. Wind erosion can be minimized or prevented by either standing residue or flat residue cover. Our objective was to develop mathematical relationships between these two crop residue properties and soil toss ratio (SLR: soil loss from protected soil/soil loss from flat, bare soil), for more accurate predictions of wind erosion on losses. Therefore, from a previously reported wind tunnel study (wind tunnel 1.1. m high, 0.51 m wide, and 5 m long) we took data for velocities ranging from 9.4 to 16.1 m s(-1) and silhouette areas (5) of upright wood dowels (simulating plant stems) ranging from 31 to 813 cm(2) m(-2) of soil surface (washed sand <0.42 mm) and developed the following equation for standing residue and SLR(5): SLR(delta) = exp(-28.49 x S-0.6413/V-2.423) (r(2) = 0.95), where 5 = stalk height (cm) x stalk diameter (cm) x stalk density (no. m(-2) and V = wind velocity in m s(-1) at a height of 0.61 m. We combined data from a second previously reported wind tunnel (0.9 m high, 0.6 m wide, and 7 m long) study in which the soil had been covered from 0.0 to 80.0% with wood dowels, artificial clods, or cotton (Gossypium hirsutum L.) gin trash with data from field studies published by other researchers for various soil types and soil coverages ranging from S to 95% with wheat (Triticum aestivum L.) residue or gravel, and developed the following equation for soil cover and SLR(c): SLR(c) = exp(-0.04380 x psc) (r(2) = 0.94), where pse is the percent of the soil that is covered by nonerodible material (e.g., soil aggregates, rocks, plant material). These equations should be useful to researchers developing and evaluating wind erosion models, prediction systems, and wind erosion control practices.
This citation is from the Crop Science Society of America.

342. **Wind erosion of saline playa sediments and its ecological effects in Ebinur Lake, Xinjiang, China**.
Liu, D., Abuduwaili, J., Lei, J., Wu, G. and Gui, D.
Environmental Earth Sciences 63: 241-250 (2011). ISSN: 1866-6280
http://dx.doi.org/10.1007/s12665-010-0690-4
Keywords: absorption/ anions/ chemical composition/ dust storms/ ecological impact/ eolian processes/ erosion rates/ lacustrine deposit/ mineral/ playas/ salts/ sediment transport/ sulfates/ wind erosion
Abstract: In many arid and semiarid areas, dry lake beds (saline playa) represent a tremendous source of unconsolidated salt-rich sediments that are available for aeolian transport. Severe salt-dust storms caused by the erosion of such landforms have become very harmful natural phenomena. In this study, sample analysis and field erosion monitoring of Ebinur Lake was conducted to investigate the salt content, chemical composition, and wind erosion intensity of surface salt-rich sediments. The effects of salt-dust rising from the playa on the growth and physiological health of plants were also evaluated in this study through a leaf dustfall test. The results indicate that water-soluble salts assemble densely on the dry lake bed surface. At a depth of 0-2 cm, the highest salt contents can exceed 40%, with sulfate and chloride being the main anions present and Na+, Ca2+, and Mg2+ being the primary cations. The annual wind erosion rate ranged from 0.48 to 5.6 cm in the northwest portion of the lake and from 0.24 to 0.96 cm in the southeast portion. Salt-dust storms caused by wind erosion of saline playa sediments seriously influenced the normal absorption of minerals by plant leaves. Under the influence of salt-dust storms, plant leaves absorb more Na+, but far less K+. 2010 Springer-Verlag.
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343. **16-year record of eolian dust in Southern Nevada and California, USA: Controls on dust generation and accumulation**.
Reheis, M. C.
Journal of Arid Environments 67: 487-520 (2006). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2006.03.006
Keywords: dust/ wind erosion/ dust source/ playas/ groundwater/ ENSO
Abstract: An ongoing project monitors modern dust accumulation in the arid southwestern United States to (1) determine the rate and composition of dust inputs to soils and (2) relate dust accumulation to weather patterns to help predict the effects of climate change on dust production and accumulation. The 16-year records of 35 dust-trap sites in the eastern Mojave Desert and southern Great Basin reveal how generation and accumulation of dust, including the silt-clay, carbonate, and soluble-salt fractions, is affected by the amount and seasonal distribution of rainfall and the behavior of different source types (alluvium, dry playas, and wet playas). Accumulation rates (fluxes) of the silt-clay fraction of dust, including carbonates, range from about 2–20 g/m2/yr. Average rates are higher in the southern part of the study area (south of latitude 36.5°N) and annually fluctuate over a larger range than rates in the northern part of the area. Sites throughout the study area show peaks in dust flux in the 1984–1985 sampling period and again in 1997–1999; northern sites also show increased flux in 1987–1988 and southern sites in 1989–1991. These peaks of dust flux correspond with both La Nina (dry) conditions and with strong El Nino (wet) periods. The accumulation rates of different components of mineral dusts fluctuate differently. For example, soluble-salt flux increases in 1987–1988, coincident with a moderate El Nino event, and increases very strongly in 1997–1999, overlapping with a strong El Nino event. Both of these high-rainfall winters were preceded and accompanied by strong summer rains. In contrast, little or no change in soluble-salt flux occurred during other periods of high winter rainfall but little summer rain, e.g. 1992–1995. The differences between northern vs. southern sites and between sites with playa dust sources vs. alluvial dust sources indicate that regional differences in the response of precipitation and vegetation growth to ENSO influence and differences in the response of source types control dust production and accumulation. A major factor is the hydrologic condition of surface sediments. The silt-clay and soluble-salt fluxes increased during the El Nino events of 1987–1988 and 1997–1998 at sites close to “wet” playas with shallow depths to groundwater (<10 m), consistent with the concept that active evaporative concentration of salts disrupts surface crusts and increases the susceptibility of surface sediment to deflation. The silt-clay flux also increased during drought periods (1989–1991, 1995–1997) at sites downwind of alluvial sources and “dry” playas with deeper groundwater (<10 m). These increases are probably related to the die-off of drought-stressed vegetation on alluvial sediments, and in some cases to local runoff events that deliver fresh sediment to playa margins and distal portions of alluvial fans.
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344. **Accumulation of salt-rich dust from Owens Lake playa in nearby alluvial soils**.
Quick, D. J. and Chadwick, O. A.
Aeolian Research 3: 23-29 (2011).
http://dx.doi.org/10.1016/j.aeolia.2011.03.004
Keywords: mineral aerosols/ desiccation/ desert soils/ dust/ alluvial soils/ soil salinity
Abstract: Over the last 100 years, Owens Lake playa in eastern California has been one of the largest point sources of PM-10 dust in the United States. Here we evaluate the spatial impact of the salt-rich playa dust on the alluvial piedmont soils of Owens Valley with the expectation that those nearest the playa will have the highest concentrations of playa-derived salts. We sampled soils of similar age on alluvial fans derived from Sierra Nevada granites along the valley axis to determine soluble salt and specific ion concentrations. Salt concentrations are indeed highest in those soils most proximate to the playa, with higher levels of sodium and elevated pH. However, one site directly north of the playa has significantly higher salt concentrations as measured by electrical conductivity (EC) compared to all other soils sampled, an average pH of about 10 and a sodium adsorption ratio (SAR) greater than 15, suggesting a strong impact of local dust as a

result of local topography and wind patterns. Although EC, pH, and SAR of other sampled soils fall into normal ranges for sandy granitic soils in a semi-arid climate, the soils closer to the playa show greater salt and sodium impact than those further away. The strong local impact of playa salts and the patterns of salt contribution away from the playa suggest a spatial effect of dust on the alluvial soils that will grow both in intensity of impact and in distance from the playa if dust fluxes remain at recent levels.
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345. **Aeolian dust in a saline playa environment, Nevada, USA**.
Blank, R. R., Young, J. A. and Allen, F. L.
Journal of Arid Environments 41: 365−381 (1999).
http://handle.nal.usda.gov/10113/6776
Keywords: eolian dust/ playas/ oxalate/ nitrate/ *Salsola paulsenii*/ sulfates/ potassium
Abstract: Saline playas in north-western Nevada, U.S.A., remnants of pluvial periods of the Pleistocene, represent a tremendous source of unconsolidated sediments available for aeolian transport. This study investigated the transport of aqueous-soluble solutes in dust from July 1994 through June 1996 along a transect from a barren salt-encrusted playa surface (elevation=1224 m), to a former pluvial lake beach (elevation=1228 m), to a dune-mantled upland (elevation=1248 m). The content of aqueous-soluble solutes in aeolian dust showed a significant ($p \leq 0{\cdot}05$) interaction with dust trap location (playa, beach, dune) and time of collection. Dust collectors on the playa surface generally contained significantly more aqueous-soluble solutes and had greater total flux of solutes than either the beach or the dune locations. The solute content of aeolian dust was usually higher, in some cases several orders of magnitude, than that in the surface 5 cm of soil. Recent changes in playa hydrology may explain this result. Pulses of nitrate-rich dust, synchronous with spring emergence, and other nutrient additions via aeolian dust may have stimulated invasion of dune-mantled uplands by the weed *Salsola paulsenii* (barb-wire Russian thistle).
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346. **Aeolian dust in Colorado Plateau soils: Nutrient inputs and recent change in source**.
Reynolds, R., Belnap, J., Reheis, M., Lamothe, P. and Luiszer, F.
Proceedings of the National Academy of Sciences of the United States of America 98: 7123-7127 (2001).
http://www.pnas.org/content/98/13/7123.full
Keywords: calcium/ magnesium/ magnetite/ molybdenum/ phosphorus/ sodium/ dust/ ecosystem/ nutrients/ particle size/ sediment
Abstract: Aeolian dust (windblown silt and clay) is an important component in arid-land ecosystems because it may contribute to soil formation and furnish essential nutrients. Few geologic surfaces, however, have been characterized with respect to dust-accumulation history and resultant nutrient enrichment. We have developed a combination of methods to identify the presence of aeolian dust in arid regions and to evaluate the roles of this dust in ecosystem processes. Unconsolidated sandy sediment on isolated surfaces in the Canyonlands region of the Colorado Plateau differs greatly in mineralogical and chemical composition from associated bedrock, mainly aeolian sandstone. Detrital magnetite in the surficial deposits produces moderately high values of magnetic susceptibility. but magnetite is absent in nearby bedrock. A component of the surficial deposits must be aeolian to account for the abundance of magnetite which formed originally in far-distant igneous rocks. Particle-size analysis suggests that the aeolian dust component is typically as much as 20-30%. Dust inputs have enriched the sediments in many elements, including P, Mg, Na, K, and Mo, as well as Ca, at sites where bedrock lacks calcite cement. Soil-surface biologic crusts are effective dust traps that apparently record a change in dust sources over the past several decades. Some of the recently fallen dust may result from human disturbance of land surfaces that are far from the Canyonlands. such as the Mojave Desert. Some land-use practices in the study area have the potential to deplete soil fertility by means of wind-erosion removal of aeolian silt.
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347. **Aeolian salinization of soils on the piedmont plain of Eastern Tian Shan (Lake Ebinur area, China)**.
Konyushkova, M. V., Abuduwaili, J. and Aidarov, I. P.
19th World Soil Congress, Brisbane, Australia (2010).
http://www.iuss.org/19th%20WCSS/Symposium/pdf/0003.pdf
Keywords: soil salinization/ eolian deposits/ rangelands/ dust storms/ soil salinity/ soil formation
Abstract: This study is focused on the effect of aeolian transport on soil formation and salinization in the piedmont plain of the northern slope of Tian Shan (Xinjiang-Uygur Autonomous Region of China). On the basis of the data on aeolian input of dust and salts (determined by dust collectors) and soil salinity at the 300-km transect it is shown that soil formation and salinization is closely related to aeolian processes. The main source of aeolian material is the dried up bottom of Lake Ebinur (wet playa). Maximum soil salinity (3-6% of salts) is observed in the soils near Jinghe settlement where the maximum aeolian input of salts is also registered. In the soils beyond 100 km from the dried bottom of the lake, salt content is low (0.1-0.4%). Chemical composition of salts in the soils is related to chemical composition of aeolian material. Chloride salts prevail in the soils located in the areas with the high Cl - to SO4 2- ratios (from 0.8 to 1.5) in aeolian salts. In places with a predominance of sulphates in the composition of aeolian salts, soils are characterized by the sulphate type of salinization. Preliminary calculations show that the formation of the modern profile of the studied soils takes about 2000 years.

348. **Aeolian saltation transport rate: an example of the effect of sediment supply**.
Williams, S. H. and Lee, J. A.
Journal of Arid Environments 30: 153-160 (1995). ISSN: 0140-1963
http://dx.doi.org/10.1016/S0140-1963(05)80066-7
Keywords: eolian transport/ sand/ sediment supply/ saltation/ sediment mobility
Abstract: The channel of the Whitewater River near Palm Springs, California, is an excellent location to assess the effect of sand supply and mobility on the quantity of material moved by aeolian saltation. Saltation fluxes at the site taken by Sharp (1964) were compared to the fluxes that would have been produced under ideal conditions for the spectrum of winds inferred for the site. The discrepancy between the two fluxes is, in general, consistent with whose observed elsewhere for similar surfaces. Variations are linked to runoff in the Whitewater River and, hence, the supply of fresh sand.
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349. **Analysis of a small agricultural watershed using remote sensing techniques**.
See record 2 in Rangeland Management Practices and Potential Impact on Salinity.

350. **Application of the Gillette model for windblown dust at Owens Lake, CA**.
Ono, D. M.
Atmospheric Environment 40: 3011-3021 (2006).
http://dx.doi.org/10.1016/j.atmosenv.2005.08.048
Keywords: wind erosion/ particulate matter/ sand flux/ Sensit (instrument)/ threshold friction velocity
Abstract: Windblown dust can have significant impacts on local air pollution levels, and in cases such as dust from Africa or Asia, can have global impacts on our environment. Models to estimate particulate matter emissions from windblown dust are generally based on the local wind speed, the threshold wind speed to initiate erosion, and the soil texture of a given surface. However, precipitation, soil crusting, and soil disturbance can dramatically change the threshold wind speed and erosion potential of a surface, making modeling difficult. A low-cost sampling and analysis method was developed to account for these surface changes in a wind erosion model. Windblown dust emissions measured as PM10 (particulate matter less than a nominal 10μm aerodynamic diameter) have been found to be generally proportional to sand flux (also known as saltation flux). In this study, a model was used to estimate sand flux using the relationship Q=AρG/g, where Q is horizontal sand flux, A is a surface erosion potential factor, ρρ is air density, g is the gravitational constant, and G=∫u*(u*2-u*t2)dt, where u*u* is friction velocity and u*tu*t is the threshold friction velocity of the surface. The variable A in the model was derived by comparing the measured sand flux for a given period and area to G for the same period. Sand flux was monitored at Owens Lake, CA using low-cost Cox Sand Catchers

(CSCs) for monthly measurements, and more expensive electronic sensors (Sensits) to measure hourly flux rates and u*tu*t. Monitors were spaced 1 km apart at 114 sites, covering one clay and three sand-dominated soil areas. Good model results relied primarily on the erosion potential A, which could be determined from CSC measurements and wind speed data. Annual values for A were found to range from 1.3 to 3.5 in the three sand areas. The value of A was an order of magnitude lower (0.2) in the less erodible clay area. Previous studies showed similar values for A of 0.7 and 2.9 for a sandy site at Owens Lake, and 1.1 for a site in the Chihuahuan desert in New Mexico. The model performed well using annual values for A and better with monthly values, with R2R2 ranging from 0.74 to 0.87 for hourly sand flux rates in the four study areas. Monthly changes in A accounted for temporal surface changes, such as precipitation and surface crusting in the model predictions. This study demonstrated that low-cost periodic sand flux sampling using CSCs can provide a practical method to determine values for A in a simple wind erosion model, and that this model can provide good hourly and monthly estimates of sand flux rates in windblown dust areas.
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351. **Biological soil crusts: Ecology and management**.
See record 210 in Surface Water Transport Processes.

352. **Calibration of GOES-VISSR, visible-band satellite data and its application to the analysis of a dust storm at Owens lake, California**.
Mackinnon, D. J., Chavez, P. S., Fraser, R. S., Niemeyer, T. C. and Gillette, D. A.
Geomorphology 17: 229-248 (1996).
http://pubs.er.usgs.gov/publication/70019027
Keywords: atmospheric dust/ scattering/ aerosols/ images/ index
Abstract: As part of a joint Russian/American dust-storm experiment, GOES-VISSR (Geostationary Operational Environmental Satellite, Visible-Infrared Spin-Scan Radiometer), data from a visible-band satellite image of a large dust storm emanating from Owens Lake, California were acquired on March 10 and 11, 1993. The satellite data were calibrated to targets of known ground reflectance factors and processed with radiative transfer techniques to yield aerosol (dust) optical depth at those stages of the dust storm when concurrent ground-based measurements of optical depth were made. Calibration of the satellite data is crucial for comparing surficial changes in remotely sensed data acquired over a period of time from the same area and for determining accurate concentrations of atmospheric aerosols using radiative transfer techniques. The calibration procedure forces the distribution of visible-band, DN (digital number) values, acquired on July 1, 1992, at 1731 GMT from the GOES-VISSR sensor over a large test area, to match the distribution of visible-band, DN values concurrently acquired from a Landsat MSS (Multispectral Scanner) sensor over the same test area; the Landsat MSS DN values were directly associated with reflectance factors measured from ground targets. The calibrated GOES-VISSR data for July 1, 1992, were then used to calibrate other GOES-VISSR data acquired on March 10 and 11, 1993, during the dust storm, Uncertainties in location of ground targets, bi-directional reflectance and atmospheric attenuation contribute an error of approximately +/-0.02 in the satellite-inferred ground reflectance factors. On March 11 at 1031 PST the satellite-received radiances during the peak of the storm were 3 times larger than predicted by our radiative transfer model for a pure clay dust plume of infinite optical depth. This result supported ground-based measurements that the plume at that time was composed primarily of large salt grains, probably sodium sulfate, which could not be properly characterized in our radiative transfer model. Further, the satellite data showed that the salt fell out of the plume within 35 km from the source. Finer-grained, clay dust was observed to extend beyond the salt-laden plume and was the major component of the dust plume after 1131 PST, when erosion of the salt crust on Owens Lake ceased. By 1331 and 1401 PST satellite-inferred, optical depths compared favorably with measurements concurrently acquired at the ground. Uncertainties in bi-directional reflectance, atmospheric attenuation, and locating ground points in the satellite data manifest errors between the inferred and measured optical depths in the range of 20 to 50%; these errors would be much greater without the calibration of the GOES-VISSR data. Changes in satellite-inferred reflectance factors over the lake bed during the course of the storm showed that 76 km(2) of the surface was

disrupted during the March 11 storm, suggesting as much as 76 x 10(3) m(3) of crustal material were displaced for each millimeter of several estimated to have been moved during the storm; an unknown fraction of the displaced material was suspended. The satellite data also showed dust fallout on mountain snowfields. Whereas fallout may have removed most of the salt, satellite data acquired at 1631 PST, when the plume had a large brightness contrast with the ground, showed that it covered over 2500 km(2) and contained at least 1.6 x 10(9) g of sediment. For such a small source area, the dust represents a substantial contribution to the regional and global load of aerosols.

353. **Causes of the fetch effect in wind erosion**.
Gillette, D. A., Herbert, G., Stockton, P. H. and Owen, P. R.
Earth Surface Processes and Landforms 21: 641-659 (1996).
http://dx.doi.org/10.1002/(SICI)1096-9837(199607)21:7<641::AID-ESP662>3.0.CO;2-9
Keywords: wind erosion/ threshold velocity/ fetch effect/ mass transport/ field/ surfaces
Abstract: The increase of soil mass flux with distance downwind, the fetch effect for wind erosion, has been observed and reported on since 1939. This model incorporates the following three mechanisms. (1) The 'avalanching' mechanism in which one particle moving downwind would dislodge one or more particles upon impact with the surface. The result of a chain of such events is an increase of mass flux with distance. (2) The 'aerodynamic feedback' effect, suggested by P. R. Owen, in which the aerodynamic roughness height is increased by saltation of particles; the resulting increased momentum flux increases saltation. These increases define a positive feedback loop with respect to distance downwind. (3) The 'soil resistance' mechanism, which is largely an expression of the change with distance of threshold velocity. Change of threshold velocities may be caused by inhomogeneities of the soil or progressive destruction of aggregates and crust in the direction of saltation fetch. An experiment was run in March 1993 at Owens Lake to test this model. Detailed measurements of wind profiles and mass fluxes were taken on a line parallel to the wind direction. These data support the proposed three-mechanism model.
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354. **Change in the aerodynamic roughness height by saltating grains: Experimental assessment, test of theory, and operational parameterization**.
Gillette, D. A., Marticorena, B. and Bergametti, G.
Journal of Geophysical Research-Atmospheres 103: 6203-6209 (1998).
http://dx.doi.org/10.1029/98JD00207
Keywords: wind erosion/ soil erosion/ models
Abstract: Data from an experiment at Owens Lake provided an opportunity to verify the validity of Raupach's formula that predicts the apparent roughness height at equilibrium with saltation during wind erosion episodes. In addition to that verification, a simplification of Raupach's formula is presented which allows the computation of the wind friction velocity affected by saltating sand grains without the need to measure the threshold wind friction velocity and to do iterative calculations. This method estimates the increase of the wind friction velocity Delta u*, above the nonsaltating wind friction velocity caused by the saltating grains: Delta u* = 0.3 [U -U-t](2) where U and U-t are the wind speed and the threshold wind speed, respectively, at 10 m.
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355. **Combined effects of groundwater and aeolian processes in the formation of the northernmost closed saline depressions of Europe: north-east Spain**.
See record 122 in Subsurface Transport Processes.

356. **Combining airborne electromagnetic induction and hydrochemistry to quantify salinity contributions to a large basin stream, Colorado River, Texas, USA**.
Paine, J. G., Collins, E. W., Nance, H. S. and Niemann, K. L.
Near Surface Geophysics 7: 271-282 (2009).
ISSN: 1569-4445
http://dx.doi.org/10.3997/1873-0604.2009016
Keywords: monitoring/ electromagnetic surveys/ pollution/ optimization/ Texas/ rivers/ hydrochemistry/ relief/ ground truth/ fluvial features/ Great Plains/ applied geophysics/ geochemistry/ environmental geology/ helicopter methods
Abstract: We combined multifrequency airborne electromagnetic induction (EM) measurements of apparent ground conductivity with chemical

analyses of surface water to delineate natural and oilfield salinity sources that degrade surface water quality by elevating total dissolved solids, chloride and sulphate concentrations along several hundred kilometres of the Colorado River (western Texas, USA). To reduce the cost of airborne geophysical surveying over such large areas, we used a helicopter to tow an EM instrument at low altitude along the stream-axis and measure the apparent electrical conductivity of the ground at multiple frequencies, examined results in the field to identify salinized stream segments and optimal water sampling locations and then flew more detailed surveys over these limited areas rather than over the entire basin as is typical in salinization studies. Minimally processed stream-axis EM data (including apparent conductivities measured at single frequencies and multifrequency 'spectrograms' along the stream-axis) helped identify salinized streambed segments, discriminate between surface and subsurface sources of salinity and determine water sampling locations upstream and downstream from each segment. We integrated EM, streamflow and hydrochemical data to calculate salinity loads, identify specific natural and oilfield salinity sources and guide and implement remediation efforts. Stream-axis flight lines offer the advantage of rapidly acquiring high-resolution subsurface conductivity data along long stream segments where traditional gridded flight-line surveys and waterborne measurements are impractical or prohibitively expensive. They also overcome difficulties associated with topographic effects when surveying deeply incised streams. Such surveys provide valuable information on location, extent and type of salinization and can guide water sampling and more intensive ground or airborne measurements.
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357. **Deposition rates and characteristics of aeolian dust in the semi-arid and sub-humid regions of the Argentinean Pampa**.
Ramsperger, B., Peinemann, N. and Stahr, K.
Journal of Arid Environments 39: 467-476 (1998). ISSN: 0140-1963
http://dx.doi.org/10.1006/jare.1997.0366
Keywords: dust deposition/ nutrient input/ semi-arid pampa/ sub-humid pampa/ Argentina
Abstract: Atmospheric dust inputs were monitored at four sites in the south-western Argentinean Pampa over a 3-year period. Dust traps (open bucket type) were installed at the soil surface and at 2 and 4 m above the surface. Total deposition rate, mineralogy, chemical properties, total element content and particle-size distribution of dust and soil samples of adjacent soil profiles were determined and analysed. Rainwater was also collected and analysed for salt content. Dust input varied between 400 and 800 kg ha−1 year−1averaged over 3 years, and did not follow a clear seasonal pattern. An unexpectedly high fine sand content in the dust samples and higher salt content of dust and rainwater at the coastal site indicate the participation of an important local component in this area. Feldspars and quartz were the principal constituents of the bulk mineralogy. Additional components were volcanic glass, micas, magnetite and calcite. The nutrient status of the dust was greater than that of the surrounding soil, and therefore may serve as a renewal factor. Nutrient input is a function of dust quantity and distance from the sea.
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358. **Desert Winds: Monitoring Wind-Related Surface Processes in Arizona, New Mexico, and California**.
See record 214 in Surface Water Transport Processes.

359. **Desertification in Russia: Problems and solutions (an example in the Republic of Kalmykla-Khalmg Tangch)**.
Zonn, I. S.
Environmental Monitoring and Assessment 37: 347-363 (1995). ISSN: 0167-6369
http://dx.doi.org/10.1007/BF00546900
Keywords: climatic controls/ terrestrial environment/ degradation/ erosion/ arid environment/ wind erosion/ desertification/ environmental analysis/ Kalmyk Russian Federation/ Kalmykla-Khalmg Tangch/ Caspian Sea/ grasslands/ ecology/ rangelands/ environmental geology/ land use/ salinization
© *ProQuest*

360. **Determination of the wind speed threshold for the emission of desert dust using satellite remote sensing in the thermal infrared**.
See record 216 in Surface Water Transport Processes.

361. **Distinguishing natural and anthropogenic sources of water quality variability, southeastern Piceance Basin, Colorado**.
See record 6 in Rangeland Management Practices and Potential Impact on Salinity.

362. **Distribution of vegetation in wind-dominated landscapes: Implications for wind erosion modeling and landscape processes**.
Okin, G. S. and Gillette, D. A.
Journal of Geophysical Research-Atmospheres 106: 9673-9683 (2001).
http://dx.doi.org/10.1029/2001JD900052
Keywords: southern New Mexico/ shrubland habitats/ nutrient losses/ desertification/ grasslands/ deserts/ runoff/ dust
Abstract: Dust emission and wind erosion from arid and semiarid environments provide a major source of global atmospheric aerosols. Well-known relations between wind stress and saltation sand flux for sand sheets and relations between sand flux and dust emission by sandblasting have enabled construction of dust models that have only been partly successful in predicting atmospheric mineral dust concentrations. Most models of wind erosion assume that vegetation is evenly distributed. Through the use of field, Fourier transform, and semivariogram analysis, we show that mesquite dunelands in the Chihuahuan Desert of southern New Mexico, United States, have anisotropic shrub distributions. Elongated areas of bare soil, "streets," which are aligned with the prevailing winds may partially explain discrepancies between observed and predicted atmospheric dust concentrations. Soils in the streets are not protected from winds blowing down the streets and may therefore produce more dust than if vegetation were more evenly distributed. Currently, few desert landscape evolution models take the rule of wind explicitly into account. The existence of streets implies that wind plays a major role in the evolution of vegetated arid and semiarid landscapes with wind-erodible soils. Here wind acts in tandem with water to enforce islands of fertility centered around individual shrubs and may provide an explanation for reduced soil fertility observed in shrublands. Furthermore, in order for mathematical models of dust flux to be successful in these landscapes, new landscape models are required which incorporate the existence and orientation of streets.
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363. **Dust characteristics and source-sink relations in eastern West Africa (SW-Niger and Benin) and South America (Argentinean Pampas)**.
Ramsperger, B., Herrmann, L. and Stahr, K.
Zeitschrift für Pflanzenernährung und Bodenkunde 161: 357-363 (1998). ISSN: 1522-2624
http://dx.doi.org/10.1002/jpln.1998.3581610404
Keywords: eolian dust/ rate of dust deposition/ particle-size distribution/ mineralogy/ element concentration
Abstract: In order to quantify dust input and to describe its characteristics under different environmental conditions, and to get information on source-sink relation, dust was collected monthly with bulk deposition samplers (open bucket type) in 2 and 4 m height over a 2—3 years period at different sites in West Africa (SW-Niger and Benin) and in the semi-arid Argentinean Pampas. Dust input, mineralogy (bulk and clay), chemical properties including total element content and particle-size distribution showed a clear seasonal pattern in eastern West Africa. Far-transported Saharan dust in the dry season could be distinguished from local material transported in the rainy season. In Argentina, high sand content of the samples pointed to an important participation of local components in the collected material. This was supported by higher contents of seaborne salts at the coastal sites, and the highest amounts of collected dust at the site of highest wind velocities. Due to the lack of seasonal differences in dust amount and its characteristics, and the aeolian genesis of the Pampas soils, a separation of local material and long-range dust was not possible.
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364. **Dust fall in the Takla Makan Desert of China**.
Chen, W. N., Fryrear, D. W. and Yang, Z. T.
Physical Geography 20: 189-224 (1999). ISSN: 0272-3646
Keywords: dust fall/ sedimentary characteristics/ Takla Makan Desert/ vertical-distribution/ terminal velocity/ mineral aerosols
Abstract: The Takla Makan Desert is one of the supposed sources of eolian deposits in the eastern China and the North Pacific Ocean. Lack of direct measurements hinders the theoretical interpretation of material exchange between the atmosphere and land surface as well as the sediment budget of the region. From

1992 to 1994, four measuring sites were established in the vicinity of 84 degrees E meridian along a 380 km observation traverse from the northern margin to the central desert. Data were collected on quantities of dust fall and sedimentary characteristics of airborne sediments, including grain-size distributions as well as chemical and mineral compositions. The quantities of annual dust fall were 10(2) to 10(3) tons km(-2) yr(-1), increasing from the margin toward the central desert. Monthly concentrations of particles finer than 0.02 mm in diameter ranged from 0.06 to 1.25 mg m(-3) over the three-year observation period. The elemental ratio and the element enrichment factor ruled out the Takla Makan Desert as possible sources of the dust in Hawaii and Alaska. The mean geometric diameter of airborne sediments in the 4 to 8 m surface layer from the Luntai oasis was 0.038 mm and from the interior ranged 0.064 to 0.067 mm being moderately to poorly sorted. Weight percent of particles finer than 0.063 mm in diameter were from 83.5% to 47.7%, decreasing toward the central desert. Distributions of the airborne particles were unimodal with peak diameters of 0.06 to 0.07 mm in the central desert and 0.02 to 0.06 mm in the sites toward the edge of the desert.
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365. **Dust Generation Resulting from Desiccation of Playa Systems: Studies on Mono and Owens Lakes, California**.
Gill, T. E., (1995).
Keywords: dust/ eolian processes/ soil crusts/ modeling/ playa lake morphometry/ geochemical cycling/ land restoration
Abstract: Playas, evaporites, and aeolian sediments frequently are linked components within the Earth system. Anthropogenic water diversions from terminal lakes form playas that release fugitive dust. These actions, documented worldwide, simulate aeolian processes activated during palaeoclimatic pluvial/interpluvial transitions, and have significant environmental impacts. Pluvial lakes Russell and Owens in North America's Great Basin preceded historic Mono and Owens Lakes, now desiccated by water diversions into dust-generating, evaporite -encrusted playas. Geochemical and hydrologic cycles acting on the Owens (Dry) Lake playa form three distinct crust types each year. Although initial dust production results from deflation of surface efflorescences after the playa dries, most aerosols are created by saltation abrasion of salt/silt/clay crusts at crust/ sand sheet contacts. The warm-season, clastic "cemented" crust is slowest to degrade into dust. If the playa surface is stabilized by an unbroken, non-efflorescent crust, dust formation is discouraged. When Mono Lake's surface elevation does not exceed 1951 meters (6400 feet), similar processes will also generate dust from its saline lower playa. Six factors--related to wind, topography, groundwater, and sediments--control dust formation at both playas. These factors were combined into a statistical model relating suspended dust concentrations to playa/lake morphometry. The model shows the extent and severity of Mono Lake dust storms expands significantly below the surface level 6376 feet (1943.5 meters). X-ray diffraction analysis of Mono Basin soils, playa sediments, and aerosols demonstrates geochemical cycling of materials through land, air and water during Mono Lake's 1982 low stand. Soils and clastic playa sediments contain silicate minerals and tephra. Saline groundwater deposited calcite, halite, thenardite, gaylussite, burkeite and glauberite onto the lower playa. Aerosols contained silicate minerals (especially micas) and salts (including calcite, thenardite, gaylussite and halite). Playa-specific compounds were detected in the aerosol, even at a site not visually impacted by dust plumes. Anthropogenic mitigation may help alleviate playa dust storms. Reducing water diversions, legally mandated for Mono Lake, is not feasible everywhere. Most successful land rehabilitation schemes for playas have combined engineering (sand fences, flooding) and ecological (revegetation) techniques to mimic and accelerate natural processes; this is recommended for Owens (Dry) Lake.

366. **Dynamic controls on wind erosion and dust generation on west-central Free State agricultural land, South Africa**.
Wiggs, G. and Holmes, P.
Earth Surface Processes and Landforms 36: 827-838 (2011). ISSN: 0197-9337
http://dx.doi.org/10.1002/esp.2110
Keywords: eolian dust/ aerodynamic roughness/ agricultural management/ erosion thresholds/ wind erosion/ aerodynamics/ dust/ forestry/ surface roughness/ wind power/ erosion/ agricultural land/ agricultural soil/ climate conditions/ environmental change/ erosion

control/ saltation/ sediment trap/ South Africa/ Helianthus/ Zea mays
Abstract: The west-central part of South Africa's Free State Province falls within the transition zone between South Africa's sub-humid, temperate grasslands to the east, and the semi-arid Karoo and arid Kalahari to the south and west, respectively. The area is characterized by low rainfall (typically 500mm or less) with high variability, but environmental conditions allow widespread dryland commercial agriculture (maize, sunflowers and stock farming). However, human activity promotes wind erosion and the area is susceptible to dust emissions. This study is the first to quantify the degree of wind erosion on the agricultural soils in the region under prevailing winter to spring climatic conditions and land management practices. Using arrays of cup anemometers, dust deposition traps and saltation impact sensors (Safires), measurements were made of the key erosivity and erodibility drivers that control the degree of wind erosion. Results demonstrate that significant quantities of dust are mobilized, particularly during the months of September and October. Thresholds of wind erosion are shown to respond particularly closely to changes in surface and aerodynamic roughness (z0) with the amount of collected dust correlating well with measures of wind erosivity that weight the impact of higher wind speeds. Given the importance of surface roughness in controlling erosion thresholds, results show that the opportunity exists for well designed farming practices to control wind erosion. However, it is likely that climatically driven environmental change will impact on some of the identified controls on erosion (wind power, moisture availability) with the result that the wind erosion hazard is likely to increase within this marginal environment. © 2010 John Wiley & Sons, Ltd..

367. **Ecological response on the shrink of Ebinur Lake, Xinjiang**.
Liu, Y.
Ziyuan Diaocha yu Huanjing = Resources Survey and Environment 29: 126-130 (2008).
ISSN: 1671-4814
Keywords: arid regions/ lakes/ salinity/ ecological degradation
Abstract: Located in Xinjiang, China, Ebinur Lake is a typical lake of arid region possessing peculiar wetland-arid ecosystem. From late upper Pleistocene, due to gradual drying of climate, Ebinur Lake continuously shrank. In the 50's to the end of 80's of the 20th century, as a result of sharp increasing of population and unreasonable development and utilization of water and soil resources, the process of shrinkage of the Lake sped up. This paper makes a preliminary analysis on the ecological response caused by the shrinkage of Ebinur Lake. It is pointed out that the natural vegetation in the lakeside desert shows a degrading and declining trend, facing a serious threat of biological diversity. The dry lakebed changes into salt desert, the lakeside sand dunes activate, the desert expands, the floating dust weather increases for a hundredfold, the buffer space between oasis and desert gradually decreases and the salinization trend increases. The shrinkage of Ebinur Lake is the result of both natural factors and man-made factors, but the man-made factors are primary, among which huge damming rivers and water diversion and large-scale reclaiming wastelands at the upper reaches of the rivers are the most important reasons of the shrinkage of the Lake.
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368. **Editorial: Aeolian sand transport processes**.
Livingstone, I.
Earth Surface Processes and Landforms 24: 381-381 (1999).
http://dx.doi.org/10.1002/(SICI)1096-9837(199905)24:5<381::AID-ESP994>3.0.CO;2-T
Keywords: eolian transport/ sand
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369. **The effect of a roughness element on local saltation transport**.
Iversen, J. D., Wang, W. P., Rasmussen, K. R., Mikkelsen, H. E., Hasiuk, J. F. and Leach, R. N.
Journal of Wind Engineering and Industrial Aerodynamics 36: 845-854 (1990).
http://dx.doi.org/10.1016/0167-6105(90)90081-M
Keywords: sand/ wind tunnel/ roughness
Abstract: Wind tunnel tests of rectangular prisms and circular cylinders have been initiated to determine the effects of such boundary layer obstacles on local aeolian saltation erosion and deposition. Preliminary results show that the drift topography adjacent to the rectangular or

cylindrical roughness element is a strong function of the element's geometry. Variation of drift topography with cylindrical element aspect ratio is illustrated.
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370. **The effect of roughness elements on wind erosion threshold**.
Raupach, M. R., Gillette, D. A. and Leys, J. F.
Journal of Geophysical Research-Atmospheres 98: 3023-3029 (1993).
http://dx.doi.org/10.1029/92JD01922
Keywords: soil cover/ wind erosion/ roughness
Abstract: A theory is developed to describe the dependence upon roughness density of the threshold friction velocity ratio R(t), the ratio of the threshold friction velocity of an erodible surface without roughness to that of the surface with nonerodible roughness present. The roughness density is quantified by the frontal area index lambda. The prediction is R(t) = (1 - msigmalambda)-1/2(1 + mbetalambda)-1/2 , where beta is the ratio of the drag coefficient of an isolated roughness element on the surface to the drag coefficient of the substrate surface itself; sigma is the basal-to-frontal area ratio of the roughness elements; and m (< 1) is a parameter accounting for differences between the average substrate surface stress and the maximum stress on the surface at any one point. The prediction is well verified by four independent data sets.
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371. **Effect of soil crusting on the emission and transport of wind-eroded sediment: field measurements on loamy sandy soil**.
Goossens, D.
Geomorphology 58: 145-160 (2004).
http://dx.doi.org/10.1016/S0169-555X(03)00229-0
Keywords: horizontal sediment flux/ vertical sediment flux/ surface crusts/ crusts/ strength/ wind erosion/ mineral aerosol production/ crushing-energy meter/ saltating particles/ desert soils/ aggregate stability/ dust accumulation/ erosion/ surfaces/ abrasion
Abstract: Field data are reported for the horizontal and vertical flux of wind-eroded sediment on an agricultural field in northern Germany. Measurements were made during a windstorm that hit the region on 18 May 1999. The magnitude of both fluxes was significantly affected by the presence of a surface crust covering the test field. Measuring the physical crust strength at 45 locations with a torvane, the relationships between crust strength (tau) and the horizontal (F-h) and vertical (F-v) sediment fluxes were investigated. Both fluxes decreased as the surface crust became stronger. The decay behaved as an exponential function for both types of flux. The horizontal sediment flux over a crusted surface can be accurately predicted by completing Marticorena and Bergametti's [Journal of Geophysical Research 100 (1995) 16415] erosion model with a crust function. The vertical particle flux over crusted soil can be calculated by adding a similar function to Alfaro and Gomes's [Journal of Geophysical Research 106D (2001) 18075] dust production model. The study also suggests that the gradual bombardment of a surface crust by impacting particles does not immediately result in a decay of the crust's protective effect, provided that the crust has a minimum thickness. However, once the crust becomes perforated, its protective effect disappears very quickly, leading to much higher horizontal and vertical sediment fluxes than predicted for undamaged crusted soil. (C) 2003 Elsevier B.V. All rights reserved.

372. **Effect of vegetation removal on air-flow patterns and dune dynamics in the southwest Kalahari Desert**.
Wiggs, G. F. S., Livingstone, I., Thomas, D. S. G. and Bullard, J. E.
Land Degradation and Rehabilitation 5: 13-24 (1994).
http://dx.doi.org/10.1002/ldr.3400050103
Keywords: vegetation/ devegetation/ sand dunes/ linear dunes/ kalahari desert/ shear stress partitioning/ velocity profile
Abstract: Vegetation is a major control of dune surface activity. To assess the effect of removing vegetation from otherwise largely inactive sand-dune surfaces, two field experiments were undertaken in the southwest Kalahari Desert of southern Africa. In the first, wind velocity profiles were measured on two flat surfaces, one vegetated and one where vegetation had been removed by fire. In the second, levels of dune surface activity were measured on burnt and vegetated sites over a ten week period. The data indicate a striking increase in the near-surface wind velocity allied to a decrease in shear stress after the destruction of the vegetation canopy as a result of burning, grazing or drought. Measurements

on the consequences of such changes in the airflow patterns on dune dynamics suggest a three-fold increase in dune surface activity after vegetation clearance. The dunes, therefore, have a staggered response to the contemporary environment, being largely inactive relicts for much of the time, but becoming more active as vegetation is episodically removed.
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373. **Effects of Salt Mineralogy on Dust Emissions, Salton Sea, California**.
Buck, B. J., King, J. and Etyemezian, V.
Soil Science Society of America Journal 75: 1971-1971 (2011).
http://dx.doi.org/10.2136/sssaj2011.0049
Keywords: eolian erosion/ salt mineralogy/ dust emissions/ crystal habits
Abstract: Some of the most emissive surfaces on Earth are dominated by salt minerals. We hypothesized that the vulnerability of surfaces to eolian erosion may be controlled by salt mineralogy and crystal habit. We used x-ray diffractometry (XRD) and scanning electron microscopy–energy dispersive x-ray spectrometry (SEM-EDS) analyses to measure salt mineral assemblages and crystal habits along exposed shorelines of the Salton Sea, California. Potential dust emissions were also measured using the Portable In-Situ Wind Erosion Lab (PI-SWERL). Results indicate that surfaces with the highest emissions, up to ~1 mg m−2 s−1, are composed of hydrous/anhydrous salt minerals and minerals with acicular or prismatic crystal habits. Hydrous/anhydrous minerals (mirabilite/thenardite, eugsterite/glauberite, gypsum/bassanite, and numerous Mg sulfates) are more unstable under changing environmental conditions, are likely to dissolve and reprecipitate repeatedly, form less cohesive tiny individual crystals or small aggregates, and are therefore more likely to result in highly emissive surfaces. Salt minerals with acicular or prismatic habits are more likely to be disruptive, enhance salt heave, lessen the degree of interlocking precipitates, and form loose, “puffy” crusts that are highly emissive. Low-sloping surfaces near the shoreline had greater fluctuations in water content and relative humidity, triggering frequent salt mineral dissolution–precipitation and increased emissions. A high water table also allowed a continuously replenishing supply of salt crystals, increasing the potential for extensive dust emissions. Surfaces containing salt minerals are incredibly dynamic, but understanding the processes that control surface characteristics is an important step in mitigating dust emissions. *This citation is from the Soil Science Society of America.*

374. **Element and mineral characterization of dust emission from the saline land at Songnen Plain, Northeastern China**.
Chen, B., Kitagawa, H., Hu, K., Jie, D., Yang, J. and Li, J.
Journal of Environmental Sciences 21: 1363-1370 (2009).
http://dx.doi.org/10.1016/S1001-0742(08)62427-4
Keywords: element geochemistry/ individual particle analysis/ Asian dust/ dust storms/ saline soils/ land degradation
Abstract: Recent observations of Asian dust storms show an eastern expansion of the source area to degraded lands, where dust emissions have been little studied. The dust concentrations over the saline land of the western Songnen Plain (SSL), Northeastern China, are circumstantially higher than those from the northwestern Chinese deserts. These concentrations are sensitive to the surface soil conditions and wind velocity on the ground. The dust samples collected during dust storm events on the SSL contain abundant Na, Mg, Al, K, Ca, Fe and Ti, as well as toxic elements such as Cu, V, Zn and Ba. Individual particle analysis reveals that fine saline particles (< 10 micron in diameter) on the saline land, consisting largely of carbonate, halite and sulfate together with lithogenic minerals such as SiO2 and aluminosilicate, are eventually uplifted during the interval from spring to autumn. The predominantly fine saline particles uplifted from the SSL are likely transported eastward by the winter monsoon circulation and westerlies. Recent degradation of saline lands in Northeastern China would not only increase the frequency of dust storm events in the downwind area, but also might change the chemical composition of the Asian dust emissions.
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375. **Elemental geochemistry of wind-erodible playa sediments, Owens Lake, California**.
Gill, T. E., Gillette, D. A., Niemeyer, T. and Winn, R. T.
Nuclear Instruments & Methods in Physics Research Section B-Beam Interactions with Materials and Atoms 189: 209-213 (2002).
http://dx.doi.org/10.1016/S0168-583X(01)01044-8
Keywords: PIXE/ sediment/ aerosols/ wind erosion/ sedimentary structure
Abstract: Wind erosion of the dried bed (playa) of Owens Lake, California is an extremely intense source of mineral aerosol, transporting dust hundreds of kilometers downwind to critical ecological areas and several cities. A dust-producing site on the playa was studied over a four-year period to document the processes associated with aerosol emission. The playa takes on a variety of sedimentary forms and phases with surface crusts of differing susceptibilities to wind erosion. The sediments are classed into three general categories based on appearance: soft (saline), loose with drifting sand (salt-silt-clay), and hard and clean (silt-clay). Sediment samples were collected over a two-year period as the study site cycled through all three crust types, and the samples were crushed and analyzed by PIXE. The results indicate that visual appearance and sedimentary structure does not correlate with elemental composition. All sediment types contain significant concentrations of various elements including sodium, calcium and silicon. Potentially toxic trace elements are also found in the sediments. All sediment types contain lead and/or arsenic in tens of parts per million, as well as various other heavy metals. Pb and As levels do not clearly correlate with salt content or sediment type. Arsenic levels may be slightly higher in the crusts with loose material present and potentially lower in the clean hard crusts,

while Pb was least frequently detected in the samples with loose material. Future research will add mineralogical and stable isotope analyses to correlate with the PIXE data. (C) 2002 Elsevier Science B.V. All rights reserved.

376. **Eolian transport of salts: A case study in the area of Lake Ebinur (Xinjiang, Northwest China)**.
Abuduwailli, J., Gabchenko, M. V. and Xu, J. R.
Journal of Arid Environments 72: 1843−1852 (2008).
http://dx.doi.org/10.1016/j.jaridenv.2008.05.006
Keywords: arid regions/ dust storms/ Dzungarian Gate/ playas/ salinity/ salt lakes
Abstract: In the Ebinur region of Western Dzungaria, strong wind flows from Dzungarian Gate predetermine the widespread development of deflation processes. As a result of human-induced desiccation of Lake Ebinur, a new source of the loose material—the dry lakebed—has formed, which has intensified dust storms in this region. Annual dynamics of the frequency and intensity of dust storms and the amount and chemical composition of salts in the eolian material deposited in the area have been studied. The frequency of dust storms and the intensity of dust and salt deposition regularly decrease with an increase in the distance from the dry lake bottom (playa). The amount of dust deposition ranges from 600 (near the lake) to 70 (100–200 km from the lake) g/m2/a. The amount of salts precipitating with dust is mainly from 14 to 27 g/m2/a; the maximum registered amount of salt deposition is 77 g/m2/a. As shown in our study, the farther from the lake, the higher the portion of sulfate and calcium and the smaller the portion of chloride and sodium ions in the composition of salts.
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377. **Eolian transport, saline lake basins, and groundwater solutes**.
See record 234 in Surface Water Transport Processes.

378. **Ephemeral lakes and desert dust sources**.
Mahowald, N. M., Bryant, R. G., Del Corral, J. and Steinberger, L.
Geophysical Research Letters 30: 1074 (2003).
http://dx.doi.org/10.1029/2002GL016041
Keywords: Southern Tunisia/ optical depth/ variability/ basin/ AVHRR/ playas
Abstract: The processes that determine which areas are strong sources of mineral aerosols are not well known. In this study we consider the role of ephemeral lakes in modulating emissions of atmospheric mineral aerosols. We focus on two ephemeral lake regions that have been

identified as source regions: the zone of Chotts in Tunisia and Algeria, and Etosha Pan in Namibia. Comparisons of satellite retrieved inundation data and the TOMS absorbing aerosol index suggest that during some periods of inundation, desert dust loadings are reduced. There is some indication that after flooded areas have dried there is increased dust loading. However, the role of the inundated ephemeral lake compared with nearby regions in modulating desert dust sources is unclear; in addition, problems with interpreting the TOMS AI make conclusions difficult. More research is required to understand the small-scale sources of atmospheric desert dust in dry, unvegetated, topographic lows.
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379. **Estimating PM10 air concentrations from dust storms in Iraq, Kuwait and Saudi Arabia**.
Draxler, R. R., Gillette, D. A., Kirkpatrick, J. S. and Heller, J.
Atmospheric Environment 35: 4315-4330 (2001).
http://dx.doi.org/10.1016/S1352-2310(01)00159-5
Keywords: long-range transport/ Southwest Asia/ resuspension/ eolian movement/ HYSPLIT/ threshold/ particles/ wind
Abstract: A model for the emission of PM10 dust has been constructed using the concept of a threshold friction velocity which is dependent on surface roughness. Surface roughness in turn was correlated with geomorphology or soil properties for Kuwait, Iraq, part of Syria, Saudi Arabia, the United Arab Emirates and Oman. The PM10 emission algorithm was incorporated into a Lagrangian transport and dispersion model. PM10 air concentrations were computed from August 1990 through August 1991. The model predicted about the right number of dust events over Kuwait (events occur 18% of the time). The model results agreed quantitatively with measurements at four locations in Saudi Arabia and one in Kuwait for one major dust event (> 1000 mug/m(3)). However, for smaller scale dust events (200-1000 mug/m(3)), especially at the coastal sampling locations, the model substantially over-predicted the air concentrations. Part of the over-prediction was attributed to the entrainment of dust-free air by the sea breeze, a flow feature not represented by the large-scale gridded meteorological data fields used in the model computation. Another part of the over-prediction was the model's strong sensitivity to threshold friction velocity and the surface soil texture coefficient (the soil emission factor), and the difficulty in accurately representing these parameters in the model. A comparison of the model predicted PM to spatial pattern with the TOMS satellite aerosol index (AI) yielded a spatial pattern covering a major portion of Saudi Arabia that was quite similar to the observed AI pattern. Published by Elsevier Science Ltd.

380. **Experimental study on the susceptibility of crusted surfaces to wind erosion: A comparison of the strength properties of biotic and salt crusts**.
See record 238 in Surface Water Transport Processes.

381. **Exploring some relationships between biological soil crusts, soil aggregation and wind erosion**.
Eldridge, D. J. and Leys, J. F.
Journal of Arid Environments 53: 457-466 (2003).
http://dx.doi.org/10.1006/jare.2002.1068
Keywords: wind erosion/ biological soil crusts/ wind erodibility/ soil/ aggregation/ cyanobacteria/ wind/ sediment flux/ cryptogamic crust/ dune blowouts/ algae/ particles/ Australia
Abstract: A portable wind tunnel was used to test the contribution of biological and physical elements to overall soil aggregation on a soil dominated by biological soil crusts in south-eastern Australia. After moderate disturbance and simulated wind erosion, 90% of surface aggregates on the loamy soil and 76% on the sandy soil were dominated by biological elements (cryptogams). Lower levels of biological bonding were observed on the severely disturbed treatment. Linear regression indicated a significant positive relationship (r(2)=0.72) between biological soil crust cover and dry aggregation levels greater than 0.85 mm. To maintain sediment transport below an erosion control target of 5 g m(-1) s(-1) for a 65 km h(-1) wind at 10 m height, a crust cover of approximately 20% is required. When a multiple regression model which sequentially fitted biological crust cover and dry aggregation greater than 0.85 mm was applied to the data, dry aggregation accounted for more of the variation in sediment transport rate than biological crust cover. These data were used to

develop a conceptual model which integrates crust cover and dry aggregation, and provides a useful framework within which to predict the likely impacts of changes in soil crust cover and aggregation. (C) 2002 Published by Elsevier Science Ltd.

382. **Factors controlling threshold friction velocity in semiarid and arid areas of the United States**.
Marticorena, B., Bergametti, G., Gillette, D. and Belnap, J.
Journal of Geophysical Research-Atmospheres 102: 23277-23287 (1997).
http://dx.doi.org/10.1029/97JD01303
Keywords: soil particles/ desert soils/ wind erosion/ elements/ dust
Abstract: A physical model was developed to explain threshold friction velocities u(*t) for particles of the size 60-120mu m lying on a rough surface in loose soils for semiarid and arid parts of the United States. The model corrected for the effect of momentum absorption by the nonerodible roughness. For loose or disturbed soils the most important parameter that controls u(*t) is the aerodynamic roughness height z(0). For physical crusts damaged by wind the size of erodible crust pieces is important along with the roughness. The presence of cyanobacterial-lichen soil crusts roughens the surface, and the biological fibrous growth aggregates soil particles. Only undisturbed sandy soils and disturbed soils of all types would be expected to be erodible in normal wind storms. Therefore disturbance of soils by both cattle and humans is very important in predicting wind erosion as confirmed by our measurements.
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383. **Field Experiments for Evaluating Wind Erosion Models**.
Van Donk, S. J. and Skidmore, E. L.
Annals of Arid Zone 40: 281-302 (2001).
http://www.weru.ksu.edu/new_weru/publications/pdf/Field%20experiments%20for%20evaluating%20wind%20erosion%20models.pdf
Keywords: wind erosion/ modeling/ airborne sediment flux/ BSNE/ Sensit (instrument)/ soil moisture/ albedo/ wind erosion/ models
Abstract: Erosion of soil by wind is a serious problem in many arid regions throughout the world. Agricultural producers, as well as managers of non-agricultural lands, need to know how different management practices impact wind erosion. For this purpose, several wind erosion models have been developed. Models, however, need to be tested using experimental data. This paper reviews wind erosion field research, emphasizing recent contributions, and describes experiments and measurements required to evaluate wind erosion models. Three types of data are needed to evaluate wind erosion models: airborne sediment flux, meteorological data and data describing the conditions of the field surface. The Big Spring Number Eight (BSNE) and the Modified Wilson and Cooke (MWAC) samplers are the most widely used collectors of airborne sediment. The Sensit and the Saltiphone do not collect sediment, but continuously record the occurrence and intensity of saltating particles. Additional work is needed to investigate their use for the actual quantification of sediment flux. Several researchers have developed some type of continuously weighing sampler: a sampler and an electronic scale combined in one apparatus. These devices are not yet fully operational and are expensive. Their cost has to decrease if they are to be used more widely. More research is also needed on methods to continuously measure soil moisture at the soil surface. Radiation data such as surface albedo may be useful In this regard.

384. **Generation, Characterization and Transport of Owens (Dry) Lake Dusts**.
Cahill, T. A., Gill, T. E., Gillette, D. A., Gearhart, E. A., Reid, J. S. and Yau, M. L.,
Sacramento, CA, California Environmental Protection Agency, Air Resources Board, Research Division, (1994).
http://www.arb.ca.gov/research/apr/past/a132-105a.pdf
Keywords: fugitive dust/ particulate matter/ dry lakes/ California/ air pollution
Abstract: The concentrations of windblown PM10 dust generated from the surface of Owens Lake are among the highest found in the United States. The dust is generated by the grinding action of sand particles, broken crust, and other debris on the salt and silt components of the lake bed. Under certain meteorological conditions, the lake bed forms a hard crust that is initially resistant to abrasion by sand, but continued erosion eventually destroys it. The particle sizes in the windblown dust are finer than typical soil-based PM10 particles. The small particle size and the topographical constraints of the Owens Valley allows Owens

Lake dust to be transported long distances to the north and south. Owens Lake dust impacts the Schulman Grove Ancient Bristlecone Pine forest and the Naval Air Weapons Center at China Lake, among other areas. The dust concentrations generated from Owens Lake could be reduced by limiting the movement of sand over the surface of the lake bed. This could be accomplished by wetting the surface, by stabilizing the surface with vegetation, or by trapping the sand in dune arrays. A combination of these methods may offer the best solution to the problem.

385. **Grain-size distributions of wind-eroded material above a flat bare soil**.
Weinan, C. and Fryrear, D. W.
Physical Geography 17: 554-584 (1996).
Keywords: eroded soil material/ eolian transport/ grain-size distribution/ sedimentology/ air-quality/ erosion/ field/ particles/ transport/ abrasion/ sampler/ sand
Abstract: Grain-size distributions and fluxes of each size fraction of aeolian materials in the surface layer are basic to understanding and predicting soil loss, air quality, and visibility, both in time and in space. Vertical distributions of eroded soil materials in a 612-cm-deep flow layer above an amarillo fine sandy loam soil in Big Spring, Texas were measured during sand-dust storms in the 1995 wind-erosion season. All 942 samples in 33 groups of measurements show that the airborne particles in the flow layer below 40 cm are bimodal in distribution, which is similar to the size distribution of the original soil. In the flow layer above 80 cm, the airborne material is distributed unimodally and consists of silt and very fine sand. The distribution of the mean diameter is a discontinuous function of height. Mean diameters vary by an asymmetric double sigmoid function of height. Size distribution of airborne particles in the 0- to 35-cm flow layer is controlled by saltation mechanisms, becoming larger with an increase in height, and moderately sorted, positively skewed, and platykurtic. In the 35- to 50-cm flow layer, particle size decreases very rapidly with increased height, becoming poorly sorted, symmetrical, or platykurtic, and thus uniformly distributed. This represents a transition zone from saltation to suspension. Grain-size parameters in the flow layer above 50 to 80 cm demonstrate a wavelike pattern with a moderately well to well-sorted, negatively skewed, and leptokurtic distribution. The weight percent of the silt content and phi(95) diameter increase by a natural logarithmic polynomial function of height. Inclusive standard deviations vary with height by an asymmetric logistic function. Total distributions of the skewness and kurtosis are wavelike. The fluctuation of grain-size parameters of eroded soil materials in the surface layer is related to saltation mechanisms and the turbulence of air flow.
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386. **Ground and aircraft lidar measurements of sea salt and dust plumes with a small wide field of view system**.
Porter, J. N.
Conference on Passive Optical Remote Sensing of the Atmosphere and Clouds IV, Proceedings of the Society of Photo-Optical Instrumentation Engineers (SPIE), Honolulu, HI (2004).
http://dx.doi.org/10.1117/12.579455
Keywords: aerosols/ LIDAR/ dust plumes/ sea salt
Abstract: A small portable lidar system was recently used to derive aerosol optical concentrations from ground and aircraft platforms. The mini lidar uses a telescope setup with a relatively wide field of view allowing for measurements from close in (~60 m range) with no near field correction. In order to account for the large dynamic range, a custom logarithmic amplifier is used. Lidar measurements have been made in Hawaii and examples will be shown. More recently the Lidar was mounted on an aircraft for an experiment in the United Arab Emirates. In this case, the Lidar system was used to looking up, forward and down. The Lidar measurements looking up and down provided vertical profiles of aerosol concentrations. The lidar looking forward were used to derive quantitative aerosol extinction values using an existing and a new approach. Preliminary examples of this UAE data are shown. Being able to model aerosol phase functions is important for both satellite and Lidar aerosol retrievals. Mie theory is adequate for spherical particles but complex aerosols such as dust and organics are more difficult to model. Here we discuss phase function measurements we have made with our ground based polar nephelometer for sea salt and more recently for dust in the United Arab Emirates. © (2004) Copyright SPIE--The International Society for Optical Engineering.

387. **Groundwater–surface water interactions in a large semi-arid floodplain: implications for salinity management**.
See record 147 in Subsurface Transport Processes.

388. **Impact of desert dust on the biogeochemistry of phosphorus in terrestrial ecosystems**.
Okin, G. S., Mahowald, N., Chadwick, O. A. and Artaxo, P.
Global Biogeochemical Cycles 18: GB2005 (2004).
http://dx.doi.org/10.1029/2003GB002145
Keywords: dust/ phosphorus/ soil/ Saharan dust/ atmospheric transport/ soil phosphorus/ deposition/ climate/ models/ land/ troposphere/ fractions/ nutrients
Abstract: [1] Leaching, biomass removal, and partitioning of phosphorus (P) into reservoirs not available to plants can limit the long-term productivity of terrestrial ecosystems. We evaluate the importance of atmospheric P inputs to the world's soils by estimating the total soil P turnover time with respect to dustborne P additions. Estimated turnover times range from similar to 10(4) to similar to 10(7) years. Our estimates provide a unique perspective on the importance and patterns of aeolian deposition to terrestrial landscapes. Dust source regions are areas of intense soil P cycling on large scales, but are too water-limited for this rapid cycling to have a major influence on ecosystem dynamics. By contrast, semiarid desert margins receive significant aeolian P from neighboring deserts and are likely influenced by dustborne P additions for the long-term maintenance of productivity. This is particularly true for the semiarid steppes of Africa and Eurasia. The prevalence of large dust sources in Africa and Eurasia indicates that these areas may generally be more influenced by dustborne P additions than soils in the Americas. Significant western hemisphere exceptions to this pattern occur on very old landscapes, such as the forests of the southeastern United States and the Amazon Basin. The Amazon Basin is highly dependent on aeolian deposition for the maintenance of long-term productivity. Dust deposition to terrestrial environments has not been constant with time. Variability in past P deposition related to geologically recent climate change may provide the strongest controls on present and future soil P in the Amazon and elsewhere.
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389. **Influence of cryptogamic crust disturbance to wind erosion on sand and loam rangeland soils**.
Leys, J. F. and Eldridge, D. J.
Earth Surface Processes and Landforms 23: 963-974 (1998).
http://dx.doi.org/10.1002/(SICI)1096-9837(1998110)23:11<963::AID-ESP914>3.0.CO;2-X
Keywords: wind erosion/ wind tunnel/ soil erodibility/ sediment flux/ dry aggregation/ cryptogamic crusts
Abstract: A portable field wind tunnel was used to assess the sediment flux rates of loam and sand textured soils in the Mallee region of southeastern Australia. Three levels of crust disturbance (nil, moderate and severe) simulating stock trampling were investigated. The results demonstrated the importance of cryptogamic crusts in binding the soil surface and providing roughness after the soil was moderately disturbed. On the loamy soil, the crust helped maintain sediment flux rates below the erosion control target to 5 g m(-1) s(-1) for a 65 km h(-1) wind measured at 10 m height. Once the crust was severely disturbed, sediment fluxes increased to 1.6 times the erosion target. On the sandy soil, even with no crust disturbance the sediment flux was 1.6 times the erosion control target. Disturbing the crust increased sediment fluxes to a maximum of 6.7 times the erosion control target. Removal of the crust also decreased the threshold wind velocity that resulted in an increase to the risk of erosion from <5 percent to 20 percent.
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390. **Influence of vegetation cover and crust type on wind-blown sediment in a semi-arid climate**.
Hupy, J. P.
Journal of Arid Environments 58: 167-179 (2004).
http://dx.doi.org/10.1016/S0140-1963(03)00129-0
Keywords: wind erosion/ rangelands/ vegetation cover/ crust type/ saltation/ biological soil crusts/ southern New Mexico/ desert soils/ dust storms/ erosion/ disturbance/ sand/ particles/ surfaces/ impacts
Abstract: This study determined the influence differing soil surface textures and vegetative covers have on the magnitude of wind erosion in a semi-arid environment. The study was conducted from March 2000 through late April

2000 on the Jornada Experimental Range approximately 37 km north of Las Cruces, New Mexico. Big Spring Number Eight (BSNE) samplers placed at nine locations, collected particulates in suspension and saltation at heights of 5, 10, 20, 50, and 100 cm from the following surfaces: loose sand, thick silty physical crust, flaky physical crust, weak desert pavement, and a forb/grass ground cover. BSNE samplers collected the largest amounts of sediment were collected in areas of loose sand and at sites directly downwind from loose sand than sites containing heavy crusting, gravel, or a forb/grass cover. Differences between sites with gravel surfaces and those with forb/grass cover were insignificant. These results quantify the importance of surface cover as an agent towards reducing the extent of wind erosion on semi-arid landscapes. (C) 2003 Elsevier Ltd. All rights reserved.

391. **Influence of vegetation cover on sand transport by wind: field studies at Owens Lake, California**.
See record 81 in Rangeland Management Practices and Potential Impact on Water.

392. **The influence of wind-borne dust on the salinization of soils in the desert region of southern California**.
El-Tag-Fadlalla, A. R.
Berkeley, California, University of California, 201 p. (1975).
Keywords: saline soils/ wind/ deserts
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393. **A joint Soviet-American experiment for the study of Asian desert dust and its impact on local meteorological conditions and climate - introduction**.
Golitsyn, G. and Gillette, D. A.
Atmospheric Environment Part a-General Topics 27: 2467-2470 (1993).
http://dx.doi.org/10.1016/0960-1686(93)90027-V
Keywords: Asian desert dust/ dust climatic effects/ dust source areas/ dust/ microphysics/ dust optical effects/ dust chemical composition
Abstract: Data were successfully obtained From an experiment during dust storms on 16 and 20 September 1989, in the Kafirnigan Valley, Tadzhik S.S.R. (Tadzhikistan). The principal purposes of the experiment were to provide data sets for modeling radiation transfer, as modified by desert dust, and to specify transport, modification, and deposition of a desert dust system. The experiment provided data for investigations of four problem areas concerning climatic effects of desert dust: (1) specification of dust-producing source areas and meteorology, (2) specification of dust microphysics, (3) description of optical and climate effects of the desert dust, including local meteorological conditions, and (4) description of chemical composition of the desert dust.

394. **Large-scale variability of wind erosion mass flux rates at Owens Lake. 1. Vertical profiles of horizontal mass fluxes of wind-eroded particles with diameter greater than 50 mu m**.
Gillette, D. A., Fryrear, D. W., Xiao, J. B., Stockton, P., Ono, D., Helm, P. J., Gill, T. E. and Ley, T.
Journal of Geophysical Research-Atmospheres 102: 25977-25987 (1997).
http://dx.doi.org/10.1029/97JD00961
Keywords: field measurement/ dust/ saltation/ aerosols/ sediment
Abstract: A field experiment at Owens (dry) Lake, California, tested whether and how the relative profiles of airborne horizontal mass fluxes for >50-mu m wind-eroded particles changed with friction velocity. The horizontal mass flux at almost all measured heights increased proportionally to the cube of friction velocity above an apparent threshold friction velocity for all sediment tested and increased with height except at one coarse-sand site where the relative horizontal mass flux profile did not change with friction velocity. Size distributions for long-time-averaged horizontal mass flux samples showed a saltation layer from the surface to a height between 30 and 50 cm, above which suspended particles dominate. Measurements from a large dust source area on a line parallel to the wind showed that even though the saltation flux reached equilibrium similar to 650 m downwind of the starting point of erosion, weakly suspended particles were still input into the atmosphere 1567 m downwind of the starting point; thus the saltating fraction of the total mass flux decreased after 650 m. The scale length difference and ratio of 70/30 suspended mass flux to saltation mass flux at the farthest downwind sampling site confirm that suspended particles are very important for mass

budgets in large source areas and that saltation mass flux can be a variable fraction of total horizontal mass flux for soils with a substantial fraction of <100-mu m particles.
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395. **Measurements of dust deposition in arid and semi-arid regions, China**.
Ta, W. and Wang, T.
Critical transitions in water and environmental resources management: Proceedings of the 2004 World Water and Environmental Resources Congress, Salt Lake City, UT, ASCE (2004).
http://dx.doi.org/10.1061/40737(2004)7
Keywords: arid lands/ China/ climate change/ dust/ measurement
Abstract: Dust samples collected monthly for 15 years from 50 sites in 10 urban cities in Gansu Province, China, provide information on modern rates of dust deposition in the desert/Gobi and loess areas. The dust deposition is highest during spring months and lowest during autumn months, in both the desert/Gobi and loess areas. There is a significant positive correlation between dust deposition and dust event, and an inverse correlation between dust deposition and precipitation. The 15-year mean maxima in the desert/Gobi area and loess area are 498.64 and 327.02 t km–2yr–1, respectively, and the mean minima 290.22 and 180.86 t km–2 yr–1, respectively. Drought may have a widespread, major influence on the modern rates of the dust deposition in the desert/Gobi and loess areas in Gansu Province, China.
This citation is from the American Society of Civil Engineers.

396. **Microbiotic crusts and ecosystem processes**.
See record 259 in Surface Water Transport Processes.

397. **Microbiotic Soil Crusts - A Review of Their Roles in Soil and Ecological Processes in the Rangelands of Australia**.
See record 260 in Surface Water Transport Processes.

398. **Microphytic crust influence on wind erosion**.
Williams, J. D., Dobrowolski, J. P., West, N. E. and Gillette, D. A.
Transactions of the ASAE 38: 131-137 (1995).
http://www.usmarc.usda.gov/sp2UserFiles/person/6112/Microphytic%20Crust%20Influence%20on%20Wind%20Erosion.pdf
Keywords: wind erosion/ soil stability/ microphytic crusts/ cryptobiotic crusts/ microbiotic crusts/ aridland processes/ dune blowouts/ algae/ stabilization/ vegetation/ piosphere/ sheep/ time factors/ Utah
Abstract: Wind is a persistent force in arid and semiarid lands. Microphytic crusts have been attributed with the ability to reduce wind erosion because of soil binding qualities. The purpose of this research was to determine if microphytic crusts contribute to soil stability in an arid land setting. Threshold friction velocity is the wind speed necessary for the initiation of soil erosion and, thus, is a measure of soil surface stability. A portable wind tunnel was used to determine threshold friction velocity on soil surfaces consisting of microphytic crusts living and undisturbed (control), chemically killed microphytic crusts but otherwise undisturbed (chemically killed), and microphytic crusts mechanically removed from the soil surface (scalped) to approximate conditions of absence. Significantly lower threshold friction velocities were measured within the scalped treatment than in the control or chemically killed treatments. Threshold friction velocities were not significantly different among control and chemically killed treatments. Significantly more wind-eroded material, entrained in the airstream and trapped by an inline filter, was obtained from the scalped treatment than from chemically killed or control treatments. Additionally, wind erosion occurred at significantly lower wind speeds in the scalped treatment. Microphytic crusts helped contribute to soil stability by binding soil particles, mainly by linked strands of cyanobacteria. Additional designed experiments are warranted to determine how the stabilizing influence of microphytic crusts are affected by type, degree, frequency, and season of disturbance and to answer pragmatic questions of concern to managers, such as determining acceptable levels of crust disruption and the wind speeds associated with erosion.

399. **Mineral soil surface crusts and wind and water erosion**.
See record 262 in Surface Water Transport Processes.

400. **Mitigation of windblown dusts and reclamation of Public Trust values, Owens Lake, California: Partial mitigation of PM10 episodes through control of saltating particles and reduction of wind shear**.
Cahill, T. A., Flocchini, R. G., White, B., Taylor, M., Nielsen, D., Toft, C., Ustin, S., Gill, T., Reid, J. and Yau, M. L. (1995).
http://archives.slc.ca.gov/Meeting_Summaries/1992_Documents/06-08-92/Items/060892R02-2.pdf
Keywords: air quality/ California/ Owens (dry) Lake/ bioremediation

401. **A model for prediction of desert dust cycle in the atmosphere**.
Nickovic, S., Kallos, G., Papadopoulos, A. and Kakaliagou, O.
Journal of Geophysical Research-Atmospheres 106: 18113-18129 (2001).
http://dx.doi.org/10.1029/2000JD900794
Keywords: step-mountain coordinate/ long-range transport/ Saharan dust/ mineral/ dust/ models/ deposition/ emission/ growth/ Africa/ wind
Abstract: An integrated modeling system has been developed to accurately describe the dust cycle in the atmosphere. It is based on the SKIRON/Eta modeling system and the EtaNCEP regional atmospheric model. The dust modules of the entire system incorporate the state of the art parameterizations of all the major phases of the atmospheric dust life such as production, diffusion, advection, and removal. These modules also include effects of the particle size distribution on aerosol dispersion. The dust production mechanism is based on the viscous/turbulent mixing, shear-free convection diffusion, and soil moisture. In addition to these sophisticated mechanisms, very high resolution databases, including elevation, soil properties, and vegetation cover are utilized. The entire system is easily configurable and transferable to any place on the Earth, it can cover domains on almost any size, and its horizontal resolution can vary from about 100 km up to approximately 4 km. It can run on one-way-nested form if necessary. The performance of the system has been tested for various dust storm episodes, in various places and resolution using gridded analysis or forecasting fields from various sources (ECMWF and NCEP) for initial and boundary conditions. The system is in operational use during the last two years, providing 72 hour forecasts for the Mediterranean region. The results are available on the internet (http://www.icod.org.mt and http://forecast.uoa.gr).
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402. **Model simulations of dust sources and transport in the global atmosphere: Effects of soil erodibility and wind speed variability**.
Grini, A., Myhre, G., Zender, C. S. and Isaksen, I. S. A.
Journal of Geophysical Research-Atmospheres 110: D02205 (2005).
http://dx.doi.org/10.1029/2004JD005037
Keywords: mineral dust/ radiative impact/ Saharan dust/ optical-thickness/ experiment shade/ gocart model/ sea salt/ aerosols/ emission/ albedo
Abstract: Global atmospheric dust is simulated using the Dust Entrainment and Deposition (DEAD) model in combination with the global-scale Oslo chemical transport model CTM2 using meteorological data for 1996. Dust sources are calculated using both mean wind speeds with model resolution T63 and subgrid wind speeds. Different data sets are used to describe soil erodibility. We explain how the different assumptions about dust production affect atmospheric dust burden and deposition. Some aspects of the annual dust cycle, such as the east Asian dust emissions, are largely dependent on the data used to determine soil erodibility. Other aspects, such as the timing of the maximum in the African plume at Northern Hemisphere summer, are well modeled with all data sets applied here. We show that the daily variation in optical depth at Cape Verde on the west coast of Africa is well simulated when we assume that erodibility is correlated with surface reflectivity from Moderate-Resolution Imaging Spetroradiometer (MODIS) satellite data. Using a subgrid probability density function of wind speed to drive the dust sources facilitates dust emissions in areas with low wind speeds. Dust concentrations in remote areas are sensitive to the parameterization of wet deposition. Our results point out the need for a detailed soil

erodibility data set for global dust modeling, and they suggest that surface reflectivity is potentially valuable for producing or evaluating such data sets.
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403. **Modeling the mineral dust aerosol cycle in the climate system**.
Tegen, I.
Quaternary Science Reviews 22: 1821-1834 (2003).
http://www.atmos.pccu.edu.tw/duststorm/paper/Modeling%20the%20mineral%20dust%20aerosol%20cycle%20in%20the%20climate%20system.pdf
Keywords: general circulation model/ long-range transport/ wind erosion/ prediction/ last glacial maximum/ North Pacific Ocean/ atmospheric dust/ Saharan dust/ desert dust/ radiative properties/ tropospheric aerosols
Abstract: Soil dust aerosol is an important factor of the climatic system. In order to evaluate the different aspects of the climatic effects of dust, estimates of its highly variable atmospheric distribution need to be computed by transport models. Such models also provide important means of evaluating the processes that govern changes in dustiness during different climatic periods. While models of the modern dust cycle are currently capable of simulating first-order patterns of its global distribution, the parameterization of dust emission in these models is still crude, since input information about soil properties and wind events cannot be resolved at a global scale. Regional models could be useful for evaluating emission parameterizations, as well as dust transport and depositional processes close to source regions. No single existing data set fully describes all aspects of the dust cycle. Validation of modeled dust distributions must therefore include comparisons with different types of observational data. While the compilation of such observational data sets is crucial for model development, model results can, in turn, provide guidance for new measurements of dust properties, which will be useful for future investigation of the dust cycle and its climatic effects. (C) 2003 Elsevier Ltd. All rights reserved.

404. **Particle production and aeolian transport from a "supply-limited" source area in the Chihuahuan desert, New Mexico, United States**.
Gillette, D. A. and Chen, W. A.
Journal of Geophysical Research-Atmospheres 106: 5267-5278 (2001).
http://dx.doi.org/10.1029/2000JD900674
Keywords: threshold friction velocity/ wind erosion/ saltation/ dust
Abstract: Wind erosion mechanisms were investigated for the "scrape site" at the Jornada Experimental Range near Las Cruces, New Mexico, in the Chihuahuan desert. The scrape site was denuded of vegetation and scraped flat in 1991. We adopted the site in 1994 because it offered an opportunity to study wind erosion mechanisms for a large area of unprotected sandy and crusted soil in an otherwise natural setting and over a period of several years. We installed and operated the following instrumentation for a period of 35 months: three meteorological towers, each 2 m in height, with wind speed sensors at 0.2, 0.5, 1.0, and 2.0 m above ground; air temperature at 0.2 and 2 m height; rain gauge; seven sets of particle collectors at 0.1, 0.5, and 1.0 m heights; and three fast-response particle mass flux sensors at 0.02, 0.1, 0.2, and 0.5 m heights; all along a transect crossing the site and parallel to the predominant southwesterly wind direction. The minimum threshold friction velocity for the scrape site with a thin layer of loose material was 25 cm s(-1). This minimum threshold velocity increased to as high as 100 cm s(-1) depending on the degree of particle depletion and the site's status which varied between supply unlimited just after a high wind episode and supply limited which was more typical for the rest of the time. The dominant mechanism producing fresh sediment for transport was sandblasting of the surface crust. The measurements showed that supply and availability of loose, fine particles on the surface is a strong control of rates of erosion rather than wind energy alone.
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405. **Particle Size/Composition Relationships of Wind-Eroding Sediments, Owens Lake, California, USA**.
Rojo, L., Gill, T. E. and Gillette, D. A.
Proceedings of the XI International Conference on PIXE and its Analytical Applications, Puebla, Mexico (2008).
http://www.fisica.unam.mx/pixe2007/Downloads/Proceedings/PDF_Files/PIXE2007-PII-32.pdf
Keywords: aerosols/ dust/ California/ sediment/ geology
Abstract: Major (Na, Mg, Al, Si, S, K, Ca, Fe), minor (Cl, Ti, Mn, Sr), and trace (Ni, Cu, Zn, Ga, As, Br, and Rb) element concentrations were determined by PIXE in 118 bulk aeolian dust samples deposited at six heights in seven locations along a 1.2 km long transect during three sequential windstorms at Owens Lake, California, USA. All elements except Ni, Ga, and Br were detected in each sample. Na and S concentrations covaried with each other (and inversely with Si and Ca), increased with height, and decreased with distance downwind and time. Mg, Al, Si, K, Mn, Fe, and Sr concentrations in dust from northerly sites varied with height and location as opposed to nearly constant concentrations at southerly locations. Volumetric particle- size distribution (PSD) for each sample was determined via laser diffraction. PSDs reflected a trimodal distribution: 63% of the samples peaked at 20-50 Cm (silt), 11% at 50-100 Cm (very fine sand) and 26% at 100-250 Cm (fine sand). Most silty samples occurred during the first two events. Significant differences in element concentrations existed in relation to the volumetric percentage of particles in a given size range. Na and S concentrations were proportional to the percent volume of submicron to silt particle fraction during each event. Al, Ti, Mn, K, Fe, and Rb concentrations correlated positively to 100-500Cm (fine/medium sand) particles in the first two events and a wider PSD range 250-1000Cm (coarse sand) in the third event. The results suggest sodium sulfate aerosol emission during the first windstorm, while subsequent saltation-dominated events released more aluminosilicate minerals containing higher trace metal concentrations. These combined techniques reveal particle size/chemical fractioning and small-scale spatial variability of sediments during re-suspension at aeolian “hotspots,” with implications to geochemical cycling and aerosol source/receptor relationships.
This citation is from UNAM Instituto de Fisica.

406. **Physical modeling and numerical simulation of factors leading to high PM10 emission fluxes from ground source fugitive dust with emphasis on Owens (dry) Lake soils**.
Roney, J. A.
Davis, Calif., University of California Davis, 314 p. (2001).
Keywords: wind/ salts/ modeling/ particulate matter
Abstract: The Saltation Wind Tunnel (SWT) at the University of California at Davis was used to simulate natural sources of fugitive atmospheric dust such as those resulting from lake playas, fallow fields, and other arid land environments. Specifically, four Owens (dry) Lake soils (an EPA superfund site for particulate matter) were studied and were chosen based on known dust activity on the lake playa in order to establish an emission inventory for this site. The Saltation Wind Tunnel facility is an environmental boundary layer tunnel developed in the spirit of R.A. Bagnold, 1941 who used a similar wind tunnel to study the movement of desert sands. The use of improved instrumentation including light scattering photometer aerosol detectors and pressure transducers along with new analysis techniques allows the measurements to be extended to include dust emissions of PM10 and PM2.5 (particulate matter of 10 microns and 2.5 microns aerodynamic diameter). These instruments are used to data-acquire velocity and dust concentration profiles simultaneously within the wind tunnel as a function of fetch along the bed of soil, surface measurements which have not been previously accomplished in any setting (field or laboratory). A control volume analysis is used to obtain emission rates. The relative dependence of the emission rate on variables such as wind shear and surface variability is addressed with this technique. These variables are imperative to understanding and modeling the mechanisms of atmospheric dust entrainment and establishing fugitive dustvii emission inventories. A numerical scheme for the diffusion equation of Pasquill, 1962, using the insight gained from the wind tunnel, is used to computationally represent the diffusion physics of the process. The numerical scheme

calculates concentration profiles along the streamwise direction, which are then directly compared to the profiles obtained in the wind tunnel. Initial comparisons indicate good agreement implying that the physical mechanism of advection-diffusion is realistically captured in the numerical model.

407. **PM10 and PM2.5 dust generation potential of soils/sediments in the Southern Aral Sea Basin, Uzbekistan**.
Singer, A., Zobeck, T., Poberezsky, L. and Argaman, E.
Journal of Arid Environments 54: 705-728 (2003). ISSN: 0140-1963
http://dx.doi.org/10.1006/jare.2002.1084
Keywords: Aral Sea Basin/ dust generation/ soil crusts/ particulate matter/ Amu Darya delta/ desiccated Aral Sea bed/ Lubbock dust generator.
Abstract: The objective of this study was to assess the contribution of the major soil/sediment surfaces in the Southern Aral Sea Basin to the dust generation potential of this region. Eight crusts and soils/sediments from seven sites, representative of these surfaces, were sampled in the field and their major characteristics (particle size distribution, organic carbon content, carbonate content, salt content and composition) that are related to dust generation, were determined. The PM10 and PM2·5 dust generation potential of the materials was determined in the laboratory using the Lubbock Dust Generation, Analysis and Sampling System (LDGASS). The highest amount of PM10 dust (579·3 mg.m−3) was generated from the Takyr crust material. The lowest by one Solonchak salt crust material (39·6 mg.m−3). Salt crusts from the desiccated Aral Sea bottom generated intermediate amounts of dust. The experimental results indicate that the Takyrs and Takyr-like soils, that occcupy over 1 million ha in the Southern Aral Sea Basin, constitute the surfaces with the highest potential for being the source for the severe dust storms of the area. Second to the Takyr soils, the Solonchaks and Solonchak-like soils, also with an extent of over 1 million ha, contribute highly saline dust. To these must be added a large, as yet uncharted, proportion of the approximately 4 million ha of exposed sea bed, that exhibit Solonchak-like characteristics.
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408. **Quantification of salt dust pathways from a groundwater-fed lake: Implications for salt budgets and dust emission rates**.
See record 174 in Subsurface Transport Processes.

409. **Quantifying wind erosion on summer fallow in southern Alberta**.
Larney, F. J., Bullock, M. S., Mcginn, S. M. and Fryrear, D. W.
Journal of Soil and Water Conservation 50: 91-94 (1995).
Keywords: field/ soil/ sampler
Abstract: Wind erosion on summer fallow is a pervasive problem on the semi-arid Canadian prairies. Quantifying soil losses caused by wind erosion in terms of weight of topsoil per unit area has not been possible in the past. A Wind Erosion Prediction System (WEPS), being developed by the Agricultural Research Service, U.S. Department of Agriculture, will calculate average soil loss/deposition over a specified area and time. A WEPS validation site was established on a fallow field in southern Alberta in November 1990. Using BSNE dust samplers, a total of 16 erosion events (wind storms causing measurable soil movement) were monitored between April 1991 and May 1992. Total soil loss was 144 Mg/ha (64.5 ton/ac). Losses due to individual storms varied from 0.3 to 30.4 Mg/ha (0.1 to 13.6 ton/ac). Based on the fastest rate of soil renewal reported, it would take about 17 years to replace the topsoil removed. Storm minimum wind speed (threshold conditions for erosion) declined as the fallow season progressed, indicating increased susceptibility to erosion. This was likely a result of the weathering action of precipitation during the summer and freeze/thaw activity during the winter. Precipitation and crusting acted as deterrents to erosion later in the fallow season. The increased surface roughness caused by a seeding operation also protected against erosion.

410. **Rehabilitating salt-desert ecosystems following wildfire and wind erosion**.
Newhall, R. L., Monaco, T. A., Horton, W. H., Harrison, R. D. and Page, R. J.
Rangelands 26: 3-7 (2004). ISSN: 0190-0528
http://dx.doi.org/10.2111/1551-501X(2004)26[3:RSEFWA]2.0.CO;2
Keywords: wildfire/ wind erosion/ ecosystem rehabilitation/ plant establishment

Abstract: This paper presents the results of a cooperative effort (from Bureau of Land Management, Forest Service Agricultural Service, Soil Conservation Service and Utah State University Cooperative Extension Service) on stabilizing and rehabilitating wildfire and wind erosion damaged and degraded salt desert ecosystems in Utah, USA. Rehabilitation treatments include straw mulch, soil berms, crested wheatgrass straw bales for reduction of wind erosion, and polyacrylamide drilled with the seed for surface water retention and to assist seedling establishment. The evaluation indicated that rehabilitation efforts should utilize perennial plant materials that rapidly establish and persist. It is suggested that, only drought tolerant species that have evolved for centuries under livestock grazing can persist in this site.
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411. **Relation of vertical flux of particles smaller than 10 mu m to total aeolian horizontal mass flux at Owens Lake**.
Gillette, D. A., Fryrear, D. W., Gill, T. E., Ley, T., Cahill, T. A. and Gearhart, E. A.
Journal of Geophysical Research-Atmospheres 102: 26009-26015 (1997).
http://dx.doi.org/10.1029/97JD02252
Keywords: mineral aerosols/ dust/ saltation/ wind
Abstract: The vertical flux of particles smaller than 10 mu m for a saline playa surface, the particle size composition of which was classified as loam-textured, was estimated for a highly wind-erodible site on the playa of Owens (dry) Lake in California. The ratio of this vertical flux to the horizontal flux of total airborne material through a surface perpendicular to the soil and to the wind, F-a/q(tot), is 2.75 x 10(-4) m(-1). This is consistent with that ratio for sand-textured soils and suggests that the binding energy and size of saltating particles for the tested surface material at Owens Lake is of the same order as that for sandier soils. The horizontal mass flux of saltating grains, q, in the reported wind erosion event is 51.3% of the total horizontal mass flux q(tot). Therefore the ratio of F-a/q is 5.4 x 10(-4) m(-1).
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412. **Relationship between the aerodynamic roughness length and the roughness density in cases of low roughness density**.
Minvielle, F., Marticorena, B., Gillette, D. A., Lawson, R. E., Thompson, R. and Bergametti, G.
Environmental Fluid Mechanics 3: 249-267 (2003).
http://dx.doi.org/10.1023/A:1022830119554
Keywords: atmospheric dust cycle/ saltation threshold/ erosion thresholds/ friction velocity/ wind erosion/ tunnel/ areas
Abstract: This paper presents measurements of roughness length performed in a wind tunnel for low roughness density. The experiments were performed with both compact and porous obstacles (clusters), in order to simulate the behavior of sparsely vegetated surfaces. The experimental results have been used to investigate the relationship between the ratio z(0)/h and the roughness density, and the influence of an obstacle's porosity on this relationship. The experiments performed for four configurations of compact obstacles provide measurements of roughness length z(0) for roughness densities lambda between 10(-3) and 10(-2) which are in good agreement with the only data set available until now for this range of low roughness densities. The results obtained with artificial porous obstacles suggests that the aerodynamic behavior of such roughness elements can be represented by the relationship established for compact obstacles, provided a porosity index has been used to determine the efficient roughness density (the fraction of the silhouette area actually sheltered by solid elements) rather than counting the porous object as solid. However, the experiments have been performed with relatively low porosity indices (maximum = 25%) for which the porosity has a negligible influence. In this range of porosity index, representing the aerodynamic behavior of porous obstacles using the relationship established for compact obstacles, should not lead to a significant error. However, the influence of the porosity may be important for porosity indices larger than 30%.

413. **Report of a preliminary investigation of the wind erosion and salt problems on the salt flats of Laguna Madre**.
Coover, J. R. and Rechenthin, C. A., Temple, TX, USDA Soil Conservation Service, 32 p. (1965).
Keywords: wind erosion/ salt flats/ Laguna Madre

414. **Runoff and runon areas in a patterned chenopod shrubland, arid western New South Wales, Australia: characteristics and origin**.
See record 282 in Surface Water Transport Processes.

415. **RWEQ: Improved wind erosion technology**.
Fryrear, D. W., Bilbro, J. D., Saleh, A., Schomberg, H., Stout, J. E. and Zobeck, T. M.
Journal of Soil and Water Conservation 55: 183-189 (2000).
Keywords: erosion factors/ farming practices/ model verification/ wind erosion/ models
Abstract: An improved wind erosion model (RWEQ) has been developed and validated with field erosion data from 45 site years. In RWEQ, the residue soil credibility, and soil roughness parameters are represented as coefficients. Within the RWEQ computer program, surface residues are decomposed with weather conditions. Residues are buried or flattened with tillage operations. Soil roughness is modified with tillage implements and roughness decayed with rain-fall or irrigation amount and storm erosivity. Effect of wind barriers is described with an optical density index, but the protected zone downwind is dependent on wind velocity and soil surface conditions. Wind speed over hills is modified and the effect is included in soil loss estimates. Soil loss data were collected from sites with art annual range of rainfall of 191 to 1255 mm. Soil sand contents varied from 10 to 87%. The majority of the erosion data are from circular fields 2.6 ha in size, but data were also collected from a 52 ha circle and rectangular fields 36 to 128 ha. Measured soil lasses varied from 0 to 31.21 kg m(2) and estimated soil losses with RWEQ for the same sites varied from 0 to 39.15 kg m(2). Statistical correlation between measured and estimated values was significant RWEQ has been tested on a broad range of soil, climate, and crop conditions, but additional testing may be needed on non mineral soils.
This citation is from the Soil and Water Conservation Society.

416. **Saline dust storms and their ecological impacts in arid regions**.
See record 285 in Surface Water Transport Processes.

417. **Saline soils in Saskatchewan due to wind deposition**.
Ballantyne, A. K.
Canadian Journal of Soil Science 58: 107-108 (1978).
http://dx.doi.org/10.4141/cjss78-012
Keywords: wind erosion/ saline water/ saline soil
Abstract: Wind is one of the mechanisms causing saline soil in Saskatchewan. This type of salinity is always adjacent to intermittant saline ponds or lakes.
This citation is from the Canadian Society of Soil Science.

418. **Salt loading from efflorescence and suspended sediments in the Price River basin**.
See record 183 in Subsurface Transport Processes.

419. **Salt source for dryland salinity: Evidence from an upland catchment on the Southern Tablelands of New South Wales**.
Acworth, R. I. and Jankowski, J.
Soil Research 39: 39-59 (2001).
http://dx.doi.org/10.1071/SR99120
Keywords: hydrogeology/ hydrogeochemistry/ electrical image/ electromagnetic induction/ aeolian dust
Abstract: A detailed study involving drilling, geophysics, hydrogeochemistry, and groundwater monitoring over a 10-year period has been carried out at a small catchment south-east of Yass on the Southern Tablelands of New South Wales to investigate the source of salt causing dryland salinity. The catchment is within 2 km of the top of a regional groundwater and surface water divide and remains substantially tree covered. The investigations have found a highly heterogeneous distribution of salt, most of which is associated with swelling clay. Dispersion of this clay causes the surface

features commonly associated with dryland salinity. There is no hydrogeochemical evidence to suggest evaporative or transpirative concentration of salt in the groundwater. The short flow path from the top of the catchment cannot provide a significant source of salt from bedrock weathering. An alternative model of salt accumulation is proposed with the salt imported into the catchment with silt during dust storms in the arid and windy conditions during the last glacial. The management implications of this model of salt distribution and the associated dryland salinity development are discussed.
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420. **Saltating Particles, Playa Crusts and Dust Aerosols At Owens (Dry) Lake, California**.
Cahill, T., Gill, T. E., Reid, J. S., Gearhart, E. and Gillette, D.
Earth Surface Processes and Landforms 21: 621-639 (1996).
http://dx.doi.org/10.1002/(SICI)1096-9837(199607)21:7<621::AID-ESP661>3.0.CO2-E
Keywords: playas/ dust/ PM(10)/ Owens (dry) Lake/ crusts/ saltation/ sand run/ vegetation/ transport/ sampler
Abstract: As part of the multinational Lake Owens Dust Experiment (LODE), we have studied the generation of dust storms on the south sand sheet of Owens (dry) Lake, California, an anthropogenically desiccated playa reported to be the single greatest source of particulate matter in North America. During March 1993, we performed an intensive field study including eight significant dust storms, building on our prior work (1978–1984) and preliminary studies (1991–1992). We studied sources and magnitude of coarse saltating particles, the meteorological conditions that allow them to become mobile across the flat playa of Owens (dry) Lake, and how the motion of saltating particles across different types of playa surfaces results in the generation of PM10 dusts (aerosol particles smaller than 10 [] μm aerodynamic diameter). Saltating grains of lacustrine sand and broken crust abrade and disaggregate the playa surface into fine aerosols, and the resulting PM10 concentrations recorded during major dust storms are among the highest ever recorded in North America. On 23 March 1993, we measured a 2[]h concentration on the playa of 40[]620[]μg[]m−3, as far as we can determine the highest ambient PM10 value ever recorded in the U.S.A. Abrasion of salt-silt-clay crusts by saltation is shown to be responsible for all but a small part of one dust storm. The quantity ‘sand run’, saltating particle transport multiplied by wind run, is shown to be very closely correlated with dust aerosol concentration. Finally, we have established that on-lake bed studies are essential for quantitative prediction of dust events on the Owens (dry) Lake bed, despite the difficult conditions encountered.
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421. **Sand fences for control of wind erosion and dust emission at Owens Lake, CA: 1. Full-scale testing, field deployment, and evaluation of effectiveness**.
Gill, T. E., Cahill, T. A., Copeland, S. A. and White, B. R.
Proceedings of the 11th International Conference on Wind Engineering, Lubbock, TX (2003).
Keywords: dust/ wind erosion/ sand fences/ Owens (dry) Lake

422. **Sand flux in the northern Chihuahuan desert, New Mexico, USA, and the influence of mesquite-dominated landscapes**.
Gillette, D. A. and Pitchford, A. M.
Journal of Geophysical Research-Earth Surface 109: F04003 (2004).
http://dx.doi.org/10.1029/2003JF000031
Keywords: dust emissions/ desert vegetation/ sand transport/ Chihuahuan desert/ mesquite/ United States/ dust/ vegetation/ saltation/ transport/ wind
Abstract: Measurements of sand flux over areas with different vegetation in the Chihuahuan desert show that mean, height-integrated, horizontal flux values for mesquite-dominated sites were higher than those for other kinds of vegetation. Sand transport over mesquite areas displayed seasonal variability for most years. This seasonal variability roughly followed the variability of strong winds. Sand transport rates for collectors within a short distance downwind of mesquite bushes were small compared to those for collectors at the end of streets (elongated patches of bare soil) aligned with wind direction. The increased rate of sand transport (wind erosion) associated with

mesquite is important because mesquite-dominated areas are increasing in the northern Chihuahuan desert and are therefore responsible for increasing land degradation (desertification).
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423. **Seasonal transport of fine particles to the Grand Canyon**.
Vasconcelos, L. a. D.
Journal of the Air & Waste Management Association 49: 268-278 (1999).
http://dx.doi.org/10.1080/10473289.1999.10463799
Keywords: aerosols/ lead/ haze
Abstract: Potential sources of pollutants can be identified by analyzing back trajectories associated with extreme ambient concentrations. Conditional frequency analysis (CFA) was used to identify statistically significant associations of geographical regions and ambient air quality observed at sites near the Grand Canyon. Stratification by season reveals a pattern of association during the fall quarter that is not observed during other seasons. Application of CFA to different source tracers provides additional information on the nature of the associations. Tracer species that were often below detection limits can be studied because the method requires only that the highest concentrations be identified.
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424. **Seasonal variations of saltation activity on a High Plains saline playa**.
Stout, J. E.
Physical Geography 24: 61–76 (2003).
http://www.lbk.ars.usda.gov/wewc/biblio/jstout/Stout_2003_PG_Playa.pdf
Keywords: playas/ deflation/ saltation/ eolian/ dust/ Southern High Plains
Abstract: The Southern High Plains region of West Texas and eastern New Mexico is often described as a flat elevated tableland. Spaced across this vast and otherwise featureless plain are 21 large closed basins containing approximately 40 irregularly shaped saline playas. Yellow Lake, located on the Yellow House Ranch northwest of Lubbock, Texas, is among the largest of the High Plains saline playas. This paper represents the first report of a 4-yr. study of saltation activity at Yellow Lake. From December 30, 1998, to January 1, 2003, a fast-response piezoelectric saltation sensor was used to collect a continuous record of aeolian activity at a point on the playa surface. Since saltation activity is often associated with dust emissions, the saltation record also provides information regarding seasonal patterns of dust emissions from the Yellow House Basin. Results suggest that blowing events can occur at any time of the year when conditions are favorable; however, the necessary conditions are rarely satisfied. As a result, the saltation record is characterized by many hours of inactivity punctuated with brief periods of occasionally intense aeolian activity. From December 30, 1998, to January 1, 2003, saltation activity was detected for only 7% of the hours measured. Although there can be substantial deviations from one year to the next, it was found that saltation activity tends to peak during winter months when winds are moderately strong and precipitation is at a minimum. Hourly saltation activity values occasionally approached unity during intense winter blowing events, indicating nearly continuous sediment transport over a one-hour period. Saltation activity is at a minimum during summer months when winds are often weak and wet conditions prevail. Although winds are typically strongest during the spring season, the playa is relatively stable due to high threshold values produced by significant spring precipitation. This contrasts sharply with the surrounding cropland, which tends to be most active during the spring season.

425. **Sediment movement and filtration in a riparian meadow following cattle use**.
See record 297 in Surface Water Transport Processes.

426. **Sensitivity of playa windblown-dust emissions to climatic and anthropogenic change**.
See record 298 in Surface Water Transport Processes.

427. **Shrub hummocks as foci for small animal disturbances in an encroached shrubland**.
Daryanto, S. and Eldridge, D. J.
Journal of Arid Environments 80: 35-39 (2012).
ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2011.12.001

Keywords: bioturbation/ encroachment/ foraging/ foraging pit/ shrubland/ soil processes/ thickening
Abstract: Resources in semi-arid landscapes are concentrated around woody plants (trees and shrubs), and therefore attract soil–disturbing fauna. Globally the trend has been to remove encroaching shrubs from semi-arid shrublands to increase their value for pastoralism, potentially affecting shrub–resident biota. We examined the distribution of animal disturbances created by a range of organisms (e.g. ants, scorpion, cicada, reptiles, small mammals) under two ploughing treatments, with and without grazing, in a semi-arid shrubland. We hypothesized that 1) animal structures would be clustered around resource-rich shrub patches, and 2) the density and composition of animal structures would differ between undisturbed (ungrazed and unploughed) and disturbed (ploughed and/or grazed) plots. Overall, we found more animal disturbance within shrub patches than in the interspaces irrespective of grazing and/or ploughing treatments, and well-defined increases in density of animal disturbances with increasing shrub cover. Our study highlights the importance of shrub hummocks as habitat patches for animals, and the potential negative feedbacks processes arising from shrub removal.
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428. **A single event wind erosion model**.
Fryrear, D. W., Saleh, A. and Bilbro, J. D.
Transactions of the ASAE
41: 1369-1374 (1998).
Keywords: soil loss/ wind erosion/ single event wind erosion model/ transport mass/ critical field length/ SEEM/ WEQ/ EPIC
Abstract: A Single Event Wind Erosion Model (SEEM) has been developed and tested with field erosion data. Estimates of mass transport and critical field lengths are possible with SEEM when given simple inputs for soil, crop, field, and weather conditions. With the transport and critical field length coefficients in a sigmoid equation, average soil loss can be computed. Estimates of soil loss from 2.6 ha circular fields with SEEM ranged from 0.03 to 6.64 kg/m(2), measured values ranged from 0.015 to 8.03 kg/m(2). Calculated soil losses were correlated with measured losses for seven sites and eleven storms (r(2) = 0.88).
This citation is from the American Society of Agricultural and Biological Engineers.

429. **Soil crust formation by dust deposition at Shaartuz, Tajik, S.S.R**.
Gillette, D. A. and Dobrowolski, J. P.
Atmospheric Environment Part a-General Topics
27: 2519-2525 (1993).
http://dx.doi.org/10.1016/0960-1686(93)90024-S
Keywords: deposition/ dust/ crusts formation/ loess
Abstract: The shrub-steppe area near Shaartuz, Tadzhik, S.S.R., is shown to be a net accumulator of dust despite being an occasional source of dust. For the accumulation of the dust to form the observed surface crust, a net deposition of about 290-490 g m(-2) yr(-1) of particles smaller than 20mu m is required, depending on the duration of the deposition period. The particles smaller than 20mu m are mixed with particles brought up from the sandy material below the surface crust bioturbation and are incorporated into the surface crust. Measurements during the 16 and 20 September 1989 dust storms provided a total deposition of 41.1 g m(-2) of particles smaller than 20mu m. Because 10-30 dust storms are observed at Shaartuz, the measured average dust storm deposition would yield 206-617 g m(-2) yr(-1). This range of deposition is of the order of that needed to provide a mass balance for the observed crust formation. Cryptogams (including algae, lichen, and moss) and rainwater are the main agents of incorporation of the aeolian dust into a stable soil crust. The role that the vascular plants played at the Shaartuz site was to reduce the rate of soil movement to levels where the cryptogamic crusting was possible. The observed mechanisms of dust deposition followed by crust incorporation are possibly an important processes in loess formation in Central Asia.
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430. **Soil losses by wind erosion**.
Fryrear, D. W., Lowery, B. and Larson, W. E.
Soil Science Society of America Journal 59: 668-672 (1995). ISSN: 0361-5995
Keywords: Alfisols/ Aridisols/ Mollisols/ erosion control/ Texas/ Nebraska/ Colorado/ Kansas/ Indiana/ Great Plains/ measurement models/ prediction/ saltation/ sampling/ sediment transport/ soil aggregates/ soil erosion/ suspended materials/ suspension/ WEPS/ Wind Erosion Prediction System/ wind transport
Abstract: Measurements of wind erosion from fields are limited, but with recently developed erosion samplers, it is possible to determine soil

losses from natural winds. Erosion of soils by wind was measured in five states. The soil loss was dependent on wind velocity, storm duration, and soil surface characteristics. Average annual rainfall varied from 356 mm at Eads, CO, to 915 mm at Crown Point, IN. Field soil varied from 29% sand at Eads, CO, to 83% sand at Big Spring, TX. Soil losses from individual erosion events in 3.1-ha fields varied from 0.050 kg m~2 at Big Spring, TX, to 7.007 kg m~2 at Elkhart, KS. Soil surface roughness, percentage of wind-erodible aggregates on the soil surface, and percentage of the soil surface covered with nonerodible material such as crop residues are extremely important in controlling wind erosion. A ground cover of 4% reduced wind erosion losses 15% compared with bare soil. Ridging a smooth soil with 50- to 70-mm ridges reduced soil erosion 98% on a sandy loam soil.
This citation is from the Crop Science Society of America.

431. **Supply-limited horizontal sand drift at an ephemerally crusted, unvegetated saline playa**.
Gillette, D. A., Niemeyer, T. C. and Helm, P. J.
Journal of Geophysical Research-Atmospheres 106: 18085-18098 (2001).
http://dx.doi.org/10.1029/2000JD900324
Keywords: threshold friction velocity/ wind erosion/ Owens (dry) Lake/ mass flux/ dust/ saltation/ California/ particles
Abstract: A site at Owens Dry Lake was observed for more than 4 years. The site was a vegetation-free saline playa where the surface formed "ephemeral crusts," crusts that form after rainfall. Sometimes these crusts were destroyed and often a layer of particles on the crust would engage in vigorous aeolian activity. Three "phases" of active sand drifting are defined as almost no movement (extreme supply limitation), loose particles on crust with some degree of sand drift (moderate supply limitation), and unlimited source movement corresponding to a destroyed surface crust (unlimited supply). These "phases" occurred 45, 49, and 6% of the time, respectively. The accumulation of loose particles on the crust was mostly the result of in situ formation. Crusted sediments with loose particles on top can exhibit mass flux rates about the same as for noncrusted sediments. Crusted sediments limit or eliminate sand drift in two conditions: for rough crusts that effect a sufficiently high threshold friction velocity (above the wind friction velocity) and for limited amounts of loose particles on the crust where particle supply is less than would be transported in normal saltation for a thick sandy surface. These "supply-limited" cases are similar to wind erosion of limited spilled material on a hard concrete surface. We quantified "Supply limitation" by defining a "potential" or "supply unlimited" sand drift function Q = AG where A represents supply limitation that decreases as the particle source is depleted. Here Q is the mass of sand transported through a surface perpendicular to the ground and to the wind and having unit width during time period t, and G = integral u(*)(u(*)(2) - u(*t)(2)) dt for u(*) > u(*t). G is integrated for the same time period t as for Q, u(*) is the friction velocity of the wind, and u(*t) is the threshold friction velocity of the wind. Hard crusts (usually formed in the summer) tended to show almost no change of threshold friction velocity with time and often gave total protection from wind erosion. Rough crusts provided sufficient protection expressed as high threshold friction velocities. For these high threshold friction velocities, aeolian activity was greatly reduced or practically prevented. The softest crusts, usually formed in the winter, provided much less protection and sometimes were destroyed by the wind. Following this destruction the "potential" or "supply unlimited" sand drift would be observed.
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432. **Temporal and spatial aspects of blowing dust in the Mojave and Colorado deserts of southern California, 1973-1994**.
Bach, A. J., Brazel, A. J. and Lancaster, N.
Physical Geography 17: 329-353 (1996).
http://dx.doi.org/10.1080/02723646.1996.10642589
Keywords: blowing dust/ dust storms/ Mojave Desert/ Colorado Desert/ wind erosion/ United States/ storms/ frequency/ Arizona/ precipitation/ Australia/ climate/ plains/ Texas
Abstract: Although dust storms rarely occur in southern California's deserts, blowing dust often reduces visibility, and large spatial and temporal variability in the frequency of blowing dust occurs throughout the region. On average only 1.3 dust storms occur in the study area each year. The annual average number of dust events (visibility <11 km) is 18.0, with the Coachella Valley being dustiest region, averaging 37.8 dust events each year. Mean annual frequencies of dust events for 1973-1994 are mapped, showing a core of activity centered over the

Imperial/Coachella Valley region, with fewer dust events around the periphery of the study area. Most stations show a coherent temporal pattern of dust frequency during the period 1973-1994, with the mid-1970s experiencing the most dust. Blowing dust generally was absent from all stations during 1979-1983, 1987-1989, and 1992-1994. The mid-1980s were moderately dusty and 1990-1991 saw a return to very dusty conditions, possibly resulting from below-normal precipitation and increased anthropogenic disturbances. Dust events in the Mojave Desert characteristically occur during the winter to spring months (February-May), associated with dry frontal activity, and are largely absent during the dry summer months. The Colorado Desert experiences a similar seasonal distribution of dust events, but has more summer events, usually associated with convective thunderstorms. Frequencies of blowing dust have weak, but statistically significant, correlations with mean annual and antecedent precipitation, suggesting that complex processes control dust emission.
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433. **Temporal and spatial variation of episodic wind erosion in unburned and burned semiarid shrubland**.
Whicker, J. J., Breshears, D. D., Wasiolek, P. T., Kirchner, T. B., Tavani, R. A., Schoep, D. A. and Rodgers, J. C.
Journal of Environmental Quality 31: 599-612 (2002).
http://www.ncbi.nlm.nih.gov/pubmed/11931452
Keywords: ponderosa pine forests/ grassland-forest continuum/ mesquite dunelands/ southwestern United States/ former grasslands/ soil moisture/ re-suspension/ deserts/ dust
Abstract: Redistribution of soil, nutrients, and contaminants is often driven by wind erosion in semiarid shrublands. Wind erosion depends on wind velocity (particularly during episodic, high-velocity winds) and on vegetation, which is generally sparse and spatially heterogeneous in semiarid ecosystems. Further, the vegetation cover can be rapidly and greatly altered due to disturbances, particularly fire. Few studies, however, have evaluated key temporal and spatial components of wind erosion with respect to (i) erosion rates on the scale of weeks as a function of episodic high-velocity winds, (ii) rates at unburned and burned sites, and (iii) within-site spatial heterogeneity in erosion. Measuring wind erosion in unburned and recently burned Chihuahuan desert shrubland, we found (i) weekly wind erosion was related more to daily peak wind velocities than to daily average velocities as consistent with our findings of a threshold wind velocity at approximately 7 in s(-1); (ii) greater crodibility in burned vs. unburned shrubland as indicated by erosion thresholds, aerodynamic roughness, and nearground soil movement; and (iii) burned shrubland lost soil from intercanopy and especially canopy patches in contrast to unburned shrubland, where soil accumulated in canopy patches. Our results are among the first to quantify post-fire wind erosion and highlight the importance of accounting for finer temporal and spatial variation in shrubland wind erosion. This finer-scale variation relates to semiarid land degradation, and is particularly relevant for predictions of contaminant re-suspension and redistribution, both of which historically ignore finer-scale temporal and spatial variation in wind erosion.
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434. **Total suspended particulate matter emissions at high friction velocities from desert landforms**.
Bacon, S. N., Mcdonald, E. V., Amit, R., Enzel, Y. and Crouvi, O.
Journal of Geophysical Research: Earth Surface 116: F03019 (2011). ISSN: 0148-0227
http://dx.doi.org/10.1029/2011JF001965
Keywords: arid lands/ particulates/ soil morphology/ wind erosion/ dust storms/ models
Abstract: Determine the utility of TSP data from arid landforms for terrain hazards Compare TSP and PM10 data in conjunction with soil-geomorphic characterization Propose the need of TSP data to support near-surface emission models Most wind erosion studies that characterize dust emission potential measure particulate matter smaller than 10mu m (PM10) for air quality purposes or atmospheric modeling. Because the PM10 size fraction is only a portion of the total range of fine-grained particles potentially emitted from desert landforms, we modified the miniature Portable In Situ Wind Erosion Lab (PI-SWERL) by adding a new instrument to measure total suspended particulate matter (TSP). The modified PI-SWERL is capable of measuring TSP with diameters <500 mu m emitted from highly erodible surfaces at friction velocities up to 1.28 m s-1. Undisturbed and artificially disturbed surfaces of six common landforms in the Negev Desert of Israel were studied to evaluate the

utility of TSP measurements. These landforms include alluvial fans and plains armored by desert pavements, loessial soils with silt-rich surficial crusts, fluvial loess with biological crusts, and active sand dunes. The landforms differ in character and surface age, thereby exhibiting a wide range of surface covers, soil properties, and soil strengths. Our results indicate that the magnitude of TSP emission is primarily controlled by geomorphic setting and surface characteristics. TSP and PM10 concentrations measured from dust-rich loessial soils were significantly correlated, and TSP emission was best predicted at all sites using PM10 content and bearing capacity. Our results demonstrate that further research is needed to determine correction factors for friction velocities related to erodible, anisotropic surface roughness elements and that the modified PI-SWERL is a promising tool to quantify total potential emission flux from desert landforms.
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435. **Transport and deposition of desert dust in the Kafirnigan River Valley (Tajikistan) from Shaartuz to Esanbay - Measurements and a simple-model**.
Gillette, D. A., Bodhaine, B. A. and Mackinnon, D.
Atmospheric Environment Part a-General Topics 27: 2545-2552 (1993).
http://dx.doi.org/10.1016/0960-1686(93)90028-W
Keywords: deposition/ transport/ dust/ deposition velocity/ central Asia/ field
Abstract: A model of deposition and transport was constructed for the Kafirnigan Valley, in Soviet Central Asia. Data, consisting of deposition measurements at Shaartuz, atmospheric columnar mass, aerosol concentrations, wind speed, optical scattering, and movement of soil, were collected for the dust storms of 16 and 20 September 1989. Results from the model were compared with measurements of total atmospheric columnar mass loading for the dust storm of 16 September. Although sensitivity of the model to dust layer height does not recommend the model for general use, the model has some merit in predicting transport and deposition for dust contained in a river valley.

436. **Vertical-distribution of wind-eroded soil over a smooth, bare field**.
Vories, E. D. and Fryrear, D. W.
Transactions of the ASAE 34: 1763-1768 (1991).
Keywords: wind erosion/ distribution/ modeling/ sediment
Abstract: Collectors for sampling wind-eroded soil were installed in a fine sandy loam field in Big Spring, Texas, during early 1988. Samples were collected after each erosion event through April 1988. Functions to describe saltation and suspension were combined into one equation, and the wind-erosion data were used to determine a relationship to describe soil movement at heights from 5 to 200 cm. The equation appeared appropriate for samples within that height range. Integration of the equation for a storm on 16 March 1988 indicated that 243 kg of soil per 1 m width moved past one set of samplers between the heights of 5 and 200 cm. Of that, 80 kg/m moved in suspension and 163 kg/m in saltation. Different sampler technology will be required to experimentally extend the relationship below 5 cm.
This citation is from the American Society of Agricultural and Biological Engineers.

437. **Viewpoint: off-road vehicle damage to public lands**.
Goodloe, S.
Rangelands 8: 107-108 (2006). ISSN: 0190-0528
http://digitalcommons.library.arizona.edu/objectviewer?o=http://rangelands.library.arizona.edu/Volume8/Number3/azu_rangelands_v8_n3_107_108_m.pdf
Keywords: off-road vehicles/ erosion/ environmental damage
Abstract: Conservationists, environmentalists, graziers, sportsmen and sportswomen, public land managers, and others express concern over growing ORV use on public lands. They are frustrated in their attempts to halt the environmental destruction that is accelerating. Some public lands have deteriorated to a state of accelerated erosion. In most of the Western states, U.S. Forest Service land is generally higher in elevation than private land. Silt from erosion of these lands, in many cases, is deposited on privately owned land. Other areas have been disturbed to the point that vegetative cover is gone, and erosion from wind and water will begin if uncontrolled traffic continues. Erosion of this magnitude not only depletes the

public land but produces silt that affects the habitat of fish and other wildlife, destroys stock and wildlife watering ponds, can clog irrigation systems, and can harm downstream crops and hay lands. Exposed soil increases storm water runoff rates and contributes to flooding and related damages. Soil erosion is not a local problem; it has widespread and costly consequences, many of which will last for decades—or longer. In California's Dove Springs Canyon, after 10 years of use, ORV's had denuded 543 acres and heavily damaged another 960 acres. The Panoche Hills area was losing 6,400 tons of soil per square kilometer, 26 times the S.C.S. tolerance level. In the eastern Mojave, tracks made by General Patton's tanks over 40 years ago are still clearly visible, and will be for centuries to come.
This citation is from the University of Arizona Institutional Repository.

438. **Viewpoint: Sustainability of pinon-juniper ecosystems: A unifying perspective of soil erosion thresholds**.
See record 335 in Surface Water Transport Processes.

439. **Wind and water erosion and transport in semi-arid shrubland, grassland and forest ecosystems: quantifying dominance of horizontal wind-driven transport**.
See record 338 in Surface Water Transport Processes.

440. **Wind effects on water and salt loss in playa lakes**.
See record 339 in Surface Water Transport Processes.

441. **Wind erodibility as influenced by rainfall and soil salinity**.
See record 43 in Rangeland Management Practices and Potential Impact on Salinity.

442. **Wind erosion - field measurement and analysis**.
Fryrear, D. W., Stout, J. E., Hagen, L. J. and Vories, E. D.
Transactions of the ASAE 34: 155-160 (1991).
Keywords: soil/ wind erosion/ measurement/ sensors/ dust sampler/ sand
Abstract: Wind erosion researchers need field equipment and techniques for ascertaining threshold wind velocities and the amount and vertical distribution of the eroded soil particles. To detect moving soil particles and field erosion, sensors and soil samples to measure surface creep and airborne particles have been developed. A power expression will describe the variation in amounts of suspended material to a 2-m height. The quantity of material (f) and height of material (y) within the salation zone can be explained by the expression f = fo(1-y/sigma)beta where "fo" is surface creep, sigma is height below which 50% of the total mass flow occurs in the saltation process, and beta is the slope of the line. With this equipment and the analytical techniques described, the wind erosion process can be studied in the field, and the effectiveness of wind erosion control systems can be evaluated.
This citation is from the American Society of Agricultural and Biological Engineers.

443. **Wind erosion and soil salinity: An examination of current agricultural practices and government initiatives**.
See record 44 in Rangeland Management Practices and Potential Impact on Salinity.

444. **Wind erosion from military training lands in the Mojave Desert, California, USA**.
Van Donk, S. J., Huang, X., Skidmore, E. L., Anderson, A. B., Gebhart, D. L., Prehoda, V. E. and Kellogg, E. M.
Journal of Arid Environments 54: 687-703 (2003). ISSN: 0140-1963
http://dx.doi.org/10.1006/jare.2002.1085
Keywords: BSNE sampler/ Sensit (instrument)/ sediment discharge/ saltation
Abstract: Military training activities reduce vegetation cover, disturb crusts, and degrade soil aggregates, making the land more vulnerable to wind erosion. The objective of this study was to quantify wind erosion rates for typical conditions at the Marine Corps Air Ground Combat Center, Twentynine Palms, CA, U.S.A. Five Big Spring Number Eight (BSNE) sampler stations were installed at each of five sites. Each BSNE station consisted of five BSNE samplers with the lowest sampler at 0·05 m and the highest sampler at 1·0 m above the soil surface. Once a month, sediment was collected from the samplers for analysis. Occurrence of saltating soil aggregates was recorded every

hour using Sensits, one at each site. The site with the most erosion had a sediment discharge of 311 kg m−1 over a period of 17 months. Other sites eroded much less because of significant rock cover or the presence of a crust. Hourly sediment discharge was estimated combining hourly Sensit count and monthly sediment discharge measured using BSNE samplers. More simultaneously measured data are needed to better characterize the relationship between these two and reconstruct a detailed time-series of wind erosion. This measured time-series can then be used for comparison with simulation results from process-based wind erosion models such as the Wind Erosion Prediction System (WEPS), once it has been adapted to the unique aspects of military lands.
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445. **Wind erosion of crusted soil sediments**.
Rice, M. A., Willetts, B. B. and Mcewan, I. K.
Earth Surface Processes and Landforms 21: 279-293 (1996).
http://dx.doi.org/10.1002/(SICI)1096-9837(199603)21:3<279::AID-ESP633>3.0.CO;2-A
Keywords: wind erosion/ saltation/ crusts/ dust/ West Africa/ abrasion/ sand/ bed
Abstract: Saltating particles increase the rate of dust release from sediments in arid and semi-arid areas. They also break interparticle bonds in aggregated and crusted soils, thereby increasing the number of particles available for entrainment. This pilot study examines rates of erosion in relation to the flux of saltating grains for three crusted sediments of different strengths. Dislodgement of surface particles decreases with increasing crust strength, as measured by a cylindrical flat-ended penetrometer. In addition, initial dust release from craters formed by single impactors in unaggregated soil is examined in relation to the associated saltator. The volume of material removed depends linearly on the kinetic energy of the abraders.
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446. **Wind erosion: Field length**.
Fryrear, D. W. and Saleh, A.
Soil Science 161: 398-404 (1996).
Keywords: wind erosion/ soil erosion/ models/ eolian deposits
Abstract: As the wind passes over eroding soil surfaces, the quantity of soil transported by wind between the soil surface and 2 m above the surface increases until the wind stream becomes saturated, The relationship between field length and the mass transported was used to test a transport model that has the form of a sigmoid curve, At the upwind portion of the field, the rate of increase in mass being transported is limited by the emission rate from the soil surface, The mathematics of the sigmoid equation implies that when 63% of the maximum transport capacity of the wind has been satisfied (field length at this point is called critical field length), the rate of increase in transport mass gradually decreases and approaches zero when the wind is saturated with soil particles, From the instrumented field sites, a maximum transport rate of 1231 kg/m width and average soil losses of 7.801 kg/m(2) were measured from a single event on a 2.6-ha field at Elkhart, Kansas, Critical field length varied from 31 to 129 m, depending on wind velocity and field conditions, Field mass transport data supports that a self-balancing mechanism of momentum extraction from the surface wind by accelerating soil particles and the associated shear stress reduction will limit the quantity of material that can be transported between the soil surface and a height of 2 meters.
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447. **Wind transport of sand surfaces crusted with photoautotrophic microorganisms**.
Neuman, C. M., Maxwell, C. D. and Boulton, J. W.
CATENA 27: 229-247 (1996).
http://dx.doi.org/10.1016/0341-8162(96)00023-9
Keywords: microphytic crusts/ crust strength/ wind erosion/ wind tunnel experiment/ cryptogamic soil crusts/ dune blowouts/ microbial aggregation/ algal crusts/ recovery/ stabilization/ deserts/ Utah/ fire/ patterns
Abstract: Wind tunnel experiments show that while surfaces inoculated with photoautotrophic organisms are stable in winds up to 19 m s(-1), only filamentous cyanobacteria, especially Nostoc commune, afford considerable protection against abrasion from windborne particles. Crusts formed by the polysaccharide secreting alga Chlamydomonas acidophila break down easily under impact, the entrainment of large, low density aggregates possibly contributing to higher transport rates than would otherwise be expected for untreated sediment. Surface disintegration encompasses a suite of complex, scale dependent processes which vary with the

structure, thickness and strength of the crust. Independent measurements of crust strength based on flexure testing are in good agreement with wind tunnel evaluation of crust stability. The accommodation of a relatively large amount of deformation without rupture is an important property of fibrous, photoautotrophic mats, perhaps outweighing consideration of their peak strength.

448. **A wind tunnel study of particle kinematics during crust rupture and erosion**.
O'brien, P. and Mckenna Neuman, C.
Geomorphology 173–174: 149-160 (2012).
ISSN: 0169-555X
http://dx.doi.org/10.1016/j.geomorph.2012.06.005
Keywords: crusts rupture/ saltation/ particle speed/ wind tunnel/ laser Doppler anemometry
Abstract: Sediments with protective crusts of varying type were subjected to particles fed from an upwind source during wind tunnel experiments carried out to compare their ability to resist erosion and alter the kinematics of the saltation cloud. A laser Doppler anemometer measured the distribution of particle velocity for saltators impacting each crusted surface and for particles ejected from this same surface, inclusive of ricochets. Biotic crusts grown on sand in an environmental chamber were able to withstand erosion over several hours of continuous particle impact, as compared to brittle salt crusts, which, regardless of wind speed or sodium chloride concentration, eroded fully within one half hour. Despite the appearance of deep pits and grooves on the ruptured crusts, loss of mass dominated over particle trapping on these rough surfaces. While decreasing salt concentration between 320 g kg− 1 and 80 g kg− 1 generally was found to be associated with an increase in the mass flux of particles ejected from the surface, little to no correlation with either wind speed or particle impact speed was observed. The range over which varying salt concentration affects the momentum of ejected particles is rather narrow, within 160 g kg− 1. Temporal changes in the velocity distribution of ejected particles with crust rupture and deflation are complicated by variations in crust strength with depth. This is especially true of biotic crusts and weak salt crusts. Fast moving particles associated with the upper 40% of the cumulative velocity distribution generally demonstrate little variation from the control surfaces, and probably represent ricochets. In comparison, those within the lower 60% of the distribution are significantly affected by crust rupture and erosion, and may include low energy rebounds as well as the entrainment of new particles loosened from within the crust. While such measurements are exceedingly rare, they are needed for the validation of physically based models of crust erosion.
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449. **A wind tunnel study of the resilience of three fungal crusts to particle abrasion during aeolian sediment transport**.
Neuman, C. M. and Maxwell, C.
CATENA 38(3-4): 151-173 (1999).
http://dx.doi.org/10.1016/0341-8162(96)00023-9
Keywords: microphytic crusts/ crusts strength/ wind erosion/ wind tunnel experiment
Abstract: This study is a comparison of the strength, stability and resistance to abrasion of monospecific sand crusts formed by three species of free-living fungi: Aureobasidium pullulans, Trichoderma harzianum, and Absidia corymbifera. Compared to three photoautotrophs examined in a previous study, the fungal crusts were thicker and stronger in flexure by a factor of two or more. In addition to the morphological properties of these fungi, the organic substrate required for growth contributes to the total crust strength. Wind tunnel tests, in which the crusts were subjected to particle impact from an upwind sediment source (nominally 0.014 kg m(-1) s(-1)) and varied levels of freestream velocity (u(infinity)), showed that crusts comprised of Trichoderma and Absidia were stable at wind velocities under 10 m s(-1). Crusts of Aureobasidium generally ruptured at velocities well below this level and to a much greater extent. The distinctive morphologies and metabolic rates of the three fungi appear to explain these differences. As compared to the wind tunnel experiments, independent tests of crust strength in flexure, which were intended to simulate crust flaking, were found to be less sensitive indicators of relative crust stability in aeolian settings, Analysis of the time rate of expansion of the perimeter of crust loss indicates that this relation is approximately exponential, with the exception of low wind velocities near the threshold for grain ejection where the momentum of the saltators at impact appears to be of prime importance. (C) 1999 Elsevier Science B.V. All rights reserved.
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450. **A wind tunnel study to determine the vegetation cover required to suppress sand and dust transport at Owens (dry) Lake, California**.
Tsang, V. M.
Davis, Calif., University of California, Davis, 1
58 p. (1997).
Keywords: vegetation/ dust/ sand transport/ wind erosion

Geologic and Geochemical Processes

451. **1980-82 salinity status report: Results of Bureau of Land Management studies on public lands in the Upper Colorado River Basin**.
See record 204 in Surface Water Transport Processes.

452. **Biological soil crusts: Ecology and management**.
See record 210 in Surface Water Transport Processes.

453. **Brazos River Natural Salt Pollution Chloride Control Project**.
Rodgers, R. W., Richmond, TX, RWR Assoc., 15 p. (2000).
Keywords: rivers/ water salinization/ water quality/ environmental projects
Abstract: Rocks of Middle and Late Permian age crop out within the Rolling Plains in narrow north-south trending belts. Halite-bearing rocks are abundant in these formations in the subsurface to the west Salt springs and seeps occur along large streams and some tributaries within the outcrop area, with large salt flats occurring at major discharge points. Dove Creek Salt Flat, located in northwestern Stonewall County, is the site of spring discharges that contribute approximately one half of the total salt load of the Salt Fork Brazos River. The brine springs discharge through major fracture systems in the Grayburg Formation (Eskota Gypswn and Childress Dolomite), and the Dog Creek Formation. Wells drilled to intercept the brine should be located along these major fractures, and at fracture intersection points. The wells will be located approximately one mile to the west of Dove Creek Salt Flat at locations determined from the geological and geophysical surveys. The Grayburg and Dog Creek Formations dip to the west at approximately twenty five (25) feet per mile. Drainage patterns in these near-flat lying rocks would normally be dendritic in form, given the soft unconsolidated character of the shales and interbedded sands. However, the conversion of anhydrite to gypsum in the Eskota Gypsum has resulted in the interbedded gypsums becoming thicker and more consolidated. The scarp-fonning Childress Dolomite and the gypsum beds are sufficiently resistant to cause a modified rectangular drainage pattern to develop (Figs. 1-3). An analysis of the drainage patterns from topographic maps, aerial photographs, photomosaics, and field studies resulted in six (6) localities being determined to conduct the geophysical surveys (Figs. 1-4). These six (6) localities all meet the necessary criteria for a well location, including; number and size (length) of intersecting fracture trends, depth to the probable aquifer/aquiclude, relationship to the strike of the Childress Dolomite (aquifer/aquiclude), accessibility (terrain conditions) for drilling rig operations, and distance to Dove Creek for discharge of produced brine waters during field testing.

454. **Channel evolution and hydrologic variations in the Colorado River Basin - Factors influencing sediment and salt loads**.
See record 46 in Rangeland Management Practices and Potential Impact on Water.

455. **Characterization of Hydrology and Salinity in the Dolores Project Area, McElmo Creek Region, Southwest Colorado, Water Years 1978—2006**.
Richards, R. J. and Leib, K. J.
USGS Scientific Investigations Report, U.S. Geological Survey, 38 p. (2011).
http://pubs.usgs.gov/sir/2010/5218/
Keywords: hydrology/ Colorado River/ salinity/ monitoring/ historical flow/ Colorado River Salinity Control Forum
Abstract: Increasing salinity loading in the Colorado River has become a major concern for agricultural and municipal water supplies. The Colorado Salinity Control Act was implemented in 1974 to protect and enhance the quality of water in the Colorado River Basin. The U.S. Geological Survey, in cooperation with the Bureau of Reclamation and the Colorado River Salinity Control Forum, summarized salinity reductions in the McElmo Creek basin in southwest Colorado as a result of salinity-control modifications and flow-regime changes that result from the Dolores Project, which consists of the construction of McPhee reservoir on the Dolores River and salinity control modifications along the irrigation water delivery system. Flow-

adjusted salinity trends using S-LOADEST estimations for a streamgage on McElmo Creek (site 1), that represents outflow from the basin, indicates a decrease in salinity load by 39,800 tons from water year 1978 through water year 2006, which is an average decrease of 1,370 tons per year for the 29-year period. Annual-load calculations for a streamgage on Mud Creek (site 6), that represents outflow from a tributary basin, indicate a decrease of 7,300 tons from water year 1982 through water year 2006, which is an average decrease of 292 tons per year for the 25-year period. The streamgage Dolores River at Dolores, CO (site 17) was chosen to represent a background site that is not affected by the Dolores Project. Annual load calculations for site 17 estimated a decrease of about 8,600 tons from water year 1978 through water year 2006, which is an average decrease of 297 tons per year for the 29-year period. The trend in salinity load at site 17 was considered to be representative of a natural trend in the region. Typically, salinity concentrations at outflow sites decreased from the pre-Dolores Project period (water years 1978—1984) to the post-Dolores Project period (water years 2000—2006). The median salinity concentration for site 1 (main basin outflow) decreased from 2,210 milligrams per liter per day in the preperiod to 2,110 milligrams per liter per day in the postperiod. The median salinity concentration for site 6 (tributary outflow) increased from 3,370 milligrams per liter per day in the preperiod to 3,710 milligrams per liter per day in the postperiod. Salinity concentrations typically increased at inflow sites from the preperiod to the postperiod. Salinity concentrations increased from 178 milligrams per liter per day during the preperiod at Main Canal #1 (site 16) to 227 milligrams per liter per day during the postperiod at the Dolores Tunnel Outlet near Dolores, CO (site 15). Calculation of the historical flow regime in McElmo Creek was done using a water-budget analysis of the basin. During water years 2000—2006, an estimated 845,000 acre-feet of water was consumed by crops and did not return to the creek as streamflow. The remaining 76,000 acre-feet, or 10,900 acre-feet per year for the 7-year postperiod, was assumed to represent a historical flow condition. The historical flow of 10,900 acre-feet per year is equivalent to 15.1 cubic feet per second. Average total dissolved solids concentrations for water in each type of sedimentary rock were used to estimate natural salinity loads. Most surface-water sites used to fit the criteria needed to achieve a natural TDS concentration were springs. An average spring TDS value for sandstones geology in the basin was 350 milligrams per liter, and the average value for Mancos Shale geology was 4,000 milligrams per liter. The natural salinity loads in McElmo Creek were estimated to be 29,100 tons per year, which is 43 percent of the salinity load that was calculated for the postperiod.

456. **Chemical and Isotopic Constraints on the Origin of Wadi El-Tarfa Ground Water, Eastern Desert, Egypt**.
See record 121 in Subsurface Transport Processes.

457. **Chemical and mineralogical composition and behavior of the Mancos Shale as a diffuse source of salts in the upper Colorado River basin**.
Evangelou, V. P.
California Univ., Davis. Water Resources Center., 215 p. (1981).
Keywords: salinity/ mineralogy/ shales/ Colorado River Basin/ saline soils/ soil chemical properties/ water quality/ Colorado River/ dolomite/ magnesium/ carbonates/ West Salt Creek watershed/ Colorado/ Mancos Shale
Abstract: Previous investigations relative to salinity in the upper Colorado River Basin have mostly dealt with the total quantities of dissolved solids moving into the Colorado River. Soluble components resulting from dissolution of mineral species have been studied as separate physical entities in the Colorado River, in tributaries of the river and in the Mancos Shale formation. Thus, the Mancos shale itself has been treated basically as an inert material without consideration of possible interactions between soluble and insoluble phases. The purpose of this investigation is to conduct a thorough study of mineralogical and chemical characteristics of Mancos Shale itself has been treated basically as an inert material without consideration of possible interactions between soluble and insoluble phases. The purpose of this investigation is to conduct a thorough study of mineralogical and chemical characteristics of Mancos Shale within the West Salt Creek watershed, Colorado. The investigation focuses on the Mancos Shale as a source of soluble components contributing to salinity of the Colorado River including interactive relationships between the more soluble and less

soluble mineral phases. The overall investigation has revealed the primary source of salts. Salts are derived from carbonates, calcite and dolomite, which upon contact with sulfuric acid (produced by the biological oxidation of pyrite), produce gypsum and magnesium sulfates. A second source is gypsum as a product of the marine environment left after evaporation had occurred. A third source is the continuous release of ions from such sources as dolomite, feldspars and micas. Finally, a fourth source is the leaching of ions of sodium and magnesium coming off the exchange complex of the unweathered Mancos Shale formation. (Snyder-California)
This citation is from University of California Berkeley.

458. **Combined effects of groundwater and aeolian processes in the formation of the northernmost closed saline depressions of Europe: north-east Spain**.
See record 122 in Subsurface Transport Processes.

459. **Controls on the regional-scale salinization of the Ogallala aquifer, Southern High Plains, Texas, USA**.
Mehta, S., Fryar, A. E. and Banner, J. L.
Applied Geochemistry 15: 849-864 (2000).
http://dx.doi.org/10.1016/S0883-2927(99)00098-0
Keywords: soil salinization/ saline soils/ oil and gas fields
Abstract: An extensive saline plume (>250 km2) within the regionally important unconfined aquifer in the Neogene Ogallala Formation overlies the Panhandle oil and gas field in the Southern High Plains, Texas, USA. Relative to upgradient Ogallala water, the plume waters have δ18O (−6.7 to −8.8‰) and δD (−42 to −88‰) values that tend to be depleted and have higher Cl (>150 mg/l) and SO4 (>75 mg/l) concentrations. Various end-member-mixing models suggest that the plume composition reflects the presence of paleowaters recharged during Middle to Late Wisconsinan time rather than salinization associated with petroleum production. Paleowaters probably mixed with salt-dissolution zone waters from the underlying Upper Permian formations before discharging upward into the Ogallala Formation. Cross-formational discharge is controlled primarily by the geometry of the underlying units, as influenced by the Amarillo uplift, pinch-out of the laterally adjoining confined aquifer in the Triassic Dockum Group, variations in the saturated thickness of the Ogallala aquifer and the presence of potential pathways related to salt dissolution.
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460. **Defining the climatic signal in stream salinity trends using the Interdecadal Pacific Oscillation and its rate of change**.
See record 124 in Subsurface Transport Processes.

461. **Delineation and correlation of salinity to landforms and geologic formations, upper Colorado River Basins**.
Whittig, L. D., Deyo, A. E., Tanji, K. K. and Higgins, C. E.
Land, Air and Water Resources Paper No. 100012, July 1986. 143 p. USGS Contract No. 14-34-0001-0521 (1986).
Keywords: Colorado/ Upper Colorado River basin/ salinity control/ dissolved mineral salts/ landform-salinity maps/ Grand Valley/ Gunnison River Valley/ salinity/ landforms/ geologic formations/ maps/ saline seeps/ saline springs/ groundwater movement/ erosion/ sediment yield/ pedimentation/ watershed management
Abstract: This investigation was aimed at assessment of the potential contribution of dissolved mineral salts by natural lands in the Grand and Gunnison River Valleys in the Upper Colorado River Basin. The Mancos, Sego and Mount Garfield formations, are important contributors of soluble salts. Springs and seeps within the study area are highly localized, but result in significant differences in water quality and discharge between nearly identical adjoining watersheds. Active saline seeps and springs are common within the Grand Valley study section, but they are limited within the Gunnison River Valley study section. In some areas the springs reach salinity levels of 80 dSm-1. The majority of salts leave some local watersheds by groundwater flow through buried stream channels. The close correspondence between salinity and landforms provided the basis for construction of landform-salinity maps covering approximately 1070 sq km within the Grand Valley and Gunnison River Valleys. Salt-contributing seeps and springs were also located on a map of the Grand Valley section of the study area. To decrease the salinity

contributions from the wildlands, it is proposed that: (1) good quality groundwater be intercepted and used locally or transported past highly saline areas; (2) saline groundwater, which reaches as high as 80 dSm-1, be intercepted and transported to evaporation ponds; and (3) erosion resulting in sediment and salt production be controlled through use of gully plugs and sediment retention dams, reversing the present dissection of the pediments. This program would decrease erosion, sediment yield and salt yield while increasing wildland water and vegetation. (USGS)

462. **Detailed study of selenium and selected elements in water, bottom sediment, and biota associated with irrigation drainage in the Middle Green River Basin, Utah 1988-90**.
See record 125 in Subsurface Transport Processes.

463. **Diffuse-source salinity: Mancos-shale terrain**.
Schumm, S. A. and Gregory, D. I., Bureau of Land Management, 169 p. (1986).
Keywords: salinity/ Colorado River Basin/ soil/ salts
This citation is from AGRICOLA.

464. **Dissolution and Desorption Rates of Calcium and Magnesium From Mancos Shale**.
Evangelou, V. P., Whittig, L. D. and Tanji, K. K.
Soil Science 139: 53-61 (1985). ISSN: 0038-075X
Keywords: calcium/ magnesium/ desorption/ leaching/ soil transport processes/ carbonates/ soil chemistry
Abstract: We studied the magnitude and rates of dissolution of Ca and Mg from alkaline earth carbonates and of desorption of Ca and Mg from the cation exchange complex of Mancos shale. Samples of surficial, partially weathered Mancos shale were selectively preconditioned prior to leaching. Selective preconditioning treatments included removal of readily soluble ions, removal of calcite, and exchange saturation with Na, Ca, and Mg, respectively. Preconditioned samples were leached by a continuous, constant-rate, flow-through system, and Ca and Mg were measured in incremental leachates. The rates of release of Ca and Mg indicate that both emanate from more than one source. Selective removal of calcite resulted in an increase in Mg release to a rate approximately 2.7 times higher than when calcite was present. The rate of release of Ca from Ca-saturated shale was remarkably constant over the 8-h leaching period. Only a slight deviation from linearity was observed for release of Mg from Mg-saturated shale. Rates of release of Mg from Ca-saturated shale and of Ca from Mg-saturated shale both increased perceptibly with leaching duration. These data demonstrate a significant influence on ion release rates by the cation exchange complex and interactive relationships between the exchange complex and alkaline earth carbonates in the system. (C) Williams & Wilkins 1985. All Rights Reserved
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465. **Dissolution potential of surficial Mancos Shale and alluvium**.
See record 217 in Surface Water Transport Processes.

466. **Dissolved mineral salts derived from Mancos Shale**.
Evangelou, V. P., Whittig, L. D. and K.K.Tanji
Journal of Environmental Quality 13: 146-150 (1984).
Keywords: calcium/ clay/ water quality/ electrical conductivity/ magnesium/ Cretaceous/ western Colorado/ clay mineralogy/ Upper Cretaceous/ Colorado River/ mineral composition/ sedimentary rocks/ gypsum/ sediment/ ion exchange/ geochemistry/ hydrology/ alkaline earth metals/ Grand Junction region/ experimental studies/ sulfate ion/ cation exchange capacity/ sulfates/ clastic sediments/ Mancos Shale/ shale/ grain size/ alkali metals/ surface water/ West Salt Creek watershed/ bicarbonate ion/ sodium/ hydrochemistry/ Mesozoic/ weathering/ X-ray data/ dissolved materials/ metals/ hydrochemistry/ potassium/ surveys/ hydrogeology/ carbonates/ clastic rocks
Abstract: The Mancos Shale, a sedimentary Upper Cretaceous marine formation exposed over extensive areas in the Upper Colorado River Basin, is recognized as a major contributor to the dissolved mineral salt load in the Colorado River system. It contains gypsum and alkaline earth carbonates, and its clay mineralogy is mica, kaolin, smectite, and intersytratified mica-vermiculite. Selected surface samples of partially weathered Mancos shale were also found to contain from 281 to 345 g/kg clay

(<2µm diameter) and to exhibit cation exchange capacities (CEC) ranging from 13.25 to 19.96 cmol/kg. Water suspension extracts from partially weathered shale (1:5 and 1:10 shale:water) were saturated with respect to gypsum (electrical conductivity (EC) values up to 3.16 dS/m and soluble Ca and SO4 up to 25.90 and 40.95 mmol/L respectively. Additional Na, K, and Mg released by water indicated sources of soluble ions other than gypsum. Water extracts from unweathered shale yielded much higher quantities of Na (and higher Mg in most cases) than did comparable extracts from partially weathered shale. Barium chloride released larger quantities of Mg from both partially weathered and unweathered shale and large quantities of Na from unweathered shale than did water at comparable dilutions. The data substantiate the important role of the cation exchange complex in retention and release of soluble ions in Mancos Shale. Sodium and magnesium were preferentially adsorbed by phyllosilicates within the shale and Ca was precipitated as calcite and gypsum following emergence after deposition in the Cretaceous sea. This cycle is essentially reversed in the present environment. Dispersed gypsum and alkaline earth carbonates provide soluble Ca to displace adsorbed Na and Mg that add to the dissolved mineral salt load of the Colorado River system.
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467. **Dryland salinity in south east Australia: Which scenario makes more sense?**
See record 8 in Rangeland Management Practices and Potential Impact on Salinity.

468. **The ecohydrological challenge of woody-herbaceous transitions in the chaco-pampas plains**.
Jobbágy, E. G., Nosetto, M. D., Santoni, C. S., Baldi, G. and Jobbágy, E. G.
Ecologia austral 18: 305-322 (2008). ISSN: 0327-5477
http://www.scielo.org.ar/scielo.php?pid=S1667-782X2008000300005&script=sci_arttext
Keywords: afforestation/ agricultural expansion/ Chaco Forest/ hydrological regulation/ land use/ pampa grasslands/ salinization
Abstract: In sedimentary regions like the Chaco-Pampa plains, characterized by a very low regional topographic gradient (<0.1%), the networks of surface water and salt evacuation towards the ocean are poor and water excesses often translate into flooding and salt redistribution. Based on local and global experience we review the risks, challenges, and uncertainties opened by two vegetation transformations, dry forest replacement by agriculture and the conversion of grasslands to tree plantations, on the hydrological regulation and soil and water salinization of flat sedimentary landscapes. Evidence from dry forests, similar to those of the Espinal and Chaco, in Australia, Africa and North America suggests that their massive replacement by dryland crops causes water table level raises and salt transport towards the surface. These forests use precipitation inputs exhaustively, generating negligible deep drainage fluxes, being able to accumulate salts of atmospheric origin and those derived from rock weathering within their soils for millennia, and maintaining deep groundwater levels. The establishment of dryland agriculture generates strong deep drainage increases followed by gradual raises of groundwater level and the mobilization of salts that end affecting soil fertility at the regional scale after many decades, when water tables and the mobilized salts reach the surface. In the Espinal of Argentina we verified the negligible recharge typical of other dry forests and the storage of salts in the vadose zone (0.25 to 7 kg Cl-/m 2 from 0 to 6 m of depth) and their leaching following agricultural use of these lands. This process may be related to the flooding and salinization phenomena observed in the Chaco and Espinal. In subhumid grasslands, like those in the Pampas, water table levels are naturally close to the surface and groundwater redistributes salts towards the lowest landscape positions. The localized water balance shifts, imposed by tree plantations established in these grasslands alter groundwater dynamics through its consumption generating an intense water and soil salinization process. This negative impact takes place under subhumid climates where tree plantations are able to switch the net water flux between ecosystems and groundwater, and under mid to coarse textured sediments, capable of maintaining a good supply of water towards the afforested stands. Salinization increases when the tolerance of tree species is higher. The regional topography of the Chaco-Pampa plains would lead towards a strong effect of land use changes on vertical and horizontal groundwater and intense salt transport in an intense and hard to anticipate way. This hydrological vulnerability

requires a better understanding and management of the water and salt cycles from an ecohydrological perspective and possess the challenge of developing an "agronomy of water" capable to contribute to the regulation of water table levels through management of both natural and cultivated ecosystems.
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469. **The effect of carbonates and gypsum precipitation in the root zone on the chemical composition of groundwater**.
Zilberbrand, M.
Journal of Hydrology (Amsterdam) 171: 5-22 (1995). ISSN: 0022-1694
http://dx.doi.org/10.1016/0022-1694(95)02736-9
Keywords: groundwater/ chemical processes/ chemical precipitation/ gypsum/ infiltration/ groundwater/ interstitial water/ carbonates/ geochemistry/ rain/ root zone
Abstract: Dissolution of a solid phase in the unsaturated zone is usually assumed to be the main factor transforming the composition of atmospheric water to that of groundwater. However, the opposite mechanism, namely a precipitation of insoluble and slightly soluble salts from rain water penetrating the root zone, may predominate, especially in arid regions. Field study of pore fluids in the unsaturated zone was carried out in the southern Ukraine, where the climate is temperate continental. Pore fluid samples were taken from soils and loessial loams at different depths in boreholes of about 1 m diameter with insulated walls. The boreholes were drilled to groundwater levels situated in loess loams at depths of 10-24 m. The sampling was performed using vacuum lysimeters. In the upper 0.5-2.5 m well-washed layer the infiltrating water composition changed from a HCO sub(3)-SO sub(4)-Ca type water to a SO sub(4)-Na type, the latter corresponding to groundwater composition. The root zone acts as a geochemical barrier which retains the calcium predominating in rain and irrigation water, owing to calcite and gypsum precipitation. This precipitation is accompanied by HCO sub(3) and SO sub(4) removal from the pore fluids and by an increase in the total dissolved solids (TDS) as a result of evapotranspiration. The observed profiles of calcium concentration in pore fluids, the manifestations of alkalization and the calcite accumulation are explained by the precipitating action of the root zone. Similar patterns were found in loess-covered arid regions of southern Israel (the Negev) on the basis of reported data on the composition of rain water, saturated soil extracts and the phreatic groundwater in sediments of the Avedat Group. A simple steady-state model of the transformation of rainwater composition to groundwater composition was developed and applied. It is based on the exclusion of Ca-Mg carbonates and gypsum from rain water. Annual precipitation rates (6-13 g m super(-2) year super(-1)) and the composition of precipitated salts calculated for the Negev are in agreement with data reported in the literature. It is shown that carbonate and gypsum precipitation in the root zone may explain the change of the HCO sub(3)-Ca type of rain water to the SO sub(4)-Na or Cl-Na type of groundwater which is fed by it under different climatic conditions.
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470. **Effects of land processes on the salinity of the upper Colorado River Basin: Final project report**.
See record 132 in Subsurface Transport Processes.

471. **Episodic sediment delivery and landscape connectivity in the Mancos Shale badlands and Fremont River system, Utah, USA**.
Godfrey, A. E., Everitt, B. L. and Duque, J. F. M.
Geomorphology 102: 242-251 (2008).
http://dx.doi.org/10.1016/j.geomorph.2008.05.002
Keywords: Mancos Shale badlands/ sediment load/ sediment control/ monitoring/ floodplain management
Abstract: The Fremont River drains about 1000 km2 of Mancos Shale badlands, which provide a large percentage of the total sediment load of its middle and lower reaches. Factors controlling sediment movement include: weathering that produces thin paralithic soils, mass movement events that move the soil onto locations susceptible to fluvial transport, intense precipitation events that move the sediment along rills and across local pediments, and finally Fremont River floods that move the sediment to the main-stem Colorado River. A forty-year erosion-pin study has shown that down-slope creep moves the weathered shale crust an average of 5.9 cm/yr. Weather records and our monitoring show that wet winters add large slab failures and mudflows. Recent sediment-trap studies show that about 95% of

sediment movement across pediments is accomplished by high-intensity summer convective storms. Between 1890 and 1910, a series of large autumn floods swept down the Fremont River, eroding its floodplain and transforming it from a narrow and meandering channel to a broad, braided one. Beginning about 1940, the Fremont's channel began to narrow. Sequential aerial photos and cross-sections suggest that floodplain construction since about 1966 has stored about 4000 to 8000 m3 of sediment per kilometer per year. These data suggest that it will take two centuries to restore the floodplain to its pre-1890 condition, which is in line with geologic studies elsewhere on the Colorado Plateau. The various landscape elements of slope, pediment, and floodplain are semi-independent actors in sediment delivery, each with its own style. Accelerated mass movement on the slopes has an approximate 20-year recurrence. Sediment movement from slope across pediments to master stream is episodic and recurs more frequently. The slope-to-pediment portion of the system appears well connected. However, sediment transport through the floodplain is not well connected in the decadal time scale, but increases in the century and millennial time scales, and changes over time depending on the cycle of arroyo cutting and filling.
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472. **Evaluation of the storage of diffuse sources of salinity in the Upper Colorado River Basin**.
See record 135 in Subsurface Transport Processes.

473. **Evaporite mineral species in Mancos Shale and salt efflorescence, Upper Colorado River basin**.
See record 236 in Surface Water Transport Processes.

474. **Evolution of brackish groundwater in a typical arid region; northern Arava rift valley, southern Israel**.
Yechieli, Y., Starinsky, A. and Rosenthal, E.
Applied Geochemistry 7: 361-374 (1992). ISSN: 0883-2927
http://dx.doi.org/10.1016/0883-2927(92)90026-Y
Keywords: terrestrial environment/ oxygen/ isotopes/ hydrogeology/ Israel/ salinity/ solution/ stable isotopes/ groundwater/ Cenozoic/ sedimentary rocks/ mixing/ Asia/ geochemistry/ Middle East/ southern Israel/ alkaline earth metals/ Hazeva Formation/ arid environment/ O-18/O-16/ isotope geochemistry/ Wadi Araba/ hydrochemistry/ evolution/ aquifers/ Sr-87/Sr-86/ recharge/ Tertiary/ brackish water/ dissolved materials/ hydrogen/ metals/ Neogene/ precipitation/ Kurnub Group/ hydrogeology/ carbonate rocks/ clastic rocks/ strontium
Abstract: A study has been made of the chemical evolution of brackish groundwater (TDS of 700-2500 mg/litre) deriving from a system of interconnected aquifers in this area in typically arid conditions. The chemical composition of groundwater flowing in the Hazeva and Arava fill aquifers resembles that of water originating in the Kurnub aquifer, the only difference being the slightly lower level of Mg observed in groundwater in the Kurnub aquifer. The salts dissolved in the groundwater derive from: 1) rainwater and resultant flash floods in the study area and W on the Negev highlands, and 2) dissolution of salts and minerals such as CaCO (sub 3), CaMg(CO (sub 3)), NaCl and CaSO (sub 4) .2H (sub 2) O. On the basis of their chemical composition the investigated groundwaters fall into two groups: 1) low-concentration water with Na/Cl approx 1; and 2) brackish water with Na/Cl < 1. The latter contains not only dissolved halite but also variable amounts of ancient brines. All waters are characterized by an excess of Mg and SO (sub 4). This anomaly is explained by surface evaporation of water to the degree of halite precipitation. The residual waters enriched in Mg and SO (sub 4) percolate into the main groundwater body. It was shown that in the studied area the ongoing salinization is due to mixing with Ca-Cl brines typical of the Arava rift valley. Similar manifestations were observed in other parts of the Jordan-Dead Sea rift valley.
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475. **Geochemical and isotopic (oxygen, hydrogen, carbon, strontium) constraints for the origin, salinity, and residence time of groundwater from a carbonate aquifer in the Western Anti-Atlas Mountains, Morocco**.
Ettayfi, N., Bouchaou, L., Michelot, J. L., Tagma, T., Warner, N., Boutaleb, S., Massault, M., Lgourna, Z. and Vengosh, A.
Journal of Hydrology 438: 97-111 (2012).
http://dx.doi.org/10.1016/j.jhydrol.2012.03.003

Keywords: isotopes/ geochemistry/ groundwater/ salinity/ residence time/ semi-arid
Abstract: Groundwater in many arid basins, particularly in developing countries, is the only available water resource that sustains local communities. Yet, information on the basic hydrological parameters and the sustainability of the groundwater exploitation are often lacking. This study investigates the origin of groundwater from the Lower Cambrian carbonate aquifer of the Lakhssas Plateau in the Anti-Atlas Mountains of southwestern Morocco. The study aims to reveal the origin of the groundwater, salinity sources, and the residence time of the water. The study is based on a comprehensive geochemical and isotopic (oxygen, hydrogen, carbon, and strontium) investigation of groundwater from different parts of the basin. The hydrochemical and isotopes results indicated three types of groundwater in the Lakhssas Plateau: (1) thermal water in the southern part of the basin with solute composition that reflects dissolution of calcium–sulfate and calcium carbonate minerals; (2) low-temperature groundwater at the southern margin of the basin with low salinity (chloride content up to 100 mg/L) and chemical composition that is expected from equilibrium with limestone–dolomite rocks; and (3) low-temperature groundwater in the northern, western, and eastern margins of the basin with a wide range of salinity (chloride up to 800 mg/L). The different water types had also different stable isotope composition; the thermal water was depleted in 18O and 2H (δ18O as low as −7.6‰) relative to the southern (−5.9 to −5.3‰) and northern waters (−5.7 to −3.8‰). The differences in δ18O and δ2H between the southern and northern waters are related to elevation that induced fractionation of oxygen and hydrogen isotopes in recharge water originated from coastal moisture. The data suggest that the high salinity in groundwater from the northern, western and eastern margins of the Lakhssas Plateau is related to the presence of schist rocks in these areas. The distinctive low Na/Cl and Br/Cl ratios, coupled with high silica contents and high 87Sr/86Sr ratios (up to 0.713) in the saline groundwater provide additional evidences for the link between salinity and the schist rocks. In contrast, the thermal water had relatively low 87Sr/86Sr ratio (0.7089), which is identical to the secular seawater Sr isotope ratio during the Early Cambrian period and presumably reflects interaction with the Early Cambrian carbonate and sulfate aquifer rocks. In the northern and southern groundwater, the 87Sr/86Sr ratios were higher and correlated with the Mg/Ca ratios, inferring mixing between the Early Cambrian limestone and other rocks with higher 87Sr/86Sr, such as the schist rocks. The radiocarbon data showed 14C activities ranging from 6pm C in the thermal water to 62pm C in the southern water. Age-modeling, corrected for dissolution of the carbonate rocks with dead carbon, simulated mean residence time of 10–15 ka BP for the thermal water and a range of 0 to 3 ka BP for the northern and southern waters, depending on the used models. The integration of the data enables us to establish a conceptual model for the origin of groundwater in the Lakhssas Plateau: (1) recharge to the aquifer from relatively heavy-isotope depleted recharge water, presumably during wetter conditions about 10–15 ka BP. The recharge water interacted at high depth with limestone and calcium sulfate minerals and emerged to the surface as thermal water at the southern part of the basin; (2) more recent recharge from coastal moisture originated from the Atlantic Ocean. The stable-isotope composition of groundwater was controlled by the elevation of their recharge areas: recharge at higher elevation, particularly in the southern margin resulted in lower δ18O and δ2H values; (3) the recharge water interacted with the carbonate aquifer rocks, particularly with calcite and dolomite minerals. In areas of exposure of schist rocks, the water–rock interaction induced salinization of the groundwater. Overall, our data reveal that the limited water resources in this semi-arid zone of orocco could be in some parts less renewable and also saline. Future exploitation of this basin will have to account the salinity factor and the suggested contribution of water recharged some thousands years ago.
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476. **A geochemical study of loess and desert sand in northern China: Implications for continental crust weathering and composition**.
Liu, C.-Q., Masuda, A., Okada, A., Yabuki, S., Zhang, J. and Fan, Z.-L.
Chemical Geology 106: 359-374 (1993). ISSN: 0009-2541
http://dx.doi.org/10.1016/0009-2541(93)90037-J
Keywords: sand/ chemical weathering/ sedimentary petrology/ clastic sediments/ Xinjiang Prov./ China/ continental crusts/

weathering/ variations/ Takla Makan Desert/ geochemistry of sediments/ composition/ sediment/ lacustrine environment/ loess/ rare earths/ fluvial environment/ geochemistry/ crust/ chemical fractionation
Abstract: Chemical compositional variations of desert sands and loess, loess-like deposits, river deposits and saline lacustrine deposits collected mostly from the southern margin of the Taklimakan Desert, China, provide strong constraints on the chemical weathering processes of continental crust, and also on the provenance compositions of these Quaternary deposits. Constant but lower concentrations of Al relative to the average upper continental crust (UCC) in these Quaternary deposits could be attributed to chemical weathering of Al-rich minerals such as feldspar and mica, and removal of clay minerals by wind and water. Large variations of mobile Na, Ca, Mg and Sr compared to relatively immobile Al, K and Ba resulted from the chemical weathering of plagioclase and carbonate minerals, salinization and carbonation of the arid lands. Most trace elements are not significantly fractionated. Their variations in absolute concentration are caused by the dilution of quartz, evaporates and carbonate minerals. Variations in Sn concentrations probably depend on relative contents of some heavy minerals. High Sr/Ba, low Th/U, K/Cs ratios of the saline lake deposits suggest differences in aqueous chemistry of these elements. The occurrence of the M-type tetrad effect (a REE pattern with four convex curves) of REE compositions, found mainly in the river deposits, is considered the result of water-particle interaction during chemical weathering of crustal materials. Y/Ho ratios of these samples are significantly higher than those of chondrite and the UCC. This suggests different chemical behavior of these two elements, and possibly the enrichment of carbonate materials. The low LREE/HREE feature of the saline lake deposits can be interpreted as due to the different aqueous chemical behavior of the REE's. However, it can also be reasonably considered as the result of inheritance from their provenance, since LREE and LREE/HREE variations may be related to the geological setting of the source. According to some elements that are not significantly fractionated, the average provenance composition of these Quaternary deposits are probably characterized by enrichments of Ni, Cr and V over Fe, higher La/Th, lower La/Sc and Th/Sc, and lower Ta/W and Nb/W ratios, compared with the UCC composition.
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477. **Geochemistry of saline soils in two arid zones of the Mediterranean basin. I. Geochemistry of the chott Melghir-Mehrouane watershed in Algeria**.
Valles, V., Rezagui, M., Auque, L., Semadi, A., Roger, L. and Zougaru, H.
Arid Soil Research and Rehabilitation 11: 71-84 (1997).
Keywords: Algeria/ arid zones/ chemical precipitation/ equilibrium/ formation/ geochemistry/ mineralogy/ minerals/ precipitation sequences/ saline soils/ saline water/ salinity/ thermodynamics/ toposequences/ water quality/ watersheds
This citation is from AGRICOLA.

478. **Geoelectrical investigation for characterizing the hydrogeological conditions in semi-arid region in Khanasser valley, Syria**.
Asfahani, J.
Journal of Arid Environments 68: 31-52 (2007).
ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2006.03.028
Keywords: aquifers/ deposits/ age/ conductivity/ Syria/ arid environment/ fractures/ maps/ resistivity/ antibodies/ profiles/ electrical conductivity/ structure/ geohydrology/ groundwater/ groundwater/ tectonics/ paleoecology
Abstract: In the Khanasser valley, considered as a semi-arid region in Syria, the shallow ground-water presents electrical conductivities ranging from 0.1 to 20mS/cm. In order to study the hydrogeological conditions of such region, a good knowledge is required of the geometry of the aquifer at depth. Ninety-six vertical electrical soundings (VES) using the Schlumberger array were carried out in the study area. The established iso-apparent resistivity maps for different AB/2 spacings indicate the presence of two different geological structures; characterized by very conductive zones of a resistivity <4 Omega m related to the intrusion of salt water in Quaternary and Paleogene deposits. Resistive zones have been signaled in Jebel Al Hass in the west and Jebel Shbith in the east, characterized by a resistivity exceeding 300

Omega m, due to the presence of basalt formation of upper Miocene age. Thickness of the Quaternary, Paleogene and their electrical characteristics have been precisely determined. The top of Maestrichtian and its electrical characteristics have been also well established. Quaternary paleosabkhas were delineated through the studying of three longitudinal profiles along the valley itself (LP1, LP2, and LP3). Fractured zones and tectonic features of the subsurface of Khanasser valley have been very well determined through the interpretation of VES of the profiles LP1, LP2, and LP3 using the Pichgin and Habibullaev method. The geoelectrical approach was successfully applied in the study area and can be therefore easily practiced in similar environments.
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479. **Geologic Map of the Carbondale Quadrangle, Garfield County, Colorado: Geologic Setting, Description of Map Units, Economic Geology, and References**.
Kirkham, R. M. and Widmann, B. L.
Open-File Report, Denver, CO, Colorado Geological Survey, 24 p. (1997).
http://cgsdocs.state.co.us/Docs/Pubs/OF97-03.pdf
Keywords: geology/ maps/ Colorado

480. **The geology of salt lake basin lunettes, southern high plains of West Texas and eastern New Mexico**.
Williams, M. G.
Lubbock, TX, Texas Tech University, 108 p. (1992).
Keywords: basins/ sand dunes/ eolian processes

481. **Geomorphic and Hydrologic Control of Sediment and Salt Loads in the Colorado River Basin: Significance for Conservation and Land Management**.
Gellis, A. C., Hereford, R. and Schumm, S. A.
USGS Open-File Report, U.S. Geological Survey, 37 p. (1989).
http://pubs.usgs.gov/of/1989/0121/report.pdf
Keywords: geomorphology/ hydrology/ rivers/ watershed management/ water salinity/ water salinization/ soil erosion/ runoff/ sediment transport/ conservation practices/ range management

Abstract: Suspended sediment and dissolved-solid (salt) loads decreased after the early 1940s in the Colorado Plateau portion of the Colorado River Basin, although discharge of the Colorado, Green, and San Juan Rivers did not change significantly. This decline followed a period of high sediment yield from about 1880-1940 that was caused by arroyo cutting and stream entrenchment in most tributary streams. Reduced sediment yield has been explained by a change in sediment sampling procedures in the 1940s, by changes in land use and conservation practices, and by channel-sediment storage caused by hydrologic change. Sampling procedures and conservation practices, however, do not adequately explain the reduced salinity and sediment load. New sampling procedures were biased toward a slight increase in sediment load, and the effect of conservation practices was probably local. Sediment storage in channels of tributary basins was coincident with the decline in sediment load and salinity, and stratigraphic studies show that sediment storage in two gaged basins resulted from a change in flood frequency and magnitude. This hydrologic explanation, however, may not apply to all basins, and study of the deposits in each basin is necessary to determine the effectiveness of hydrologic change. Experimental studies and field observations suggest that on a regional basis both geomorphic and hydrologic factors contributed to sediment storage and decreased sediment yield. Arroyo evolution, a model described here for sequential channel deepening, widening, and partial refilling, probably affected sediment yield of tributary basins. According to this model, the widespread channel incision of the late 19th century resulted in high sediment yield, but yield has decreased during the period of record and especially in the early 1940s as incised channels evolved to a new aggrading condition.

482. **Geomorphic and lithologic controls of diffuse-source salinity: Grand Valley, Western Colorado**.
Johnson, R. K. and Schumm, S. A.
Colorado Water Resources Research Institute Completion Report, Fort Collins, Colorado, Colorado Water Resources Research Institute, Colorado State University, 99 p. (1982).
http://www.cwi.colostate.edu/publications/cr/110.pdf

Keywords: saline water/ Colorado River Watershed/ Colorado River (Colo.-Mexico)/ water quality

483. **Geophysical Survey - Salt Pollution Study: Dove Creek Site, Stonewall County, Texas (Final Report)**.
SDII Global Corp, 126 p. (2000).
http://www.twdb.state.tx.us/publications/reports/contracted_reports/doc/2000483341.pdf
Keywords: water salinization/ desalination/ water quality/ rivers/ industrial wastes/
Abstract: A geophysical survey was conducted at the Dove Creek Area in Stonewall County, Texas with the objective of locating optimal drilling locations for brine productions wells. The best potential locations for such brine production wells would be in areas where there are several such brine-filled fracture conduits and where the reservoir is known to exist. Traditional methods of locating possible fractures include ground geologic reconnaissance coupled with analysis of photo linear trends. The geophysical survey was designed to determine which linear features correlate with brine-carrying fractures. One task/objective of the geophysical investigation was to perform a combination of Very Low Frequency (VLF) electromagnetic and electromagnetic terrain conductivity (EM34) methods to map the trend and locations of brine-filled fractures. The other task/objective was to use Time Domain Electromagnetic (TOM) surveying to help identify the existence, depth and thickness of the brine reservoir across the project site. The combination of the three techniques was intended to build a three-dimensional model of the brine reservoir-conduit system at a series of specific locations within the site study area. There were six primary survey areas (Area A through Area F as defined on attached Figure 2) within the overall study area where all three surveys were applied. An additional ten sites (also defined on Figure 2 were selected for TDM-only investigation to determine depth to the brine reservoir. The result of the geophysical program can be summarized as follows. The VLF and EM34 data have demonstrated that we can see discrete vertical conductive bodies that we interpret as brine filled fractures at all sites except Areas D and E. At these two areas, we consider the brine level in the fractures to be so deep below ground surface that these near-surface geophysical devices to not detect it. In the other areas (A, B, C, and F), we were able to detect areas where brine must be locally closer to the surface (in vertical fractures). We can sometimes correlate the positions of these discrete, high conductivity areas from line-to-line in order to determine apparent fracture azimuth across these areas. There is no consistent, dominant fracture azimuth that is observed over the entire site. Rather it would seem that link the multiple azimuths seen in Bob Rodgers' of RWR Associates photolinear analysis, there are several fracture orientations and the orientation preference varies around the site.

484. **Global impacts of conversions from natural to agricultural ecosystems on water resources: Quantity versus quality**.
See record 140 in Subsurface Transport Processes.

485. **Grand Valley salt pick-up calculations**.
Inman, R. R., Olson, D. C. and King, D. L.
Stoneham, MA, United States (USA), Butterworth Publ., Stoneham, MA. 1984.
Keywords: hydrology/ electrical conductivity/ chemically precipitated rocks/ Gunnison River/

hydrogeology/ salinity/ evaporites/ groundwater/ Grand Valley/ Colorado River/ sedimentary rocks/ surveys/ hydrogeology/ seasonal variation/ Colorado/ Plateau Creek
© *ProQuest*

486. **Groundwater salinity as a control on development of eolian landscape: An example from the White Sands of New Mexico**.
Langford, R. P., Rose, J. M. and E, W. D.
Geomorphology 105: 39-49 (2009).
http://dx.doi.org/10.1016/j.geomorph.2008.01.020
Keywords: parabolic dune/ groundwater salinity/ water table/ landscape stability/ sand transport
Abstract: The White Sands of southern New Mexico form the largest field of gypsum dunes in the world. The juxtaposition of several different types of dunes within the field has long been recognized and has generally been attributed to changes in the rate of sand transport across the dune field. However, Steven Fryberger [Fryberger, S.G., 2003. Geology of White Sands National Monument, web page www2.nature.nps.gov/geology/parks/whsa/] recently hypothesized, however, that a primary

control is groundwater salinity. The White Sands dune field is underlain by saline waters. Fryberger proposed that parabolic dunes could form in topographic highs that accumulated a lens of fresher water derived from precipitation. Water with lower salinity allowed vegetation to grow, and stabilized the sand except for the active noses of the parabolic dunes. This study is a test of that hypothesis. A study transect was established across the boundary between parabolic and barchan dunes. Groundwater and soil at six sites were sampled during December, 2004 and March, May, and June of 2005. Two sites were established in the parabolic field, two in the barchans, and two in the transition zone between them. Groundwater was found to be three times more saline in the barchan area. Conductivity and chloride decreased across the transition zone. A GPS topographic survey revealed two abrupt topographic steps, one at the boundary between the barchans and the transition zone and a second at the edge of the parabolic field. A second, larger topographic step was found outside the study area defining a higher parabolic dune field. These data indicate that Fryberger's (2003) hypothesis is correct and groundwater is controlling the dune field morphology. The dune field did not begin to form until the Mid-Holocene (6500 years ago). A compilation of dates shows that the parabolic dune field has probably been stable for the last 3500 years. In contrast, the barchan area has been recently deflated and exposed 2000 year old sediment near the surface.
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487. **Hydro-geochemical behaviour of two coastal aquifers under severe climatic and human constraints: comparative study between Essaouira basin in Morocco and Jeffara basin in Tunisia**.
Bahir, M., Chkir, N., Trabelsi, R., Friha, H. A., Zouari, K. and Chamchati, H.
International Journal of Hydrology Science and Technology 2: 75-100 (2012). ISSN: 2042-7808
http://dx.doi.org/10.1504/IJHST.2012.045940
Keywords: aquifers/ mining and dredging operations/ Morocco/ Tunisia/ climate/ sedimentary structures and stratigraphy/ climatic conditions/ halite/ groundwater hydrology/ comparative studies/ coastal zone/ gypsum/ aquifer recharge/ groundwater/ hydrology/ seawater intrusion/ vulnerability/ Essaouira Basin

Abstract: Since surface waters are mostly irregular and rare, groundwater in arid and semi-arid regions are submitted to high human constraints enhanced by severe climatic conditions. Multiple isotope analyses and chemical tracing of groundwater from the Essaouira basin (South-Western Morocco) and from the Jeffara basin (South-Eastern Tunisia) reveal that salinisation processes are mainly related to natural conditions such as dissolution of evaporate rocks (gypsum and halite minerals) along the recharging outcrops. However, since these basins are coastal, seawater intrusion is one of multiple salinity sources that could affect the quality of groundwater if intense exploitation goes on. The comparison of hydro-geochemical and isotopic data available for the two basins provide a framework for a comprehensive diagnostic in which different states of risks could be defined according to climatic and human constraints. We argued that these heavily exploited coastal aquifers have exacerbated vulnerability given relatively low current recharge and salinisation processes.
© *ProQuest*

488. **Hydrogeochemical processes in arid and semi-arid regions; focus on North Africa**.
See record 150 in Subsurface Transport Processes.

489. **Hydrogeochemistry of three watersheds (the Erlqis, Zhungarer and Yili) in northern Xinjiang, NW China**.
Zhu, B., Yang, X., Rioual, P., Qin, X., Liu, Z., Xiong, H. and Yu, J.
Applied Geochemistry 26: 1535-1548 (2011). ISSN: 0883-2927
http://dx.doi.org/10.1016/j.apgeochem.2011.06.018
Keywords: water quality/ electrical conductivity/ terrestrial environment/ Xinjiang Prov./ Yili basin/ drinking water/ irrigation/ temperature/ water-rock interaction/ drainage basins/ mineral assemblages/ chemical composition/ geochemistry/ pH/ China/ Zhungarer basin/ Erlqis basin/ human activity/ arid environment/ physicochemical properties/ surface water/ agriculture/ hydrochemistry/ Tarim Basin/ weathering/ Huang He/ models/ dissolved materials/ ion chromatograms/ hydrochemistry/ Alashan Basin/ hydrogeology/ leaching/ water resources/ land use

Abstract: In the arid region of northern Xinjiang, one of the least-studied areas in China, three watersheds, namely those of the Yili, Zhungarer and Erlqis, have become the focus of attention due to rapidly increasing human population and water demands. The hydrogeochemistry of natural water from the three watersheds was investigated. The ionic chemistry of natural waters from these watersheds changes considerably on a regional scale. The waters are neutral to alkaline in nature and most of them are soft-fresh waters. The total dissolved solid (TDS) varies over two orders of magnitude with a mean value of 580mg/L, about 1.2 times and 4.6 times those of the Huanghe (Yellow River) and the world spatial median, respectively, but only 40% and 0.8% of those of the Tarim and the western Alashan watersheds, respectively. Much of the solutes and physicochemical parameters in these waters are under the highest desirable limits of the World Health Organization (WHO) for drinking purpose and a plot of sodium adsorption ratio versus EC shows that most waters are of good water quality for irrigation. Water-rock interaction and saturation index (SI) for selected minerals are evaluated. The SI of these natural waters is out of equilibrium (undersaturated) with respect to major carbonates (calcite and dolomite) and evaporites (gypsum and halite). The high concentrations of alkali earth metals, alkalinity and the high (Ca+Mg)/(Na+K) and Na/Cl ratios indicate that the release of major solutes in these waters is controlled largely by dissolution processes of carbonate and partly by silicate weathering, while, cation exchange reactions, soil-salt leaching and evaporation processes also play an important role. The effects of local pollution are minimal in the montane and piedmont areas of these watersheds but are significant in the oases and central areas of the drainage basins.
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490. **Hydrologic and biotic characteristics of grazed and ungrazed watersheds of the Badger Wash Basin in western Colorado, 1953-58**.
Lusby, G. C., Turner, G. T., Thompson, J. R. and Reid, V. H.
Geological Survey Water-Supply Paper 1532-B in cooperation with USDA, Forest Service, U.S.D.I., Fish and Wildlife Service, the Bureau of Land Management, and Bureau of Reclamation., 73 p. (1964).
http://pubs.er.usgs.gov/publication/wsp1532B
Keywords: hydrologic analysis/ biotic characteristics/ drainage basins/ erosion/ precipitation/ Colorado Plateau
Abstract: A comprehensive study of the hydrologic and biotic characteristics of small drainage basins on the Colorado Plateau and the effect of grazing on these characteristics was begun in 1953. This report presents data obtained during the first 5 years of the proposed 20-year study. Periodic observations were made at permanent transects in 8 paired fenced and unfenced watersheds to characterize plant and ground cover, determine degree of use by livestock and measure changes in watershed cover. Results after 5 years of study indicate that changes in watershed cover have been relatively small on both grazed and ungrazed areas. Changes that did take place were mainly on shale and mixed type soil. Ground-cover index on mixed type soil was significantly higher, 4 percent, on ungrazed areas at the end of the 5 years. Plot records were obtained using the Rocky Mountain Infiltrometer at 12 plots in each of the 8 study watersheds to determine the effect of livestock exclusion on infiltration and sheet erosion. Infiltration rates for the last 20 minutes of both the wet and dry runs were significantly higher in 1958 than they were 5 years before, but this difference was not associated with treatment because rates on both grazed and ungrazed plots increased about the same amount. The initial water-absorbing capacity increased significantly on ungrazed plots. No change in erosion rates was observed. Rainfall was variable and below normal during 4 of the first 5 years of study. Runoff was produced mainly by thunderstorms during the summer months and was characterized by high rates of flow for short periods. Comparison of runoff in grazed and ungrazed watersheds indicates a change in the relationship between precipitation and runoff because the exclusion of livestock. More sediment per unit area was produced during the 5 years of study from grazed areas than from ungrazed areas. No definitive trend in small mammal population on grazed and ungrazed watersheds has yet been determined. Results of preliminary studies on rabbit population indicates that rabbits prefer to inhabit ungrazed areas, but populations were judged to be not high in any area.

491. **Hydrology, Salinity, and Salinity Control Possibilities of the Middle Pecos River: A Reconnaissance Report**.
Miyamoto, S., Anand, S. and Hatler, W., (2008).
http://hdl.handle.net/1969.1/86109
Keywords: hydrology/ geochemistry/ water management/ water quality/ river salinity/ salinity control/ brine intrusion/ groundwater/ precipitation/ salt loading/ water supply
Abstract: The Middle Pecos River between Malaga, New Mexico, and Girvin, Texas, is known for high salinity. Streamflow salinity during the last decade (1991-2000), for example, averaged 3,500 and 6,150 mg L-1 at Malaga and at the Red Bluff release, and upwards of 12,000 mg L-1 at Girvin. These high levels of streamflow salinity not only reduce the economic uses of the water, but also limit the biodiversity of aquatic and riparian species along the river. This report outlines the hydrology, geochemistry, and water management practices of the Middle Pecos River in order to explain the reasons for the high salinity, and to discuss the potential for salinity control. The main causes of high salinity between Malaga and Red Bluff are brine intrusion at Malaga Bend and Bottomless Lakes and a drastic reduction in flow since the late 1930s that does not adequately dilute the intrusion. The amount of salts entering the Pecos River from these two sites is estimated at 450,000 tons/year while freshwater flow at Malaga has decreased from 260 Mm3 (210,000 acre-ft) per year from 1929 through 1937 to 81 Mm3 (66,000 acre-ft) per year from 1959 through 2001. The causes of high salinity between Red Bluff and Girvin are saline water intrusion from both surface and subsurface sources, low runoff into the river, and the evaporative concentration of the stream. The amount of salts entering this reach is estimated at 250,000 tons/year, primarily from Salt Creek, Salt Draw, Toyah Creek, and shallow saline groundwater. The sources of the shallow saline groundwater which enters the Pecos River between Coyanosa and Girvin are suspected to be groundwater flow from adjacent areas, but details are yet to be investigated. Diversion for irrigation, high seepage loss above Pecos, and low runoff resulted in inadequate flow to prevent intrusion or to dilute saline water entering the Pecos below Coyanosa. The annual flow at Coyanosa decreases below 30 Mm3 (24,000 acre-ft) per year. There are interests to lower the salinity of the Middle Pecos River for preserving its biodiversity, protecting groundwater quality, and encouraging the regrowth of native riparian species after ongoing saltcedar control activities, besides increasing the economic value of this water for irrigation. A regional level of concern is its impact on Amistad International Reservoir, located downstream along the Texas/Mexico border. The salinity of this huge reservoir (6.8 billion m3 or 5.5 million acre-ft) has increased from 560 mg L-1 to about 1000 mg L-1, the upper limit of the Texas drinking water standard. The Pecos River accounts for nearly 30 percent of the salt loading into Amistad International Reservoir while providing about 10 percent of the flow, thus raising the background salinity of the reservoir. In addition, historical records from 1941 and 1942 indicate that a high precipitation event between Roswell and Red Bluff can cause the Pecos River to send enough saline water to Amistad to raise the salinity level of the reservoir well above the Texas drinking water standard. Since the potential for additional freshwater inflow from runoff appears to be limited, salinity management strategies must incorporate ways to reduce saline water intrusion and percolation losses from reservoirs and river beds. Streamflow salinity can be restored closer to the original level by reducing saline water intrusion roughly in proportion to the reduction in fresh water flow caused by diversion and percolation losses. Potential control options include saline water intrusion control upstream at Malaga Bend and Bottomless Lakes, and possibly in the segment between Pecos and Girvin. The methods of salt source control at each of these sites are yet to be addressed. Preliminary estimates show that salt source control at Malaga Bend and/or Bottomless Lakes will result in a significant reduction of salinity of Red Bluff Reservoir. The control of brine intrusion at Malaga Bend alone can lower salinity of the Red Bluff release from 6150 to 4800 mg/L, the level comparable to the level that existed shortly after the construction of Red Bluff Reservoir in 1936. However, its impact on Amistad International Reservoir is yet to be analyzed, and it requires good understanding of the hydrologic connection between the middle and the lower reaches. If the connection is weak, salt sources below Pecos should be evaluated for control as a part of the salinity control plan for Amistad International Reservoir. Streamflow salinity below Coyanosa can be lowered simply by reducing the percolation losses from the reservoir and river beds above Pecos, provided that the water saved is left in the river. However, this option will increase salt transport to the Lower Pecos River unless implemented in conjunction with salt

source control. Impacts of water management and salt source control options on monthly or daily salinity of the middle and the lower reaches are yet to be evaluated.
This citation is from Texas A&M University.

492. **Hydrosalinity fluxes in a small scale catchment of the Berg river (South Africa)**.
See record 152 in Subsurface Transport Processes.

493. **Identification and Modeling the Impact of Marine Shale Bedrock on Groundwater and Stream Salinity: Upper Colorado River Basin**.
Duffy, C. J., Jurinak, J. J., Sangani, S. and Azimi, A.
Reports. Utah Water Research Laboratory, Logan, Utah, Utah Water Research Laboratory, Utah State University, 104 p. (1985).
http://digitalcommons.usu.edu/water_rep/506/
Keywords: groundwater/ Colorado River Watershed (Colo.-Mexico)/ saline water
Abstract: Recent studies have shown that groundwater is a major contributor to stream salinity in the Upper Colorado River Basin. The primary salt sources are the marine shale's and shale residuum that underlie the soils of much of the basin. A field site in the Price River Basin, a tributary to the Green and Colorado Rivers, was selected to study the physical and chemical factors that control the interactions between groundwater and these shale's. Preliminary data were available at the site as a result of a Bureau of Reclamation study conducted by CH2M Hill. On the basis of the CH2M Hill study and the additional data collected during this study groundwater flow paths, salt transport and weathering processes were identified. Results show that the groundwater evolved from a calcium-bicarbonate water to a sodium-sulfate water with depth and distance along the flow paths. Geochemical equilibrium modeling and mass balance computations were performed using the USGS models PHREEQE and BALANCE. A preliminary saturated-unsaturated two-dimensional flow model (UNSAT) was implemented along the identified groundwater flow path. Once a satisfactory flow calibration was achieved, a solute transport model was then implemented to examine the relative importance of advective, dispersive and diffusive mixing processes along the flow profile. Preliminary management runs were made to study the effect of possible changes in land use practices. Results of these hypothetical cases suggest that water conservation methods (improved irrigation efficiency, canal lining and retiring irrigated land) will reduce return flow salt loads over the short run (about 50 years), when the transport of salts by displacement is most important. However, these salinity control alternatives are much less effective in the long range (> 50 years) because the diffuse salt loading from underlying marine shale's is unaffected by groundwater flow rates in the alluvium. Although additional field data must be collected for verification the proposed model is a realistic first step towards a quantitative physically based approach to land use-salinity control issues.

494. **The impact of climate change on geomorphology and desertification along a Mediterranean-arid transect**.
See record 245 in Surface Water Transport Processes.

495. **Impacts of climate change on groundwater recharge and salinization of groundwater resources in Senegal**.
See record 155 in Subsurface Transport Processes.

496. **Influences of climate, terrain and land cover on stream salinity in southeastern Australia, and implications for management through reforestation**.
Van Dijk, A. I., Gilfedder, M. and Austin, J.
Hydrological Processes 22: 3275-3284 (2008).
ISSN: 1099-1085
http://dx.doi.org/10.1002/hyp.6968
Keywords: salinity/ Australia/ catchment hydrology/ land use change/ water quality
Abstract: Reforestation of cleared land has the potential to reduce groundwater recharge, salt mobilization and streamflow. Stream salinity change is the net result of changes in stream salt load and streamflow. The net effect of these changes varies spatially as a function of climate, terrain and land cover. Successful natural resource management requires methods to map the spatial variability of reforestation impacts. We investigated salinity data from 2000 bores and streamflow and salinity measurements from 27 catchments in the Goulburn–Broken region in southeast Australia to assess the main factors

determining stream salinity and opportunities for management through reforestation. For groundwater systems of similar geology, relationships were found between average annual rainfall and groundwater salinity and between groundwater salinity and low-flow salinity. Despite its simplicity, we found that the steady-state component of a simple conceptual coupled water–salt mass balance model (BC2C) adequately explained the spatial variation in streamflow and salinity. The model results suggest the efficiency of afforestation to reduce stream salinity could be increased by more than an order of magnitude through spatial planning. However, appreciable reductions in stream salinity in large rivers through land cover change alone would still require reforestation on an unprecedented scale. Copyright © 2008 John Wiley & Sons, Ltd.

497. **Infrared thermography of evaporative fluxes and dynamics of salt deposition on heterogeneous porous surfaces**.
Nachshon, U., Shahraeeni, E., Or, D., Dragila, M. and Weisbrod, N.
Water Resources Research 47 (2011).
ISSN: 1944-7973
http://dx.doi.org/10.1029/2011WR010776
Keywords: IRT/ evaporation/ heterogeneity/ precipitation/ salts/ vapor pressure/ energy budgets/ soil/ soil moisture/ vadose zone
Abstract: Evaporation of saline solutions from porous media, common in arid areas, involves complex interactions between mass transport, energy exchange and phase transitions. We quantified evaporation of saline solutions from heterogeneous sand columns under constant hydraulic boundary conditions to focus on effects of salt precipitation on evaporation dynamics. Mass loss measurements and infrared thermography were used to quantify evaporation rates. The latter method enables quantification of spatial and temporal variability of salt precipitation to identify its dynamic effects on evaporation. Evaporation from columns filled with texturally-contrasting sand using different salt solutions revealed preferential salt precipitation within the fine textured domains. Salt precipitation reduced evaporation rates from the fine textured regions by nearly an order of magnitude. In contrast, low evaporation rates from coarse-textured regions (due to low capillary drive) exhibited less salt precipitation and consequently less evaporation rate suppression. Experiments provided insights into two new phenomena: (1) a distinct increase in evaporation rate at the onset of evaporation; and (2) a vapor pumping mechanism related to the presence of a salt crust over semidry media. Both phenomena are related to local vapor pressure gradients established between pore water and the surface salt crust. Comparison of two salts: NaCl and NaI, which tend to precipitate above the matrix surface and within matrix pores, respectively, shows a much stronger influence of NaCl on evaporation rate suppression. This disparity reflects the limited effect of NaI precipitation on matrix resistivity for solution and vapor flows.
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498. **Institutional and Salinity Issues on the Upper Rio Grande**.
Phillips, F. M. and Michelsen, A. M.
Agricultural Salinity Assessment and Management. Wallender, W. W. and Tanji, K. K., ASCE**:** 1033-1051 (2012).
Keywords: Rio Grande basin/ salinity/ water management
Abstract: A study of the upper Rio Grande basin from the perspective of hydrologic and institutional management issues, sources and impacts of salinity, and potential management alternatives covers physical, climate and geographic conditions; water sources, flows and use; and water allocation, management and institutions.
This citation is from the American Society of Civil Engineers.

499. **Interim Report to the California State Legislature on the Salinity Control Barrier Investigation**.
State of California, Department of Water Resources and Division of Resources Planning Bulletin. State of California. Department of Water Resources, 76 p. (1957).
http://www.water.ca.gov/waterdatalibrary/docs/historic/Bulletins/Bulletin_60/Bulletin_60__1957.pdf
Keywords: salinity/ water quality/ rivers/ saline water/ planning/ government programs and projects/ environmental projects/ hydrology
Abstract: The objective of the investigation resulting from the Abshire-Kelly Salinity Control Barrier Act of 1953 was to weigh the relative merits of alternative harrier plans; the objective of the investigation directed by the Abshire-Kelly Salinity Control Barrier Act of 1955, is to choose

between the Junction Point Barrier Plan (Biemond Plan) and Chipps Island Barrier Plan and design the most feasible plan. The current studies, therefore, require (1) refinements of the previous plans, cost estimates, and economic studies and (2) development of data for the design and construction of the selected plan. The cost estimates and economic studies of the Junction Point and Chipps Island Barrier Plans, as described in the 1955 report were reviewed and the plans were modified as found necessary. The studies of future water requirements, previously prepared for the extremes of population, were re-evaluated to reflect the probable supplemental water requirements of the San Francisco Bay Area. A plan was then developed which could deliver sufficient water to keep pace with the demands. A subsurface exploration program was initiated in the Delta to acquire information on (1) the depth of peat, and the nature and strength of the underlying stratum, and (2) the location, depth to, and thickness of the confining layer overlying the connate water which underlies portions of the Delta. Hydrologic studies were made to determine the amount of fresh water needed to maintain the line of 1,000 parts of chlorides to 1,000,000 parts of water at various locations, under conditions which would exist with the Biemond Plan in operation. An interagency committee, containing representatives of the United States Bureau of Reclamation, United States Corps of Engineers, University of California and the Department of Water Resources, was established to explore the use of an electronic analog as a tool in evaluating possible changes in Delta tidal characteristics which would result from construction of the Biemond Plan. At the recommendation of this committee, the construction and operation of an analog is being performed by the University of California at Berkeley under the direction of Dr. Hans A. Einstein. A study was made to reappraise the economic value of a vehicular crossing at the Chipps Island barrier site. This study was made by the Division of Highways, Department of Public Works, under terms of a service agreement. An experimental vertical baffle fishway was constructed to test its efficiency in passing anadromous fish, especially striped bass and shad. The structure was designed in accordance with general plans supplied by Department of Fish and Game officials, and is being operated jointly by the Departments of Fish and Game and Water Resources. In January, 1957, a special board of consulting engineers was retained to review the progress of the investigation and to appraise the conclusions being formulated. This board consists of engineers having national recognition in the fields of foundations, flood control and hydrology.

500. **Inventories and mobilization of unsaturated zone sulfate, fluoride, and chloride related to land use change in semiarid regions, southwestern United States and Australia**.
See record 162 in Subsurface Transport Processes.

501. **Land degradation due to salinization in arid and semi-arid regions with the aid of geo-information techniques**.
Jabbar, M. T. and Chen, X.
Geo-spatial Information Science 11: 112-120 (2008). ISSN: 1009-5020
http://dx.doi.org/10.1007/s11806-008-0013-z
Keywords: soil/ terrestrial environment/ monitoring/ degradation/ geologic hazards/ arid environment/ semi-arid environment/ data processing techniques/ satellite methods/ Landsat/ Shaanxi Prov./ China/ risk assessment/ applied geophysics/ environmental geology/ salinization/ remote sensing
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502. **Limnology of Lake Powell and the Chemistry of the Colorado River**.
Stanford, J. A. and Ward, J. A.
Colorado River Ecology and Dam Management, Santa Fe, NM, National Academies Press (1990).
http://www.nap.edu/openbook.php?record_id=1832&page=75
Keywords: limnology/ water quality/ geology/ climate/ groundwater/ water budget/ hydrology/ sediment/ saline water/ total dissolved solids/ metals/ aquatic ecosystems

503. **Mancos shale literature review on the Colorado Plateau**.
See record 166 in Subsurface Transport Processes.

504. **Mass movement of Mancos Shale crust near Caineville, Utah: A 30-year record**.
Godfrey, A. E.
Geografiska Annaler Series a-Physical Geography 79A: 185-194 (1997).
http://dx.doi.org/10.1111/j.0435-3676.1997.00015.x
Keywords: sandstone weathering/ lichens/ backscatter SEM/ soil creep/ precipitation
Abstract: Rates of soil creep were studied periodically over a 30-year period in southeastern Utah on Mancos Shale badland slopes averaging 35 degrees. More intensive studies were carried out over a 10-year period on slopes averaging 40 degrees. On the 35 degree slope the average rate of movement was 2.71 cm yr(-1) On the 40 degree slopes, rates varied from 3.14 to 5.94 cm yr(-1). Individual rates of movement varied widely, but average movement of a given line was consistent. No statistical differences in rates of movement were found between north- and south-facing slopes. About two-thirds of the total movement occurred during the winter/spring period; episodes of rapid movement coincided with years in which storms deposited at least 0.6 cm of precipitation per day for at least two consecutive days. Downslope rotation of nails indicates that creep involves only the top few centimeters of soil.
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505. **Modelling the effects of land use changes on runoff and soil erosion in two Mediterranean catchments with active gullies (South of Spain)**.
See record 263 in Surface Water Transport Processes.

506. **Modern sediment yield compared to geologic rates of sediment production in a semi-arid basin, New Mexico: Assessing the human impact**.
Gellis, A. C., Pavich, M. J., Bierman, P. R., Clapp, E. M., Ellevein, A. and Aby, S.
Earth Surface Processes and Landforms 29: 1359-1372 (2004).
ftp://ftp.blm.gov/pub/blmlibrary/BLMpublications/Minerals/PDFMancos/gellis04.pdf
Keywords: erosion/ sediment/ arroya/ grazing/ cosmogenic radionuclides/ Luquillo Experimental Forest/ erosion rates/ Puerto Rico/ denudation/ Be-10/ delivery/ channel
Abstract: In the semi-arid Arroyo Chavez basin of New Mexico, a 2(.)28 km(2) sub-basin of the Rio Puerco, we contrasted short-term rates (3 years) of sediment yield measured with sediment traps and dams with long-term, geologic rates (similar to 10 000 years) of sediment production measured using Be-10. Examination of erosion rates at different time-scales provides the opportunity to contrast the human impact on erosion with background or geologic rates of sediment production. Arroyo Chavez is grazed and we were interested in whether differences in erosion rates observed at the two time-scales are due to grazing. The geologic rate of sediment production, 0.27 kg m(-2) a(-1) is similar to the modern sediment yields measured for geomorphic surfaces including colluvial slopes, gently sloping hillslopes, and the mesa top which ranged from 0.12 to 1.03 kg m(-2) a(-1). The differences between modem sediment yield and geologic rates of sediment production were most noticeable for the alluvial valley floor, which had modern sediment yields as high as 3.35 kg m(-2) a(-1). The hydraulic state of the arroyo determines whether the alluvial valley floor is aggrading or degrading. Arroyo Chavez is incised and the alluvial valley floor is gullied and piped and is a source of sediment. The alluvial valley floor is also the portion of the basin most modified by human disturbance including grazing and gas pipeline activity, both of which serve to increase erosion rates. Copyright (C) 2004 John Wiley Sons, Ltd.

507. **Natural history of a saline mound ecosystem**.
Blank, R. R., Young, J. A., Trent, J. D. and Palmquist, D. E.
Great Basin Naturalist 58: 217-230 (1998).
ISSN: 0017-3614
https://ojs.lib.byu.edu/ojs/index.php/wnan/article/viewFile/837/1674
Keywords: Allenrolfea occiclentalis/ *Atriplex lentiformis* spp. *torreyi*/ eolian dust/ *Sarcobatus vermiculatus*
Abstract: Along the margins of playas in northwestern Nevada, a salt-tolerant plant community occupies mounds that dot a largely unvegetated landscape. In this environment we studied soil development and plant-soil relationships. The mounds, averaging 0.3 m in height, are occupied by file shrubs *Allenrolfea occidentalis* (iodine bush), *Sarcobatus vermiculatus* (black greasewood), and *Atriplex lentiformis* ssp. *torreyi* (Torrey saltbush). *Distichlis spicata* (desert salt-grass) is the only

herbaceous plant occupying this community. Soil salinity decreases with depth in this environment, and content of aqueous-extractable solutes is significantly influenced by site-specific vegetation. Content of silt, clay, mid salt in mound surface horizons suggests a chronosequence of mound formation, with the youngest at the barren playa interface and the oldest at the upland vegetation border. Plant demography and mound soil stratigraphy suggest that a pulse of plant recruitment and mound building occurred during a time of neoglacial cooling. As a substrate for plant recruitment, mounds have a limited lifespan because deposition of eolian-transported salts and geochemical cycling by plants quickly render them too saline for seed germination. The apparent periodicity of mound formation precludes definitive conclusions regarding those mound characteristics favorable for plant recruitment and survivorship.
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508. **Natural salinity of the Colorado River**.
Williams, J. S.
Utah Water Research Laboratory Occasional Paper, Logan, Utah, Utah Water Research Laboratory, College of Engineering, Utah State University, 18 p. (1975).
http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1005&context=water_rep
Keywords: saline water/ Colorado River (Colo.-Mexico)/ geology

509. **Natural vegetation as a source of diffuse salt within the Colorado River Basin**.
Malekuti, A. and Gifford, G. F.
Water Resour. Bull. 14: 195-205 (1978).
http://dx.doi.org/10.1111/j.1752-1688.1978.tb02138.x
Keywords: natural vegetation/ runoff/ ecosystems/ energetics/ freshwater/ water salinity
Abstract: Foliage and litter leachate from selected natural vegetation in the Price River Basin (within the Upper Colorado River Basin) was studied to determine the probable impact of plants on the amount of diffuse salt movement from rangeland watersheds. Calculations using concentrations of various leachates and characteristics of range sites expected to be high salt producers indicate that plants contribute between 0.01 and 0.02% or less of the total annual salt load to the Price River. It was therefore concluded that plants are not a significant source of diffuse salt within the Colorado River Basin.
© *ProQuest*

510. **Origin of dissolved salts in a large, semi-arid groundwater system: Murray Basin, Australia**.
Herczeg, A. L., Dogramaci, S. S. and Leaney, F. W. J.
Marine and Freshwater Research 52: 41-52 (2001). ISSN: 1323-1650
http://dx.doi.org/10.1071/mf00040
Keywords: groundwater/ provenance/ salts/ semi-arid regions/ water chemistry/ Australia
Abstract: Hypotheses to explain the source of the 1011 tons of salt in groundwaters of the Murray Basin, southeastern Australia, are evaluated; these are (a) mixing with original sea water, (b) dissolution of salt deposits, (c) weathering of aquifer minerals and (d) acquisition of solutes via rainfall. The total salinity and chemistry of many groundwater samples are similar to sea-water composition. However, their stable isotopic compositions (δ18O= -6.5‰; δ2H = -35) are typical of mean winter rainfall, indicating that all the original sea water has been flushed out of the aquifer. Br/Cl mass ratios are approximately the same as sea water (3.57 × 10-3) indicating that NaCl evaporites (which have Br/Cl<10-4) are not a significant contributor to Cl in the groundwater. Similarly, very low abundances of Cl in aquifer minerals preclude rock weathering as a significant source of Cl. About 1.5 million tons of new salt is deposited in the Murray-Darling Basin each year by rainfall. The groundwater chemistry has evolved by a combination of atmospheric fallout of marine and continentally derived solutes and removal of water by evapo-transpiration over tens of thousands of years of relative aridity. Carbonate dissolution/precipitation, cation exchange and reconstitution of secondary clay minerals in the aquifers results in a groundwater chemistry that retains a 'sea-water-like' character.
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511. **Phenology of salt desert plants near contour furrows**.
See record 17 in Rangeland Management Practices and Potential Impact on Salinity.

512. **Preclearing hydrology of the Western Australia wheatbelt: Target for the future?**
See record 21 in Rangeland Management Practices and Potential Impact on Salinity.

513. **Preliminary identification of Price River Basin salt pickup and transport processes**.
See record 173 in Subsurface Transport Processes.

514. **Quality of Water: Colorado River Basin**.
U. S. Bureau of Reclamation, 69 p. (2005).
http://www.usbr.gov/uc/progact/salinity/pdfs/PR22.pdf
Keywords: water quality/ rivers/ salinity/ water salinization/ government programs and projects/ conservation practices

515. **Regolith controls on salt movement in dryland erosional landscapes: A multi-scaled approach within the Murray-Darling Basin, Australia**.
Wilford, J., Pain, C., Lawrie, K. C., Gibson, D., Roberts, L., James, J., Halas, L., Apps, H., Fitzpatrick, A. and Tan, K. P.
International salinity forum - managing saline soils and water: science, technology and social issues., Riverside, California, USA (2005).
Keywords: arid lands/ geomorphology/ land use/ landscape/ mathematical models/ movement in soil/ rocks/ saline water/ salinity/ salts/ surface water/ water flow/ groundwater/ regoliths/ salt water/ Australia
Abstract: In Australia the regolith forms a discontinuous and highly variable layer that reflects a long history of landscape evolution. The regolith is the main store for salts, and the groundwaters that mobilise these salts. Thus resolving regolith architecture and composition is a high priority for salinity and groundwater studies. 3D regolith and bedrock information, derived from the approach and analysis outlined in this paper, is being used to add value to existing GFS (groundwater flow system) frameworks and hydrological models. The aim of the study is to quantify surface and groundwater contributions of salt export, and to predict the impacts of land use change on salt movement.
© CABI

516. **Results of Chemical Analyses of Soil, Shale, and Soil/Shale Extract from the Mancos Shale Formation in the Gunnison Gorge National Conservation Area, Southwestern Colorado, and at Hanksville, Utah**.
Tuttle, M. L. W., Fahy, J., Grauch, R. I., Ball, B. A., Chong, G. W., Elliott, J. G., Kosovich, J. J., Livo, K. E. and Stillings, L. L.
24 p. (2007).
http://pubs.usgs.gov/of/2007/1002/D/
Keywords: chemical analysis/ Colorado/ geologic/ geological survey/ geology/ Gunnison Gorge National Conservation Area/ Hanksville/ Mancos Shale/ minerals/ shale/ soil/ USGS/ Utah
Abstract: Results of chemical and some isotopic analyses of soil, shale, and water extracts collected from the surface, trenches, and pits in the Mancos Shale are presented in this report. Most data are for sites on the Gunnison Gorge National Conservation Area (GGNCA) in southwestern Colorado. For comparison, data from a few sites from the Mancos landscape near Hanksville, Utah, are included. Twelve trenches were dug on the GGNCA from which 258 samples for whole-rock (total) analyses and 187 samples for saturation paste extracts were collected. Sixteen of the extract samples were duplicated and subjected to a 1:5 water extraction for comparison. A regional soil survey across the Mancos landscape on the GGNCA generated 253 samples for whole-rock analyses and saturation paste extractions. Seventeen gypsum samples were collected on the GGNCA for sulfur and oxygen isotopic analysis. Sixteen samples were collected from shallow pits in the Mancos Shale near Hanksville, Utah.

517. **Runoff and runon areas in a patterned chenopod shrubland, arid western New South Wales, Australia: characteristics and origin**.
See record 282 in Surface Water Transport Processes.

518. **Runoff and water quality from three soil landform units on Mancos Shale**.
See record 283 in Surface Water Transport Processes.

519. **Saline soils under dryland agriculture in southeastern Saskatchewan (Canada) and possibilities for their improvement - Part I. Distribution and composition of water-soluble salts in soils in relation to physiographic features and plant growth**.
Lüken, H.
Plant and Soil 17: 1-25 (1962).
ISSN: 0032-079X
http://dx.doi.org/10.1007/BF01377819
Keywords: saline soils/ range management/ soil treatment/ soil salinization/ climatic factors/ soil water/ runoff/ agriculture/ environmental impact
Abstract: Soil salinization in some areas of southeastern Saskatchewan was discussed from the standpoint of its occurrence in relation to climatic conditions, soil type, topography, and land use. Accumulations of salts resulted from temporary water tables and the capillary movement of water upwards and its subsequent evaporation. Maximum concentrations of salts occurred on the soil surface or in deeper soil layers, depending on the location of the profile with respect to the topographical contour. Salt leaching on the slope was reduced because of water run-off, but was high in the depression due to water accumulation. A comparison between grassland and cultivated land showed a favourable influence of grass on the reduction of surface salinization. These favourable effects may be related to the influence of the vegetational cover on water run-off and water evaporation. It was concluded, that the increase in cultivated land over the years at the expense of grassland and also the summer fallowing practice are contributing factors towards the spreading of soil salinization. Analytical data from saturated extracts are discussed from the viewpoint of concentration and composition. All test locations showed a preponderance of Mg- and SO4-ions in the salinized samples. SSP values did not exceed 30 per cent. The influence of varying concentrations of these salts on the yields of three cereal crops was tested. The sequence of salt tolerance of barley, wheat, and oats in decreasing order was identical with results reported elsewhere from irrigated plots. Absolute salt concentrations affecting a 50 per cent yield decrease, however, were considerably lower. This was attributed to differences in the environment. © 1962 Martinus Nijhoff.
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520. **Salinisation as an ecological perturbation to rivers, streams and wetlands of arid and semi-arid regions**.
See record 104 in Rangeland Management Practices and Potential Impact on Biotic Processes.

521. **Salinity Investigations in West Salt Creek, Colorado**.
Whittig, L. D., Tanji, K. K., Biggar, J. W., Evangelou, V. P. and Deyo, A. E.
California Water Resources Center Completion Report, Univ. of California, Davis, March 1983. 161 p. (1983).
Keywords: salinity/ saline soils/ erosion/ shale's/ dissolved salts/ Colorado/ Mancos Shale/ Colorado River/ salts/ West Salt Creek watershed/ nonpoint source pollution
Abstract: This investigation was aimed at assessment of the potential for contribution of dissolved mineral salts to the Colorado River by natural forces for contribution of dissolved mineral salts to the Colorado River by natural forces acting within a small, representative watershed in the Upper Colorado River Basin. The 440 km super 2 West Salt Creek watershed in west central Colorado was chosen for the study. Certain geologic strata and geomorphic landforms were identified as major contributors of dissolved mineral salts, whereas others within the watershed contribute little to the salt load of streams of the area. The Late Cretaceous marine Mancos Shale, in particular, is a principal contributor of soluble salts. In many areas, however, the saline Mancos shale is effectively protected from erosion and salt release by surface coverings of sandstone cuestas and pediment surfaces. High salt-hazard areas within the watershed are delineated and mapped. (Snyder-California)

522. **Salinity investigations of Mancos landforms and springs in the upper Colorado River Basin**.
See record 180 in Subsurface Transport Processes.

523. **Salinity Investment Framework: New approach to public investment in dryland salinity**.
Pannell, D. J. and Ridley, A. M., Salinity Investment Framework (SIF3), Australia, 2 p. (2007).
http://www.nccma.vic.gov.au/library/scripts/objectifyMedia.aspx?file=KMSMedia/pdf/12/07.pdf
Keywords: soil salinity/ watershed management/ government programs and projects/ water salinization/ economic impact/ water quality/ socioeconomics

524. **Salinization and Saline Environments**.
Vengosh, A.
Environmental Geochemistry [Treatise on Geochemistry series]. Sherwood Lollar, B. and Turekian, K. K. Oxford, Pergamon.
9**:** 1-35 (2003).
http://dx.doi.org/10.1016/B0-08-043751-6/09051-4
Keywords: water quality/ water salinization/ arid regions/ semi-arid zones/ soil salinization/ watershed management/ land use/ environmental policy/ economic impact
Abstract: One of the most conspicuous phenomena of water-quality degradation, particularly in arid and semi-rid zones, is salinization of water and soil resources. The salinization is a long-term phenomenon, and during the last century many aquifers and river basins have become unsuitable for human consumption owing to high levels of salinity. Future exploitation of thousands of wells in the Middle East and in many other water-scarce regions in the world depends to a large extent on the degree and rate of salinization. Moreover, every year a large fraction of agricultural land is salinized and becomes unusable. Salinization is a global environmental phenomenon that affects many different aspects of our life (Williams, 2001a, b): changing the chemical composition of natural water resources (lakes, rivers, and groundwater), degrading the quality of water supply to the domestic and agriculture sectors, contribution to loss of biodiversity, taxonomic replacement by halotolerant species (Williams, 2001a, b), loss of fertile soil, collapse of agricultural and fishery industries, changing of local climatic conditions, and creating severe health problems (e.g., the Aral Basin). The damage due to salinity in the Colorado River Basin alone, for example, ranges between $500 and $750 million per year and could exceed $1 billion per year if the salinity in the Imperial Dam increases from 700 to 900 mg 1⁻¹ (Bureau of Reclamation, USA). In Australia, accelerating soil salinization has become a massive environmental and economic disaster. As such, Western Australia is ''losing an area equal to one football oval an hour'' due to spreading salinity (Murphy, 1999). The annual cost for dryland salinity in Australia is estimated as AU$700 million for lost land and AU$130 million for lost production (Williams et al., 2002). In short, the salinization process has become pervasive. [from p. 1]
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525. **Salinization of the upper Colorado River—Fingerprinting geologic salt sources**.
Tuttle, M. L. and Grauch, R. I.
USGS Scientific Investigations Report, Reston, Virginia, U.S. Geological Survey, 62 p. (2009).
http://pubs.usgs.gov/sir/2009/5072/
Keywords: rivers/ water salinization/ water quality/ land use/ environmental policy/ geochemistry/ saline soils/ runoff/ soil transport processes
Abstract: Salt in the upper Colorado River is of concern for a number of political and socioeconomic reasons. Salinity limits in the 1974 U.S. agreement with Mexico require the United States to deliver Colorado River water of a particular quality to the border. Irrigation of crops, protection of wildlife habitat, and treatment for municipal water along the course of the river also place restrictions on the river's salt content. Most of the salt in the upper Colorado River at Cisco, Utah, comes from interactions of water with rock formations, their derived soil, and alluvium. Half of the salt comes from the Mancos Shale and the Eagle Valley Evaporite. Anthropogenic activities in the river basin (for example, mining, farming, petroleum exploration, and urban development) can greatly accelerate the release of constituents from these geologic materials, thus increasing the salt load of nearby streams and rivers. Evaporative concentration further concentrates these salts in several watersheds where agricultural land is extensively irrigated. Sulfur and oxygen isotopes of sulfate show the greatest promise for fingerprinting the geologic sources of salts to the upper Colorado River and its major tributaries and estimating the relative contribution from each geologic formation. Knowing the salt

source, its contribution, and whether the salt is released during natural weathering or during anthropogenic activities, such as irrigation and urban development, will facilitate efforts to lower the salt content of the upper Colorado River.

526. **Salt efflorescence in Price River Basin**.
Rao, B. K., Bowles, D. S. and Wagenet, R. J.
Journal of Environmental Engineering 110: 457-471 (1984).
http://dx.doi.org/10.1061/(ASCE)0733-9372(1984)110:2(457)
Keywords: salt efflorescence/ Price River basin/ saline water intrusion/ salinity/ saline soils/ water pollution sources/ pollutant fate
Abstract: Salt efflorescence has been hypothesized to be an important nonpoint source of salinity in the Price River basin which is a major salt contributor, relative to its contribution of water, to the Colorado River system. Efflorescent salt loading was investigated through field studies, aerial photography, laboratory experiments, and mathematical modeling. The conditions favorable to the formation of salt efflorescence crusts are highly saline soil water near the soil surface and a source of heat above the soil for evaporating the soil water. Field data indicate that the salt efflorescence crust forms over the first 10-15 days after a storm runoff washes off the earlier efflorescence. After this period, the efflorescence crust apparently acts as a physical barrier to further soil water evaporation. Observation from aerial photography suggest that the major source of salt for efflorescence is the water that infiltrates saline geological formations and returns to ephemeral streams with dissolved salts. An expected value of salt efflorescence crust density at the time of a storm was computed by fitting an exponential probability distribution for the time interval between consecutive summer storms in the Price River basin. This density, which was estimated as 1.40 kg/sq m, was used with an average number of four storms per year and the fraction of the total basin area underlain by marine Mancos shale to obtain the estimate that salt efflorescence contributes approximately 8.5% of the total salt loading in the Price River basin. It was assumed that all the salt efflorescence crust is washed off during each storm, and that no salt is leached back into the soil. Therefore, the foregoing percentage may be expected to be an upper bound estimate. Also, it neglects efflorescent salt loading outside the summer season. This study adds to the previous studies in the Price River basin in concluding that the surface salt sources produce a relatively small fraction of the total loading. This conclusion suggests that subsurface sources of salt pickup are significant and future salt loading studies in the basin should consider subsurface processes. (Murphy-IVI)
This citation is from the American Society of Civil Engineers.

527. **Salt impacts on organic carbon and nitrogen leaching from senesced vegetation**.
See record 30 in Rangeland Management Practices and Potential Impact on Salinity.

528. **Salt loading from efflorescence and suspended sediments in the Price River basin**.
See record 183 in Subsurface Transport Processes.

529. **Salt Transport by the South Platte River in Northeast Colorado**.
See record 185 in Subsurface Transport Processes.

530. **Salt Transport in Heavy Clay Soil**.
See record 293 in Surface Water Transport Processes.

531. **Salt transport in the Bremer Hills, SA: report for NAP South Australian salt mapping and management**.
See record 186 in Subsurface Transport Processes.

532. **Salt-weathering simulations under hot desert conditions: Agents of enlightenment or perpetuators of preconceptions?**
Smith, B. J., Warke, P. A., Mcgreevy, J. P. and Kane, H. L.
Geomorphology 67: 211-227 (2005). ISSN: 0169-555X
http://dx.doi.org/10.1016/j.geomorph.2004.03.015
Keywords: salt weathering/ laboratory simulations/ hot deserts
Abstract: Because of access difficulties and inhospitable environmental conditions, our

understanding of rock weathering in hot deserts has been strongly influenced by laboratory simulations. However, a risk exists that results may come to owe more to experimental design than to actual environmental conditions experienced at the atmosphere/rock surface interface. This was especially true in early salt-weathering simulations that seemingly sought to reinforce the orthodoxy of a physically dominated weathering environment driven by extremely high absolute temperatures and large diurnal temperature ranges. However, improvements in environmental sensors over the last 20 years have established the complexity of desert climates and the importance of microclimatic controls and allowed considerable refinement of experimental design. This overview evaluates the implications of recent simulation studies and presents new information on possible fatigue effects of differential thermal expansion of salts and the salt weathering of test blocks under compressive loading. In doing so, it demonstrates how physical rock properties change during experimentation, the importance of short-term surface temperature fluctuations, distinctions between the weathering of unconfined debris and larger rock surfaces, the importance of moisture and salt applications that replicate their availability in deserts, the importance of rock thermal properties in controlling their weathering response in environments dominated by radiative heating and cooling, and the overall complexity of weathering regimes.
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533. **Seepage scald in southeastern Australia**.
Bullock, P. R.
Applied Geography 11: 59-81 (1991). ISSN: 0143-6228
http://dx.doi.org/10.1016/0143-6228(91)90005-T
Keywords: soil salinity/ soil salts/ seepage/ Australia/ grasslands
Abstract: This study addresses the problem of seepage scald in southeastern New South Wales. Limited information was available on soil and hydrological properties of these areas and a case study of the Yarralaw seepage scald was undertaken to answer questions concerning the scald's origin, the threat of scald expansion and possible offsite effects. The results have application to a number of similar sites in southeastern New South Wales. Scald formation was not related to any particular soil property inherent to the scalded area. Grassland and scald soil profiles were similar, with the major difference being the surface horizon. The grassland surface was relatively permeable but the scald surface was sodic, highly dispersive and compacted. As a result, it had lower permeability than the grassland. Soil salt loads were high only in the surface horizons of the scald. The water table in the lower catchment, even at its lowest level, was within 2 m of the ground surface. Upward capillary water movement is causing the salinity, but the salinity is confined to the scald because downward leaching in the grassland keeps the surface of these areas relatively salt-free. The areal extent of the Yarralaw seepage scald has been stable since 1962. High runoff conditions in the future may cause further scald expansion and it is important that reasonable measures be taken to prevent this. However, scald growth appears to be catastrophic in nature, with the majority of the damage occurring in a relatively short period of time in the early stage of formation. On the scald surface, the degradation is a progressive process but scald expansion appears to be catastrophic. This type of formation has important implications for management and emphasizes the need for seepage scald prevention.
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534. **Sensitivity analysis of a general rangeland model**.
Macneil, M. D., Skiles, J. W. and Hanson, J. D.
Ecological Modelling 29: 57-76 (1985).
http://dx.doi.org/10.1016/0304-3800(85)90047-X
Keywords: rangelands/ models/ water salinization/ grazing management/ range management/ water quality/ vegetation/ forage/ grazing management
Abstract: An extensive sensitivity analysis of a model for the Simulation of Production and Utilization on Rangelands (SPUR) was conducted. A perturb and observe approach was employed in a series of fractional factorial experiments. State variables selected as sensitivity indicator variables included: peak standing crop, maximum plant nitrogen to carbon ratio, integrated year-long mineralization of soil nitrogen, integrated season-long plant death, integrated season-long carbon assimilation, integrated effect of soil moisture on net photosynthesis, integrated season-long forage intake by steers and cumulative season-long change in steer weight. The 1st of three

stages of the analysis showed the dynamics which affect simulated warm and cool-season grasses, warm and cool-season forbs and shrubs were similar in the absence of grazing. Therefore, one plant functional group (warm-season grasses) was used in subsequent stages, allowing a greater number of plant species specific parameters to be examined. In the 2nd stage, also without grazing, optimum, minimum and maximum temperatures for plant activity, the day senescence ends and their joint effects had the largest impacts on the plant component. Characteristics of the soil and soil-water relationships had only minor effects on plant-related indicators. Grazing caused many of the interactions which previously affected plant-related indicators to become less important. Effects associated with day senescence ends were greatly reduced in both magnitude and importance. Steer forage intake and weight change were sensitive to stocking rate and the parameter which converts the percent nitrogen of the forage into total digestible nutrients. Plant parameters which affected the relative quantities of carbon and nitrogen in plant biomass, tended to mediate the effects of livestock-related parameters.
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535. **Soil erosion effects on productivity in rangeland environments: where is the research? in western United States**.
See record 302 in Surface Water Transport Processes.

536. **Soil Movement and Surface Roughness on Wyoming Rangelands**.
See record 304 in Surface Water Transport Processes.

537. **Soil physical and physico-chemical variability induced by *Atriplex nummularia***.
See record 305 in Surface Water Transport Processes.

538. **Soluble mineral content in surficial alluvium and associated Mancos Shale**.
See record 309 in Surface Water Transport Processes.

539. **Spatial and temporal variability of water salinity in an ephemeral, arid-zone river, central Australia**.
See record 189 in Subsurface Transport Processes.

540. **Spatial variability of soluble salt content in a Mancos Shale watershed**.
Wagenet, R. J. and Jurinak, J. J.
Soil Science 126: 342-349 (1978).
Keywords: saline soils/ salinity/ saline water/ spatial distribution/ Colorado River Basin/ sampling/ statistical methods/ soil chemistry
Abstract: A study was conducted to examine data collected in the microwatershed land process studies with regard to quantifying spatially variable soil properties. All 35 sampling sites were classified as occurring on the Mancos shale formation within a 777 sq km (300 sq mi) area of the Price River Basin. Samples were taken at 0-2.5, 2.5-7.5, and 7.5-15.0-cm depths. Using the electrical conductivity (EC) of either the 1:1 or saturation extract as the salinity index parameter, it was found that EC values were distributed log-normally about the mean EC value of 35 observations. The coefficient of determination for the log-normal statistical plots was 1.00 for all three depths sampled at the 35 sites. The variance in the EC values increased with depth. (Skogerboe-Colorado State)
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541. **Spatially referenced statistical assessment of dissolved-solids load sources and transport in streams of the Upper Colorado River Basin**.
Kenney, T. A., Gerner, S. J., Buto, S. G. and Spangler, L. E.
USGS Scientific Investigations Report, Reston, Virginia, U.S. Geological Survey, 50 p. (2009).
http://pubs.usgs.gov/sir/2009/5007
Keywords: total dissolved solids/ sediment transport/ rivers/ watersheds/ models/ soil erosion
Abstract: The Upper Colorado River Basin (UCRB) discharges more than 6 million tons of dissolved solids annually, about 40 to 45 percent of which are attributed to agricultural activities. The U.S. Department of the Interior estimates economic damages related to salinity in excess of $330 million annually in the Colorado River Basin. Salinity in the UCRB, as measured by dissolved-solids load and concentration, has been studied extensively during the past

century. Over this period, a solid conceptual understanding of the sources and transport mechanisms of dissolved solids in the basin has been developed. This conceptual understanding was incorporated into the U.S. Geological Survey Spatially Referenced Regressions on Watershed Attributes (SPARROW) surface-water quality model to examine statistically the dissolved-solids supply and transport within the UCRB. Geologic and agricultural sources of dissolved solids in the UCRB were defined and represented in the model. On the basis of climatic and hydrologic conditions along with data availability, water year 1991 was selected for examination with SPARROW. Dissolved-solids loads for 218 monitoring sites were used to calibrate a dissolved-solids SPARROW model for the UCRB. The calibrated model generally captures the transport mechanisms that deliver dissolved solids to streams of the UCRB as evidenced by R2 and yield R2 values of 0.98 and 0.71, respectively. Model prediction error is approximated at 51 percent. Model results indicate that of the seven geologic source groups, the high-yield sedimentary Mesozoic rocks have the largest yield of dissolved solids, about 41.9 tons per square mile (tons/mi2). Irrigated sedimentary-clastic Mesozoic lands have an estimated yield of 1,180 tons/mi2, and irrigated sedimentary-clastic Tertiary lands have an estimated yield of 662 tons/mi2. Coefficients estimated for the seven landscape transport characteristics seem to agree well with the conceptual understanding of the role they play in the delivery of dissolved solids to streams in the UCRB. Predictions of dissolved-solids loads were generated for more than 10,000 stream reaches of the stream network defined in the UCRB. From these estimates, the downstream accumulation of dissolved solids, including natural and agricultural components, were examined in selected rivers. Contributions from each of the 11 dissolved-solids sources were also examined at select locations in the Grand, Green, and San Juan Divisions of the UCRB. At the downstream boundary of the UCRB, the Colorado River at Lees Ferry, Arizona, monitoring site, the dissolved-solids contribution of irrigated agricultural lands and natural sources were about 45 and 57 percent, respectively. Finally, model predictions, including the contributions of natural and agricultural sources for selected locations in the UCRB, were compared with results from two previous studies.

542. **State and Local Management Actions to Reduce Colorado River Salinity**.
See record 36 in Rangeland Management Practices and Potential Impact on Salinity.

543. **Stochastic modeling of soil salinity**.
Suweis, S., Rinaldo, A., Van Der Zee, S. E., Daly, E., Maritan, A. and Porporato, A.
Geophysical Research Letters 37: 1-5 (2010).
http://dx.doi.org/10.1029/2010GL042495
Keywords: soil salinity/ soil salinization/ models/ stochastic processes/ rain/ hydrology/ vegetation/ climate change
Abstract: A stochastic model for soil salinity in which the rate of soil salinization is determined by the balance between dry and wet salt deposition and the intermittent leaching events caused by rainfall events. The analytical solutions show the interplay of soil, plant and climate parameters responsible for long-term soil salinization. In particular, they show the existence of two distinct regimes, one where the mean salt mass remains nearly constant (or decreases) with increasing rainfall frequency, and another where mean salt content increases markedly with increasing rainfall frequency. As a result, relatively small reductions of rainfall in drier climates may entail dramatic shifts in long-term soil salinization trends, with significant consequences e.g. for climate change impacts on rain-fed agriculture.
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544. **Surface control of desert pavement pedologic process and landscape function, Cima volcanic field, Mojave Desert, California**.
Wood, Y. A., Graham, R. C. and Wells, S. G.
CATENA 59: 205-230 (2005). ISSN: 0341-8162
http://dx.doi.org/10.1016/j.catena.2004.06.001
Keywords: eolian features/ United States/ terrestrial environment/ volcanic rocks/ igneous rocks/ characterization/ vegetation/ deserts/ California/ controls/ basalts/ Mojave Desert/ water regimes/ ecology/ Cima volcanic field/ soil/ San Bernardino County/ soil/ pedogenesis/ lava flows/ textures/ arid environment/ landform evolution/ desert pavement/ Aridisols/ morphology/ volcanic fields/ physical properties/ parent materials/ geomorphology/ landscapes/ leaching/ salinization
Abstract: Desert pavement is a distinctive feature widespread across arid lands of the world. It plays a dynamic role in geomorphic,

hydrologic, and ecologic processes. Where desert pavement predominates, infiltration is limited and rainfall is delivered as runoff to nearby bare ground areas where shrubs cluster. Desert pavement surfaces may appear monotonously flat and barren, but we have found, instead, that they are a complex association of landscape and hydrologic elements governed by their surface characteristics. Previously, we identified six unique surface mosaic types that accurately capture the subtle, but distinct, variations in surface clast arrangements for a desert pavement landscape formed on a single-aged basalt flow in the Mojave Desert. We now report that these surface mosaics predict the spatial distribution of fundamental desert vegetation and soil characteristics. Characteristics of soil morphology and texture, the leaching depth of soluble salts, percent plant cover, and shrub species diversity are remarkably consistent for each mosaic type across a 580,000-year-old basalt flow even when measured >1 km apart. Hydrologic character is distinctly different between desert pavement and bare ground regions and vegetation distributions reflect the spatially heterogeneous soil moisture. Where desert shrubs cluster on the three bare ground surface mosaics, leaching is deep, removing most soluble salts to below the 50-cm depth. Where shrubs are absent or few, on the three desert pavement mosaics, leaching depths are shallow, with soluble salt depth distributions as well as desert shrub percent cover precisely controlled by the percent clast cover of the surface.
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545. **Three-dimensional mapping of salt stores in the southeast Murray–Darling Basin, Australia**.
Cresswell, R. G., Dent, D. L., Jones, G. L. and Galloway, D. S.
Soil Use and Management 20: 133-143 (2004).
ISSN: 1475-2743
http://dx.doi.org/10.1111/j.1475-2743.2004.tb00348.x
Keywords: Salinity/ airborne electromagnetic survey/ electrical conductivity/ salt-risk map
Abstract: An airborne electromagnetic survey yields a three-dimensional map of ground electrical conductivity. The remotely sensed data are translated into salt load by field and laboratory calibration: drilling, measurement of borehole conductivity, electrical conductivity of 1:5 soil–water extracts (EC1:5) and chemical analysis of pore fluids. Using these field measurements, the conductivity map is calibrated by constraining model parameters within limits defined by the measured values. Once the airborne data is calibrated, we can derive a regional constant (Ksalt) by comparing total ground conductivity with the mass of salt measured in bore samples. Pore fluid chemistry provides a definitive measure of salt, but EC1:5 values may be used, provided that the procedure ensures complete dispersal of clay aggregates to release all the salt. Maps of salt load can be generated from the conductance (total conductivity) maps using a geographical information system. Without calibration, airborne electromagnetic surveying is misleading. Properly calibrated, it provides a detailed, semi-quantitative, three-dimensional map of the distribution of salt in the landscape: a prerequisite for the effective management of salinity. Salt appearing at the surface and in streams is the result of processes operating throughout entire catenas and groundwater flow systems. Across the southeastern catchments of the Murray–Darling Basin, we found that salt is stored predominantly in thick clay horizons within the regolith (encompassing the soil cover, weathered parent material and unlithified sediments down to unweathered basement). Coarse materials, for example in prior stream channels, may serve as conduits for salt transport to rivers and the land surface.
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546. **Time-domain reflectometry method for measuring soil water content and salinity**.
Dalton, F. N. and Van Genuchten, M. T.
Geoderma 38: 237-250 (1986).
http://dx.doi.org/10.1016/0016-7061(86)90018-2
Keywords: soil water/ soil salinity/ time domain reflectometry/ unsaturated flow/ electrical conductivity
Abstract: This paper discusses the physical principles and use of time-domain reflectometry as a new tool for studying water and solute transport in unsaturated soils. In-situ measurements of water content and bulk soil electrical conductivity are shown to give results that are comparable with those obtained by conventional non-destructive techniques. An equation is presented that relates the bulk soil

electrical conductivity to the soil solution electrical conductivity. Also derived are constraints that water content and electrical conductivity place on the use of time domain reflectometry sensors.
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547. **Timing of recharge, and the origin, evolution and distribution of solutes in a hyperarid aquifer system**.
See record 84 in Rangeland Management Practices and Potential Impact on Water.

548. **Tracer-based studies of soil water movement in semi-arid forests of New Mexico**.
See record 325 in Surface Water Transport Processes.

549. **Tracking salinity sources to Texas streams; examples from West Texas and the Texas Gulf Coastal Plain**.
See record 197 in Subsurface Transport Processes.

550. **Transport of salts from disturbed geologic formations**.
See record 39 in Rangeland Management Practices and Potential Impact on Salinity.

551. **Upper Colorado River Basin Rangeland Salinity Control Project: Natural Resource Inventory Phase I Report**.
Rasely, R. C. and Roberts, T. C.
Colorado River Basin Salinity Forum, 18 p. (1991).
Keywords: rangelands/ range management/ salinity/ conservation practices/ watershed management/ surveys/ natural resources
Abstract: Historically, salinity control work in the Colorado River Basin has been accomplished solely by irrigation water management projects. Rangeland watershed salinity control was determined to be too expensive due to the very large number of acres of rangeland within the basin. Soil Conservation Service watershed planning work has shown that severely eroding rangeland can be successfully treated in a cost effective manner using the principle of resource problem targetting. Studies have also shown that most of the watersheds will have approximately 5% to 15% of the surface area in severely eroding condition and in need of improved conservation treatment. A two phase project was implemented that inventoried watersheds in the State of Utah that are in the Colorado River Basin. Phase I of the project involved an interdisciplinary team of specialists from the US Soil Conservation Service (SCS), US Bureau of Land Management (BLM), and US Geological Survey. The project was supported by the Colorado River Basin Salinity Forum. The 218 watersheds in the Colorado River Basin within the State of Utah were inventoried for various resource parameters including potential sediment yield, potential salt yield, rangeland condition, and annual precipitation range. This inventory gave each watershed a rating on a scale of one to twelve with the highest ratings in those watersheds most in need of conservation planning to control offsite nonpoint source sediment and salt problems. The steering committee and cooperating agencies identified eight watersheds for detailed planning in Phase II of the project based on the Phase I parameters and individual agency needs.

552. **Upper Colorado River Basin Rangeland Salinity Control Project: Proposed Revision (1991) of Pacific Southwest Interagency Committee Sediment Yield Procedure**.
Rasely, R. C.
Salt Lake City, Utah, Soil Conservation Service, (1991).
Keywords: rivers/ rangelands/ salinity/ sediment transport/ erosion control/ conservation practices
Abstract: The Pacific Southwest Interagency Committee, 1968, Sediment Yield Procedure, is a resource evaluation tool that can be used to characterize sediment and salt yield from various sized hydrologic units, watersheds, and geomorphic units. This sediment yield model is a documented reliable procedure that will result in quantification of sediment and salt yield. A sediment delivery ratio can be applied to derive sediment and salt delivery quantification from the modeled hydrologic unit or watershed to a downstream delivery point. These proposed revisions incorporate recent research into the procedure and improve the utility of the procedure. The revisions include applying the procedure to three planning frameworks: Present Condition, Future Without Project Condition, and Future With Project Condition, and to a burned watershed (wildfire) condition. All of these planning models procedures can be

used in a timely manner for planning purposes or for emergency watershed protection evaluations. A new evaluation sheet is presented for efficient field use. Emphasis is placed on the necessity of maintaining the field-oriented interdisciplinary method of applying the sediment yield model. An example of the use of the revised sediment yield model is cited for the Colorado River Basin Rangeland Salinity Project, State of Utah, 1990-1991, as conducted by an interagency, interdisciplinary team.

553. **Upper Colorado River Basin Rangeland Salinity Control Project: Watershed Resource Condition Evaluation Phase II Procedure**.
See record 40 in Rangeland Management Practices and Potential Impact on Salinity.

554. **Variations in soil dispersivity across a gully head displaying shallow sub-surface pipes, and the role of shallow pipes in rill initiation**.
See record 41 in Rangeland Management Practices and Potential Impact on Salinity.

555. **Victorian catchment management approaches to salinity: Learning from the National Action Plan experience**.
Alexander, J. K., Roberts, A. M. and Pannell, D. J.
Australasian Journal of Environmental Management 17: 45-52 (2010).
http://dx.doi.org/10.1080/14486563.2010.9725248
Keywords: asset-based environmental management/ environmental policy/ institutional arrangements/ investment/ natural resource management/ organizational capacity/ salinity/ targeting
Abstract: Given the limited budgets of environmental programs in Australia, spatially explicit, asset based approaches to investment planning are likely to result in more cost-effective environmental outcomes than less-targeted approaches. The conclusion of the National Action Plan for Salinity and Water Quality (NAP) provided opportunity to explore the compatibility of Victorian Catchment Management Authority (CMA) dryland plans with an asset-based approach, with a view to providing guidance on how to improve practices for new programs. In 2008, we reviewed plans for dryland areas of eight Victorian CMAs against the following criteria: 1) identification of spatially explicit assets; 2) asset prioritisation; 3) level of threat considered; 4) capacity to influence the threat; 5) linkage between intervention and asset protection; 6) consideration of landholder adoption circumstances; 7) whether the intervention was based on analysis of public and private benefits; and 8) whether research and development gaps were identified. Gaps in knowledge were identified in all plans. Overall, two regions had plans that were moderately consistent with a spatially explicit, asset-based approach. There was a generally positive response from CMAs regarding the implementation of such an approach, with strong indications of the need to consider multiple environmental threats. We conclude that clear guidance or recommendations from governments will be needed to achieve widespread adoption of spatially explicit, asset based approaches in Victoria and other states.
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556. **Viewpoint: off-road vehicle damage to public lands**.
See record 437 in Wind Transport.

557. **Water quality in the upper Colorado River basin, Colorado, 1996-98**.
Spahr, N. E., Apodaca, L. E., Deacon, J. R., Bails, J. B., Bauch, N. J., Smith, C. M. and Driver, N. E.
USGS Circular, U.S. Geological Survey, 33 p. (2000).
http://pubs.usgs.gov/circ/circ1214/
Keywords: water quality/ rivers/ watersheds/ surveys/ conservation practices/ government programs and projects/ environmental policy/ water resources/ water policy
Abstract: This report summarizes major findings about water quality in the Upper Colorado River Basin that emerged from an assessment conducted between 1996 and 1998 by the U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program. Water quality is discussed in terms of local and regional issues and compared to conditions found in all 36 NAWQA study areas, called Study Units, assessed to date. Findings are also explained in the context of selected national benchmarks, such as those for drinking water quality and the protection of aquatic organisms.

The NAWQA Program was not intended to assess the quality of the Nation's drinking water, such as by monitoring water from household taps. Rather, the assessments focus on the quality of the resource itself, thereby complementing many ongoing Federal, State, and local drinking-water monitoring programs. The comparisons made in this report to drinking-water standards and guidelines are only in the context of the available untreated resource. Finally, this report includes information about the status of aquatic communities and the condition of instream habitats as elements of a complete water-quality assessment. Many topics covered in this report reflect the concerns of officials of State and Federal agencies, water-resource managers, and members of stakeholder groups who provided advice and input during the Upper Colorado River Basin assessment. Basin residents who wish to know more about water quality in the areas where they live will find this report informative as well. The NAWQA Program seeks to improve scientific and public understanding of water quality in the Nation's major river basins and ground-water systems. Better understanding facilitates effective resource management, accurate identification of water-quality priorities, and successful development of strategies that protect and restore water quality. Guided by a nationally consistent study design and shaped by ongoing communication with local, State, and Federal agencies, NAWQA assessments support the investigation of local issues and trends while providing a firm foundation for understanding water quality at regional and national scales. The ability to integrate local and national scales of data collection and analysis is a unique feature of the USGS NAWQA Program. The Upper Colorado River Basin is one of 51 water-quality assessments initiated since 1991, when the U.S. Congress appropriated funds for the USGS to begin the NAWQA Program. As indicated on the map, 36 assessments have been completed, and 15 more assessments will conclude in 2001. Collectively, these assessments cover about one-half of the land area of the United States and include water resources that are available to more than 60 percent of the U.S. population.

558. **Water Quality Standards for Salinity, Colorado River System: Supplemental Report on the 1999 Review**.
Colorado River Basin Salinity Control Forum, Bountiful, UT, Colorado River Basin Salinity Control Forum, 109 p. (1999).
Keywords: water quality/ water salinization/ rivers/ saline water/ hydrology/ models/ conservation practices/ government programs and practices
Abstract: Section 303 of the Clean Water Act requires that water quality standards be reviewed from time to time, but at least once during each three-year period. Accordingly, the seven-state Colorado River Basin Salinity Control Forum (Forum) has reviewed the existing state-adopted and Environmental Protection Agency (EPA)-approved water quality standards for salinity consisting of numeric criteria and a plan of implementation for salinity control for the Colorado River System. Since the issuance of the 1996 Review, the U.S. Bureau of Reclamation (Reclamation) has initiated development of a new model to analyze the Colorado River System, including salinity. The model development is not yet completed, and new salinity projections are not available for this Review. Projections developed for the 1996 Review are used in this Review. This 1999 Review updates funding and salinity control component implementation requirements following 1999. Also, since the 1996 Review, federal legislation has been implemented which allows the Basin states to cost share up-front in both Reclamation's Basinwide Program and the U.S. Department of Agriculture's EQIP program. This has brought a new and important source of funding to the program and has accelerated the rate of implementation of salinity control measures. Federal authorization given by Congress in 1996 has already allowed for the addition of $6,476,000 to the effort. The Forum's recommendations are to be submitted to each of the Basin states for consideration at a public hearing prior to adoption. The Forum recommends no change in the numeric salinity criteria at the three stations located on the lower mainstem of the Colorado River. The numeric criteria at these stations will remain: (Station / Salinity in mg/L - Flow-weighted average annual salinity) Below Hoover Dam / 723 mg/L; Below Parker Dam / 747 mg/L; At Imperial Dam / 879 mg/L. The plan of implementation as set forth in this Review is designed to meet the objective of maintaining the salinity concentrations at or below the numeric criteria while the Basin states

continue to develop their compact-apportioned waters. The plan is based on maintaining the numeric criteria under a long-term mean water supply of 15 million acre-feet annually at Lee Ferry, the Compact Point. The Forum recommends that the plan of implementation described in this report be carried out. The plan of implementation includes: 1. Completion of Reclamation, Bureau of Land Management (BLM), and U.S. Department of Agriculture (USDA) salinity control measures to the extent that each unit remains viable and appropriately cost-effective. 2. Implementation of the Forum's recommended and adopted policies for effluent limitations, principally under the National Pollutant Discharge Elimination System (NPDES) permit program established by Section 402 of the Clean Water Act as amended. The implemented policies (included in Appendix B of this Review) are the following: "Policy for Implementation of Colorado River Salinity Standards Through the NPDES Permit Program;" "Policy for Use of Brackish and/or Saline Waters for Industrial Purposes;" "Policy for Implementation of the Colorado River Salinity Standards Through the NPDES Permit Program for Intercepted Ground Water;" and "Policy for Implementation of the Colorado River Salinity Standards Through the NPDES Permit Program for Fish Hatcheries." 3. Implementation of nonpoint source management plans developed by the states and approved by EPA. Item 1 of the plan listed above is to be implemented by federal agencies in conjunction with state, local, and private participants. The Forum works jointly with federal agencies on developing measures to be implemented. The Forum also urges Congress to ensure that the funds necessary to successfully fulfill this plan of implementation are appropriated as needed. Items 2 and 3 above are primarily implemented by each of the Basin states. Major components of this Review's plan of implementation are the federal programs. Table 1 summarizes the salinity control achieved by federal p rticipants through 1998, and the salinity control measures which must be implemented to meet the goal of approximately 1.477 million tons of salt-load reduction annually through 2015. As 1.105 million tons of salt load reduction was required by 1998, and only 721,000 tons of salt load reduction was achieved, a shortfall of 384,000 tons must be made up. In order to do so, the Forum recommends that salinity control be accelerated to remove 87,000 tons/year through 2005. This includes removing at least 64,000 tons/year over the next six years, through the funding recommendations herein, to eliminate the shortfall, and 23,000 tons/year through the remaining period to maintain the numeric criteria through 2015. The federal programs are described in detail in Chapter 4 of this Review. The plan of implementation is designed to control enough salt to maintain the numeric criteria under a long-term mean water supply of 15 million acre-feet per year. It is recognized that the river system is subject to highly variable flows. Consequently, salinity will vary from year to year and may temporarily exceed the adopted numeric criteria in some years and remain well below the criteria in others.

559. **Water Quality Standards for Salinity: Colorado River System, 2008 Review**.
Colorado River Basin Salinity Control Forum, Colorado River Basin Salinity Control Forum, 89 p. (2008).
http://www.crb.ca.gov/Salinity/2008/2008%20Review.pdf
Keywords: water quality/ water salinization/ rivers/ saline water/ hydrology/ models/ conservation practices/ government programs and practices
Abstract: This is a review of the water quality standards for salinity for the River. Section 303 of the Clean Water Act requires that water quality standards be reviewed from time to time, but at least once during each three-year period. Accordingly, the seven-state Forum has reviewed the existing state-adopted and USEPA approved water quality standards for salinity consisting of numeric criteria and a plan of implementation for salinity control for the River system. During the period of the 2005 Review, Reclamation enhanced its model to include analysis of the River salinity. The model has been used to make new salinity projections for this Review. Upon adoption by the Forum, this Review will be submitted to each of the Basin states for consideration as each state proceeds with its three-year water quality review process. The Forum recommends no change in the numeric salinity criteria at the three stations located on the lower main stem of the River. The numeric criteria at these stations will remain: (Station / Salinity in mg/L - Flow-weighted average annual salinity.) Below Hoover Dam 723 mg/L; Below Parker Dam 747 mg/L; At Imperial Dam 879 mg/L. In past reviews, the plan of implementation was intended to maintain the salinity concentrations at or below the

numeric criteria while the Basin states continued to develop their compact-apportioned waters. Reclamation's computer model runs indicate there is little probability of the numeric criteria being exceeded in the next three years. The Act requires the implementation of salinity control programs to reduce the salinity of the River. Reducing the salinity of the River will reduce economic damages. The plan of implementation accompanying the review emphasizes the reduction of salinity levels to reduce economic damages in the Lower Basin, as well as providing benefits in the Upper Basin. The Forum's plan of implementation includes: 1. Completion of Reclamation, BLM, and USDA-NRCS salinity control measures to the extent that each unit remains viable and appropriately cost-effective. 2. Completion of activities implemented under the cooperative agreements between Reclamation and the States of Colorado, Utah, and Wyoming. 3. Implementation of the Forum's recommended and adopted policies for effluent limitations, principally under the NPDES permit program established by Section 402 of the Clean Water Act as amended. The implemented policies (included in Appendix B of this Review) are the following: Policy for Implementation of Colorado River Salinity Standards Through the NPDES Permit Program; NPDES Permit Program for Implementation of Colorado River Salinity Standards; Policy for Use of Brackish and/or Saline Waters for Industrial Purposes; Policy for Implementation of the Colorado River Salinity Standards Through the NPDES Permit Program for Intercepted Ground Water; and Policy for Implementation of the Colorado River Salinity Standards Through the NPDES Permit Program for Fish Hatcheries. 4. Implementation of non-point source management plans developed by the states and approved by the USEPA. The Program is a unique cooperative watershed effort between several federal agencies and seven states designated to meet national, international and state water quality objectives. Item 1 of the plan listed above is to be implemented by federal agencies in conjunction with state, local, and private participants. The Forum works jointly with federal agencies on developing measures to be implemented. The Forum also urges Congress to ensure that the funds necessary to successfully fulfill this plan of implementation are appropriated as needed. Item 2 above involves the expenditure of cost sharing funds required by The Act to be obtained from the Upper Colorado River Basin Fund and the Lower Colorado River Basin Development Fund. Items 3 and 4 above are primarily implemented by each of the Basin states. The water quality standards involve both a plan of implementation and numeric criteria. With the plan of implementation as proposed in this review in place, the probability of exceeding the numeric criteria is low based on Reclamation computer model simulations. The analysis indicates the probability of exceedance of the numeric criteria with the plan of implementation in place in the next three years at the Hoover Dam, Parker Dam and Imperial Dam stations is 1% or less. This low probability of exceedance opportunity was an important factor in the Forum’s decision to adopt the plan of implementation accompanying this review.

560. **Water Quality Standards for Salinity: Colorado River System, 2011 Review**.
Colorado River Basin Salinity Control Forum, Colorado River Basin Salinity Control Forum, 99 p. (2011).
http://www.coloradoriversalinity.org/docs/2011%20REVIEW-October.pdf
Keywords: water quality/ water salinization/ rivers/ saline water/ hydrology/ models/ conservation practices/ government programs and practices
Abstract: This is a review of the water quality standards for salinity for the Colorado River. Section 303 of the Clean Water Act requires that water quality standards be reviewed from time to time, but at least once during each three-year period. Accordingly, the seven-state Colorado River Basin Salinity Control Forum has reviewed the existing state-adopted and EPA approved water quality standards for salinity consisting of numeric criteria and a Plan of Implementation. During the period of the 2008 Review, the Colorado River Basin Salinity Control Act was amended to include the Basin States Program. The salinity model continues to be improved in order to provide the best salinity projections for this review. Upon adoption by the Forum, this review will be submitted to each of the Basin States for consideration as each state proceeds with its three-year water quality review process. The Forum recommends no change in the numeric salinity criteria at the three stations located on the lower main stem of the Colorado River. The numeric criteria at these stations will remain: (Station / Salinity in mg/L - Flow-weighted average annual salinity): Below Hoover Dam / 723 mg/L; Below Parker Dam /

747 mg/L; At Imperial Dam / 879 mg/L. The Plan of Implementation is intended to maintain the salinity concentrations at or below the numeric criteria while the Basin States continue to develop their compact-apportioned waters. Reclamation's computer model runs indicate there is little probability of the numeric criteria being exceeded in the next three years. The Act requires the implementation of salinity control programs to reduce the salinity of the Colorado River. Reducing the salinity of the Colorado River reduces economic damages. The Plan of Implementation included in this Review, while insuring the numeric criteria will not be exceeded during the review period, also recognizes additional salinity control further reduces economic damages in the Lower Basin, as well as providing additional benefits in the Upper Basin. The Forum's Plan of Implementation includes: 1. Construction of salinity control measures by Reclamation, USDA, the Basin States Program and BLM to the extent that those measures remain viable and appropriately cost-effective. 2. Application of the Forum-adopted policies by each of the states (the text of the policies are included in Appendix A of this review). 3. Implementation of non-point source management plans developed by the states and approved by EPA. The Colorado River Basin Salinity Control Program is a unique cooperative watershed effort between several federal agencies and seven states designated to meet national, international and state water quality objectives. The Forum participates with federal, state, local agencies and private participants to ensure the Plan of Implementation is implemented. The Forum also urges Congress to appropriate the funds needed for implementation and recommends legislative changes when necessary. The water quality standards involve both a Plan of Implementation and numeric criteria. With the Plan of Implementation as proposed in this review in place, the probability of exceeding the numeric criteria is low based on Reclamation computer model simulations. The analysis indicates the probability of exceedance of the numeric criteria with the Plan of Implementation in place in the next three years at the Hoover Dam, Parker Dam and Imperial Dam stations is 1 percent or less and, with the Plan in place, probabilities stay below 5 percent through the 20-year evaluation period. This low probability of exceedance opportunity was an important factor in the Forum's decision to adopt the Plan of Implementation accompanying this review.

561. **Water salinization in arid regions -- observations from the Negev desert, Israel**.
Nativ, R., Adar, E., Dahan, O. and Nissim, I.
Journal of Hydrology 196: 271-296 (1997).
ISSN: 0022-1694
http://dx.doi.org/10.1016/S0022-1694(96)03260-X
Keywords: limestone/ sodium chloride/ groundwater movement/ Israel/ Negev Desert/ arid lands/ deserts/ chemical processes/ evaporation/ bicarbonates/ aeration zone/ vadose water/ ion exchange/ salinization
Abstract: The processes affecting salinization of precipitation, surface water, vadose water and groundwater were studied in the Negev desert, Israel. Observations spanning 18 years included the collection of rainfall at three rain sampling stations, flood water at six flood stations, vadose water from four coreholes penetrating chalk formations, and groundwater from 16 monitoring wells tapping the chalk aquitard. Dissolved carbonate dust and evaporation of the falling raindrops result in Ca(HCO sub(3)) sub(2) facies and increased ion concentration of the rainwater with respect to inland, more humid regions. The exposure of flood water to evaporation during flood events is minimal. The observed Ca(HCO sub(3)) sub(2) facies and salt enrichment by a factor of three to five in the flood water with respect to precipitation results primarily from interactions of the flood water with the chalk and limestone bedrock, including ion exchange on Na- and K-bearing minerals and the dissolution of calcite, gypsum and halite. The presence of these salts at and near land surface results from the complete evaporation of rainwater in land surface depression storage areas following most rain events. Except for a small portion moving through the low permeability chalk matrix, most of the vadose water moves through preferential pathways and is typically not exposed to evaporation. This dual movement of water accounts for the NaCl facies of vadose water and the variable rates of isotopic depletion and salt dilution observed in the underlying heterogeneous groundwater in the saturated zone. Although the variable mixing with low-salinity, isotopically depleted water percolating from the fractures accounts for the depleted isotopic composition of the groundwater, its

relatively low solute content cannot modify the groundwater NaCl facies. Consequently, only groundwater salinity in the chalk is reduced by the preferentially flowing water, but the Ca(HCO sub(3)) sub(2) facies prevailing in the rainwater and flood water disappears, and the NaCl imprint from the vadose zone prevails.
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562. **Water Supply Reliability as Influenced by Natural Salt Pollution**.
Wurbs, R. A.
Journal of the Universities Council on Water Resources 108: 116-126 (1997).
http://bit.ly/11dfqxC
Keywords: water salinization/ water resources/ rivers/ water quality/ water management/ watershed management
Abstract: Natural salt pollution is the primary water quality problem constraining water resources management in several major river basins in the southwestern United States. The Arkansas, Brazos, Canadian, Colorado, Red, and Rio Grande Rivers supply agricultural, municipal, industrial, and environmental water needs in the states of Arkansas, Colorado, Kansas, Louisiana, New Mexico, Oklahoma, and Texas. Water management is governed largely by salinity in this region of increasing demands on limited water resources. Salinity severely limits the use of large quantities of water in major river/reservoir systems. The primary sources of salt loads in the rivers are geologic formations underlying portions of their upper watersheds. Federal, state, and local water agencies and university researchers have investigated various aspects of the salinity problem. The Corps of Engineers and other entities continue to perform feasibility studies and, in some cases, implement projects for controlling the runoff from primary salt source subwatersheds. The U.S. Geological Survey has conducted water quality sampling programs in support of the natural salt pollution control studies.

563. **Water-quality data analysis of the upper Gunnison River watershed, Colorado, 1989–99**.
Gurdak, J. J., Greve, A. I. and Spahr, N. E.
U.S. Geological Survey Water-Resources Investigations Report, 61 p. (2002).
http://pubs.usgs.gov/wri/wri02-4001/
Keywords: water quality/ surface water/ groundwater/ phosphorus/ ammonia/ nitrate/ land use/ metals/ mining/ sediment/ biochemical oxygen demand
Abstract: Water-Resources Investigations Report 02-4001. Water-quality data from October 1969 to December 1999 for both surface water and ground water in the upper Gunnison River watershed were retrieved and compiled from the U.S. Geological Survey National Water Information System and the U.S. Environmental Protection Agency Storage and Retrieval databases. Analyses focused primarily on a subset of these data from October 1989 to December 1999. The upper Gunnison River watershed is located west of the Continental Divide in the Southern Rocky Mountains physiographic province. Surface-water-quality data were compiled for 482 sites in the upper Gunnison River watershed. Most values of surface-water temperature, dissolved oxygen, and pH were within Colorado Department of Public Health and Environment (CDPHE) in-stream standards. Calcium bicarbonate type water was the most spatially dominant water type in the basin. Nutrients were most commonly sampled along the Slate River and East River near Crested Butte and along the Gunnison River from the confluence of the East and Taylor Rivers to the western edge of the watershed. Median ammonia concentrations were low, with many concentrations less than laboratory reporting levels. All nitrate concentrations met the CDPHE in-stream standard of 10 milligrams per liter. More than 30 percent of stream sites with total phosphorus data (23 of 61 sites) had concentrations greater than the U.S. Environmental Protection Agency (USEPA) recommendation for controlling eutrophication. Ammonia concentrations at a site on the Slate River near Crested Butte had a statistically significant upward trend for the 1995-99 period. The Slate River near Crested Butte site is located immediately downstream from the towns of Crested Butte and Mount Crested Butte and may reflect recent population growth or other land-use changes. However, the rate of change of the trend is small (0.017 milligram per liter per year). Although a multiple comparison test showed nitrate concentrations were statistically different between agriculture and forest sites and between agriculture and urban land-use classified sites, median concentrations were low among all land-use settings. Median concentrations of total phosphorus were greatest in rangeland areas and least in urban

areas. No significant differences were identified for median concentrations of total phosphorus in agriculture and forest land-use areas. Median concentrations of arsenic, lead, mercury, selenium, and silver were low or below reporting levels throughout the watershed. Aluminum, cadmium, copper, lead, manganese, and zinc concentrations were elevated near the town of Crested Butte and on Henson Creek upstream from Lake City, which may be explained by upstream areas of historical mining. Samples for six trace elements exceeded standards: cadmium, copper, lead, manganese, silver, and zinc. A downward trend (3 micrograms per liter per year) was identified for the dissolved iron concentration at a site on the Gunnison River at County Road 32 downstream from the city of Gunnison. Streambed-sediment samples from areas affected by historical mining also had elevated concentrations of some trace elements. Chlorophyll-a concentrations in samples from Blue Mesa Reservoir and streams in the Crested Butte and Gunnison areas were typical of unenriched to moderately enriched conditions. Median concentrations of 5-day biochemical oxygen demand concentrations for sites between Crested Butte and Blue Mesa Reservoir were less than 2 milligrams per liter. Occasional high (greater than 200 counts per 100 milliliters)

564. **Weathering of a gypsum-calcareous mudstone under semi-arid environment at Tabernas, SE Spain; laboratory and field-based experimental approaches**.
Canton, Y., Sole-Benet, A., Queralt, I. and Pini, R.
CATENA 44: 111-132 (2001). ISSN: 0341-8162
http://instructional1.calstatela.edu/ckhachi/weathering/Caton_etal_2001.pdf
Keywords: anions/ badlands/ bassanite/ Cenozoic/ clastic rocks/ cyclic processes/ dehydration/ deserts/ El Cautivo basin/ eolian features/ erosion features/ erosion rates/ experimental studies/ field studies/ geomorphology/ gypsum/ hexahydrite/ hydration/ laboratory studies/ landscapes/ loeweite/ major elements/ migration of elements/ mineral composition/ mudstone/ Neogene/ pore size/ porosity/ salt weathering/ sediment yield/ sedimentary rocks/ semi-arid environment/ size distribution/ Spain/ sulfates/ Tabernas Desert/ terrestrial environment/ thin sections/ trace elements/ upper Miocene/ weathering

Abstract: The weathering of a Late Miocene gypsum-calcareous mudstone outcropping in large badland areas of SE Spain, under a semi-arid Mediterranean climate, was studied by means of two experimental approaches. Field and laboratory experiments were carried out to reproduce, though in accelerated form, some of the weathering conditions of the consolidated mudstone. In the laboratory, three sequences of 5, 10 and 20 wetting-drying cycles were produced on undisturbed blocks of fresh mudstone samples. At the end of the three sequences, samples were analysed for their micromorphology, elemental and soluble salt chemistry, and total mineralogy. Unweathered dry samples, as blanks, and permanently wet samples were also analysed. In the field, two small plots of freshly exposed mudstone were monitored over 3 years for their response to natural weathering in terms of morphological changes and sediment output. The porosity was increased by a few wetting-drying cycles, as assessed by significant increases in water absorption capacity of the mudstone. A combination of three factors is responsible for mudstone weathering: repeated cycles of wetting-drying, the presence of geologically-induced cracks and fissures, and dissolution-crystallisation of relatively soluble minerals, gypsum being the most abundant within this category. A few wetting-drying cycles were sufficient to reveal ion migration (specially Na (super +), Ca (super ++), Mg (super ++), SO (sub 4) (super -), HCO (super -) and Cl (super -)) within the mudstone, explaining mineral dissolution. In the field, surface weathering rates from 0.7 to 8 mm year (super -1) were measured. Weathering rates were found to be proportional to the number of rainfall events during the sampling periods, confirming what was found in laboratory conditions, namely, that the number of wetting-drying cycles has the greatest influence on weathering. These weathering rates might be considered as the probable range of incision rates under present semi-arid conditions.
This citation is from California State University.

565. **Wind and water erosion and transport in semi-arid shrubland, grassland and forest ecosystems: quantifying dominance of horizontal wind-driven transport**.
See record 338 in Surface Water Transport Processes.

566. **The Yearly Circulation of Chloride and Sulfur in Nature; Meteorological, Geochemical and Pedological Implications. Part II**.
Eriksson, E.
Tellus 12: 63-109 (1960). ISSN: 0040-2826
http://dx.doi.org/10.1111/j.2153-3490.1960.tb01284.x
Keywords: biogeochemical cycles/ chlorides/ sulfates/ soil nutrient dynamics/ soil transport processes

Abstract: The yearly global circulation of sea salts between continents and oceans can be estimated in several ways. One is by actually measuring the yearly amounts brought down on land by available techniques. It is clear from the preceding chapter that this is technically difficult. *This citation is from the International Meteorological Institute.*

567. **Advances in the use of polyacrylamide (PAM) for soil and water management: Third joint symposium**.
Delgado, J. A., Cox, C. A., Sojka, R. E. and Busscher, W. J.
Journal of Soil and Water Conservation 58: 269 p. (2003).
Keywords: disturbed soils/ polyacrylamide/ soil conditioners/ watershed management
Abstract: This edition of the Journal of Soil and Water Conservation includes papers presented at two symposia-the 2002 annual conference of the Soil and Water Conservation Society (SWCS) held in Indianapolis, Indiana and the Soil Science Society of America (SSSA) held in Indianapolis, Indiana. Together, these joint symposia, that addressed advances in the use of polyacrylamide (PAM) for soil water management, mark the third annual joint symposium organized by the two Societies and presented at both societies' annual meetings. The nine oral and eleven poster presentations provided technical background on recent advances in PAM technology for conservationists working to improve soil and water conservation practices. These joint symposia demonstrate how important and relevant the partnership between practitioner conservationist and scientist is to soil and water conservation, agriculture, and the environment. The manuscripts cover topics about the advances of PAM and potential uses to reduce erosion. PAM is currently being used to reduce erosion on irrigated agriculture in several different countries.
This citation is from the Soil and Water Conservation Society.

568. **Application of Superabsorbent Polymers for Improving the Ecological Chemistry of Degraded or Polluted Lands**.
Hüttermann, A., Orikiriza, L. J. B. and Agaba, H.
CLEAN – Soil, Air, Water 37: 517-526 (2009).
ISSN: 1863-0669
http://dx.doi.org/10.1002/clen.200900048
Keywords: biodegradation/ environmental safety/ evapotranspiration/ heavy metals/ hydrogels/ land degradation/ mitigation/ plant growth/ salinity/ superabsorbent polymers/ water stress
Abstract: About 3.5 billion ha of land, which amounts to almost 30% of the total solid land of the world, has been degraded by human activities. The ecological restoration of these lands is a major challenge for mankind since they are the only option left for increasing the amount of arable land and producing food for the ever growing worldwide population. One common feature of these degraded lands is the fact that their organic soil matter is degraded also. Rainfall therefore, changes from a blessing to a menace since it is not kept in the soil and therefore causes erosion. A solution for the restoration of these lands could be the application of superabsorbent polymers (SAPs) to these soils. These substances are like 'artificial humus' as they are hydrophilic and contain carboxylic groups. This enables them to bind cations and water. They have the following advantages for the restoration of degraded lands. They increase the plant available water in the soil which enables the plants to survive longer under water stress. SAP amendment to soils reduces the evapotranspiration rate of the plants. They induce a significantly higher growth rate in plants growing on SAP amended soil. They bind heavy metals and mitigate their action on plants. They mitigate the effects of salinity. The benefits of SAP amendment to soils substantially outweigh their costs.
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569. **Arbuscular mycorrhizal fungi improve reestablishment of *Leymus chinensis* in bare saline-alkaline soil: Implication on vegetation restoration of extremely degraded land**.
Zhang, Y. F., Wang, P., Yang, Y. F., Bi, Q., Tian, S. Y. and Shi, X. W.
Journal of Arid Environments 75: 773-778 (2011). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2011.04.008
Keywords: AM fungi rehabilitation/ root-shoot ratio/ soil alkalinization/ soil disturbance/ soil salinization
Abstract: Salinization and alkalinization are increasing problems in the world. Some land has been degraded to bare saline-alkaline soil where vegetation restoration is difficult because high toxic ionic content and pH are harmful to the survival of introduced plants. We grew *Leymus chinensis* with and without arbuscular

mycorrhizal fungi (*Glomus mosseae* and *G. geosporum*) in either pots filled with soil from bare saline-alkaline land, or transplanted seedlings into field plots, to determine the influence of AM fungi on the reestablishment of this dominant grass species in bare degraded land. Association with AM fungi increased the absorption of N, P, K+, Ca2+, but decreased Mg2+, Na+ and Cl− uptake under saline-alkaline stress. Therefore, higher K/Na, Ca/Na, P/Na, and P/Cl ratios were found in the inoculated plants. Plants inoculated with AM fungi accumulated significantly higher biomass, root/shoot ratio and tiller number than non-inoculated plants. AM fungi also significantly increased the survival of seedlings when they were transplanted into a bare saline-alkaline land in the field. The improvement of survival, growth and asexual reproduction of inoculated plants indicated that the plant-AM fungi mutualism could improve the reestablishment of vegetation in bare saline-alkaline soil, drive the vegetation restoration to a community dominated by original species.
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570. **Australia's National Action Plan for Salinity and Water Quality: A retrospective assessment**.
Pannell, D. J. and Roberts, A. M.
Australian Journal of Agricultural and Resource Economics 54: 437-456 (2010). ISSN: 1467-8489
http://dx.doi.org/10.1111/j.1467-8489.2010.00504.x
Keywords: environment/ institutions/ integrated catchment management/ mechanism choice/ natural resource management/ policy
Abstract: Perceptions of a salinity 'crisis' in Australia around 2000 resulted in the establishment of a major national program that aimed to prevent, stabilize, and reverse trends in salinity. The National Action Plan for Salinity and Water Quality allocated A$1.4 billion of public funds to 1700 projects over 7 years. Here, we assess the performance of the program in relation to 12 features that we propose as being essential for programs that aim to address complex environmental problems. The features include use of technical information to guide investment prioritization, use of socio-economic information, effective integration of information for prioritization, selection of appropriate targets, choice of appropriate policy mechanisms, and provision of incentives and support to environmental managers to pursue environmental outcomes cost effectively. Our assessment reinforces findings from a number of public reviews that found serious weaknesses in the program. Overall, with a few exceptions, projects under the National Action Plan generated few worthwhile salinity mitigation benefits and will have little enduring benefit. This was readily foreseeable given attention to the scientific and economic knowledge of salinity available at the time the program was developed. © 2010 The Authors. (AJARE) © 2010 Australian Agricultural and Resource Economics Society Inc. and Blackwell Publishing Asia Pty Ltd.
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571. **Bioindicator capacity of trees towards dryland salinity**.
Mitloehner, R. and Koepp, R.
Trees 21: 411-419 (2007).
http://dx.doi.org/10.1007/s00468-007-0133-3
Keywords: rangelands/ range management/ indicator species/ soil salinity/ trees
Abstract: To investigate plant–soil reactions towards site salinity we chose Ruprechtia triflora as the dominant tree species in its natural habitat in dry forests of Paraguay. We applied freezing point osmometry to measure tree leaves and soil samples identically on the basis of colligative solute properties. In order to substantiate the first field findings, the relation of tree and soil in terms of salinity was further investigated under controlled conditions in the greenhouse. R. triflora shows extreme osmotic adaptability. In three independent greenhouse experiments with NaCl application, Ruprechtia seedlings and later Eucalyptus dunnii seedlings from E Australia (for inter-species comparison) showed highly significant responses to their soil salinities. We conclude that tree leaves can serve as bioindicator for soil salinity within the tree's rhizosphere.

572. **Cheatgrass control and seeding**.
Young, J. A. and Clements, C. D.
Rangelands 22: 3-7 (2000). ISSN: 0190-0528
https://journals.uair.arizona.edu/index.php/rangelands/article/view/11466/10739
Keywords: seeding/ weed control/ herbicides/ invasive plants/ grasses/ management practices
Abstract: Currently, there is a rebirth of interest in using herbicides to control the invasive annual cheatgrass in conjunction with seeding perennial

grasses, forbs, and shrubs to restore what once were big sagebrush/bunchgrass plant communities. This work is being conducted by a new generation of range scientists who may benefit from knowledge of how some of the basic principles of herbaceous range weed control were established. This is a brief account of the development of several of the basic principles of herbaceous range weed control conducted in conjunction with seeding perennial grasses.
This citation is from the University of Arizona Institutional Repository.

573. **Corrigendum to: The potential for developing fodder plants for the salt-affected areas of southern and eastern Australia: An overview**.
Rogers, M. E., Craig, A. D., Munns, R. E., Colmer, T. D., Nichols, P. G. H., Malcolm, C. V., Barrett-Lennard, E. G., Brown, A. J., Semple, W. S., Evans, P. M., Cowley, K., Hughes, S. J., Snowball, R., Bennett, S. J., Sweeney, G. C., Dear, B. S. and Ewing, M. A.
Australian Journal of Experimental Agriculture 46: 1665 (2006). ISSN: 0816-1089
http://dx.doi.org/10.1071/EA04020_CO
Keywords: fodder/ saline soils/ salinity tolerance/ Australasia/ Australia/ Animalia/ Poaceae
Abstract: This paper reviews the major issues that impact upon the development of improved fodder species for saline environments across temperate Australia. It describes past and present research that has been, or is being, undertaken towards improvements in salt tolerance in forage species within Australia in relation to the principal regions where salinity occurs. It includes a discussion on the mechanisms of salt tolerance in plants. An extensive list of known or potential salt-tolerant fodder species is provided and the key opportunities for advancement within each of the 4 major forage groups: grasses, legumes, herbs and shrubs are discussed. Constraints to developing new salt and waterlogging tolerant fodder species are identified. A number of recommendations are made for research that should ensure that Australian producers have access to a new array of productive fodder species suited to saline environments. © CSIRO 2006.
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574. **Cost/benefit considerations for recent saltcedar control, Middle Pecos River, New Mexico**.
Barz, D., Watson, R. P., Groeneveld, D. P., Kanney, J. F. and Roberts, J. D.
Environmental management 43: 282-298 (2009). ISSN: 0364-152X
http://dx.doi.org/10.1007/s00267-008-9156-9
Keywords: saltcedar control/ cost/benefit/ erosion/ sedimentation/ water management/ economics/ *Tamarix*/ tamarisk
Abstract: Major benefits were weighed against major costs associated with recent saltcedar control efforts along the Middle Pecos River, New Mexico. The area of study was restricted to both sides of the channel and excluded tributaries along the 370 km between Sumner and Brantley dams. Direct costs (helicopter spraying, dead tree removal, and revegetation) within the study area were estimated to be $2.2 million but possibly rising to $6.4 million with the adoption of an aggressive revegetation program. Indirect costs associated with increased potential for erosion and reservoir sedimentation would raise the costs due to increased evaporation from more extensive shallows in the Pecos River as it enters Brantley Reservoir. Actions such as dredging are unlikely given the conservative amount of sediment calculated (about 1% of the reservoir pool). The potential for water salvage was identified as the only tangible benefit likely to be realized under the current control strategy. Estimates of evapotranspiration (ET) using Landsat TM data allowed estimation of potential water salvage as the difference in ET before and after treatment, an amount totaling 7.41 million m3 (6010 acre-ft) per year. Previous saltcedar control efforts of roughly the same magnitude found that salvaged ET recharged groundwater and no additional flows were realized within the river. Thus, the value of this recharge is probably less than the lowest value quoted for actual in-channel flow, and estimated to be < $63,000 per year. Though couched in terms of costs and benefits, this paper is focused on what can be considered the key trade-off under a complete eradication strategy: water salvage vs. erosion and sedimentation. It differs from previous efforts by focusing on evaluating the impacts of actual control efforts within a specific system. Total costs (direct plus potential indirect) far outweighed benefits in this simple comparison and are expected to be ongoing. Problems induced by saltcedar control may permanently reduce reservoir capacity and increase reservoir

evaporation rates, which could further deplete supplies on this water short system. These potential negative consequences highlight that such costs and benefits need to be considered before initiating extensive saltcedar control programs on river systems of the western United States. © 2008 Springer Science+Business Media, LLC.
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575. **Degradation and recovery processes in arid grazing lands of central Australia. Part 1: soil and land resources**.
Tongway, D. J., Sparrow, A. D. and Friedel, M. H.
Journal of Arid Environments 55: 301-326 (2003). ISSN: 0140-1963
http://dx.doi.org/10.1016/S0140-1963(03)00025-9
Keywords: geomorphic strata/ erosion/ deposition/ nutrient cycling/ hydrological processes/ patterns
Abstract: The distribution and quality of soil and land resources in heterogeneous grazing lands of central Australia were changed by grazing. Sites located at increasing distances from livestock watering points showed greater degrees of landscape organization and soil productive potential. The depositional strata, where resources tended to accumulate, occupied a larger proportion of the landscape as distance increased. Physical and nutrient cycling soil properties improved. All soil chemistry variables except pH and electrical conductivity increased and the trend was most apparent in the top 1 cm of the soil. Increasing erosion closer to water was a key degrading process. We showed degradation to be a systematic decline in regulation of scarce resources, which had implications for potential productivity.
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576. **Development of practical site-specific management methods for reclaiming salt-affected soil**.
Horney, R. D., Taylor, B., Munk, D. S., Roberts, B. A., Lesch, S. M. and Plant, R. E.
Computers and Electronics in Agriculture 46: 379–397 (2005).
http://herman.marc.usda.gov/SP2UserFiles/Place/53102000/pdf_pubs/P2069.pdf
Keywords: salinity/ electrical conductivity/ electromagnetic induction/ EM38/ saline-sodic soils/ soil reclamation
Abstract: Sustaining irrigated agricultural production systems in semi-arid and arid regions requires consideration of with saline and sodic soil conditions. The spatial variability of these conditions makes soil reclamation an ideal practice in which to apply site-specific management (SSM). We discuss an application of SSM in which preliminary measurements of apparent soil electrical conductivity (ECa), supplemented by ECa-directed soil sampling, are used to construct a GIS map of salinity zones on which site-specific amendment application can be based. Our primary objective was to develop afield-implementable methodology for site-specific soil amendment application. The focus of the pro-gram was on cotton production, although the method should be applicable to other crops. A second objective was to establish experiments to test the effectiveness of this program. Evaluating the effectiveness of a sprinkler application for the first irrigation was incorporated as a part of this program in hopes of reducing variability due to poor germination. This study consisted of two commercial fields located in the San Joaquin Valley of California. Based on the consideration that ECais directly related to electrical conductivity from soil saturation paste extract (ECe) for known saline-sodic conditions, we developed a four-step method for site-specific salinity management in commercial fields. The steps included the following: (1) generation of an ECamap; (2) directed soil sampling for ECe; (3) determination of the estimated amendment requirement as a function of location in the field; and (4) integration of the individual amendment requirements into a practical spatial pattern for amendment application. Cotton yield monitors were utilized to indicate spatial yield variation throughout the replicated plots instead of aggregated yield values. Because of the high levels of variability in these commercial fields and the time required for amendments to have a substantial effect, we can provide only short-term results of these experiments. In both of the experiments no significant differences existed between the irrigation and amendment treatments (p> 0.05), but increased yield trends supported the benefit of sprinkler application of the first irrigation. A Scheffe test of the cotton yield monitor data indicated significant yield differences between in-plot treatment zones.
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577. **Diagnosis and Improvement of Saline and Alkali Soils**.
See record 5 in Rangeland Management Practices and Potential Impact on Salinity.

578. **Drainage for salinity control at Pithara**.
Cox, N. M.
Salinity and land use impacts series, Perth, Australia, Department of Water, 94 p. (2010).
http://www.water.wa.gov.au/PublicationStore/first/76905.pdf
Keywords: watershed management/ water salinization/ surface drainage/ groundwater/ water table/ rivers/ soil salinization
Abstract: A single groundwater drainage scheme slightly reduced but was unable to totally prevent the risk of dryland salinity in a Wheatbelt trial funded by the Engineering Evaluation Initiative. While the drainage removed saline groundwater it did not sufficiently lower the water table beneath the land targeted for salinity recovery. Deep open drains have been constructed in many catchments in Western Australia and are increasingly seen as useful for draining groundwater with the aim of reducing land salinisation. As drain effectiveness remains unclear, the factors that contribute to the success or otherwise of these drainage schemes were not well understood and knowledge was not being transferred from one scheme to another. The Pithara drainage project assessed the practicality of lowering the watertable beneath a saline valley floor for the recovery of agricultural land for dryland cereal cropping. In 2004, 18 kilometres of 2.5 m deep groundwater drain were dug to manage a growing salinity problem in the valley floor of a small Wheatbelt catchment east of Pithara. The mainly single drains wound their way along the valley floors and discharged directly into a naturally saline watercourse. The drains contributed to small reductions in the watertable height that lead to some improvement in land condition but not enough to allow for dryland cereal cropping. To allow for cropping the watertable needed to fall an additional half to one metre below its original height. Drain discharge water quality varied markedly with discharge rates. Highly saline and acidic discharges were associated with low flow conditions while higher flows both diluted salts and neutralised acidity. Of the total water drained during 2004–06, 85% was from groundwater with most of the surface water inflows originating from one severe storm event.

579. **Dryland management for salinity control**.
See record 127 in Subsurface Transport Processes.

580. **Dryland salinity: Early indicators and control measures**.
Chaffey, R. E., Reilly, L. and Strudwick, D. G.
Melbourne, Vic. (Australia), Department of Agriculture, 56 p. 1992.
Keywords: soil fertility/ soil erosion/ soil conservation/ reclamation/ agricultural ecology/ salinization/ soil degradation
Abstract: Salinity is one of the most pressing environmental problems facing Victoria, with more than 300, 000 ha (about 2 percent of agricultural land) being salt-affected. An overview is given of what dryland salinity is, why it has become a problem and how it can be overcome. Processes controlling water balance in different parts of Victoria can affect the optimum management strategy for each region.
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581. **Ecological and functional roles of mycorrhizas in semi-arid ecosystems of Southeast Spain**.
Barea, J. M., Palenzuela, J., Cornejo, P., Sánchez-Castro, I., Navarro-Fernández, C., Lopéz-García, A., Estrada, B., Azcón, R., Ferrol, N. and Azcón-Aguilar, C.
Journal of Arid Environments 75: 1292-1301 (2011). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2011.06.001
Keywords: biodiversity/ community dynamics/ drought stress/ revegetation/ soil quality
Abstract: Mycorrhizas are worldwide symbiotic associations established between certain soil fungi and most vascular plants and are fundamental in optimizing plant fitness and soil quality. Mycorrhizal symbioses improve the resilience of plant communities against environment stresses, including nutrient deficiency, drought and soil disturbance. Since these stresses are paramount in the degradation of semi-arid ecosystems in the SE Spain, a series of basic, strategic and applied studies have been made to ascertain how the activity and diversity of mycorrhizal fungi affect plant community composition, structure and dynamics in this region. These investigations are reviewed here in terms of: (i) analysing the diversity of mycorrhizal fungi; (ii) assessing the ecological and functional interactions among plant

communities and their associated mycorrhizal fungal populations; and (iii) using mycorrhizal inoculation technology for the restoration of degraded semi-arid areas in Southeast Spain. Disturbance of the target semi-arid ecosystems decreases the density and diversity of mycorrhizal fungust populations. Nevertheless, the mycorrhizal propagules do not disappear completely suggesting a certain degree of stress adaptation, and these remaining, resilient ecotypes are being used as plant inoculants. Numerous field experiments, using plant species from the natural succession inoculated with a community of indigenous mycorrhizal fungi, have been carried out in revegetation projects in the semi-arid Iberian Southeast. This management strategy improved both plant development and soil quality, and is a successful biotechnological tool to aid the restoration of self-sustaining ecosystems. However, despite a 20-year history of this work, we lack a comprehensive view of the mycorrhizal potential to improve the composition, diversity, structure and functionality of drought-adapted plant communities in the Region.
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582. **Effect of polyacrylamide additions on infiltration and erosion of disturbed lands**.
Vacher, C. A., Loch, R. J. and Raine, S. R.
Australian Journal of Soil Research 41: 1509-1520 (2003).
http://www.publish.csiro.au/?paper=SR02114
Keywords: sediment/ rehabilitation/ stabilization/ rehabilitated areas/ rainfall simulation/ soil conditioners/ molecular weight/ furrow erosion/ water quality/ amendments/ management practices/ emergence/ runoff
Abstract: The removal of vegetation and disturbance of the soil surface due to a range of human activities results in the potential for soil structure degradation and sediment movement. Polyacrylamides have been used to improve infiltration and reduce erosion on agricultural lands. However, they are not commonly used as part of management and rehabilitation programs on land disturbed by construction or mining activities in Australia. A study was undertaken to investigate the potential for polyacrylamides to improve infiltration and reduce erosion of soil material from 3 Australian mine sites. The polyacrylamides were found to significantly ($P < 0.05$) increase total infiltration under rainfall, reduce surface hardness, and reduce sediment entrainment and erosion by both rainfall and overland flows. The effectiveness of the polyacrylamide was found to be related to clay content of the soil as well as the molecular weight and charge density of the polyacrylamide. The implications of these results for the management and rehabilitation of disturbed lands are discussed.
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583. **The effect of polyacrylamide on runoff, erosion, and cotton yield from fields irrigated with moving sprinkler systems**.
Levy, G. J., Benhur, M. and Agassi, M.
Irrigation Science 12: 55-60 (1991).
http://dx.doi.org/10.1007/BF00190010
Keywords: infiltration rate/ water infiltration/ raindrop impact/ crusts/ formation/ soil/ energy/ salinity
Abstract: Irrigation with self-propelled moving sprinkler irrigation system (MSIS) enhances seal formation at the soil surface and results in large amounts of runoff and erosion which are aggravated by the MSIS high water application rate and reflected in lower yields. The effect of polyacrylamide (PAM) application (at the equivalent rate of 20 kg ha-1), prior to the irrigation season, on runoff and erosion from bare soil and soil covered with a crop, as well as on cotton yield was studied in a clay loam vertisol (Typic Chromoxert) and a slit loam loess (Calcic Haploxeralf). A center pivot and a lateral MSIS were used in the vertisol and loess, respectively. Vegetative growth of cotton plants in the vertisol was inversely related to water application intensity, which in turn affects runoff. PAM significantly reduced runoff in both the bare and crop-covered soils. The runoff level from the PAM treatments was 50-70% of that of the control. PAM also reduced erosion especially in the vertisol soil. However, the amount of eroded material carried by a unit runoff was similar in both treatments for both soils, indicating that PAM influences erosion by reducing runoff levels. A trend whereby PAM increased yield of cotton (Gossypium hirsutum L., cv. Pima S5) compared with the control was observed. Our results suggest that, under irrigation with a MSIS, reducing runoff is essential for obtaining higher yields. PAM is suggested as an effective tool to attain this target.

584. **Effects of Vesicular–Arbuscular Mycorrhizae on *Distichlis spicata* Under Three Salinity Levels**.
Bach Allen, E. and Cunningham, G. L.
New Phytologist 93: 227-236 (1983). ISSN: 1469-8137
http://dx.doi.org/10.1111/j.1469-8137.1983.tb03427.x
Keywords: salt tolerance/ halophytes/ *Sporobolus airoides*/ mycorrhizae/ *Distichlis spicata*/ soil salinity
Abstract: Inland and coastal populations of the salt-tolerant plant *Distichlis spicata* were grown under three salinity levels (0, 1000 and 2000 mg Na+ added kg−1 soil as NaCl) with and without inoculum of vesicular–arbuscular mycorrhizae. Mycorrhizal infection averaged 28% for the inland plants and 9% for the coastal plants, and was unaffected by soil salinity. Dry mass of non-mycorrhizal plants was significantly higher at the low salinity for inland plants and at the intermediate salinity for coastal plants. Mycorrhizal roots had higher Na concentrations than did non-mycorrhizal roots, but also had higher K and P concentrations, and thus maintained a high K/Na ratio. Leaf concentrations of Na were similar in mycorrhizal and non-mycorrhizal plants. Excretion by salt glands may serve to maintain constant leaf Na concentrations. Stomatal conductances were the same for mycorrhizal and non-mycorrhizal plants at all salinities. While mycorrhizae had little effect on *D. spicata* in this short-term greenhouse experiment, a full evaluation might require long-term field observations.
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585. **Emergence and root-growth of 3 pregerminated cool-season grasses under salt and water-stress**.
Mueller, D. M. and Bowman, R. A.
Journal of Range Management 42: 490-495 (1989).
https://journals.uair.arizona.edu/index.php/jrm/article/view/8424/8036
Keywords: saline soils/ vegetation/ salt stress/ rangelands/ soil water/ soil treatment
Abstract: Reclaiming salt-affected soils under semiarid conditions without irrigation is difficult. High salt concentrations both delay and decrease germination and emergence, which increases the time a soil must remain moist for germination and emergence to take place. Delayed germination can also affect a plant's capability to withstand summer drought because of limited root development. Cultural practices that encourage rapid growth at conditions sub-optimal for germination should increase seedling emergence and reduce moisture requirements for emergence. We determined from greenhouse studies the effects of different levels of soil salinity and soil water on emergence and on root and shoot growth of 3 pre- germinated-cool-season grasses: 'Nordan' crested wheatgrass (*Agropyron desertorum*) (L.) Gaertn.), 'Flintlock' western wheatgrass (*Pascopyrum smithii* (Rydb.) A. Love), and 'Vinall' Russian wildrye (*Psathyrostachys juncea* (Fischer) Nevski). Seed pregerminated prior to sowing resulted in more rapid emergence than untreated seed for all species at all levels of soil salinity and soil water. Salinity and water stress delayed and/or reduced emergence more in the untreated than pregermlnated seed of Russian wildrye and western wheatgrass. Regerminating seed before planting also resulted in greater root biomass for all speck and greater root lengths for the 2 wheatgrass species than did untreated seed.
This citation is from the University of Arizona Institutional Repository.

586. **Enhancing the germination of three fodder shrubs (*Atriplex amnicola, A. nummularia, A. undulata;* Chenopodiaceae): Implications for the optimisation of field establishment**.
Stevens, J. C., Dixon, K. W., Barrett-Lennard, E. G., Barrett-Lennard, E. G. and Dixon, K. W.
Australian journal of agricultural research 57: 1279-1289 (2006). ISSN: 0004-9409
http://dx.doi.org/10.1071/AR06031
Keywords: seeding/ Saltbush/ *Atriplex*/ seed germination
Abstract: Saltbush (*Atriplex*) species are widely grown in Australia as saltland pastures. Direct seeding practices for saltbush currently result in asynchronous and unreliable seedling establishment (5% successful establishment is not uncommon from field-sown seed). In part this may stem from a limited understanding of *Atriplex* seed germination requirements. This paper presents findings with 3 *Atriplex* species, *A. amnicola* (Paul G. Wilson.), *A. nummularia* (Lindl.), and *A. undulata* (D. Dietr), each of which differs in germination characteristics. For *A. amnicola*, the presence of light (and artificial substitution of light by 1000 ppm gibberellic acid) improved germination under controlled conditions and resulted in a 4-fold increase

(70% total emergence) in field emergence of seedlings. For *A. undulata*, removing bracteoles increased germination under controlled conditions (~15%), with a 1.5-fold improvement in field seedling emergence (55% final emergence); however, seed priming or gibberellic acid application had no significant effect. In contrast, for *A. nummularia*, bracteole removal and light had minor positive effects on germination under controlled conditions, but this did not translate into improved emergence in soil or in the field. Under -0.5 MPa NaCl stress, application of gibberellic acid, salicylic acid, or kinetin to the germination medium significantly increased the final germination percentage of *A. amnicola* seeds (58, 16, and 14%, respectively) and improved the rate at which seeds germinated. All plant signalling compounds significantly increased final germination percentage and germination rate of A. undulata, albeit with a <10% increase at -0.5 MPa NaCl. Priming seeds with plant signalling compounds had similar effects on seed germination under low water potentials compared to direct treatment of the germination media. The effects of seed priming on *Atriplex* seedling emergence from saline soils varied among species. Priming with water significantly increased emergence percentage of *A. amnicola* but had no effect on *A. nummularia* and *A. undulata*. Gibberellic acid improved A. amnicola germination parameters only, whereas salicylic acid and kinetin improved the rate of emergence in all 3 species at various levels of salinity. This study suggests that a basic understanding of seed dormancy and germination requirements has the potential to substantially improve field emergence of saltbush species. © CSIRO 2006.
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587. **Establishing alkali sacaton on harsh sites in the Southwest**.
Aldon, E. F.
Journal of Range Management 28: 129-132 (1975). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/6421/6031
Keywords: Sporobolus airoides/ planting seed/ soil water/ mulching/ rain/ riparian areas
Abstract: Because of critical establishment requirements, seeds of alkali sacaton (*Sporobolus airoides* (Torr.) Torr.) must be planted when both soil moisture and probability of rain are high. Large seeds should be mulched to maintain moisture and darkness.
This citation is from the University of Arizona Institutional Repository.

588. **Evaporation loss from sandy soils mixed with a polyacrylamide hydrogel under different saline conditions**.
Salem, N., Pini, R. and Guidi, G. V.
Agrochimica 39: 334-342 (1995).
Keywords: water/ polyacrylamide/ PAM/ evaporation time
Abstract: The application of a polyacrylamide hydrogel increased both the water retained by a sand soil and sand mixed with the polymer and the evaporation time. The water inside the hydrogel showed three states of evaporation when the polymer was swollen in distilled water. These states were evidenced by three straight lines and were attributed to: i) unbound water, ii) water weakly bound to hydrophilic sites, and iii) strongly bound water. The increase of total soluble salts reduced the three states of the evaporation rate of water to two states. A further increase of total soluble salts above a concentration of 10 meq.L(-1) for NaCl, and 5 meq.L(-1) for CaCl2, reduced the two states of water in the hydrogel to one state.
© *AGRIS*

589. **Exchangeable Na, polymer, and water-quality effects on water Infiltration and soil loss**.
Benhur, M., Clark, P. and Letey, J.
Arid Soil Research and Rehabilitation 6: 311-317 (1992).
http://dx.doi.org/10.1080/15324989209381325
Keywords: soil conditioner/ polyacrylamide/ polysaccharide/ sodicity
Abstract: Increasing exchangeable sodium percentage (ESP) contributes to increased soil dispersion and swelling of clay, which reduces the infiltration rate and increases runoff Synthetic polymers are available that may decrease soil dispersion. A study was conducted to determine the effect of three polymers dissolved in water at 10 or 50 mg L-1 concentrations and applied through a rainfall simulator on the infiltration rate, erosion, and soil migration through the layer of a soil at ESP equal to 8.5 and 30.6 The polymers were a cationic polysaccharide and two anionic Polyacrylamides with different negative charge densities. The infiltration rate decreased with time and approached a final steady-state infiltration rate (FIR). The runoff water and

associated sediment were captured and measured. Water coming through the soil layer and the amount of particulates contained in the water were measured. The FIR was significantly lower for the soil at ESP equal to 30.6 than at ESP equal to 8.5. There was no statistically significant effect of the polymer type or concentration on FIR. The amount of soil loss through erosion was significantly affected by the soil ESP, polymer type, and polymer concentration of the polymer application. More soil was in the runoff for the higher ESP than for the lower ESP The polymer treatment effects on soil loss were in the following order: cationic polysaccharide > untreated > low anionic PAM > higher-charged anionic PAM. Soil loss from application of the polymer at 50 mg L-1 was significantly less than at 10 mg L-1. The amount of soil migrating through the soil layer with the percolate was significantly higher for the higher ESP soil, whereas there was no significant effect of polymer treatment on this parameter

590. **Experience in accelerated irreversible desalinization of soils in Golodnaya Steppe**.
See record 53 in Rangeland Management Practices and Potential Impact on Water.

591. **Feasibility of Incorporating Aquaculture, Solar Pond Energy, and Mineral Extraction Technologies to Control Localized Sources of Salinity in River Systems**.
Riley, J.
Reports, Utah Water Research Laboratory, Logan, Utah, Utah State University, (1986).
http://digitalcommons.usu.edu/water_rep/131
Keywords: river salinity/ water quality/ water treatment/ aquaculture/ salt gradient solar ponds/ economics
Abstract: Salinity poses a serious and continuing problem to the full utilization of water resources in many river basins of western U.S. A variety of management measures have been employed to mitigate the damaging effects of salinity on agricultural crops as well as on municipal and industrial uses of water. The Colorado River Basin Salinity Control Act illustrates the logic of addressing the problem on a basin wide basis under a strategy that gives priority to those localized sources of salinity that contribute disproportionately large amounts of salt to the system. It remains then to devise control measures specific to each site which are the most cost-effective in arresting or revising the progressive degradation of water quality. It is within the above conceptual framework that this study seeks to evaluate the feasibility of combining a particular set of technologies whose joint operation might accomplish the salt reduction while converting certain liabilities into assets and introducing new benefit streams so as to increase the net benefits accruing from the management measures. Specifically it is the objective of this study to evaluate the feasibility of removing salt from a hydrologic system by using mineral extraction ponds that double as sources of salt gradient solar energy and are also managed to provide habitat for fish or shellfish that grow in marine environments. The solar energy would be used to maintain proper year-round water temperatures for aquaculture as well as for enhancement of the mineral extraction process. The approach would be to design a combination aquaculture-energy-mineral extraction system for a specific location near Sigurd, Utah, where the hydrogeochemistry dynamics of the Sevier River and a high salt contributing section have been recently studied by Sepehr (1984) and for which a validated and high resolution computer model is available. Ambient site conditions, actual hydro-salinity information, and current economic and marketing information will be used in determining the feasibility of the joint technologies. If the integrated use of these technologies appears feasible, it can be adapted to other "hot spots" of the Sevier River or other western U.S. rivers where such problems exist. The results of this study are of particular interest to state agencies responsible for water resources planning and management, those concerned with energy use, and those interested in economic development. The study is also of interest to the federal SCS, and the Bureau of Reclamation. Those living in close proximity to these salt producing reaches have keen interest in management options that they might be profitably exploited under private initiatives.
This citation is from Utah State University.

592. **Fire Rehabilitation Using Native and Introduced Species: A Landscape Trial**.
Thompson, T. W., Roundy, B. A., Mcarthur, E. D., Jessop, B. D., Waldron, B. and Davis, J. N.
Rangeland Ecology and Management 59: 237-248 (2006). ISSN: 1550-7424
http://dx.doi.org/10.2111/05-189R1.1
Keywords: big sagebrush/ pinyon-juniper/ revegetation/ weed suppression/ wildfire

Abstract: Following the 1999 Railroad Fire in Tintic Valley, Utah, we initiated a large-scale fire rehabilitation study comparing a predominately introduced species seed mix used by the US Department of Interior–Bureau of Land Management (BLM), a mix of native and introduced species provided by the US Department of Agriculture–Agricultural Research Service (ARS), and 2 native seed mixes (high and low diversity). Mixes were seeded with a rangeland drill on the big sagebrush (*Artemisia tridentata* var. wyomingensis [Beetle & A. Young] Welsh) study area whereas the pinyon–juniper (*Pinus edulis* Engelm.–*Juniperus osteosperma* [Torr.] Little) woodland study area was aerially seeded followed by 1-way chaining. On drill-seeded plots and by the third year after seeding the native high-diversity mix (16.4 kg pure live seed [PLS]·ha−1) had the highest seeded species cover (11.5%) and density (14 plants·m−2). Both the BLM (9.3 kg PLS·ha−1) and ARS (9.1 kg PLS·ha−1) seed mixes had higher seeded species cover (BLM = 8.5%, ARS = 8.2%) and density (BLM = 8.4 and ARS = 7.2 plants·m−2) than plots seeded to the low-diversity native mix (8 kg PLS·ha−1, cover = 3.8%, density = 3.6 plants·m−2). Indian ricegrass (*Achnatherum hymenoides* [Roemer and J. A. Schultes] Barkworth 'Nezpar') in the native high-diversity mix was especially successful on the sandy soils of the drill site, whereas seeds of other species may have been buried too deep for optimum emergence. Aerially-seeded and chained plots had similar and successful seeded species frequency, cover, and density (third-year average = 10.6% cover, 17.2 plants·m−2) among all species mixes. All seeded plots had lower cover of annual species than unseeded plots, indicating that revegetation is necessary to reduce weed invasion following catastrophic wildfire in big sagebrush communities lacking residual perennial understory vegetation.
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593. **Forage plants for salt affected areas in developing countries (Africa)**.
Kernick, M. D.
Reclamation & Revegetation Research 5: 451-459 (1986).
Keywords: land degradation/ revegetation/ salt affected soils/ seeding methods/ species selection
Abstract: Discusses the role of the Food and Agriculture Organization (FAO) in the past 25 years of promoting the evaluation and establishment of forage plants in a number of field projects in arid and semi- arid areas of the Near East and North Africa. Detailed achievements and experience are outlined for selected projects in Algeria, Iran, Iraq, Libya, Pakistan and Tunisia. Promising species, ecotypes, or varieties of forage plants that are well adapted to saline soils have been identified. After suitable pre-testing and multiplication, such plants can be grown on an extended field scale to increase fodder production. Emphasis was given to planting forage crops on farmers' fields and to revegetating demonstration areas on degraded rangeland close to villages. -from Author
© *Elsevier*

594. **Growth of *Atriplex amnicola* on salt-affected soils in Western Australia**.
Davidson, N. J., Galloway, R. and Lazarescu, G.
Journal of Applied Ecology 33: 1257-1266 (1996). ISSN: 0021-8901
Keywords: drought/ environmental heterogeneity/ penetrability/ salinity/ soil strength/ waterlogging/ *Atriplex amnicola*/ Chenopodiaceae/ halophytes/ Australia
Abstract: 1. On a broad scale, growth of *Atriplex amnicola* declined greatly in response to reduced depth to the water table during the summer. 2. On a micro-environmental scale of 2-10 m, growth was limited by a combination of adverse soil physical properties, salinity, drought and waterlogging. 3. Waterlogging occurred after rains in low lying areas and elevated regions where perched water tables developed above the dense clay subsoil. 4. Salinity, measured as electrical conductivity, varied greatly over short distances and in extreme cases ranged from 300 to 6500 mS m-1 over a distance of c. 10 m. 5. The sandy A.-horizons of the soil profile varied from 10 to 110 cm in depth but were generally shallow (average depth c. 40 cm) and had limited reserves of moisture. 6. The penetrability of the clay subsoils was low, reaching 5-8 MPa in places, preventing the entry of plant roots except where fossil root channels existed. 7. Where plant roots were confined to shallow sandy surface soils they were exposed to drought during summer (leaf water potentials as low as -5.5 MPa).
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595. **Infiltration and erosion in soils treated with dry PAM and gypsum**.
Yu, J., Lei, T., Shainberg, I., Mamedov, A. I. and Levy, G. J.
Soil Science Society of America Journal 67: 630-636 (2003).
http://dx.doi.org/10.2136/sssaj2003.6300
Keywords: silt loam soil/ water infiltration/ simulated rainfall/ furrow erosion/ amendments/ polymers/ irrigation/ energy/ chemistry
Abstract: Seals formed at the soil surface during rainstorms reduce rain infiltration and cause runoff and erosion. Surface application of anionic polyacrylamide (PAM) in solution has been found to be very effective in decreasing seal formation, runoff, and erosion. The objective of this study was to investigate the effect of surface application of granular PAM (10 and 20 kg ha(-1)) and gypsum (2 and 4 Mg ha(-1)) on the infiltration rate (IR) and soil erosion from a silty loam (Calcic Haploxeralf) and sandy clay (Typic Chromoxerert) during simulated distilled water rainstorms. Mixing dry PAM with the upper 5 mm of the soil surface reduced slightly the IRs, and reduced significantly soil erosion from the two soils. Spreading gypsum at the soil surface doubled the final IR compared with that of control and reduced erosion slightly. Spreading dry PAM mixed with gypsum was very effective in increasing the rain IR and reducing erosion. Mixture of 20 kg ha(-1) PAM and 4 Mg ha(-1) gypsum increased the final IR of the two soils by four times and reduced erosion to 30% that of the control. Gypsum added to the erosion benefits of PAM by increasing infiltration and decreasing runoff. However, mixing gypsum with dry PAM decreased the beneficial effect of PAM in reducing erosion in the silty loam soil. The mechanisms responsible for the specific effects of PAM (mixed with soil and gypsum) on rain infiltration and soil losses are discussed.

596. **Influence of cryptobiotic soil crusts on elemental content of tissue of 2 desert seed plants**.
Belnap, J. and Harper, K. T.
Arid Soil Research and Rehabilitation 9: 107-115 (1995).
http://digitalcommons.usu.edu/crc_research/584/
Keywords: microbiotic soil crusts/ cryptogamic soil crusts/ rangelands/ nutrients
Abstract: Soil surface growths dominated by cyanobacteria and the lichen Collema in southeastern Utah are shown to be associated with greater tissue content of several bioessential elements in two co-occurring seed plants (*Festuca octoflora*, Poaceae, and *Mentzelia multiflora*, Loasaceae). The elements N, P, K, Ca, Mg, and Fe were present in significantly greater concentrations in Festuca growing on soils heavily encrusted with cyanobacteria and cyanolichens than in plants on the same soil where foot traffic had destroyed the cryptobiotic crusts. With Mentzelia, N, Mg, and Fe were present in significantly greater concentrations in plants from sites with encrusted soil surfaces than on blow-sand sires. The cryptobiota appeared to compete vigorously with Mentzelia for available P: Mentzelia plants from crusted sites contained significantly smaller concentrations of P than plants grown on soils where wind action precluded development of surface crusts. These cryptobiotic crusts fix considerable amounts of N, which apparently becomes available to associated seed plants via decomposition and cellular secretion processes. Other macronutrients are apparently accumulated in forms available to seed plants as the crusts develop in inter-spaces between higher plants. The trace element Fe appears to be rendered more available to higher plants by the cryptobiotic growth. That effect may be related to chelating compounds known to be present in the mucilaginous sheaths of cyanobacteria. Other possible reasons are discussed for the enhanced nutrient uptake of seed plants growing in cryptobiotic crusts.
This citation is from Utah State University.

597. **Inhibiting water infiltration with polyacrylamide and surfactants: Applications for irrigated agriculture**.
Lentz, R. D.
Journal of Soil and Water Conservation 58: 290-300 (2003).
Keywords: furrow irrigation/ infiltration/ irrigation uniformity/ PAM/ polyacrylamide/ sealing/ nonionic surfactants/ hydraulic conductivity/ aggregate stability/ furrow infiltration/ soil conditioners/ clay dispersion/ flow velocity/ impact energy/ erosion
Abstract: Efficiencies of surface irrigation systems are often limited by infiltration conditions. Treatments that decrease infiltration into unlined canals, reservoirs, and the inflow end of furrows relative to outflow ends would reduce seepage tosses and improve application uniformity. Several laboratory studies evaluated effects of high molecular weight (10 to 15 Mg

mol(-1)), water-soluble, anionic polyacrylamide (PAM), alone and combined with anionic surfactants, on the hydraulic conductivity (KSAT) of soils. Dry soils were treated with one or two treatment solutions and subjected to conditions that simulated those in an irrigation furrow or pond. The KSAT of soil packed in columns was measured with a constant head apparatus for 19 hours. PAM treatment concentrations > 125 mg L-1 applied to dry soils preceding flooding reduced KSAT by 25%, and a 10 mg-L-1 PAM + 29 k-mg-L-1, sodium-lauryl-sulfate surfactant application reduced KSAT by 70%, relative to controls. Mini-flume tests then applied the treatments only to the inflow end of the mini-furrows. The 125 and 250 mg L-1 PAM treatments significantly improved water application uniformity: Cumulative infiltration was reduced in the upper half of mini-flume furrows and increased in the tower, relative to controls. When applied to dry soils and allowed to dry overnight, as may be done when treating irrigation ponds, the 1,000 mg L-1 PAM solution reduced KSAT by 60% to > 90% in silt loam and clay loam soils. Either the single or combination treatments could potentially be used to increase the uniformity of furrow water applications and reduce seepage from unlined irrigation ponds and canals.

598. **Land restoration by fodder shrubs in a semi-arid agro-pastoral area of Morocco; effects on soils**.
Zucca, C., Julitta, F. and Previtali, F.
Catena (Giessen) 87: 306-312 (2011). ISSN: 0341-8162
http://dx.doi.org/10.1016/j.catena.2011.06.017
Keywords: Morocco/ terrestrial environment/ Luvisols/ North Africa/ reclamation/ Marrakech Morocco/ semi-arid environment/ desertification/ Calcisols/ vegetation/ carbon/ alkalinity/ Leptosols/ organic carbon/ chemical composition/ Cambisols/ geochemistry/ environmental geology/ *Atriplex nummularia*/ soils/ revegetation/ pedogenesis/ physicochemical properties/ statistical analysis/ agriculture/ Ouled Dlim Morocco/ depth/ parent materials/ Africa/ rangelands/ land use
Abstract: The present study assesses the effects of *Atriplex nummularia* Lindl growth on soil chemical properties in a semi-arid area. The area is located in the Marrakech province (Morocco), in a degraded agropastoral region subjected to soil restoration actions based on fodder shrub plantations. Three plantations of different age (1995, 2000, 2001), conducted in three different sites, were investigated. In each site, three plots with different degree of plant development (Good, Medium, Poor), were chosen. Three under-canopy (Uc) and three between-plants (Bp) mini-pits were sampled (0-10cm and 10-20cm) and analyzed in each plot, for a total number of 54 mini-pits. Statistic analysis was carried out to check the significance of the observed Uc-Bp average differences. A significant increase under canopy was observed in soil Sodium Adsorption Ratio (SAR; +139%) and OC (+32%) in the top layer (0-10cm). The overall effects of the plantations on soil quality are discussed.
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599. **Lignite mine spoil characterization and approaches for its rehabilitation**.
Praveen, K., Kumar, S., Sharma, K. D., Choudhary, A. and Gehlot, K.
Arid Land Research and Management 19: 47-60 (2005). ISSN: 1532-4982
http://dx.doi.org/10.1080/15324980590887218
Keywords: dehydrogenase/ nitrification/ pearl millet/ phosphatases/ revegetation/ soil sodium/ surface modification/ lignite/ mine waste/ open pit mine/ physicochemical property/ spoil heap/ Cenchrus/ *Cenchrus ciliaris*/ *Pennisetum glaucum*
Abstract: Open cast mining of lignite leaves behind stockpiles of excavated materials (dumps) and refilled mining pits (spoils). Dumps and spoils remain barren and their surface materials are deposited to adjoining fields through wind and water erosion deteriorating their productivity. Physicochemical and biochemical properties of both kinds of sites were estimated to identify the reasons for their barrenness. Subsequently, surface modifications were attempted, first in a greenhouse and later in field to develop a suitable approach for their rehabilitation. Dumps had low pH (4.8) and high Na + (2.5 mg g -1), spoils high pH (8.7) and high Na + (1.59 mg g -1 soil). Both sites had low available nitrogen and phosphorus and showed very low dehydrogenase and phosphatases activity but no nitrification. The extreme physicochemical conditions and inert nature of dumps and spoils explained their barrenness. In the greenhouse experiment, 14 plant species sown in surface materials of dumps and spoils after spreading a 0.15 m thick layer of dune sand, germinated (>85%), and their seedlings survived for two months. This technique was

followed at a spoil site (modified spoil site). After three years of stabilization the modified spoil site had only one-fifth Na + of that in spoil surface in the beginning and also showed higher dehydrogenase and phosphatase activity and nitrification. Pearl millet and *Cenchrus ciliaris* grown in modified spoil produced 128 to 394 kg and 2.25 to 3.50 Mg dry matter ha -1. Addition of farmyard manure with N and P fertilizers increased pearl millet yields.
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600. **Management of Dryland Saline Seeps**.
See record 165 in Subsurface Transport Processes.

601. **Microbiotic Crusts: Ecological Roles and Implications for Rangeland Management in the Interior Columbia Basin and Portions of the Klamath and Great Basin (review draft)**.
Leonard, S. G., Rosentreter, R. and Karl, M. G., (1995).
http://www.icbemp.gov/science/leonard2.pdf
Keywords: microbiotic crusts/ grazing/ ecology/ soil

602. **Mitigation of windblown dusts and reclamation of Public Trust values, Owens Lake, California: Partial mitigation of PM10 episodes through control of saltating particles and reduction of wind shear**.
See record 400 in Wind Transport.

603. **Native couch grasses for revegetating severely salinised sites on the inland slopes of NSW**.
Semple, W. S., Cole, I. A. and Koen, T. B.
Rangeland Journal 26: 88-101 (2004). ISSN: 1036-9872
http://dx.doi.org/10.1071/RJ04006
Keywords: groundcover/ native grasses/ pH/ production/ salt-tolerance/ survival/ topsoil moisture/ Cynodon/ *Cynodon dactylon*/ Paspalum/ *Paspalum distichum*/ *Paspalum vaginatum*/ Pennisetum/ *Pennisetum clandestinum*/ *Pennisetum glaucum*/ Poaceae/ Sporobolus/ *Sporobolus virginicus*
Abstract: Two scalded saline sites on the inland slopes of NSW were selected for an evaluation of ten accessions of warm-season stoloniferous/rhizomatous grass species: common couch (*Cynodon dactylon*), marine couch (*Sporobolus virginicus*), rats-tail couch (*S. mitchellii*), salt-water couch (*Paspalum vaginatum*), water couch (*P. distichum*) and one exotic, kikuyu (*Pennisetum clandestinum*). Most species performed well at Wagga Wagga but only common couch, marine couch and salt-water couch did at Manildra, where they consistently outperformed the other native species in terms of survival, groundcover and vigour. Salt-water couch had the highest mean vegetative cover at both sites. Differences in salinity, pH (acid cf. alkaline) and particularly topsoil moisture probably accounted for differing plant performances at the two sites. In a follow-up production study of the most successful accessions under relatively dry conditions at Manildra, the 'Yamba' accession of marine couch consistently produced more leaf/seedhead dry matter (1057 ± 172 kg/ha) during the growing season than the others. However, salt-water couch consistently produced more ex-plot stolon/rhizome dry matter (974 ± 127 kg/ha) than the other two species. This probably explained its ability, unlike marine couch, to maintain groundcover during a regime of regular cutting. Further evaluation under grazing and recreational uses is recommended. The genetic material evaluated was only a small sample of salt-tolerant native grasses. The variable performance of the four accessions of rats-tail couch, for example, suggested that more salt-tolerant types are likely to be found. *This citation is from the Australian Rangeland Society.*

604. **Nature and Management of Salt-Affected Soils in Saskatchewan**.
See record 14 in Rangeland Management Practices and Potential Impact on Salinity.

605. **Nipa (*Distichlis palmeri*): A perennial grain crop for saltwater irrigation**.
Pearlstein, S. L., Felger, R. S., Glenn, E. P., Harrington, J., Al-Ghanem, K. A. and Nelson, S. G.
Journal of Arid Environments 82: 60-70 (2012). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2012.02.009
Keywords: halophytes/ hypersaline/ hypoxic/ non-tillage agriculture/ relative growth rates/ seawater crops
Abstract: The perennial saltgrass nipa (*Distichlis palmeri*, Poaceae) is endemic to northern Gulf of

California tidal marshes flooded with hypersaline (38–42 g L−1) seawater. Nipa was a wild harvest staple of the Cocopah people of the Río Colorado delta. We investigated the physiology, anatomy, chromosome number, and agronomic potential of nipa as a global food crop. Nipa seeds had 60–93% germination on salinities ranging from 0 to 30 g L−1. Relative Growth Rates (RGR) on both flooded and aerobic conditions remained above 4% d−1 up to 30 g L−1, about half the RGR on freshwater. Nipa grain (caryopses) had 7–8% protein, 8% sugar and 79% total digestible carbohydrates (mostly starch) and only 2% ash and 8% fiber, equal to conventional grains in apparent nutritional value. Shoots were low in ash and sodium, and compared favorably to alfalfa forage in protein, digestible carbohydrates and energy contents. Mature female stands in the Colorado River delta produced an estimated 1.25 t ha−1 of grain, but over two years in the greenhouse only partial flowering was observed. Nevertheless, *D. palmeri* appears to be worth developing as a perennial grain and forage crop, especially for salinized, flooded soils.
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606. **Options for salinity mitigation in the Murray–Darling Basin**.
See record 15 in Rangeland Management Practices and Potential Impact on Salinity.

607. **An overview of modelling techniques and decision support systems and their application for managing salinity in Australia**.
Littleboy, M., Vertessy, R. and Laurence, P.
Proceedings of the 9th National Produce Use and Rehabilitation of Saline Land (PURSL) Conference, Queensland, Australia (2003).
http://www.environment.nsw.gov.au/resources/salinity/pursllittleboyetal.pdf
Keywords: models/ salinity management/ drylands
Abstract: In Australia, computer models are being used to support the development and implementation of salinity management strategies. These models facilitate the assessment of the impacts of salinity management options, and enable the outcomes of implementation to be quantified. Models can be used to estimate both potential benefits and any unwanted impacts of management actions. There is a myriad of salinity models developed or under development across Australia. A recent stock take of models conducted by URS for the National Action Plan for Salinity and Water Quality (URS Australia 2002) contained details of over 100 models that can be used to assess salinity management options. While it could be argued that such a vast number of models is overkill, many of these models focus on different processes and aspects of salinity. This paper reviews the range of modelling techniques and approaches used in Australia to improve the management and understanding of dryland salinity. The numerous modelling approaches being used in Australia have evolved to answer a variety of questions across different scales. While the main focus of this paper is on biophysical models, some case studies highlighting social and economic models and decision support tools currently being used in Australia are also be presented.

608. **PAM application techniques and mobility in soil**.
Nadler, A., Magaritz, M. and Leib, L.
Soil Science 158: 249-254 (1994).
Keywords: aggregate stability/ plant growth/ polyanions
Abstract: High application rates (50-200 mg Kg-1 soil) and strong adsorption to soil aggregates severely limit polyacrylamide (PAM) application as a soil conditioner below the top soil. Limited penetration, 0 to 20 cm, was obtained upon introducing tritium-labeled PAM-2J into a clayey and sandy loam, respectively. This low penetration rate is related to the adsorption of the polymer to the surface of soil particles. This study tested the potential effect of modifying PAM application management by lowering the viscosity of the applied PAM solution, thus increasing the efficiency of polymer subsurface penetration under reduced application rates. One way of enhancing PAM penetrability may be a temporary reduction in adsorption. A significant reduction (up to five fold) in the viscosity of polymer solution flowing through narrow capillaries, caused by the addition of NaCl or CaCl2 to the solution, was observed in the laboratory. The application of PAM affected soil structure by redistributing soil pore sizes, as indicated by changes in water content under different pressures.
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609. **Performance of selected tree and shrub species grown for stream salinity control in the Wellington reservoir catchment**.
See record 16 in Rangeland Management Practices and Potential Impact on Salinity.

610. **Phenology of salt desert plants near contour furrows**.
See record 17 in Rangeland Management Practices and Potential Impact on Salinity.

611. **Phytoremediation of Sodic and Saline-Sodic Soils**.
Qadir, M., Oster, J. D., Schubert, S., Noble, A. D. and Sahrawat, K. L.
Advances in Agronomy. Donald, L. S., Academic Press. Volume 96**:** 197-247 (2007).
http://dx.doi.org/10.1016/S0065-2113(07)96006-X
Keywords: phytoremediation/ saline sodicsoils/sodic soils A*bstract:* Sodicity induced soil degradation is a major environmental constraint with severe negative impacts on agricultural productivity and sustainability in arid and semiarid regions. As an important category of salt-affected soils, sodic soils are characterized by excess levels of sodium ions (Na+) in the soil solution phase as well as on the cation exchange complex, exhibiting unique structural problems as a result of certain physical processes (slaking, swelling, and dispersion of clay) and specific conditions (surface crusting and hardsetting). Saline-sodic soils, another category of salt-affected soils, are generally grouped with sodic soils because of several common properties and management approaches. Sodic and saline-sodic soils occur within the boundaries of at least 75 countries, and their extent has increased steadily in several major irrigation schemes throughout the world. The use of these soils for crop production is on the increase as they are a valuable resource that cannot be neglected, especially in areas where significant investments have already been made in irrigation infrastructure. It is imperative to find ways to improve sodic and saline-sodic soils to ensure that they are able to support highly productive land use systems to meet the challenges of global food security. Nearly a century old record reveals amelioration of sodic soils through the provision of a readily available source of calcium (Ca2+) to replace excess Na+ on the cation exchange complex; the displaced Na+ subject to leaching from the root zone through the application of excess irrigation water in the presence of a drainage system. Many sodic soils do contain inherent or precipitated sources of Ca2+, that is calcite (CaCO3), at varying depths within the soil profile. However, due to its negligible solubility, natural dissolution of calcite does not provide sufficient quantities of Ca2+ to affect soil amelioration with routine management practices. Consequently, amelioration of these soils has been predominantly achieved through the application of chemical amendments. However, amendment costs have increased prohibitively over the past two decades due to competing demands from industry and reductions in government subsidies for their agricultural use in several developing countries. In parallel, scientific research and farmers' feedback have demonstrated that sodic soils can be brought back to a highly productive state through a plant assisted approach generically termed "phytoremediation." Typical plant based strategies for contaminated soils, such as those containing elevated levels of metals and metalloids, work through the cultivation of specific plant species capable of hyperaccumulating target ionic species in their shoots, thereby removing them from the soil. In contrast, phytoremediation of sodic soils is achieved by the ability of plant roots to increase the dissolution rate of calcite, thereby resulting in enhanced levels of Ca2+ in soil solution to effectively replace Na+ from the cation exchange complex. Phytoremediation has shown to be advantageous in several aspects: (1) no financial outlay to purchase chemical amendments, (2) accrued financial or other benefits from crops grown during amelioration, (3) promotion of soil aggregate stability and creation of macropores that improve soil hydraulic properties and root proliferation, (4) greater plant nutrient availability in soil after phytoremediation, (5) more uniform and greater zone of amelioration in terms of soil depth, and (6) environmental considerations in terms of carbon sequestration in the postamelioration soil. Phytoremediation is particularly effective when used on moderately saline-sodic and sodic soils. It is a viable solution for resource poor farmers through community based management, which would help in strengthening the linkages among researchers, farm advisors, and farmers. These linkages will continue to be fostered as the use of sodic soils becomes more prevalent. The success of phytoremediation of sodic soils requ res a greater understanding of the

processes fostering phytoremediation, the potential of plant species to withstand ambient salinity and sodicity levels in soil and water, and also of the uses and markets for the agricultural products produced. Strategic research on such aspects would further elucidate the role of phytoremediation in the restoration of sodic soils for sustainable agriculture and conservation of environmental quality.
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612. **Plant and soil recovery along a series of abandoned desert roads**.
Bolling, J. D. and Walker, L. R.
Journal of Arid Environments 46: 1-24 (2000).
ISSN: 0140-1963
http://dx.doi.org/10.1006/jare.2000.0651
Keywords: disturbance/ Larrea/ Mojave Desert/ revegetation/ soil recovery
Abstract: Soil and vegetation dynamics were examined along roads abandoned for 5, 10, 21, 31, 55 and 88 years in southern Nevada in an attempt to elucidate factors controlling desert succession. None of the measured soil or vegetation parameters varied significantly with road age. Differences were found, however, between soils and vegetation on roads vs. nearby controls, and soils differed between roads created by surface vehicular traffic and bulldozing. Studies of recovery following disturbance in deserts must take into account natural patterns of plant and soil heterogeneity and initial disturbance type.
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613. **Polyacrylamide quantification methods in soil conservation studies**.
Lu, J. and Wu, L.
Journal of Soil and Water Conservation 58: 270-275 (2003).
Keywords: quantification/ soil water/ substrate-borne polyacrylamide/ water-borne polyacrylamide/ spectrophotometric determination/ hydrolyzed polyacrylamide/ polysaccharide polymers/ acrylamide copolymers/ water quality/ adsorption/ flocculation/ minerals/ pam
Abstract: Polyacrylamide (PAM) application in soil conservation has gained rapid acceptance in recent years. Determination of PAM concentration in waters containing soil constitutes (defined as soil waters in this paper)- such as runoff water, irrigation tail water, and soil solution and PAM content in soil matrix is important for improving PAM application efficiency, understanding PAM conditioning depth, and assessing PAM's fate in the environment. Methods for quantifying PAM concentration in soil waters should be sensitive and reliable at low concentrations (0.1 to 10 mg L-1, or 0.1 to 10 ppm) and invulnerable to interferences from dissolved salts and organic matter. There are about 11 groups of PAM analytical methods in literature. In this article we discuss and review the principles, lower detection limits, major interferences, advantages, and limitations of these methods. The N-bromination method (a PAM analytical technique based on spectro photometry) is satisfactory for quantification of polyacrylamide in both soil waters and organic-matter-removed soil.

614. **Polymer effects on runoff and soil-erosion from sodic soils**.
Levy, G. J., Levin, J. and Shainberg, I.
Irrigation Science 16: 9-14 (1995).
http://dx.doi.org/10.1007/BF00208390
Keywords: infiltration rate/ crusts formation/ water quality/ amendments/ rainfall/ energy
Abstract: High levels of soil sodicity, resulting from intensive irrigation with saline-sodic waters, lead to an increased soil susceptibility to seal formation and to severe problems of runoff and soil erosion. The objective of this study was to investigate the efficacy of the addition of small amounts of an anionic polyacrylamide (PAM) to the irrigation water in controlling seal formation, runoff and soil erosion. Two predominantly montmorillonitic sails were studied, a grumusol (Typic Haploxerert) and a loess (Calcic Haploxeralf), having naturally occurring exchangeable sodium percentage (ESP) >12. The soils were exposed to 60 mm of simulated irrigation with commonly used tap water (TW, electrical conductivity=0.8 dS m(-1); sodium adsorption ratio (SAR)=2), or saline water (SW, electrical conductivity=5.0 dS m(-1);SAR>12). PAM effectiveness in controlling runoff and erosion from the sodic soils was compared with runoff and erosion levels obtained from untreated soils having low ESPs (<4). For both soils and for both water qualities and polymer concentrations in the irrigation water, PAM was efficient in controlling runoff at low ESP levels and inefficient at high ESP levels. At moderate ESP levels, PAM's efficacy in controlling runoff was inconsistent and varied with water quality and polymer concentration. Conversely, in

general, soil loss originating from rill erosion, was significantly and effectively reduced in moderate and high ESP soils by addition of PAM to the irrigation water, irrespective of water quality and polymer concentration. PAM was more effective in reducing rill erosion than in reducing runoff in the moderate and high ESP samples, because the energy involved in generating runoff is much higher than that involved in rill erosion. PAM treated surface aggregates were not stable against the destructive forces leading to seal formation and runoff production; but they were stable enough to resist the hydraulic shear exerted by the runoff flow.

615. **The potential for developing fodder plants for the salt-affected areas of southern and eastern Australia: An overview**.
Rogers, M. E., Craig, A. D., Munns, R. E., Colmer, T. D., Nichols, P. G. H., Malcolm, C. V., Barrett-Lennard, E. G., Brown, A. J., Semple, W. S., Evans, P. M., Cowley, K., Hughes, S. J., Snowball, R., Bennett, S. J., Sweeney, G. C., Dear, B. S. and Ewing, M. A.
Australian Journal of Experimental Agriculture 45: 301-329 (2005). ISSN: 0816-1089
http://dx.doi.org/10.1071/EA04020
Keywords: fodder/ saline soils/ Australia/ Poaceae/ salt tolerance/ forage
Abstract: This paper reviews the major issues that impact upon the development of improved fodder species for saline environments across temperate Australia. It describes past and present research that has been, or is being, undertaken towards improvements in salt tolerance in forage species within Australia in relation to the principal regions where salinity occurs. It includes a discussion on the mechanisms of salt tolerance in plants. An extensive list of known or potential salt-tolerant fodder species is provided and the key opportunities for advancement within each of the 4 major forage groups: grasses, legumes, herbs and shrubs are discussed. Constraints to developing new salt and waterlogging tolerant fodder species are identified. A number of recommendations are made for research that should ensure that Australian producers have access to a new array of productive fodder species suited to saline environments. © CSIRO 2005.
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616. **Potential role of cryptobiotic soil crusts in semiarid rangelands**.
Belnap, J.
Symposium on Ecology, Management, and Restoration of Intermountain Annual Rangelands, Boise, Idaho, U.S. Forest Service (1995).
http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=2987
Keywords: soil crusts/ rangelands/ soil microstructure/ soil nutrients
Abstract: The role of cryptobiotic soil crusts in the functioning of semiarid and arid ecosystems is discussed. These roles include microstructuring of soils in cold-desert ecosystems, influencing soil nutrient levels, and influencing the nutrient status, germination, and establishment of vascular plants in crusted areas when compared to uncrusted areas. For these reasons, re-establishment of these crusts should be an important part of reclamation efforts. Natural recovery rates and the effectiveness of inoculation efforts are discussed.

617. **Preliminary identification of Price River Basin salt pickup and transport processes**.
See record 173 in Subsurface Transport Processes.

618. **Production and nutrient status of whitetop**.
Smith, A. L.
Journal of Range Management 26: 117-120 (2006).
https://journals.uair.arizona.edu/index.php/jrm/article/view/6163/5773
Keywords: Scolochloa festucacea/ whitetop/ nutrients/ land use practices
Abstract: Post-flowering production of whitetop (*Scolochloa festucacea* (Willd./ Link.) was greater from burned and mowed sites than from undisturbed sites. Production from grazed stands was equal to that from undisturbed sites. Whitetop growth was initiated earlier on burned sites resulting in an earlier flowering time. Phenological differences in N content of the plant could be detected relative to water depth in the pothole. Nitrogen content decreased through flowering then increased. Potassium content decreased through the growing season. No concentration patterns were noted for other basic cations in the plant tissue relative to growth stage, sire condition, or land-use

practice. No relationship was ascertained between nutrient status of whitetop and land-use practice of the supporting site.
This citation is from the University of Arizona Institutional Repository.

619. **Reclamation of saline-sodic soils in the upper Colorado River Basin**.
Robinson, C. W.
Colorado Agricultural Experiment Station, Bulletin, 19 p. (1968).
Keywords: reclamation/ crop production/ soil-water-plant relationships/ drainage practices/ irrigation practices/ salts/ alkaline soils/ saline soils/ saline water/ Colorado/ electrical conductance/ gravels/ aquifers/ sodium compounds/ calcium compounds/ magnesium compounds/ chlorides/ sulfides/ leaching/ pumping/ irrigation efficiency/ water table/ wheat/ corn(field)/ rehabilitation/ treatment/ soil amendments/ crop response
Abstract: Below-average yields in arid and semi-arid lands may be due to accumulation of soluble salts and alkaline soils. Sodic soils commonly become abandoned. The irrigated Grand Valley of western Colorado has 20,000 acres of below-average crop production. The Mancos Shale, parent material for soil, contains highly saline groundwater--electrical conductivity of 9.0 mmhos/cm in the shallow gravel aquifer, and more than 100 mmhos/cm in saturated soil pastes. Sodium, calcium, and magnesium chlorides and sulfates accumulate and may be leached to reclaim soils by additional irrigation. Soil amendments and salt tolerance are discussed. Pump drainage lowers the water table to reclaim soils efficiently. Pumping at 250 to 300 gallons per minute after 15 months lowered the water table about 2 feet in 150 to 200 acres with significant wheat and corn production improvement. Over irrigation and pump drainage proved a successful rehabilitation method for saline-sodic soils in the upper Colorado River Basin. A table shows effects of leaching treatments on soluble salt content and exchangeable sodium percentages of soil. Eleven figures show general topography of study area, typical fields of reclaimed and abandoned land, leaching effects conductivities, yields and crop response.
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620. **Recovery of severely compacted soils in the Mojave Desert, California, USA**.
Webb, R. H.
Arid Land Research and Management 16: 291-305 (2002). ISSN: 1532-4982
http://dx.doi.org/10.1080/153249802760284829
Keywords: rangelands/ soil compaction/ arid regions/ models/ wheel tracks/ all terrain vehicles/ land restoration/ military lands
Abstract: Often as a result of large-scale military maneuvers in the past, many soils in the Mojave Desert are highly vulnerable to soil compaction, particularly when wet. Previous studies indicate that natural recovery of severely compacted desert soils is extremely slow, and some researchers have suggested that subsurface compaction may not recover. Poorly sorted soils, particularly those with a loamy sand texture, are most vulnerable to soil compaction, and these soils are the most common in alluvial fans of the Mojave Desert. Recovery of compacted soil is expected to vary as a function of precipitation amounts, wetting-and-drying cycles, freeze-thaw cycles, and bioturbation, particularly root growth. Compaction recovery, as estimated using penetration depth and bulk density, was measured at 19 sites with 32 site-time combinations, including the former World War II Army sites of Camps Ibis, Granite, Iron Mountain, Clipper, and Essex. Although compaction at these sites was caused by a wide variety of forces, ranging from human trampling to tank traffic, the data do not allow segregation of differences in recovery rates for different compaction forces. The recovery rate appears to be logarithmic, with the highest rate of change occurring in the first few decades following abandonment. Some higher-elevation sites have completely recovered from soil compaction after 70 years. Using a linear model of recovery, the full recovery time ranges from 92 to 100 years; using a logarithmic model, which asymptotically approaches full recovery, the time required for 85% recovery ranges from 105-124 years.

621. **Recovery rates of cryptobiotic crusts - inoculant use and assessment methods**.
Belnap, J.
Great Basin Naturalist 53: 89-95 (1993).
https://ojs.lib.byu.edu/ojs/index.php/wnan/article/viewFile/370/241
Keywords: cyanobacteria/ soil algae/ cryptobiotic crusts/ cryptogamic crusts/ recovery/ disturbance/ reclamation/ inoculation/ *Microcoleus vaginatus*

Abstract: Recovery rates of cyanobacterial-lichen soil crusts from disturbance were examined. Plots were either undisturbed or scalped, and scalped plots were either inoculated with surrounding biological crust material or left to recover naturally. Natural recovery rates were found to be very slow. Inoculation significantly hastened recovery for the cynobacterial/green algal component, lichen cover, lichen species richness, and moss cover. Even with inoculation, however, lichen and moss recovery was minimal. Traditional techniques of assessing recovery visually were found to underestimate time for total recovery. Other techniques, such as extraction of chlorophyll a from surface soil and measurement of sheath material accumulation, were used and are discussed.
This citation is from Brigham Young University.

622. **Reducing Salinity of Surface Runoff from Rangeland**.
See record 23 in Rangeland Management Practices and Potential Impact on Salinity.

623. **Rehabilitating salt-desert ecosystems following wildfire and wind erosion**.
See record 410 in Wind Transport.

624. **Rehabilitation of saline ecosystems through cultivation of salt tolerant plants**.
Yasin Ashraf, M., Awan, A. R. and Mahmood, K.
Pakistan Journal of Botany 44: 69-75 (2012).
ISSN: 0556-3321
http://www.pakbs.org/pjbot/PDFs/44(SI2)/10.pdf
Keywords: ecosystems/ perennial plants/ sustainable restoration/ salt tolerance
Abstract: In Pakistan, salt-affected regions have been drastically disturbed by unchecked activities of local populations. Removal of deep-rooted perennials and overgrazing destroy the native vegetation leading to rapid desertification. Shallow-rooted agricultural crops are grown on marginal soils on limited area that is not enough with respect to the spread of salinity problem. Sustainable restoration of these ecosystems requires a large scale integration of perennial plants (trees, shrubs and herbs) back in to farming systems. However, salinization processes continue because the available options for cultivation of perennial plants prove less profitable than agricultural crops. This study relates to resort the salt-affected lands for plant production and develop a technology for sustainable saline ecosystem. Plants, having salt tolerance potential, have been identified and introduced on salt-affected wastelands to develop a sustainable ecosystem with increased productivity. The biomass so produced can be used directly as forage, fuel, and even as food or feed. In addition, fish aquaculture, and some value-added products make this ecosystem more sustainable. This technology is practically demonstrated at Biosaline Research Station of Nuclear Institute for Agriculture and Biology (NIAB), Pakka Anna, Faisalabad, Pakistan. The marginally saline soils and wastelands ameliorated as a result of growing salt tolerant perennials can also be used for growing salt tolerant cultivars of conventional crops like wheat, barley and mustard. So, through proper management the saline ecosystem can become economical and profitable.
This citation is from the Pakistan Botanical Society.

625. **Responses of three arid zone grass species to varying Na/Ca ratios in saline sand culture**.
See record 95 in Rangeland Management Practices and Potential Impact on Biotic Processes.

626. **Restoration of riparian vegetation in the south-western United States: importance of flow regimes and fluvial dynamism**.
Stromberg, J. C.
Journal of Arid Environments 49: 17-34 (2001).
ISSN: 0140-1963
http://dx.doi.org/10.1006/jare.2001.0833
Keywords: restoration/ riparian ecosystem/ hydrology/ stream flow regime/ arid and semi-arid/ *Populus*
Abstract: Riparian ecosystems in the south-western United States have undergone extensive physical and biological changes, due, in part, to alteration of natural flow regimes and suppression of fluvial processes. Many riparian ecosystem restoration projects are achieving success because they recognize the importance of restoring the hydrologic regime. In other words, these projects are restoring flows of water and sediment in sufficient quantities and with appropriate temporal and spatial patterns. Other projects have proceeded without recognition of the need to incorporate environmental stream flow requirements into

management plans. To increase success rate of riparian ecosystem restoration, this paper describes some changes that have occurred within riparian ecosystems of the southwestern United States, reviews the role of stream flow regimes in structuring riparian plant communities, and assesses various ways in which riparian plant communities can be restored by naturalizing ecological processes.
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627. **Restoration of saline land through revegetation**.
Barrett-Lennard, E. G.
Agricultural Water Management 53: 213-226 (2002). ISSN: 0378-3774
http://dx.doi.org/10.1016/S0378-3774(01)00166-4
Keywords: halophytes/ water logging/ inundation/ salt uptake/ groundwater use/ salt accumulation
Abstract: In southern Australia, the replacement of deep-rooted perennial native vegetation with shallow-rooted annual crops has resulted in a rising water table and the development of a major secondary salinity problem. It is now acknowledged that the restoration of landscapes will require the reintegration of perennial plants (trees, shrubs and fodders) back into farming systems. Notwithstanding this, in many regions, salinisation processes will continue because the available perennial options are less profitable than annual cropping. This review therefore focuses on a less holistic approach, namely, the partial restoration of productivity of saltland through revegetation with salt tolerant plants (halophytes). Three major stresses affect plant growth on saltland: salinity, water logging and inundation. Although halophytes can accumulate quite high concentrations of salt in their shoots, it is argued that the use of the halophytes to lower salt concentrations in most saline soils would be slow (at best). However, data are available to show that stands of halophytes can transpire sufficient water to lower watertables, thereby ameliorating water logging (and presumably inundation). One consequence of the use of groundwater by salt tolerant perennial plants is the accumulation of salt in the rootzone. This has the potential to be highly damaging to plant growth and survival in the longer-term.
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628. **Restoring habitat for riparian birds in the lower Colorado River watershed: An example from the Las Vegas Wash, Nevada**.
Shanahan, S. A., Nelson, S. M., Van Dooremolen, D. M. and Eckberg, J. R.
Journal of Arid Environments 75: 1182-1190 (2011). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2011.06.017
Keywords: conservation/ invertebrates/ *Populus*/ *Salix*/ Soil moisture/ *Tamarix*/ saltcedar/ tamarisk
Abstract: The success of riparian restoration projects in the arid southwestern U.S. is often measured in terms of vegetation characteristics such as growth, cover, and structure. Among low-elevation riverine environments within the Colorado River watershed, restoration is typically conducted to improve degraded habitats for birds of conservation concern by replacing the exotic tamarisk (*Tamarix ramosissima*) with native cottonwoods (*Populus* spp.) and willows (*Salix* spp.). The working assumption for many restoration practitioners is that replacing exotic plants with native plants will improve habitat quality and will, therefore, benefit birds. Based on data collected at exotic and restored (i.e., native) sites along the Las Vegas Wash, Nevada, not all birds benefit from restoration. Broad measures of community benefit, including benefits to birds of conservation concern and riparian obligate/dependent birds, were not detected. There were, however, some species-specific benefits. Some environmental variables that were associated with exotic and native sites were significant in explaining the composition of the bird community. For example, the richness of forbs and grass-like plants (a proxy of soil moisture), invertebrate mass, and percent shade (a proxy for canopy characteristics) were important. Considering our results and depending on restoration goals, tamarisk replacement projects may not inherently provide benefits to birds.
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629. **Restoring Western Ranges and Wildlands (Vol 1)**.
See record 96 in Rangeland Management Practices and Potential Impact on Biotic Processes.

630. **Restoring Western Ranges and Wildlands (Vol 2)**.
See record 97 in Rangeland Management Practices and Potential Impact on Biotic Processes.

631. **Restoring western ranges and wildlands (Vol 3)**.
See record 98 in Rangeland Management Practices and Potential Impact on Biotic Processes.

632. **Riparian management: the future is in our hands**.
See record 100 in Rangeland Management Practices and Potential Impact on Biotic Processes.

633. **The role of endomycorrhizae in revegetation practices in the semiarid west. I. A comparison of incidence of mycorrhizae in severely disturbed vs. natural environments**.
Reeves, F. B., Wagner, D., Moorman, T. and Kiel, J.
Amer. J. Bot. 66: 6-13 (1979).
Keywords: endomycorrhizae/ land disturbance/ plant succession/ plant communities/ ecosystems/ rangeland restoration
Abstract: A comparison of a natural, undisturbed ecosystem, a mid-elevation sage community, with a severely disturbed old roadbed through this community revealed that more than 99% of the plant cover in the natural community was mycorrhizal (vesicular-arbuscular), whereas less than 1% of the plant cover in the disturbed area (roadbed) was mycorrhizal. Examples of nonmycorrhizal plants as primary successional species in severely disturbed habitats are discussed. The importance of maintaining or re-establishing the mycorrhizal fungal components in reclamation programs designed to produce stable ecosystems is emphasized.

634. **Sagebrush conversion to grassland as affected by precipitation, soil, and cultural practices**.
See record 103 in Rangeland Management Practices and Potential Impact on Biotic Processes.

635. **Salinity Control on Bureau of Land Management (BLM)-Administered Public Lands in the Colorado River Basin: A Report to Congress**.
See record 29 in Rangeland Management Practices and Potential Impact on Salinity.

636. **Salinity investigations of Mancos landforms and springs in the upper Colorado River Basin**.
See record 180 in Subsurface Transport Processes.

637. **Saltcedar Water Use: Realistic and Unrealistic Expectations**.
Owens, M. K. and Moore, G. W.
Rangeland Ecology and Management 60: 553-557 (2007). ISSN: 1550-7424
http://dx.doi.org/ 10.2111/1551-5028(2007)60[553:SWURAU]2.0.CO;2
Keywords: rangeland hydrology/ semi-arid/ tamarisk/ transpiration/ water yield/ *Tamarix*/ saltcedar
Abstract: Saltcedar (*Tamarix* spp.) is a widespread invasive plant found in riparian corridors and floodplains in 16 western states. In addition to being associated with such problems as increased soil salinity and decreased plant diversity, saltcedar has been reported to be a prolific water user. Popular press articles widely report that each individual saltcedar tree can use as much as 757 L (200 gallons) per day. Consequently massive control and removal efforts are underway to reduce transpirational water loss and increase water salvage for arid and semiarid environments. Although the potential economic benefits of these control efforts are touted, it has not been proven whether such water savings are possible on a stream level. The original citation for the 757-L estimate does not list the experimental design or techniques used to arrive at this value. We use three lines of evidence—peer-reviewed scientific literature, sap flux rates and sap wood area, and potential evaporation rates—to demonstrate the improbability that saltcedar, or any other woody species, can use this much water per tree on a daily basis. A more realistic estimate of maximum tree-level daily water use derived from sap flux measurements would be <122 L d^{-1} (32.2 gallons). Estimates of water salvage would

be grossly overestimated using the popular water use value (757 L· d−1), and economic benefits from saltcedar control based solely on water salvage are questionable.
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638. **Sediment movement and filtration in a riparian meadow following cattle use**.
See record 297 in Surface Water Transport Processes.

639. **Seed inoculation with effective root-nodule bacteria enhances revegetation success**.
See record 32 in Rangeland Management Practices and Potential Impact on Salinity.

640. **Seeding salt-desert shrub ranges in western Wyoming**.
Hull, A. C.
Journal of Range Management 16: 253-258 (1963). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/5189/4799
Keywords: rangeland management/ seeding/ revegetation
Abstract: The demands for increased forage, reduced erosion, and control of undesirable plants indicate the need for improvement of salt-desert shrub ranges below their potential production. Most depleted areas can best be improved by better management. Where desirable plants are absent and favorable soil and moisture permit, seeding may speed up revegetation. To determine the possibilities for revegetation, the Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service, the Bureau of Land Management, and the University of Wyoming initiated 25 studies during 1948 to 1951 to evaluate species and methods of seeding Wyoming rangelands. With the departmental reorganization in 1954, this work was transferred to Agricultural Research Service. Experimental seedings with 14 species were made on 18 salt- desert shrub areas in Wyoming during 1948-50. Seeded stands were poor; but considering the aridity, salinity, and alkalinity of the soils, even a few surviving plants gave encouragement. Russian wildrye was the best species with some stands ranging to good. Crested wheatgrass was slightly inferior to Russian wild-rye. Other species either failed or were reduced to very poor stands. Seedling emergence was poor to excellent on all seedbeds but all plants died on unprepared seedbeds.
This citation is from the University of Arizona Institutional Repository.

641. **Seedling survival on erosion control treatments in a salt desert area**.
Wein, R. W. and West, N. E.
Journal of Range Management 24: 352-357 (1971). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/5964/5574
Keywords: seeding/ gully plugs/ contour furrows/ precipitation/ seedling survival/ soil infiltration rates/ crested wheatgrass/ *Agropyron cristatum*
Abstract: Counts of seeded crested wheatgrass (*Agropyron cristatum*) and volunteer species were made on gully plugs and contour furrows in the spring to determine emergence and in the summer to determine survival rates. Soil surface moisture was measured 2 and 7 days following summer rain storms. Many seedlings emerged in the spring in response to winter and early spring precipitation. This moisture was quickly depleted. The retention of moisture from summer storms determined the seedling survival pattern around the structures. Drowning was apparent in gully plug bottoms, while slopes of the structures retained little water during the storms. The combination of irregular rainfalls, high evaporation rates, and poor soil infiltration rates reduced the effectiveness of summer rains. Only at the high water line of the gully plug retention dam and at the bottom of the furrows was there enough soil moisture to benefit seedlings.
This citation is from the University of Arizona Institutional Repository.

642. **Self-sustainable reclamation: Shrub and tree establishment on saline mine wastes**.
See record 109 in Rangeland Management Practices and Potential Impact on Biotic Processes.

643. **Severe Mechanical and Chemical Range Renovation in Northeastern Wyoming**.
Rauzi, F.
Journal of Range Management 28: 319-326 (1975).
https://journals.uair.arizona.edu/index.php/jrm/article/view/6475/6085

Keywords: rangeland renovation/ soil types/ precipitation/ plowing/ spraying/ dozing/ herbicides/ herbage production/ grasses
Abstract: Range renovation using a moldboard plow, disc plow, rotovator, blade, and strip spraying with atrazine was evaluated on a clayey and a sandy range site 35 miles south of Gillette, Wyoming. Herbage yields and vegetative composition were influenced by the individual renovation treatment, range site, and distribution and amount of April, May, and June precipitation. The amount of total perennial grass was significantly increased on the plots treated with the rotovator and strip spraying with atrazine on the clayey site, and on plots treated with atrazine on the sandy site. The 5-year average yield of blue grama from the atrazine treatments averaged 872 and 939 lb/acre on the clayey and sandy range sites, respectively, as compared with 237 and 229 lb/acre, respectively, on the check. The blue grama on plots sprayed with atrazine produced a profusion of seed heads and remained green later in the season than on any of the other treatments. The disc plow and the rotovator appear to have a greater potential than the moldboard plow or blade for range renovation. Annual grasses may become a problem with any range renovation, and should be controlled.
This citation is from the University of Arizona Institutional Repository.

644. **Soil and water salinity in Queensland: the prospect of ecological sustainability through the implementation of land clearing policy**.
See record 33 in Rangeland Management Practices and Potential Impact on Salinity.

645. **Soil erosion and conservation in Australia**.
See record 301 in Surface Water Transport Processes.

646. **Soil microstructure in soils of the Colorado Plateau - the role of the cyanobacterium *Microcoleus vaginatus***.
Belnap, J. and Gardner, J. S.
Great Basin Naturalist 53: 40-47 (1993).
https://ojs.lib.byu.edu/ojs/index.php/wnan/article/view/366/237
Keywords: Microcoleus vaginatus/ cyanobacteria/ cryptobiotic crusts/ cryptogamic/ crusts/ soil/ soil microstructure
Abstract: The role of the cyanobacterium *Microcoleus vaginatus* in cold-desert soil crusts is investigated using scanning electron microscopy. Crusts from sandstone-, limestone-, and gypsum-derived soils are examined. When dry, polysaccharide sheath material from this cyanobacterium can be seen winding through and across all three types of soil surfaces, attaching to and binding soil particles together. When wet, sheaths and living filaments can be seen absorbing water, swelling and covering soil surfaces even more extensively. Addition of negatively charged material, found both as sheath material and attached clay particles, may affect cation exchange capacity of these soils as well. As a result of these observations, we propose that the presence of this cyanobacterium may significantly enhance soil stability, moisture retention, and fertility of cold-desert soils.
This citation is from Brigham Young University.

647. **Soil moisture patterns on two chained pinyon-juniper sites in Utah**.
See record 74 in Rangeland Management Practices and Potential Impact on Water.

648. **Soil salinity patterns in *Tamarix* invasions in the Bighorn Basin, Wyoming, USA**.
See record 35 in Rangeland Management Practices and Potential Impact on Salinity.

649. **Soil salinity: A neglected factor in plant ecology and biogeography**.
See record 111 in Rangeland Management Practices and Potential Impact on Biotic Processes.

650. **Spy mesa yields better understanding of pinyon-juniper in range ecosystem**.
Thatcher, A. P. and Hart, V. L.
Journal of Range Management 27: 354-357 (1974). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/6357/5967
Keywords: pinyon-juniper/ fire/ grasses/ soil/ plant communities

Abstract: A 2-year study on the Spy Mesa relict of the Arizona Strip provides information concerning the natural occurrence of pinyon-juniper in range ecosystems of this area. The 40-acre relict is unique because there is a wide variety of soils and natural fires have occurred over the past 50 years. The plants have been grazed by rodents and mule deer and yet they have been inaccessible to livestock. This study reveals that, following natural fires, grass became significant in the plant community only on soils that had sandy surface textures. Pinyon-juniper was the dominant species in the absence of fire, regardless of the kind of soil. Those soils having a vesicular, massive or platy surface layer did not produce significant quantities of grass at any stage of plant succession.
This citation is from the University of Arizona Institutional Repository.

651. **State and Local Management Actions to Reduce Colorado River Salinity**.
See record 36 in Rangeland Management Practices and Potential Impact on Salinity.

652. **Surface disturbance of cryptobiotic soil crusts - nitrogenase activity, chlorophyll content, and chlorophyll degradation**.
Belnap, J., Harper, K. T. and Warren, S. D.
Arid Soil Research and Rehabilitation
8:1-8 (1994).
http://digitalcommons.usu.edu/crc_research/590/
Keywords: soil crusts/ arid zones/ range management/ disturbed soils/ nitrogenase/ chlorophyll/ biodegradation
Abstract: Cryptobiotic soil crusts are an important component of semiarid and arid ecosystems. An important role of these crusts is the contribution of fixed nitrogen to cold-desert ecosystems. This study examines the residual effects of various intensities and combinations of different surface disturbances (raking, scalping, and tracked vehicles) on nitrogenase activity, chlorophyll content, and chlorophyll degradation in these soil crusts. Nine months after disturbance chlorophyll content of disturbed soils was not statistically different from undisturbed controls, except in the scalped treatments, indicating recovery of this characteristic is fairly quick unless surface material is removed Differences in chlorophyll degradation among treatments were not statistically significant. However, nitrogenase activity in all treatments showed tremendous reductions, ranging from 77-97%, when compared to the control, indicating this characteristic is slow to recover. Consequently, assessment of crustal recovery, from disturbance must include not only visual and biomass characteristics but other physiological measurements as well. Areas dominated by these crusts should be managed conservatively until the implication of crustal disturbance is better understood.
This citation is from Utah State University.

653. **Tall wheat grass (*Thinopyrum ponticum*) and puccinellia (*Puccinellia ciliata*) may not be the answer for all saline sites: A case study from the Central Western Slopes of New South Wales**.
See record 114 in Rangeland Management Practices and Potential Impact on Biotic Processes.

654. **Transport of salts from disturbed geologic formations**.
See record 39 in Rangeland Management Practices and Potential Impact on Salinity.

655. **Upper Colorado River Basin Rangeland Salinity Control Project: Watershed Resource Condition Evaluation Phase II Procedure**.
See record 40 in Rangeland Management Practices and Potential Impact on Salinity.

656. **Use of native plants on federal lands: Policy and practice**.
Richards, R. T., Chambers, J. C. and Ross, C.
Journal of Range Management 51: 625-632 (1998). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/9366/8978
Keywords: native plants/ natural resource management/ BLM/ seed policy
Abstract: Changing social values and advances in ecological knowledge determine native seed policy for revegetating range and forest lands. Natural resource managers are shifting from seeding introduced species for their widespread adaptability to reestablishing native species in order to maintain or restore the genetic and ecological integrity of native ecosystems. Addressing the problems of reestablishing native plants on a site-specific basis has been increasingly recognized as an integral part of

ecosystem management of large landscapes. We review the formation and implementation of native seed policy for fire rehabilitation and mining reclamation by the major federal land management agencies in the United States, the Department of Interior's Bureau of Land Management (BLM) and the Department of Agriculture's Forest Service. We then examine native seed policy implementation on specific land revegetation projects over the past 10 years for 4 BLM districts in the state of Nevada. We conclude with an analysis of native seed policy in principle versus practice and suggest implications for future policy review and implementation.
This citation is from the University of Arizona Institutional Repository.

657. **Use of saline–sodic waters through phytoremediation of calcareous saline–sodic soils**.
Qadir, M., Ghafoor, A. and Murtaza, G.
Agricultural Water Management 50: 197-210 (2001). ISSN: 0378-3774
http://dx.doi.org/10.1016/S0378-3774(01)00101-9
Keywords: vegetative bioremediation/ soil salinity/ soil sodicity/ gypsum/ farm manure/ sulphuric acid/ drainage water quality
Abstract: Use of poor-quality groundwater has become inevitable for irrigation to compensate rapidly increasing water demands in many arid and semiarid regions. Salinity and sodicity are the principal soil and water quality concerns in such areas. Many saline–sodic and sodic soils have saline or saline–sodic subsurface drainage waters. Amelioration of these soils needs a source of calcium (Ca2+) that can replace the excess exchangeable sodium (Na+). Most of these soils, however, contain calcite (CaCO3) of extremely low solubility. The native calcite does not supply adequate levels of Ca2+ for soil amelioration as do other chemical amendments. Phytoremediation may help ameliorate such soils through cultivation of certain crops tolerant to ambient soil salinity and sodicity. This amelioration strategy works through plant root action to help dissolve CaCO3 to supply adequate Ca2+ without the application of an amendment. During a 3-year field experiment conducted under irrigated conditions, we evaluated phytoremediation against soil application of gypsum and farm manure, and water treatment with sulphuric acid on a calcareous saline–sodic soil (pHs=8.0–8.4, ECe=24–32 dS m−1, SAR=57–78, CaCO3=45–50 g kg−1 for the top 0.15 m depth; Calcic Haplosalids). A saline–sodic water (EC=2.9–3.4 dS m−1, SAR=12.0–19.4, RSC=4.6–10.0 mmolc l−1, SARadj=15.6–18.4) was used to irrigate the rice (Oryza sativa L.) and wheat (Triticum aestivum L.) crops grown in rotation. Active desalinisation and desodication processes were observed in all the treatments. After the final wheat crop, the 1.2 m soil profile ECe was 7±0.5 dS m−1 and SAR was 15±2 with non-significant treatment differences, indicating comparable soil amelioration effect of phytoremediation with other treatments. Better crop yields were obtained from the manure-treated plots, owing to its annual addition to the soil that possibly improved soil fertility. Phytoremediation needed minimum capital input because no initial investment was made to purchase the amendments.
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658. **The use of seedbed modifications and wood chips to accelerate restoration of well pad sites in western Colorado, U.S.A**.
Eldridge, J. D., Redente, E. F. and Paschke, M.
Restoration ecology 20: 524-531 (2012). ISSN: 1061-2971
http://dx.doi.org/10.1111/j.1526-100X.2011.00783.x
Keywords: ecological processes/ microcatchments/ native plants/ natural gas/ revegetation techniques/ soil amendments
Abstract: Semiarid ecosystems of Western North America are experiencing a boom in natural gas development. However, these systems are slow to recover from the disturbances created. The purpose of this study was to develop improved restoration techniques on natural gas well pads in Western Colorado. This study examined effects and interactions of seedbed modifications, soil amendments, seed mixtures, and seeding methods. The experiment was conducted in pinyon-juniper and semidesert shrub plant communities on five natural gas well pads beginning in 2006. Soil and plant cover data were collected to assess the effectiveness of 16 different treatment combinations. After two growing seasons, we found that patches of soil salinity (>4 dS/m) reduced plant cover to less than 20% on 55 of our 240 experimental plots. These patches of salinity, such as where reserve pits were buried, may need to be treated to completely restore cover on the total gas pad area, although causes of salinity patches needs

further investigation. After removing the 55 saline plots from our data analyses, we found that wood chips (WC) as a soil amendment increased organic matter content and reduced non-native species. Rough seedbed modifications increased the establishment of native species, especially during years of below average precipitation. Island broadcasting resulted in an increase of noxious plant cover during the second growing season. From these findings we recommend that disturbed well pads in a similar environment be restored by seeding native species on sites that are amended with WC and physically modified to create a roughened seedbed. © 2011 Society for Ecological Restoration International.
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659. **Using geographic information systems and remote sensing to map rangeland salinity source areas, Upper San Rafael River, Utah**.
Nield, S. J.
Utah State University, 178 p. (2004).
Keywords: geographic information systems (GIS)/ remote sensing/ soil salinity/ soil surveys/ alluvial soils/ upland soils/ watershed management/ gypsum
Abstract: This study used geographical information systems (GIS), remotely-sensed spectral data, electromagnetic induction (EMI) surveys, and solute analysis to identify salinity sources in upland and alluvial areas of the San Rafael Swell. Separate spectral models were developed to identify soils with nitric or gypsy properties. Ground-trotting procedures revealed an overall accuracy of 80%. Apparent electro conductivity (EC a) and saturated paste conductivity (EC e) values for alluvial soils were analyzed by a weighted coefficients method. With this method, the EC a /EC e relationship produced r 2 values from 0.45 to 0.94. The EC a values were interpolated to produce EC a contour maps. Interpretations of EC a maps and upland soil properties suggest salinity concentrations in alluvial areas are a function of upland soil properties, watershed size, and geology. Solute analyses of alluvial and upland soils suggest the salt composition and concentration of alluvial soils reflect the upland soils and geologies to which they are hydrologically linked.
This citation is from Utah State University.

660. **Using rangeland health assessment to inform successional management**.
Sheley, R. L., James, J. J., Vasquez, E. A. and Svejcar, T. J.
Invasive Plant Science and Management 4: 356-366 (2011). ISSN: 1939-7291
http://dx.doi.org/10.1614/IPSM-D-10-00087.1
Keywords: rangeland health assessment/ successional management/ ecologically-based invasive plant management/ EBIPM/ plant succession/ ecology/ ecological site description
Abstract: Rangeland health assessment provides qualitative information on ecosystem attributes. Successional management is a conceptual framework that allows managers to link information gathered in rangeland health assessment to ecological processes that need to be repaired to allow vegetation to change in a favorable direction. The objective of this paper is to detail how these two endeavors can be integrated to form a holistic vegetation management framework. The Rangeland Health Assessment procedures described by Pyke et al. (2002) and Pellant et al. (2005) currently are being adopted by land managers across the western United States. Seventeen standard indicators were selected to represent various ecological aspects of ecosystem health. Each of the indicators is rated from extreme to no (slight) departure from the Ecological Site Description and/or the Reference Area(s). Successional management identifies three general drivers of plant community change: site availability, species availability, and species performance, as well as specific ecological processes influencing these drivers. In this paper, we propose and provide examples of a method to link the information collected in rangeland health assessment to the successional management framework. Thus, this method not only allows managers to quantify a point-in-time indication of rangeland health but also allows managers to use this information to decide how various management options might influence vegetation trajectories. We argue that integrating the Rangeland Health Assessment with Successional Management enhances the usefulness of both systems and provides synergistic value to the decision-making process. © 2011 Weed Science Society of America.
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661. **Variations in soil dispersivity across a gully head displaying shallow sub-surface pipes, and the role of shallow pipes in rill initiation**.
See record 41 in Rangeland Management Practices and Potential Impact on Salinity.

662. **Vegetation communities on the shores of a salt lake in semi-arid Western Australia**.
See record 202 in Subsurface Transport Processes.

663. **Vegetation restoration of secondary bare saline-alkali patches in the Songnen plain, China**.
See record 116 in Rangeland Management Practices and Potential Impact on Biotic Processes.

664. **Water Harvesting From Ranch Roads**.
Thorpe, J.
Rangelands 29: 56-58 (2007). ISSN: 1551-501X
https://journals.uair.arizona.edu/index.php/rangelands/article/view/12280/11558
Keywords: roads/ runoff/ water control
Abstract: Rangeland roads are often designed, built, and maintained with speed and least-costs in mind with too little attention to their potential impact on surface runoff patterns and consequent influence on vegetative growth. Installing and maintaining rolling dips and other contemporary water control structure designs are discussed.
This citation is from the University of Arizona Institutional Repository.

665. **Waterponding: Reclamation technique for scalded duplex soils in western New South Wales rangelands**.
See record 80 in Rangeland Management Practices and Potential Impact on Water.

666. **Wildfire-resistant biological soil crusts and fire-induced loss of soil stability in Palouse prairies, USA**.
Bowker, M. A., Belnap, J., Rosentreter, R. and Graham, B.
Applied Soil Ecology 26: 41-52 (2004).
http://dx.doi.org/10.1016/j.apsoil.2003.10.005
Keywords: biological soil crusts/ soil stability/ fire ecology/ grasslands/ pigments/ sand prairie/ recovery/ disturbance/ shrubland/ plant
Abstract: Frequent low-intensity fires are a natural component of the ecology of the Palouse prairies of northwestern North America. To study the effects of fire upon biological soil crusts (BSCs) occurring in these grasslands, we sampled three burned (in 2000) sites and three unburned sites in the Hell's Canyon area (OR, USA) similar to1 year post-fire. We measured vascular plant and BSC cover, soil microbe pigmentation, texture and chemistry, and soil surface physical properties (stability and rugosity). *Festuca idahoensis* was two times more abundant in unburned plots (P = 0.0006), and vascular plant and litter cover were generally higher in unburned plots. At the community scale, there was no difference in the lichen and moss species composition, suggesting much less drastic effects of fire on BSCs than reported in other systems. Soil surface stability (measured using slake value) was significantly lower in burned sites than unburned sites (median value = 5 versus 6, P = 0.008), a result which is likely due to the greater density of lichens and mosses encountered in the unburned plots. Soil microbe pigmentation was lower in burned plots (P = 0.03), suggesting that the biomass of photosynthetic microbes had decreased; however, the presence of intra- and extracellular pigments in burned soils indicates that microorganisms were not eradicated. Pigments most strongly associated with cyanobacteria were more abundant in unburned sites, suggesting that cyanobacteria may have been more strongly impacted by the fire than other BSC components. Composition of nutrients and surface rugosity did not differ significantly between treatments. We hypothesize that Palouse prairie soil crusts are relatively resistant to wildfire because of low fire intensity and their occupation of space away from the vascular plant fuel load. Published by Elsevier B.V.

667. **A wind tunnel study to determine the vegetation cover required to suppress sand and dust transport at Owens (dry) Lake, California**.
See record 450 in Wind Transport.

668. **AGWA: The Automated Geospatial Watershed Assessment tool to inform rangeland management**.
Goodrich, D. C., Guertin, D. P., Burns, I. S., Nearing, M. A., Stone, J. J., Wei, H., Heilman, P., Hernandez, M., Spaeth, K. and Pierson, F.
Rangelands 33: 41-47 (2011). ISSN: 0190-0528
http://dx.doi.org/10.2111/1551-501X-33.4.41
Keywords: rangeland management/ erosion/ sediment/ watersheds/ decision support tool/ ecology/ hydrology/ runoff/ conservation
Abstract: Effective rangeland management requires the ability to assess the potential impacts of management actions on soil erosion and sediment yield at both the hillslope and watershed scales. Many of the current tools for assessing and evaluating the effects of rangeland management practices on soil and water resources originally were developed for traditional cropland agricultural practices. These tools and models assumed a uniform vegetation distribution and surface cover across the landscape, which was inadequate to represent typical rangeland conditions. Current technologies also do not directly use information at the ecological site level. In this article, we focus on a Decision Support Tool (DST) that incorporates ecological concepts and rangeland management practices, uses readily available data, and is designed to represent rangeland hydrologic and erosion processes. The recently developed RHEM (Rangeland Hydrology and Erosion Model) and the Automated Geospatial Watershed Assessment tool (AGWA) form the foundation of this DST. RHEM is applicable at the hillslope scale, and when executed, completes a simulation for a single hillslope. AGWA, via the KINEROS2 watershed model, executes RHEM for all hill-slopes within a watershed. Runoff and sediment are routed through channels draining the hillslopes, enabling rapid watershed scale assessments. The current RHEM and AGWA tools, as well as those in development, will support the analysis of alternative management systems as well as their placement in a watershed to reduce conservation investments and increase cumulative conservation benefits over a range of scales (i.e., pasture to landscape). They will link rangeland field measurements directly to decision-making for public land management and improved conservation programs.
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669. **Applications and research using remote sensing for rangeland management**.
Hunt, E. R., Everitt, J. H., Ritchie, J. C., Moran, M. S., Booth, D. T., Anderson, G. L., Clark, P. E. and Seyfried, M. S.
Photogrammetric Engineering and Remote Sensing 69: 675-693 (2003).
http://handle.nal.usda.gov/10113/6776
Keywords: range management/ rangelands/ remote sensing/ grasslands/ shrubland/ savannas/ monitoring/ ecosystem management/ noxious weeds/ ecological succession/ plant communities/ spatial data/ plant growth/ Landsat/ lidar/ vegetation cover/ algorithms/ soil properties/ evapotranspiration/ spectral analysis
Abstract: Rangelands are grasslands, shrublands, and savannas used by wildlife for habitat and livestock in order to produce food and fiber. Assessment and monitoring of rangelands are currently based on comparing the plant species present in relation to an expected successional end-state defined by the ecological site. In the future, assessment and monitoring may be based on indicators of ecosystem health, including sustainability of soil, sustainability of plant production, and presence of invasive weed species. USDA Agricultural Research Service (ARS) scientists are actively engaged in developing quantitative, repeatable, and low-cost methods to measure indicators of ecosystem health using remote sensing. Noxious weed infestations can be determined by careful selection of the spatial resolution, spectral bands, and timing of image acquisition. Rangeland productivity can be estimated with either Landsat or Advanced Very High Resolution Radiometer data using models of gross primary production based on radiation use efficiency. Lidar measurements are useful for canopy structure and soil roughness, indicating susceptibility to erosion. The value of remote sensing for rangeland management depends in

part on combining the imagery with other spatial data within geographic information systems. Finally, ARS scientists are developing the knowledge on which future rangeland assessment and monitoring tools will be developed.

670. **Assessing contaminant transport vulnerability in complex topography using a distributed hydrologic model**.
Martens, S. N. and Breshears, D. D.
Vadose Zone Journal 4: 811-818 (2005).
http://dx.doi.org/10.2136/vzj2004-0037
Keywords: ponderosa pine hillslope/ pinyon-juniper woodland/ erosion/ runoff/ vegetation
Abstract: Modeling of vadose zone hydrology is required to address a variety of applied problems in general and risk assessments associated with contaminants in particular. Risk assessments increasingly must focus on multisite, multipathway analyses as opposed to single-site, single pathway analyses. Such assessments can be particularly challenging when contaminants are widely dispersed in complex topography. Here highlight how a set of contaminated sites situated within complex topography can be effectively prioritized relative to vulnerability of contaminant transport from surface and subsurface flows. We used a distributed hydrologic model, SPLASH, to assess the lateral flows of surface and subsurface water following the simulation of a 100-year precipitation event, which could correspond to an intense thunder-storm. Our case study was conducted in the North Ancho watershed of Los Alamos National Laboratory, in northern New Mexico, USA, an area with widely dispersed contaminants and diverse topography. Simulated surface flows generally exceeded subsurface flows by more than four orders of magnitude, indicating the relative importance of redistribution of contaminants by surface flows for this type precipitation event. For the 18 potential contaminant release sites, the maximum surface flow varied by more than an order of magnitude across the sites. Half of the sites had surface flows <25% of the maximum surface flow for a site, allowing for prioritization of those sites with the greatest vulnerability. Our results highlight how risks of contaminant transport can be effectively assessed in complex topography using distributed hydrologic modeling.
This citation is from the Soil Science Society of America.

671. **Assessing salt-affected soils using remote sensing, solute modelling, and geophysics**.
Farifteh, J., Farshad, A. and George, R. J.
Geoderma 130: 191-206 (2006).
http://dx.doi.org/10.1016/j.geoderma.2005.02.003
Keywords: geophysics/ percolation (fluids)/ rain/ remote sensing/ salinization/ salts/ soil degradation/ solubility/ solute modeling/ solute transport
Abstract: Salinization and alkalinization are the most common land degradation processes, particularly occurring in arid and semi-arid regions, where precipitation is too low to maintain a regular percolation of rainwater through the soil. Under such a climatic condition, soluble salts are accumulated in the soil, influencing soil properties and environment which cause lessening of the soil productivity. The consistent identification of the processes is essential for sustainable soil management. Identification, large scale mapping and monitoring of the salt-affected areas have been done using three different data and techniques. Remote sensing has been widely used to detect and map salt-affected areas, since thousands of medium to high-resolution imageries from the earth surface are available. In practice, most of these studies have focused on severely saline areas and have given less attention to the detection and monitoring of slightly or moderately affected areas. The major constrain is related to the nature of the satellite images, which do not allow extracting information from the third dimension of the 3-D soil body e.g., where salts concentrate in subsoil. Solute transport modelling is another technique which is used to predict the salt distribution in the subsoil. It has the advantage of providing subsoil information on dynamics of the salt movement regimes. This technique provides complementary data on salt movement in the soil profile which can be used in combination with remote sensing data. Since a few years, near-surface geophysics sensors, particularly airborne, are widely used to map and monitor salt-affected areas. This technology has the advantage of effectiveness for cropped land and

can efficiently be used to highlight conductive areas where no surface expression of salt is evident. The paper outlines the conceptual framework of a method where the data obtained from optical remote sensing sensors should be integrated with the results of simulation models and geophysical survey in order to predict different levels (low, moderate, severe) of salinization/alkalinization in a cost-attractive and efficient way. In the proposed integrated method, data are combined not only to demarcate the existing salt-affected soils, but also to track down the salinization as a pedogenic process. Such an approach focuses on the integration of the data with different natures and scales, meaning that data fusion and up-scaling are strongly involved. © 2005 Elsevier B.V. All rights reserved.

672. **Catchment scale spatial variability of soil salt content in agricultural oasis, Northwest China**.
Wang, Y., Li, Y. and Xiao, D.
Environmental Geology 56: 439-446 (2008). ISSN: 0943-0105
http://dx.doi.org/10.1007/s00254-007-1181-0
Keywords: geology/ catchment area/ landforms/ landscape/ remote sensing/ agricultural land/ spatial variation/ soil/ China/ Xinjiang Prov./ salts/ salinity/ soil salinity/ salinity effects/ catchments/ agricultural runoff/ salinization
Abstract: Soil salinization is a serious environmental problem in the world, especially in arid and semi-arid regions. Therefore, estimating spatial variability of soil salinity plays an important role in environmental sciences. Aiming at the problem of soil salinization inside an oasis, a case study was carried out at the Sangong River catchment in Xinjiang province, northwest China. Methods of classical statistics, geostatistics, remote sensing (RS) and geographic information system (GIS) were applied to estimate the spatial variability of soil salt content in the topsoil (0-20cm) and its relationship with landscape structure at catchment scale. The objective of this study was to provide a scientific basis to understand the heterogeneous of spatial distribution of soil salt content at a large scale. The results revealed that (1) elevation of landform was a key factor for soil salt content's spatial variability, and soil salt content had a strong spatial autocorrelation, which was mainly induced by structural factors. (2) Mapping of soil salt content by Kriging and comparing it with landscape maps showed that area of soil salinization in old oasis was smaller than that in new oasis, and degree of soil salinization in old oasis was also lower than that in the new one. Among all landscapes, cropland was mostly affected by salinity, with 38.8% of the cropland in new oasis moderately affected by soil salinity, and 8.54% in old oasis.
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673. **Climate change impacts on northwestern and intermountain United States rangelands**.
Chambers, J. C. and Pellant, M.
Rangelands 30: 29-33 (2008). ISSN: 1551-501X
http://handle.nal.usda.gov/10113/31585
Keywords: climate change/ temperature/ precipitation/ evapotranspiration/ range management/ climatic factors/ water management/ water supply/ water quantity/ groundwater/ plant communities/ biodiversity/ habitat fragmentation/ invasive species/ noxious weeds/ fire regime/ stream flow/ Northwestern United States/ Intermountain West region
Abstract: Our focus is on the Pacific Northwest and Intermountain Region including the Great Basin, Columbia Plateau, Colorado Plateau, and surrounding areas. Population growth, water resources, invasive species, fuels and fire management, and threatened, sensitive, and endangered species will likely continue to dominate management and policy decisions. Policies that facilitate the management of rangeland ecosystems across administrative boundaries and that promote planning and management over longer time frames and larger spatial scales will be critical for implementing practices to respond to an increasingly variable climate. Developing reasonable response strategies and practices will require 1) accurate predictions of the changes that are likely to occur, especially at a management scale, 2) concepts and management approaches for dealing with the changes, and 3) policies and programs that will provide the necessary funds, mechanisms, and flexibility to implement large-scale adaptive management approaches.

674. **Desertification control: A framework for action**.
Dregne, H. E.
Environmental Monitoring and Assessment 37: 111-122 (1995). ISSN: 0167-6369
http://dx.doi.org/10.1007/BF00546884

Keywords: soil/ terrestrial environment/ degradation/ erosion/ arid environment/ wind erosion/ soil treatment/ water erosion/ desertification/ vegetation/ compactness/ physical properties/ ecology/ rangelands/ environmental geology/ land use/ salinization
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675. **Development and use of state-and-transition models for rangelands**.
Bestelmeyer, B. T., Brown, J. R., Havstad, K. M., Alexander, R., Chavez, G. and Herrick, J. E.
Journal of Range Management 56: 114-126 (2003). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/9781/9393
Keywords: state-and-transition models/ management practices/ ecological processes
Abstract: State-and-transition models have received a great deal of attention since the introduction of the concept to range management in 1989. Nonetheless, only recently have sets of state-and-transition models been produced that can be used by agency personnel and private citizens, and there is little guidance available for developing and interpreting models. Based upon our experiences developing models for the state of New Mexico, we address the following questions: 1) how is information assembled to create site-specific models for entire regions, 2) what ecological issues should be considered in model development and classification, and 3) how should models be used? We review the general structure of state-and-transition models, emphasizing the distinction between changes among communities within states (pathways) that are reversible with changes in climate and "facilitating practices" (e.g. grazing management), and changes among states (transitions) that are reversible only with "accelerating practices" such as seeding, shrub control, or the recovery of soil stability and historical hydrologic function. Both pathways and transitions occur, so these models are complementary. Ecological sites and the climatically-defined regions within which they occur (land resource units) serve as a framework for developing and selecting models. We illustrate the importance of clearly delineating ecological sites to produce models and describe how we have dealt with poorly-delineated sites. Producing specific models requires an understanding of the multiple ecological mechanisms underlying transitions. We show how models can represent and distinguish alternative and complementary hypotheses for transitions. Although there may be several mechanisms underlying transitions, they tend to fall within discrete categories based upon a few, fundamental ecological processes and their relationships can be readily understood. A knowledge of mechanisms is closely related to the use of ecological indicators to anticipate transitions. We conclude that models should include 1) reference values for quantitative indicators, 2) lists of key indicators and descriptions of changes in them that suggest an approach to a transition, and 3) a rigorous documentation of the theory and assumptions (and their alternatives) underlying the structure of each model.
This citation is from the University of Arizona Institutional Repository.

676. **Digitally mapping gypsic and natric soil areas using landsat ETM data**.
Nield, S. J., Boettinger, J. L. and Ramsey, R. D.
Soil Science Society of America Journal 71(1): 245-252 (2007).
http://dx.doi.org/10.2136/sssaj2006-0049
Keywords: Colorado Basin/ Colorado Plateau/ computer simulation/ drainage/ gypsic soil/ LANDSAT thematic mapper/ mathematical models/ NDVI/ normalized difference ratio/ North America/ remote sensing/ river drainage/ soil/ threshold values/ United States/ detection method/ digital mapping/ gypsum/ iron/ satellite data/ soil analysis/ spectral analysis/ spectral reflectance/ surface reflectance/ threshold
Abstract: Mapping salt-affected soils in remote rangelands is challenging. We used Landsat 7 ETM data to facilitate digital mapping of gypsic and natric soil areas in the upper Colorado River drainage. Optimum index factor band combinations were used to explore the scene. Normalized difference ratio models and threshold values were developed by comparing spectral signatures with gypsic and natric soil areas verified in the field. Gypsic soil areas were mapped using the normalized difference ratio of Bands 5 and 7 with a threshold >0.11, probably related to the spectral reflectance of gypsum within a few centimeters of the surface. All sites predicted to be gypsic soil areas were determined to be gypsic by field assessment, and 87% of the field-observed gypsic soil areas were correctly predicted. Natric soil areas were mapped using the normalized difference ratio of Bands 5 and 4 with a threshold >0.19, possibly

related to the co-occurrence of Fe-bearing minerals with natric soil areas. Most of the sites predicted to be natric were determined in the field to be natric (82%), but only half of the field-observed natric areas were correctly predicted, indicating that natric soils are harder to detect spectrally than gypsic soils. While the gypsic model may be transferred to other areas, particularly in the arid Colorado Plateau, transfer of natric models would be difficult. Normalized difference ratio models can be developed for other digital soil mapping areas where land surface features produce differences in Landsat spectral band reflectances. © Soil Science Society of America.
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677. **Dryland management for salinity control**.
See record 127 in Subsurface Transport Processes.

678. **Effects of crust and cracks on simulated catchment discharge and soil loss**.
Stolte, J., Ritsema, C. J. and Deroo, A. P. J.
Journal of Hydrology 195: 279-290 (1997).
http://dx.doi.org/10.1016/S0022-1694(96)03249-0
Keywords: hydraulic conductivity/ loess soils/ field/ loamy/ rain
Abstract: Sealing, crusting and cracking of crusts of the soil surface has been observed in many parts of the world in areas with sandy, silty and loamy soils. Sealing and crust formation occurs under the influence of rain storm and drying weather, With prolonged drying, surface crusts might crack, leading to complex situations with respect to infiltration and runoff generation. Cracking of crusted loamy soils appears to be a general process. This study aims to measure the hydraulic properties of fully crusted and cracked-crusted areas and to evaluate the effects of these measurements on catchment discharge and soil loss in a loess region of the Netherlands, using the LISEM soil erosion model. Samples with minimum infiltration rates (fully crusted) and with maximum infiltration rates (cracked-crusted surfaces) were taken from fields with bare soil or winter wheat and their soil hydraulic functions were measured, The results of these measurements were used as input in the LISEM soil erosion model, Simulations of discharge and soil loss were done for each of these two land-uses and for two rain events, Additionally, simulated discharge and soil loss under actual recorded land-use were calculated. In all cases, soils with no surface cracks produced higher figures for discharge and soil loss than those where 10% of the surface crust was cracked, For a good interpretation of the results for soil loss, the spatial distribution of cracked-crusted areas and fully crusted areas has to be investigated in detail. To deal with cracked-crusted and fully crusted areas in simulation modelling, care has to be taken to accurately measure the soil physical functions representing the maximum and minimum infiltration rates. An assignment of these functions to calculation grids has to be made. As the LISEM model is capable of assigning different soil physical functions to each calculation grid, an improved prediction of the soil physical behaviour of the catchment can be simulated.
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679. **Electrical methods (VES and ERT) for identifying, mapping and monitoring different saline domains in a coastal plain region (Alt Empordà, Northern Spain)**.
Zarroca, M., Bach, J., Linares, R. and Pellicer, X. M.
Journal of Hydrology 409: 407-422 (2011).
ISSN: 0022-1694
http://dx.doi.org/10.1016/j.jhydrol.2011.08.052
Keywords: salinity of soils and water/ Vertical Electrical Sounding (VES) surveys/ Electrical Resistivity Tomography (ERT)/ geophysical mapping/ coastal plain
Abstract: The spatial variability through time of the degree of salinity of soils and groundwater is a major issue concerning the sustainable management of water resources. The problem is accentuated in coastal plain areas where saline bodies of different origin coexist. We present an extensive geoelectrical resistivity dataset collected in the Alt Empordà clastic coastal aquifer system (NE Spain) integrating the results of field campaigns undertaken within a period of more than two decades. The dataset is unique in the literature and comprises highly valuable information for the investigation of saline domains. The joint application of Vertical Electrical Sounding (VES) and Electrical Resistivity Tomography (ERT) methods allowed the identification of saline domains and monitoring their evolution through time. Geophysical data gathered during field campaigns in 1982, 2002 and 2010 were

calibrated and interpreted on the basis of soil and groundwater physico-chemical analyses and hydrogeological, stratigraphic and geomorphological data. The results illustrate the potential of electrical resistivity methods at differentiating saline domains in coastal aquifer areas and at nmodelling their configuration and evolution. Although the VES data processing allows solving the one-dimensional resistivity structure of the subsurface, the inversion imposes a 1D layered model, thus interpretation of two-dimensional structures is subject to the interpolation between discrete measures. In contrast, ERT data offer a continuous 2D-image of the resistivity distribution, both laterally and in depth. Given that the bulk resistivity of the medium is extremely sensitive to salt content, the ERT profiles permitted identifying and determining the geometry of hyper-saline areas (characterized by resistivities of less than 5 Ω m). The study demonstrates the efficiency of the electrical methods to map subsurface conductive zones and illustrates how the accurate knowledge of the hydrogeological pattern results critical to meet this objective.
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680. **Evaluating change in rangeland condition using multitemporal AVHRR data and geographic information system analysis**.
Minor, T. B., Lancaster, J., Wade, T. G., Wickham, J. D., Whitford, W. and Jones, K. B.
Environmental Monitoring and Assessment 59: 211-223 (1999).
http://dx.doi.org/10.1023/A:1006126622200
Keywords: geographic information systems (GIS)/ multitemporal analysis/ NDVI/ normalized difference vegetation index/ rangeland condition/ remote sensing
Abstract: Coarse-scale, multitemporal satellite image data were evaluated as a tool for detecting variation in vegetation productivity, as a potential indicator of change in rangeland condition in the western U.S. The conterminous U.S. Advanced Very High Resolution Radiometer (AVHRR) biweekly composite data set was employed using the six-year time series 1989-1994. Normalized Difference Vegetation Index (NDVI) image bands for the state of New Mexico were imported into a Geographic Information System (GIS) for analysis with other spatial data sets. Averaged NDVI was calculated for each year, and a series of regression analyses were performed using one year as the baseline. Residuals from the regression line indicated 14 significant areas of NDVI change: two with lower NDVI, and 11 with higher NDVI. Rangeland management changes, cross-country military training activities, and increases in irrigated cropland were among the identified causes of change.

681. **Gamma-ray remote sensing of aeolian salt sources in the Murray–Darling Basin, Australia**.
Bierwirth, P. N. and Brodie, R. S.
Remote Sensing of Environment 112: 550-550 (2008).
http://dx.doi.org/10.1016/j.rse.2007.05.012
Keywords: gamma-ray/ salinity/ Murray-Darling Basin/ eolian transport
Abstract: This paper presents a new technique for mapping regional salt sources that has major implications for salinity management in southeastern Australia. This was achieved by analyzing a regional mosaic of airborne gamma-ray emission derivatives and verified by existing airborne electromagnetic and drilling data. A significant correlation was found between aeolian (windblown) materials, upland salts and gamma-ray signatures. This is consistent with the conceptual model that much of the salt in the upland areas of the Murray–Darling Basin is sourced from deposited aeolian materials that have been derived from deflationary events in salt-bearing landscapes in the western arid part of the basin. From gamma-ray emissions, and based on an observed relationship with borehole salinity, concentrated aeolian salt source deposits contained about 0.7% potassium and 10 ppm thorium. Using this signature on normalized data, an Euclidean distance algorithm provided mapping and information relating to salt-mobility pathways over a wide region. The resulting gamma-ray salt source model (GSM) facilitates focused management of salinity infiltration zones in catchments across the basin.
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682. **Geoelectrical imaging of groundwater salinization in the Okavango Delta, Botswana**.
Bauer, P., Supper, R., Zimmermann, S. and Kinzelbach, W.
Journal of Applied Geophysics 60: 126-141 (2006). ISSN: 0926-9851
http://dx.doi.org/10.1016/j.jappgeo.2006.01.003

Keywords: tomography/ water quality/ imagery/ terrestrial environment/ density/ Okavango Delta/ freshwater/ salinity/ groundwater/ hydrodynamics/ applied geophysics/ environmental geology/ hydrology/ arid environment/ electrical methods/ geophysical methods/ resistivity/ evapotranspiration/ wetlands/ brines/ Botswana/ Africa/ deltaic environment/ salinization
Abstract: Soil and groundwater salinization is a major problem in aquatic systems throughout the semi-arid and arid regions. An interesting example of a natural terminal evaporative system is the Okavango Delta, a large inland delta in Botswana. The system accumulates about 300,000 tons of dissolved solids per year. The majority of the accumulated solutes are deposited on small islands in the wetland. In the centre of the islands, the shallow groundwater is therefore highly saline and displays total dissolved solid (TDS) concentrations around 30 g/l. Fresh groundwater underlying the superficial brines gives rise to a hydrodynamically unstable situation with dense brine perched on less dense fresh water. Instabilities (density fingers) can potentially occur and effectively transport the superficial brines into deeper aquifer units. Electrical resistivity tomography (ERT) was used in this study to directly map the salinity distribution in the subsurface below two different islands in the Okavango Delta. Surface arrays as well as borehole-to-surface layouts were used. Due to differences in the regional hydrologic setting, a density finger could be observed on one island, whereas on the other, the high salinity anomaly was confined to the surface layer. To our knowledge, this is the first time that fingering instabilities were observed under field conditions in natural aquifers.
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683. **Geophysical surveys for identifying saline groundwater in the semi-arid region of the central Altiplano, Bolivia**.
Guerin, R., Descloitres, M., Coudrain, A., Talbi, A. and Gallaire, R.
Hydrological Processes 15: 3287-3301 (2001).
ISSN: 0885-6087
http://dx.doi.org/10.1002/hyp.284
Keywords: aquifers/ groundwater salinity/ boreholes/ groundwater hydrology/ Bolivia/ semi-arid lands/ geohydrology/ groundwater/ groundwater data/ mapping/ geophysics
Abstract: In the central part of the Bolivian Altiplano, the shallow groundwater presents electrical conductivities ranging from 0.1 to 20 mS/cm. In order to study the origin of this salinity pattern, a good knowledge is required of the geometry of the aquifer at depth. In this study, geophysics has been used to complement the sparse data available from drill holes. One hundred time-domain electromagnetic (TDEM) soundings were carried out over an area of 1750 km super(2). About 20 geological logs were available close to some of the TDEM soundings. Three intermediate results were obtained from the combined data: (i) the relationship between the electrical conductivity of the groundwater and the formation resistivity, (ii) geoelectrical cross-sections and (iii) geoelectrical maps at various depths. The limited data set shows a relationship between resistivity and the nature of the rock. From the cross-sections, a conductive substratum with a resistivity of less than 1 Omega -m was identified at most of the sites at depths ranging from 50 to 350 m. This substratum could be a clay-rich formation containing brines. Using derived relationships, maps of the nature of the formation (sandy, intermediate and clayey sediments) were established at depths of 10 and 50 m. Discrimination between sand and clays was impossible where groundwater conductivity is high (>3 mS/cm). In the central part of the area, where the groundwater conductivity is low, sandy sediments are likely to be present from the surface to a depth of more than 200 m. Clayey sediments are more likely to be present in the south-east and probably constitute a hydraulic barrier to groundwater flow. In conclusion, the study demonstrates the efficiency of the TDEM sounding method to map conductive zones.
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684. **A GIS approach to the water and salt balance algorithms for control of river salinity**.
Houser, L. E. and Bishop, A. B.
International Conference/Workshop on Integrating Geographic Information Systems and Environmental Modeling 2 (1993).
Keywords: water quality/ concentration/ monitoring/ Colorado River basin/ water balance/ salinity control/ geographic information systems (GIS)/ dissolved materials/ information systems/ algorithms/ fluvial environment/ saline composition
Abstract: Since the initial development of the Colorado River Basin in the 19th century, the

salinity, measured in total dissolved solids (mg/L), has continually increased. Before development of the Colorado River resources, salinity averaged approximately 500 mg/L. With development of the Colorado River for agricultural, municipal, and industrial purposes, salinity has increased to an 864 mg/L average. For the past several years, federal agencies and the Colorado River Basin states have worked on various programs to reduce the salinity of the Colorado River. In this study, a GIS based water and salt balance model, GISALT, is developed to analyze the effects of agricultural management upon the salinity of the Duchesne River in the Upper Colorado River Basin. This approach assumes that water is finite in quantity within a river basin and all hydrologic components are accountable. These components include precipitation, river inflow and outflow, evaporation, transpiration, groundwater inflow and outflow, deep percolation, surface return flow and changes in storage. The water balance approach is identical to water budget calculations. The salt balance applies a TDS concentration to each variable of the water balance equation. Historically, this approach has averaged input variables over the entire basin unless tedious database management has been incorporated. With the development of GIS, the water and salt balance algorithms now consider the intersection of individual land parcel attributes with salinity data. The GIS calculates the areas of all polygons with homogeneous characteristics within the basin needed to calculate the water and salt balance. This provides an efficient tool for modeling the effects of various management alternatives. By changing the management classification or crops on individual land parcels, or all areas with specific attributes, GISALT quickly evaluates various alternate scenarios. These scenarios include conversion of flood irrigation to sprinkler systems, canal lining, land retirement or swapping, and general improvements in irrigation efficiency. It is realized that GIS is not the perfect answer to the water and salt balance approach. Maps are often inaccurately scaled and geographically referenced lending to misalignment of overlays (geodetic errors), and polygon slivers at the development level. Errors in digitizing can also reduce the precision of map overlays, and when extreme, lead to confusion and inaccuracy. The water resource planner needs to exercise caution and care when developing the maps, overlays, and associated databases. These problems do not eliminate the benefit of GIS, but emphasize that it should never be used blindly. GIS is an excellent tool, but the data and results require trained interpretation. GIS provides a powerful tool for the water resource planner and manager. It incorporates spatial data such as irrigation management, cropping pattern, land ownership, salinity information, and groundwater flow patterns into modeling of river salinity. GISALT is being used to trace salinity in the Colorado River resulting from changes in agricultural management. It is also helping in the evaluation of the feasible alternatives for salt reduction from agricultural return flows in the Colorado River Basin, and determining the effectiveness of current salinity control programs.
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685. **Identification of sources of ground-water salinization using geochemical techniques**.
See record 153 in Subsurface Transport Processes.

686. **IMAGES: An Integrated Model of an Arid Grazing Ecological-System**.
Hacker, R. B., Wang, K. M., Richmond, G. S. and Lindner, R. K.
Agricultural Systems 37: 119-163 (1991).
http://dx.doi.org/10.1016/0308-521X(91)90002-R
Keywords: vegetation dynamics/ herbage intake/ management practices/ rangelands
Abstract: A conceptual model of the pastoral production system within the arid, winter rainfall shrublands of Western Australia is described. The building blocks of this model are pasture-type models which are considered to represent the major productive resource within individual paddocks. A generalised model of such an arid-zone pasture type is described which incorporates the major components of the soil-plant-animal system, and which treats explicitly the effect of herbivores on the condition of the resource. The model has been parameterised for five pasture types based on data from long term exclosures, grazing trials and rangeland monitoring programmes in Western Australia. Validation of the pasture-type models against a range of hypothetical scenarios has produced results generally in agreement with expectations, suggesting that the models have utility for the evaluation of alternative management strategies and identification of key

ecological processes or research priorities. Future development of the pasture-type models is discussed, in particular the development of a whole property model which would facilitate research into holistic management strategies and the contribution that pasture-type models may make to the development of decision support systems for rangeland management.
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687. **Impact of Water Resource Development on Salinization of Semi-Arid Lands**.
Orlob, G. T.
Agricultural Water Management 4: 275-293 (1981). ISSN: 0378-3774
http://dx.doi.org/10.1016/0378-3774(81)90054-8
Keywords: water quality/ development/ environmental impact/ freshwater/ dynamics of lakes and rivers/ resource exploitation/ historical account/ conservation/ California/ San Joaquin R./ composition of water/ water resources/ environmental degradation
Abstract: Historical development of the water resources of California's San Joaquin Valley is described. Impacts of increased consumptive use of water and reallocation of available resources within the valley include reduction of flows in the lower reaches of the river system, and progressive deterioration of water quality. Salt accretions associated with the development of saline lands can be reduced by installation of drainage facilities. Preliminary assessments of the efficacy of tile drains using two-dimensional finite element models are presented.
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688. **The influence of free convection on soil salinization in arid regions**.
Gilman, A. and Bear, J.
Transport in Porous Media 23: 275-301 (1996). ISSN: 0169-3913
http://dx.doi.org/10.1007/BF00167100
Keywords: engineering geology/ soil mechanics/ terrestrial environment/ moisture/ arid environment/ unsaturated zone/ porous materials/ mathematical models/ eigenvalues/ convection/ simulation/ porosity/ boundary conditions/ groundwater/ evaporation/ thermal diffusivity/ viscosity/ algorithms/ permeability/ salinization
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689. **Influence of soil pattern on matter transport in and from terrestrial biogeosystems: A new concept for landscape pedology**.
Sommer, M.
Geoderma 133: 107-123 (2006).
http://dx.doi.org/10.1016/j.geoderma.2006.03.040
Keywords: agriculture/ dissolved organic carbon (DOC)/ emission/ erosion/ forestry/ industrial emissions/ landscape pedology/ methane/ methane emissions/ multiscale soil landscape analysis/ sensitive areas/ soil/ soil surveys/ agricultural land/ biogeochemical cycles/ grassland/ soil type
Abstract: A better understanding of spatial soil variability, its development over time (pedogenesis) and its functional relationships to recent processes in soil landscapes is one of the biggest challenges in soil science. This paper presents three case studies on the influence of soil pattern-developed in geological time scales-on actual matter transport: (i) solid phase transport in agricultural landscapes, (ii) solute transport from forested catchments, and (iii) gas fluxes from agricultural landscapes. In case study I the exclusion of sedimentation zones as well as a segmentation of soil landscapes by digital terrain analysis leads to a more realistic picture of measured erosion rates compared to area-wide modeling. Soil landscape analysis in forested catchments (case study II) identifies riparian soils to be most sensitive areas for DOC- and Fe-fluxes between terrestrial and fluvial biogeosystems. Regardless of the absolute or relative acreages, the existence of riparian soils as pedochemical barriers or zones of high element mobility determine catchment outputs. In case study III the influence of soil pattern development on the emergence of biogeochemical hot spots in grassland systems is demonstrated. Past solid phase transport (soil erosion) into wet parts of agricultural landscapes led to small fringes of very high CH4 fluxes. The latter are comparable to paddy soils in respect to unit area emissions. From the results a generalized concept for soil landscape research is developed-the so-called multiscale soil landscape analysis. Special emphasis is given to the role of "sensitive areas" in soil landscapes. © 2006 Elsevier B.V. All rights reserved.

690. **An integrated model for evaluating hydrology, hydrodynamics, salinity and vegetation cover in a coastal desert wetland**.
Huckelbridge, K. H., Stacey, M. T., Glenn, E. P. and Dracup, J. A.
Ecological Engineering 36: 850-861 (2010).
ISSN: 0925-8574
http://dx.doi.org/10.1016/j.ecoleng.2010.03.001
Keywords: hydrodynamics/ ecosystems/ issues in sustainable development/ anthropogenic factors/ oceans and estuaries/ deltas/ models/ Colorado River/ vegetation cover/ salinity/ engineering/ hydrologic models/ environmental effects/ salinity effects/ sources and fate of pollution/ nearshore dynamics/ hydrology/ inflow/ wetlands/ management and conservation/ data processing/ surface area/ vegetation/ evapotranspiration/ coastal zone/ deserts/ pollution control and prevention/ Mexico/ groundwater/ evolution
Abstract: An integrated model describing hydrology, hydrodynamics, salt dynamics and vegetation was developed to predict the evolution of the Cienega de Santa Clara, a non-tidal, anthropogenic wetland located in the Colorado River Delta. The Cienega, an important part of the Delta ecosystem, is supported by saline groundwater from the U.S. that is sent to Mexico to control salinity in the U.S. The future of this water source is uncertain, and thus, the model was developed to predict how the Cienega would respond to changes in the quantity and salinity of its inflow. Over the calibration period, 1993-2007, modeled results of wetland surface area, the fraction of the wetland covered in vegetation and salinity concentrations compare well to actual data. The model shows that between 1993 and 2007 evapotranspiration rates range from 0 to 8mm/day, wetland surface area increases 44% from 4500 to 6500ha, the fraction of the wetland covered in vegetation decreases slightly from 0.92 to 0.88, and the mean salinity concentration in the wetland increases from 3100 to 6700ppm. The model was used to run nine hypothetical scenarios, representing the range of inflow quantity and salinity to the Cienega that could occur if the source of the inflow is altered, including the possible re-opening of the Yuma Desalting plant. Model results show that the Cienega ecosystem is more sensitive to changes in salinity than to changes in flow. However, in almost all cases, an increase in salinity and/or a decrease in flow would cause a significant decrease in vegetation cover, compromising a large portion of the habitat currently available to wildlife at the Cienega.
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691. **Integrated modeling of flow and transport processes in salt-affected soil**.
See record 161 in Subsurface Transport Processes.

692. **Kinetics of salt release from a saline soil**.
Jurinak, J. J., Whitmore, J. C. and Wagenet, R. J.
Science Society of America Journal 41: 721-724 (1977).
http://dx.doi.org/10.2136/sssaj1977.03615995004100040021x
Keywords: saline soils/ Utah/ water quality/ soil chemical properties/ leaching/ salinity/ kinetics/ salts/ diffusion/ analytical techniques/ percolation/ soil moisture/ soil water/ soil water movement/ physical properties/ properties/ saline water
Abstract: The kinetics of salt release from simulated saline sediments was studied to ascertain the potential of sediments as a diffuse source of salinity. Two rate equations were derived, both based on the premise that dissolution is a diffusion controlled process. The equations were 1n(1-C/C sub s) = -kt and C = k 't(1/2), where c is the concentration at any point in the bulk solution, c sub s is the equilibrium concentration of the soluble soil minerals, t is time, k is the first-order rate constant, and k ' a proportionality constant. Kinetic data were obtained from a saline typic torriorthent soil derived from Mancos shale in the Price River Basin, Utah. During the initial 72 hours of reaction, dissolution can be described by three diffusion controlled reactions. Increasing particle size decreased the rate of reaction. Both derived equations were equally effective in describing salt release. (Henley-ISWS)

693. **Mapping of Spatial Distribution of Soil Salinity and Alkalinity in a Semi-arid Region**.
Keshavarzi, A. and Sarmadian, F.
Annals of Warsaw University of Life Sciences, Land Reclamation 44: 3-14 (2012).
ISSN: 1898-8857
http://dx.doi.org/10.2478/v10060-011-0057-x

Keywords: spatial distribution/ soil salinity/ alkalinity/ spatial interpolation methods/ Iran
Abstract: Spatial variability of salinity and alkalinity is important for site-specific management since they are the most important factors influencing soil quality and agricultural production. Geo-statistical methods provide a means to study the heterogeneous nature of spatial distributions of soil salinity and alkalinity. The present study was carried out to evaluate the accuracy of different spatial interpolation methods including kriging, cokriging and IDW methods for prediction of spatial distribution of salinity (EC) and sodium adsorption ratio (SAR) in soils of Ziaran region in Qazvin province, Iran. The tracking of the soil profiles was done using a Garmin eTrex-H model global positioning system (GPS) receiver. Sampling was done with stratified random method and sixty soil samples from 0 to 15 cm depth were collected. After data normalization, the variograms were developed. For selecting the best model for competing on experimental variograms, the lower RSS value was used. Experimental variograms were fitted to spherical and exponential models. The best model for interpretative was selected by means of cross validation and error evaluation methods, such as RMSE method. The sum of Ca super(2+) + Mg super(2+) and Na super(+) concentration, which were highly correlated with soil salinity and sodium adsorption ratio, respectively, are is used as auxiliary parameters in this study. The results showed that kriging and cokriging methods were better than IDW method for prediction of EC and SAR. Finally, the soil EC and SAR maps were prepared, using different spatial interpolation methods in GIS environment.
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694. **Mapping soil salinity using a combined spectral response index for bare soil and vegetation: A case study in the former lake Texcoco, Mexico**.
Fernández-Buces, N., Siebe, C., Cram, S. and Palacio, J. L.
Journal of Arid Environments 65: 644-667 (2006). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2005.08.005
Keywords: sodium absorption ratio/ halophytic plants/ electrical conductivity/ NDVI/ remote sensing
Abstract: Mapping soil salinity is difficult due to its large spatial and temporal variability. Remote sensing is widely used to lower survey costs, but existing studies usually analyze bare soils and make little reference to the halophytic plants and their role as salinity indicators. This paper aims to correlate soil characteristics (electric conductivity in saturation extract (ECe) and sodium absorption ratio (SAR) with the spectral response of plant species and bare soils, integrating an algorithm to allow multi-scale mapping using remote sensors. Ground radiance was measured on different plant species and bare soils. A Combined Spectral Response Index (COSRI) was calculated for bare soils and vegetation by adjusting the normalized difference vegetation index (NDVI). ECe and SAR were determined in surface soil samples. Correlation coefficients between COSRI and soil salinity were obtained and a model was adjusted to predict soil salinity. Landsat-ETM and airborne digital images were used to calculate raster maps of COSRI, and ECe and SAR were estimated using adjusted models. Correlation between COSRI and ECe and SAR was of −0.885 and −0.857, respectively. Variance accounted for by exponential models for ECe and SAR was of 82.6% and 75.1%, respectively. It may be concluded that the method is an easy, low-cost procedure to map salt-affected areas.
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695. **A method for determining salt sources in surface waters**.
See record 167 in Subsurface Transport Processes.

696. **Model on Water-Salt Movement and Application in Field of Arid Land**.
Yao, D. L., Zhu, J. S., Xie, Z. T., Li, X. R., Zhang, J. G. and Liu, L. C.
Journal of Desert Research 21: 286-290 (2001). ISSN: 1000-694X
Keywords: water in soils/ hydrometeorology/ desert climate/ prediction-correction method
Abstract: The Prediction-Correction method is applied to solve the h type of Richards equation for water movement in soil. Satisfactory precision is gotten while the iteration steps are constrained by this method. Furthermore, the quadratic upstream interpolation difference method is adopted to solve the convection-diffusion equation for soil salt movement. It can avoid the problem of numerical dispersion and presents steeper apex of soil salt profile. Finally, this mathematical model is also utilized to

simulate water-salt movement and the process of upwards accumulation of soil salt in cotton field of arid land under the condition of evaporation. The numerical results turn out in good agreement with the experimental data, thus the mathematical model may provide scientific basis for predicting salinization of soil. The water-salt movement in cropland with canopy and evaporation influence may be calculated by the present model, and the variation with depth of salt can also be obtained.
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697. **Modeling salinity effects on soil reflectance under various moisture conditions and its inverse application: A laboratory experiment**.
Wang, Q., Li, P. and Chen, X.
Geoderma 170: 103-111 (2012).
ISSN: 0016-7061
http://dx.doi.org/10.1016/j.geoderma.2011.10.015
Keywords: moisture/ reflectance/ sewage/ laboratories/ salinization/ soil water/ research facilities/ model studies/ salts/ moisture content/ China/ saline soils
Abstract: Soil salinization is an important desertification process that threatens the stability of ecosystems, especially in arid lands. Quantifying and mapping soil salinity to monitor soil salinization is difficult because of its large spatial and temporal variability. There has been a growing interest in the use of hyperspectral reflectance as a rapid and inexpensive tool for soil salinity characterization in the recent past. However, as soil moisture often jointly affects soil reflectance, a moisture-insensitive reflectance model is needed to provide the base for soil salinity monitoring from soil reflectance. In this paper, we developed an exponent reflectance model to estimate soil salt contents inversely under various soil moisture conditions, based on a control laboratory experiment on the two factors (soil salinity and soil moisture) to soil reflectance. Main soil salt types (Na2SO4, NaCl, Na2CO3) with wide soil salinity (0% to 20%) and soil moisture (1.75% to 20%) levels (in weight base) from Western China were examined for their effects on soil reflectance through a model based approach. Moisture resistant but salt sensitive bands of reflected spectra have been identified for the model before being applied to inversely estimate soil salt content. Sensitive bands for Na2SO4 type of salt affected soils were identified as from 1920 to 2230 nm, and 1970 to 2450 nm for NaCl, 350 to 400 nm for Na2CO3 type of salt affected soils, respectively. The sensitive bands focused on ranged from 1950 to 2450 nm when all data were considered when ignoring salt types. The model was then applied to inversely estimate soil salt contents. High R2 of 0.87, 0.79, and 0.66, and low mean relative error (MRE) of 16.42%, 21.17%, and 27.16%; have been obtained for NaCl, Na2SO4 and Na2CO3, respectively. Performance of the inverse model dropped but remained significant when ignoring salt types with an R2 of 0.56 and a MRE of 33.25%. The approach proposed in this study should thus provide a new direction for estimating salinity from reflectance under various soil moisture conditions and should have wide applications in future monitoring of soil salinization.
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698. **Modeling salt movement through a Mojave Desert soil**.
Marion, G. M., Verburg, P. S. J., Mcdonald, E. V. and Arnone, J. A.
Journal of Arid Environments 72: 1012-1033 (2008). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2007.12.005
Keywords: desert soils/ salt flux/ biogeochemical model/ salt mineralogy/ calcite stability/ global carbon balance
Abstract: Salt flux through soils can significantly influence local and global processes. For example, desert soils can atypically concentrate NO 3 - at depth in soil profiles. CaCO3 precipitation/dissolution can play significant roles as either sinks or sources of global carbon. The objectives of this work were to develop a salt-flux model for long-term (>1000 years) simulations of desert soils and examine the consequences of climate, soils, system inputs, and land-use change on salt movement in arid soils. The field study was conducted at the Nevada Test Site in the northern Mojave Desert. New additions to the CALGYP model allowing for site-specific parameterization included stochastic rainfall model, salt inputs, soil water-holding capacities, and soil CO2 profiles. New ions added to the model included Na+, K+, Mg2+, Cl−, and NO 3 - . About 81% of Ca2+ input remained within the surface 1.0 m of soil as CaCO3, which argues in favor of soil CaCO3 serving as a recalcitrant sink for global carbon. In contrast, ≈99.96% of Na+, K+, Mg2+, Cl−, NO 3 - , and SO 4 2 - ions leached to soil depths >1.0 m and 94.3% leached to soil depths >2.0

m. This is true despite only 1.64% of the rainfall leached beyond 1.0 m and 0.020% of the rainfall leached beyond 2.0 m. The leachability of NO 3 - and Cl− to soil depths > 2.0 m agrees with NO 3 - and Cl− accumulations at depth in Mojave Desert soils (1.3–2.7 m). Simulation of extreme events and years with a stochastic rainfall model and accurate soil water-holding capacities are critical for modeling water and salt flux through soils.
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699. **Modeling Salt Transport in Irrigated Soils**.
Ayars, J. E., Mcwhorter, D. B. and Skogerboe, G. V.
Ecological Modelling 11(4): 256-290 (1981).
http://dx.doi.org/10.1016/0304-3800(81)90062-4
Keywords: pollution sources/ pollution fate/ salt transport/ models/ Dutt model
Abstract: A salt transport model developed by Dutt et al. (1972) and subsequently modified in 1976 determined that the salt concentration of leachate at the bottom of the soil profile is independent of the volume of leachate. Field data (infiltration data, soil water content profiles, and soil water storage change data) collected in the Grand Valley, Colorado, was used to calibrate and test the model. The Dutt model was varied during the course of study with respect to hydraulic conductivity and soil water diffusivity. After making these changes, the model predicted infiltration, water content distributions, and changes in storage. Using the chemistry component of the model, total dissolved solids were adequately modeled but individual ionic species were not. The calcium salt system (sulfate-carbonate-bicarbonate) was not adequate for these soils. (Cassar-FRC)
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700. **Modeling the atmospheric dust cycle. 1. Design of a soil-derived dust emission scheme**.
Marticorena, B. and Bergametti, G.
Journal of Geophysical Research-Atmospheres 100: 16415-16430 (1995).
http://dx.doi.org/10.1029/95JD00690
Keywords: general circulation model/ numerical 3-dimensional models/ Antarctic/ ice core/ wind erosion/ desert dust/ turbulence structure/ saltation/ threshold/ surface roughness/ boundary layer/ North Atlantic
Abstract: A soil-derived dust emission scheme has been designed to provide an explicit representation of the desert dust sources for the atmospheric transport models dealing with the simulation of the desert dust cycle. Two major factors characterizing the erodible surface are considered: (1) the size distribution of the erodible loose particles of the soil which controls the erosion threshold and the emission strength and (2) the surface roughness which imposes the efficient wind friction velocity acting on the erodible surface. These two parameters are included in a formulation of the threshold wind friction velocity by adapting a size-dependent parameterization proposed by Iversen and White (1982) and by applying to the rough erodible surfaces a drag partition scheme derived from Arya (1975). This parameterization of the threshold friction velocity has been included in an horizontal flux equation proposed by White (1979). This allows to attribute a specific production rate to each soil size range for each type of surface. The dust flux F is then considered as a fraction of the total horizontal flux G, the value of the ratio F/G being imposed, at this time, by the soil clay content. In summary, the computed mass fluxes depend on the soil size distribution, the roughness lengths, and the wind friction velocity. The different steps of this scheme have been independently validated by comparison with relevant experimental data. Globally, the agreement is satisfying, so that the dust fluxes could be retrieved with less uncertainties than those observed in previous simulations of the desert dust cycle.
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701. **Modeling the Displacement of Resident Soluble Salt During Infiltration**.
Nachabe, M. H. and Morel-Seytoux, H. J.
Soil Science 160: 243-249 (1995).
http://www.eng.usf.edu/~nachabe/SOIL96.pdf
Keywords: infiltration (hydrology)/ models/ saline soils/ disturbed soils
Abstract: We present two analytical models to assess the displacement of the initial saline soil solution during infiltration. The models are extensions of the analytical infiltration solutions of Morel-Seytoux and Khanji (1974) and Broadbridge and White (1988). We then introduce simple experimental methods with the tension infiltrometer to measure the parameters of the two models in the field. A single measurement of sorptivity is needed to determine the free parameter, C, in the

Broadbridge and White solution, and the viscous correction factor, [beta], in the Morel-Seytoux and Khanji solution. The tension infiltrometer method, in conjunction with the analytical models, provided simple and inexpensive means to predict the leaching of soil-solution as required for saline soils. The tension infiltrometer was simple to operate and measurements were performed at the surface to minimize installation time and soil disturbance. The analytical models contained parameters with precise physical meaning and need modest amounts of computation time. The narrow range of 0 to - 15 cm of soil-water pressure, in which infiltration rates were measured with the infiltrometer, appeared sufficient for modeling the displacement of soil-solution. This was attributed to the rapid decrease of hydraulic conductivity with water pressure, which was manifested by a short macroscopic capillary length for the field soils tested. (C) Williams & Wilkins 1995. All Rights Reserved.
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702. **Modeling transport of reactive solutes during leaching saline—Sodic soils rich in soluble carbonates**.
Dahiya, I. S., Abrol, I. P. and Hajrasuliha, S.
Agricultural Water Management 3: 3-16 (1980).
ISSN: 0378-3774
http://dx.doi.org/10.1016/0378-3774(80)90011-6
Keywords: saline sodic soils/ models/ soil transport processes/ unsaturated flow/ leaching
Abstract: A multicompartment model to describe the transport of reactive solutes in soils under unsaturated flow conditions is presented. The movement of salts, precipitation of calcium, and replacement of sodium by calcium on the exchange complex in a relatively dry soil are considered jointly. The soil profile is divided into a number of segments and the soil solution is assumed to reach chemical equilibrium in each segment as it flows downward. Unlike in most previous descriptions of miscible displacement, the exchange in the model is assumed to be limited by the degree of saturation of the soil. It uses simple parameters which are often known or can be measured in situ. The applicability and predictive power of the model were tested with soil column experiments. In most cases, there was a fairly good quantitative agreement between calculated and experimental data. Thus, even with the simple assumptions underlying it, the model was found to be sufficiently good and safe for screening of treatments and general prediction purposes.
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703. **Modeling Transport of Subsurface Salinity from a Mancos Shale Hillslope**.
See record 168 in Subsurface Transport Processes.

704. **Modelling of salt movement in the root zone**.
See record 169 in Subsurface Transport Processes.

705. **Modelling solute leaching during fingered flow by integrating and expanding various theoretical and empirical concepts**.
De Rooij, G. H. and Cho, H.
Hydrological Sciences Journal = Journal des Sciences Hydrologiques 44: 447-465 (1999).
ISSN: 0262-6667
http://dx.doi.org/10.1080/02626669909492239
Keywords: solute transport/ soil/ hydrology/ terrestrial environment/ rainfall/ moisture/ arid environment/ unsaturated zone/ solutes/ pollution/ mathematical models/ capillary water/ preferential flow/ simulation/ aquifers/ groundwater/ two-dimensional models/ humidity/ theoretical models/ hydrogeology/ shallow aquifers/ hydraulic conductivity/ leaching/ environmental geology
Abstract: Wetting front instability (fingered flow) accelerates solute transport through the unsaturated zone to the groundwater table. Whether fingers widen or dissipate close to the groundwater is unclear. Water flow in a two-dimensional artificial capillary fringe below a dry layer exhibiting fingered flow was investigated. The flow diverged strongly in the wet soil, suggesting that fingers dissipate. Expressions for the finger radius in dry and wet soil were combined and adapted to a soil hydraulic property parameterization popular in numerical modelling. The modified equation provided finger radii for soils in humid and arid climates. The fingers in the arid soil were excessively wide. The finger radii were used to model solute transport, assuming fingers dissipated in the subsoil. Modelling was cumbersome for the arid

climate. One shower may often be insufficient to trigger fingering in arid regions with short, heavy showers. In soils with shallow groundwater, the diverging subsoil flow determines solute leaching.
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706. **Models to Predict Water-Retention in Semiarid Sandy Soils**.
Meng, T. P., Taylor, H. M., Fryrear, D. W. and Gomez, J. F.
Soil Science Society of America Journal 51: 1563-1565 (1987).
http://dx.doi.org/10.2136/sssaj1987.03615995005100060028x
Keywords: models/ semi-arid soils/ soil water retention/ sandy soils

707. **A multi-scale perspective of water pulses in dryland ecosystems: climatology and ecohydrology of the western USA**.
Loik, M. E., Breshears, D. D., Lauenroth, W. K. and Belnap, J.
Oecologia 141: 269-281 (2004).
http://dx.doi.org/10.1007/s00442-004-1570-y
Keywords: drought duration/ El Nino/ Southern Oscillation/ evapotranspiration/ infiltration depth/ Pacific Decadal Oscillation/ North American monsoon/ United States/ semi-arid woodland/ soil moisture/ Rocky Mountains/ warming manipulation/ *Artemisia tridentata*/ Chihuahuan Desert
Abstract: In dryland ecosystems, the timing and magnitude of precipitation pulses drive many key ecological processes, notably soil water availability for plants and soil microbiota. Plant available water has frequently been viewed simply as incoming precipitation, yet processes at larger scales drive precipitation pulses, and the subsequent transformation of precipitation pulses to plant available water are complex. We provide an overview of the factors that influence the spatial and temporal availability of water to plants and soil biota using examples from western USA drylands. Large spatial- and temporal-scale drivers of regional precipitation patterns include the position of the jet streams and frontal boundaries, the North American Monsoon, El Nino Southern Oscillation events, and the Pacific Decadal Oscillation. Topography and orography modify the patterns set up by the larger-scale drivers, resulting in regional patterns (10(2)-10(6) km(2)) of precipitation magnitude, timing, and variation. Together, the large-scale and regional drivers impose important pulsed patterns on long-term precipitation trends at landscape scales, in which most site precipitation is received as small events (<5 mm) and with most of the intervals between events being short (<10 days). The drivers also influence the translation of precipitation events into available water via linkages between soil water content and components of the water budget, including interception, infiltration and runoff, soil evaporation, plant water use and hydraulic redistribution, and seepage below the rooting zone. Soil water content varies not only vertically with depth but also horizontally beneath versus between plants and/or soil crusts in ways that are ecologically important to different plant and crust types. We highlight the importance of considering larger-scale drivers, and their effects on regional patterns; small, frequent precipitation events; and spatio-temporal heterogeneity in soil water content in translating from climatology to precipitation pulses to the dryland ecohydrology of water availability for plants and soil biota.

708. **On using particle tracking methods to simulate transport in single-continuum and dual continua porous media**.
Hassan, A. E. and Mohamed, M. M.
Journal of Hydrology 275: 242-260 (2003).
ISSN: 0022-1694
http://dx.doi.org/10.1016/S0022-1694(03)00046-5
Keywords: mobile-immobile systems/ particle tracking methods/ particle transfer proability
Abstract: The use of particle tracking methods to predict transport in single continuum and dual continua (mobile–immobile systems and fractured media) is studied. The accuracy of the particle tracking methods with different interpolation and tracking techniques is evaluated, and its transport predictions are compared to analytical solutions, finite element solutions (e.g. SUTRA) and finite difference solution (e.g. MT3D). For a two-dimensional problem with homogeneous conductivity and pulse injection of contaminant, the particle tracking solution matches the analytical solution better than those using standard finite difference and finite element techniques, which suffer from numerical dispersion. Furthermore, the particle tracking method accurately predicts the mean and variance of the stochastic concentration distribution and compares favorably with

MT3DMS that employs a total variance diminishing technique for discretizing the advection term. For modeling matrix diffusion in fractured media and mass transfer in dual porosity (mobile–immobile) systems, two approaches are studied and compared. A semi-analytical approach is compared to a particle tracking technique that accounts for matrix diffusion using particle transfer probabilities. An empirical relationship that can be used to map the governing parameter of the semi-analytical approach to the corresponding particle transfer probability is derived. The similarities and differences between these two techniques and their suitability for practical applications are also discussed.
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709. **On variable density surface water–groundwater interaction: A theoretical analysis of mixed convection in a stably-stratified fresh surface water – saline groundwater discharge zone**.
Massmann, G., Simmons, C., Love, A., Ward, J. and James-Smith, J.
Journal of Hydrology 329: 390-402 (2006).
http://dx.doi.org/10.1016/j.jhydrol.2006.02.024
Keywords: equivalent freshwater head/ mixed convection ratio/ river salinization/ surface water/groundwater interaction/ variable density flow
Abstract: Understanding the discharge behaviour of saline groundwater into fresh surface water can be critical for the effective management of water resources. While variable density flow has been studied intensely in a number of settings, the role it plays on the discharge behaviour of saline groundwater into freshwater streams is often neglected when calculating salt loads into a stream. The aim of this study was to determine what role variable-density flow behaviour plays in surface water/groundwater interaction in a stably-stratified fresh surface water/saline groundwater interface. The mixed convection ratio M, a measure of the ratio of density driven flow to advective driven flow, was defined for a matrix of one-dimensional numerical simulations that employed both varying hydraulic and density gradients. Vertical salt breakthrough into the surface water only occurred in the advection dominated cases (M < 1) and the salt flux into the surface water increased with increasing groundwater concentration until M reached a value of 1. Beyond this, when the flow was driven by the density difference between the two fluids (M > 1) vertical discharge of salt into surface water did not occur and the saltwater/freshwater interface migrated downwards with increasing density differences between the two fluids. This study therefore shows that there is a critical concentration difference that maximizes salt loads to a surface water body and that a density-invariant approach to estimate the salt flux into the surface water (as the product of flow velocity determined through a potentiometric analysis and groundwater concentration) may be inadequate, especially where large density differences exist between the fresher surface water body and the underlying saline groundwater. The study is a purely theoretical approach and conclusions were drawn from simplified 1D simulations. Hence, further laboratory and modelling work is needed to confirm and test the plausibility of these findings for more realistic 2D and 3D cases.
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710. **The possibilities of remote diagnostics of soils salinisation in arid regions**.
Karavanova, E. I., Orlov, D. S. and Lomonsov, M. V.
Proceedings of the International Cartographic Conference (1995).
http://icaci.org/files/documents/ICC_proceedings/ICC1995/PDF/Cap226.pdf
Keywords: Dzhizakskaya Steppe/ terrestrial environment/ mapping/ salinity/ brightness/ multispectral analysis/ Commonwealth of Independent States/ errors/ spectra/ Asia/ soil/ monitoring/ Uzbekistan/ arid environment/ space photography/ humus/ detection/ Lomakinskaya Plain/ soil surveys/ surveys/ aerial photography/ reflectance/ salinization/ remote sensing
Abstract: The possibilities of using of aero- and space photographs for the remote diagnostics of the salinisation process in arid regions are considered in the work. The area of investigations was territory of Dzhizakskaya steppe of Uzbekistan (the former Soviet Union). The main soil types are: serosems, meadow-serosemic, meadow, swampy-meadow soils (with different salinity level) and different species of the solonchaks. Analysis of remotely measured data showed that soils spectral brightness linearly correlates with the salts contents. Standard error of salts estimation is 2.34%. The regression has a negative character: the more salinity level, the smaller values of

soils spectral brightness. Spectral classification of the colour composite allows separation of 5 classes of salinity: 1) non-saline area (less than 1 mg-cq Na/100 g in the upper 1 m layer). 2) areas with slight salinity (1-2 mg-cq Na/100 g). 3) complexes of slight and medium salinity. 4) areas with medium salinity (2-6 mg-cq Na/100 g). 5) areas with high (6-12 mg-cq Na/100 g) and very high (more than 12 mg-cq Na/100 g) salinity. Most informative for the determination of salinity level is green band, where non saline and slightly saline soils are differed from soils with medium salinity with the accuracy not more than 70%.
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711. **Preliminary identification of Price River Basin salt pickup and transport processes**.
See record 173 in Subsurface Transport Processes.

712. **Progress in the study of models for water and salinity transport in soils**.
Guo, R., Feng, Q., Si, J., Chang, Z., Xi, H. and Liu, W.
Bingchuan Dongtu = Journal of Glaciology and Geocryology 30: 527-534 (2008). ISSN: 1000-0240
Keywords: soils/ transport/ saline soils/ applications/ mathematical models/ water content/ water regimes/ salinity/ soil/ simulation
Abstract: Salinization of soil is one of the factors that impact the agriculture development in the world, so it is of great importance for monitoring, evaluating and treating the salinization of soil in arid and semi-arid regions to research the mechanism of watersalt movement in soil and to simulate its process accurately. In this paper, two types of transport models widely used for water and salinity in soils are introduced; one is physical models, which include convection-dispersion Equation(CDE), stream tube model(STM) and HYDRUS developed by US Salinity Laboratory. At the same time, the parameter research is related to physical models. Another is system models, such as Transfer Function Model(TFM) and BP-Network model. The resemblances and the differences among these modeling are compared and analyzed. The excellences and drawbacks of the modeling and the applicability and the application situation are also analyzed and compared. In the last, some questions about the development and applications of these modeling are pointed out, and an outlook for their development in the future is provided.
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713. **Rangeland experiments to parameterize the water erosion prediction project model - vegetation canopy cover effects**.
See record 278 in Surface Water Transport Processes.

714. **Rangeland monitoring using remote sensing**.
Booth, D. T. and Tueller, P. T.
Arid Land Research and Management 17: 455-467 (2003).
http://dx.doi.org/10.1080/713936105
Keywords: bare ground/ cover/ ecological indicator/ image analysis/ platforms/ upscaling/ stereophotographic technique/ vegetation changes/ grazing treatments/ permanent plots/ cover/ photography/ grasslands/ Patagonia/ Argentina/ Colorado
Abstract: Monitoring vast landscapes has, from the beginning of rangeland management, depended on people's judgments. This is no longer tenable, but a more effective method has yet to be devised. The problem is how to do an economical inventory that will detect ecologically important change over extensive land areas with acceptable error rates. The error risk is a function of adequate sample numbers and distribution for each indicator monitored. Of all of the indicators identified for monitoring, ground cover and its inverse, bare ground, may be the most discussed. Ground-cover measurements address soil stability and watershed function which are first-priority ecological concerns; are well adapted to remote sensing frameworks thus allowing extensive, unbiased, economical sampling; and, the measurements, especially when done by computer image analysis, have the potential to reduce or avoid the human judgment factor. Data collection through remote sensing appears the most logical approach to acquiring appropriately distributed information over large areas in short time periods and on random sites far removed from easy ground access. The value of satellite and high-altitude sensors for landscape-level evaluations, such as plant community distribution, is well established but these tools are inadequate for inventory and measurement of details needed for valid

conclusions about range condition. New advances in low-altitude remote sensing may give us the ability to accurately measure bare ground and perhaps other indicators. Combining information from high and low-altitude sensors appears to offer an optimal path for developing a practical system for cost-effective, data-based, rangeland monitoring and management.

715. **A regional approach to salinity management in river basins. A case study in southern Iran**.
Shiati, K.
Agricultural Water Management 19: 27-41 (1991). ISSN: 0378-3774
http://dx.doi.org/10.1016/0378-3774(91)90060-V
Keywords: salt transport/ soil salinity/ environmental management
Abstract: The present level of salinity in the Shapur and Dalaki river basin (southern Iran) is hardly influenced by human activities and may be denoted as “natural” salinity. This paper aims to describe the engineering measures for the salinity control of the river water in this basin. Among possible salt disposal measures, collection and evaporation of polluted sources in ponds is the most practicable and feasible one. However, greater benefits can be gained by implementation of salt mitigation measures. The model dyresm was used to simulate the salinity distribution in the planned Jarreh reservoir. Results of the simulation indicate that the Jarreh storage reservoir can regulate and reduce the salt concentration of the irrigation water to a range between 1500 and 2400 mg l−1 compared with between 1000 and 4200 mg l−1 for the original river salinity. Furthermore, the diversion of the most saline inflow in summer also decreases salinity.
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716. **Regional-scale models for relating land cover to basin surface-water quality using remotely sensed data in a GIS**.
Versace, V. L., Ierodiaconou, D., Stagnitti, F., Hamilton, A. J., Walter, M. T., Mitchell, B. and Boland, A. M.
Environmental Monitoring and Assessment 142: 171-184 (2008).
http://dx.doi.org/10.1007/s10661-007-9918-5
Keywords: environmental monitoring/ geographic information systems (GIS)/ plants/ rivers/ sodium chloride/ time factors/ Victoria/ water pollution/ analysis
Abstract: Plant-based management systems implementing deep-rooted, perennial vegetation have been identified as important in mitigating the spread of secondary dryland salinity due to its capacity to influence water table depth. The Glenelg Hopkins catchment is a highly modified watershed in the southwest region of Victoria, where dryland salinity management has been identified as a priority. Empirical relationships between the proportion of native vegetation and in-stream salinity were examined in the Glenelg Hopkins catchment using a linear regression approach. Whilst investigations of these relationships are not unique, this is the first comprehensive attempt to establish a link between land use and in-stream salinity in the study area. The results indicate that higher percentage land cover with native vegetation was negatively correlated with elevated in-stream salinity. This inverse correlation was consistent across the 3 years examined (1980, 1995, and 2002). Recognizing the potential for erroneously inferring causal relationships, the methodology outlined here was both a time and cost-effective tool to inform management strategies at a regional scale, particularly in areas where processes may be operating at scales not easily addressed with on-site studies.

717. **Remote Sensing Technology for Development Planning along the US-Mexico Border: Hydrogeology and Geomorphology**.
Granados-Olivas, A. and Monger, H. C.
New Mexico Journal of Science 39: 123-137 (1999). ISSN: 0270-3017
Keywords: remote sensing/ hydrogeology/ geomorphology/ development policy/ government programs and projects
Abstract: Arid land ecosystems along the border region of the United States and Mexico are being rapidly developed. Two of the most important natural resources of this region are water and soil. Hydrogeological characteristics (such as the size and quality of aquifers) combined with geomorphic units (such as alluvial fans and floodplains), provide important information that can help prevent poorly planned development. Making these maps involves 1) delineating geomorphic features based on aerial photographs and satellite images, 2) ground-truthing the features, and 3) combining geomorphic maps with groundwater maps using GIS (Geographic Information System). These hydro-geomorphic maps help to locate high producing wells, as along faults, and identify

groundwater recharge zones, as along mountain arroyos. Moreover, these hydro-geomorphic maps identify areas unsuitable for development. For example, housing development should not take place in arroyo and river floodplains, which are subject to flooding. Instead, housing should occur on higher, geomorphologically stable fan-piedmont surfaces. Building on stable surfaces not only will protect houses from flooding and erosion, but also will preserve the topographically lower and texturally finer floodplains for agriculture, wildlife, and recreation.

718. **River basin hydrosalinity modeling**.
Tanji, K. K.
Agricultural Water Management 4: 207-225 (1981). ISSN: 0378-3774
http://dx.doi.org/10.1016/0378-3774(81)90051-2
Keywords: watersheds/ salinity/ hydrology/ modeling
Abstract: Hydrologic-salinity modeling at the river sub-basin and basin spatial scales in the Western U.S.A. are evaluated. In the past two decades, significant advances have been made in basin hydrosalinity modeling. These models are providing increased understanding of the complexity of water and salt flows in large-scale systems. Most models, however, have been developed for specific problems and do not lend themselves for application to a wide variety of salinity problems. Much more work is needed in the areas of field verification of models and increasing their utility for management and policy-making decisions.
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719. **River basin salinity management via the ASTRAN method: I. Model development**.
See record 176 in Subsurface Transport Processes.

720. **The role of playas in pedogenic gypsum crust formation in the Central Namib Desert: A theoretical model**.
Eckardt, F. D., Drake, N., Goudie, A. S., White, K. and Viles, H.
Earth Surface Processes and Landforms 26: 1177-1193 (2001).
http://dx.doi.org/10.1002/esp.264
Keywords: gypsum/ playas/ sabkhas/ Namib Desert/ mineral dust
Abstract: The formation of Namibia's extensive pedogenic gypsum crusts (CaSO4·2H2O) is interpreted in a new light. It is suggested that gypsum primarily precipitates at isolated points of evaporitic concentration, such as inland playas, and that deflation of evaporitic-rich gypsum dust from these playas contributes to the formation of pedogenic gypsum duricrusts on the coastal gravel plains of the Namib Desert surrounding these playas. This study establishes the nature, extent and distribution of playas in the Central Namib Desert and provides evidence for playa gypsum deflation and gravel plain deposition. Remote sensing shows the distribution of playas, captures ongoing deflation and provides evidence of gypsum deflation. It is proposed that, following primary marine aerosol deposition, both inland playas and coastal sabkhas generate gypsum which through the process of playa deflation and gravel plain redeposition contributes to the extensive pedogenic crusts found in the Namib Desert region. Copyright © 2001 John Wiley & Sons, Ltd.

721. **Role of solute-transport models in the analysis of groundwater salinity problems in agricultural areas**.
See record 179 in Subsurface Transport Processes.

722. **Runoff from a military deposition site in a semiarid, highland environment; comparison of environmental results with those predicted by the WEPP model**.
Naranjo, R. C., Warwick, J. J. and French, R.
2000 AWRA Spring specialty conference; Water resources in extreme environments, Anchorage, AK, United States, May 1-3, 2000 (2000).
Keywords: California/ climate/ environmental analysis/ erosion/ experimental studies/ government agencies/ highlands/ human activity/ hydrology/ military facilities/ models/ Nevada/ Northern California/ runoff/ semi-arid environment/ Sierra Nevada/ soil erosion/ soils/ terrestrial environment/ United States/ Water Erosion Prediction Project
Abstract: Arid rangeland erosion is dependent on several interacting factors, including landscape and climate characteristics, as well as current and historic disturbance. Generally, changes to the landscape due to anthropogenic activity rapidly increase the soil instability, posing the risk of erosion. However, the

response due to current and historic disturbance may take several years to become evident. To evaluate the relative potential for erosion based on overland flow, physically based distributed models can provide an effective approach for estimating and predicting soil loss. Infiltration and runoff was simulated using the USDA-ARS Water Erosion Prediction Project (WEPP) model on five hillslope profiles representing a small watershed in northeastern California. Single event and five-year continuous simulations will be used to evaluate runoff and erosion potential on variable slope, vegetation, and rock cover. The single storm events are based on maximum depths for 6 hr and 24 hr storms provided by atlas maps (NOAA, 1973) for the general area. The continuous simulation examines the relative differences of soil loss over a five-year period. The continuous climate data will be generated using the Climate Generator (CLIGEN) model, which is a separate model developed for use with the WEPP model. The relative predictions will aid in development of basin management strategies for Sierra Army Depot.

723. **Salt release from suspended sediments: A simulation model**.
Peterson, S. R., Jurinak, J. J. and Wagenet, R. J., 184 p. (1980).
Keywords: chemical reactions/ suspended sediment/ particle size/ Mancos shale/ saline water/ saline soils/ soil water/ diffuse source/ sediment interaction
Abstract: The effects of particles size, soil to water ratio and time on the rate of release of salts from Mancos shale derived soils were studied by taking four different size fraction at three different dilutions of soil to water. The kinetic model was formulated using data obtained from a soil dominated by highly soluble salts (evaporites) and using dimensional analysis. The chemical equilibrium model developed in this project was based on ion association theory, with equilibrium constants chosen as the data base. The requisite chemical equations programmed were solved by iterative techniques (successive approximations). The chemical model was interfaced with the kinetic model, thus all input data necessary for the chemical model were produced by the kinetic model; these input data were the total concentrations of individual ions. The equilibrium model accepted these input data and calculated the concentrations, activities, and activity coefficients for all ions and their soluble complexes. The model also predicted which salts were dissolving and by determining the saturation indices how quickly individual mineral salts approached equilibrium.

724. **Salt Release Model for Suspended Sediments**.
Nezafati, H., Bowles, D. S. and Riley, J. P.
Journal of Environmental Engineering (ASCE) 112: 647-662 (1986).
http://dx.doi.org/10.1061/(ASCE)0733-9372(1986)112:4(647)
Keywords: sources and fate of pollution/ erosion and sedimentation
Abstract: The major controlling factors in the release of salt from suspended sediments in the Colorado River Basin are described and quantified with experimental and mathematical modeling. An overall assessment of the importance of the salt contribution from suspended sediments is provided. Salt release characteristics of suspended sediments from various locations were studied using sediments from various locations in the Price River Basin, a tributary of the Colorado River. The sediments were mixed with water in the laboratory and the change in electrical conductivity of the solutions was monitored while varying the following factors: dilution, particle size, mixing velocity, and initial electrical conductivity. The Buckingham Pi Theory was employed to develop equations for predicting the electrical conductivity of sediment-water solutions as a function of factors controlling salt release from suspended sediments. The salt release equations were verified with additional laboratory data. In a companion paper incorporation of the salt release equations into a watershed erosion and sediment transport model as a salinity submodel is described. (McFarlane-PTT)
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725. **Simulated long-term vegetation response to alternative stocking strategies in savanna rangelands**.
Weber, G. E., Moloney, K. and Jeltsch, F.
Plant Ecology 150: 77-96 (2000).
http://www.public.iastate.edu/~kmoloney/Instructor/Papers/Weber_2000.pdf
Keywords: grazing heterogeneity/ grazing management/ livestock grazing/ rangeland management/ semi-arid rangeland/ vegetation change

Abstract: Increasing cover by woody vegetation, prevalent in semiarid savanna rangelands throughout the world, is a degrading process attributed to the grazing impact as a major causal factor. We studied grazing effects on savanna vegetation dynamics under alternative stocking strategies with a spatially explicit grid-based simulation model grounded in Kalahari (southern Africa) ecology. Plant life histories were modeled for the three major life forms: perennial grasses, shrubs, annuals. We conducted simulation experiments over a range of livestock utilization intensities for three alternative scenarios of small scale grazing heterogeneity, and two alternative strategies: fixed stocking versus adaptive stocking tracking herbage production. Additionally, the impact of the duration of the management planning horizon was studied, by comparing community response and mean stocking rates after 20 and 50 years. Results confirmed a threshold behavior of shrub cover increase: at low, subcritical utilization intensity little change occurred; when utilization intensity exceeded a threshold, shrub cover increased drastically. For both stocking strategies, thresholds were highly sensitive to grazing heterogeneity. At a given critical utilization intensity, the long term effect of grazing depended on the level of grazing heterogeneity: whereas under low heterogeneity, shrub cover remained unchanged, a large increase occurred under highly heterogeneous grazing. Hence, information on spatial grazing heterogeneity is crucial for correct assessment of the impact of livestock grazing on vegetation dynamics, and thus for the assessment of management strategies. Except for the least heterogeneous grazing scenario, adaptive stocking allowed a more intensive utilization of the range without inflating the risk of shrub cover increase. A destabilizing feedback between rainfall and herbage utilization was identified as the major cause for the worse performance of fixed compared to adaptive stocking, which lacks this feedback. Given the usually high grazing heterogeneity in semiarid rangelands, adaptive stocking provides a management option for increasing herbage utilization and thus returns of livestock produce without increasing degradation risks.
This citation is from Iowa State University.

726. **Simulating the hydrology and total dissolved solids (TDS) of an ephemeral river in South Africa for environmental water requirement determinations**.
Hughes, D. A.
River Research and Applications
25: 850-860 (2009).
http://dx.doi.org/10.1002/rra.1188
Keywords: industrial effluents/ basins/ brackish/ ecosystem and ecology studies/ data processing/ dissolved solids/ water pollution/ flow rates/ hydrologic models/ freshwater pollution/ pools/ dynamics of lakes and rivers/ rainfall/ rainfall-runoff relationships/ river basins/ river discharge/ rivers/ sources and fate of pollution/ semi-arid environments/ simulation/ South Africa/ Orange River/ storage/ stormwater runoff/ stream flow/ streams/ tributaries/ water requirements/ water quality
Abstract: Existing hydrological approaches to support the determination of environmental water requirements (EWRs) were largely developed for perennial rivers and may not be applicable to ephemeral rivers, where the quantity and quality dynamics of pool storage and frequency of connection can be more important than flow rates. The current understanding of semi-arid hydrological processes and how best to apply hydrological models in ephemeral systems is less well developed than for more humid regions. The paper reports on the application of monthly and daily time-step rainfall-runoff models to simulating the hydrology (including pool storage) of the Seekoei River basin, a tributary of the Orange River in the Northern Province, South Africa. The hydrological response of the basin is spatially variable, a relatively small part of the basin generating a large proportion of the total stream flow. The outputs from the hydrological models have been used as inputs to a simple water quality mass balance model designed to simulate the total dissolved solids (TDS) of both flow and pool storage. The results from both the water quantity and quality models are encouraging when compared with the available observed data. While there are no data to confirm the simulation results at sub-basin scales, they do appear to be conceptually acceptable. The conclusion is that the results are adequate to support ecological studies in the determination of EWRs.
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727. **Simulation of groundwater interception at Lake Ranfurly, Victoria, incorporating variable density flow and solute transport**.
Narayan, K. A. and Armstrong, D.
Journal of Hydrology 165(1-4): 161-184 (1995).
http://dx.doi.org/10.1016/0022-1694(94)02566-T
Keywords: groundwater/ hydrogeology/ saline water/ hydrology/ models/ aquifers/ soil transport processes
Abstract: The movement of salt from Lake Ranfurly West towards the River Murray and the associated groundwater interception scheme has been modelled in cross-section using the SUTRA model. Recharge from irrigation areas, and saline seepage from the lake have been taken into account. Owing to the salinity contrast between Lake Ranfurly West and groundwater, it was considered appropriate to simulate density-dependent flow behaviour. Concentration profiles in the aquifers and salt loads to the river under various management scenarios were computed under conditions of both density-dependent and non-density-dependent flow. The model simulations have shown that the salt load to the river is (1) dependent on the rate of pumping from interception bores, (2) dependent on the aquifer(s) in which groundwater is intercepted, and (3) marginally greater (11–15%) for density-dependent flow behaviour at less than full interception compared with calculations which neglect density-dependent flow.
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728. **Simulations of multipurpose water availability in a semi-arid catchment under different management strategies**.
Burte, J., Jamin, J.-Y., Coudrain, A., Frischkorn, H. and Martins, E. S.
Agricultural Water Management 96: 1181-1190 (2009). ISSN: 0378-3774
http://dx.doi.org/10.1016/j.agwat.2009.03.013
Keywords: water management/ alluvial aquifer/ semi-arid/ scenarios/ modeling/ multipurpose use
Abstract: In the semi-arid Brazilian Northeast, the exploitation of alluvial aquifers for irrigation and domestic supply to rural communities over the last 10 years has upset the traditional mechanisms of water resources management. In the Forquilha watershed (221 km2; 5°17″S, 39°30″W), the two main water resources are reservoirs (with a capacity exceeding 0.9–6.7 × 106 m3), used for domestic water supply only, and an alluvial aquifer (2.3 × 106 m3), used for irrigation and domestic water supply. From 1998 to 2006, the irrigated area with alluvial groundwater increased from 0 to 75 ha, and the fraction of population supplied through domestic water networks, using reservoirs and the aquifer, increased from 1% to 70%. Based on physical and socioeconomic issues, three main water territories have been defined (“Aquifer”, “Reservoirs”, and “Disperse Habitat”). Considering the next 30 years with a realistic population growth, three hypotheses regarding irrigated area (i.e., 0, 75, or 150 ha), and several possible water-management scenarios, hydrological balance models were built and used to simulate the different impacts on water resource availability and salinity. Simulation results showed that, in all cases, releases from the upstream main reservoir are necessary to keep reservoir salinity below 0.7 g L−1 and for guaranteeing domestic needs in the whole watershed. As a consequence, a management approach that takes into account the interrelations among the three territories is necessary. Moreover, the simulations showed that the area of irrigated fields cannot exceed the current extent (75 ha), or serious restrictions on water availability and salinity will take place. Moreover, important socioeconomic problems are expected, including a high cost of palliative water supply with tank trucks from external sources.
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729. **Simulations on soil water variation in arid regions**.
Dong, W., Yu, Z. and Weber, D.
Journal of Hydrology 275: 162-181 (2003).
ISSN: 0022-1694
http://dx.doi.org/10.1016/S0022-1694(03)00041-6
Keywords: arid regions/ macropore flow/ modeling/ transpiration/ unsaturated flow
Abstract: Significant soil water variation has often been found in top few meters of arid soils. Understanding soil water variation in these soils is crucial to groundwater recharge estimation, rainfall runoff process, risk assessment, and water resource management. A soil hydrologic model (SHM) was developed for simulating soil water movement in the vertical direction using time steps of minutes to days. To account for the dual processes of matrix and macropore flow, a parameterization scheme of dual processes has been adopted to derive effective hydraulic conductivity used in the SHM simulation. The

integral-balance model based on water flux at different degrees of water saturation used to calculate the macropore conductivity is more useful in quantitatively integrating the macropore contribution to the dynamic soil water fluxes. The SHM, successfully applied to humid and semi-arid regions and validated at the Nevada Test Site (NTS) in this study, was used to evaluate soil water variation in an arid region, the NTS. Soil texture effects on soil water content have been evaluated; results indicate that higher hydraulic conductivity soils have less soil water content. A representative vegetation type at the NTS—Larrea tridentate is included to simulate the effects of vegetative cover on the soil water content. The simulations show that the bare soils have higher soil water content than the vegetated soils, which is consistent with observations and other modeled results. Due to low precipitation at the NTS for much of the year, effects of the macropore flow on soil water content are insignificant. However, the macropore flow could be an important factor influencing the soil water content during high precipitation events.
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730. **Using airborne geophysics to identify salinization in West Texas**.
Paine, J. G., Dutton, A. R. and Blum, M. U.
Report of Investigations - Texas, University, Bureau of Economic Geology, 69 p. (1999).
http://129.116.232.161/staffinfo/paine-pubs/RI257_paine.pdf
Keywords: United States/ Runnels County/ Texas/ water quality/ terrestrial environment/ geophysical surveys/ halogens/ environmental analysis/ environmental effects/ oil and gas fields/ groundwater/ conductivity/ chloride ions/ transport/ time domain analysis/ applied geophysics/ environmental geology/ electromagnetic induction/ soils/ chlorine/ concentration/ pollutants/ arid environment/ ground methods/ West Texas/ pollution/ magnetic anomalies/ Texas/ organic compounds/ hydrocarbons/ aerial photography/ surveys/ salinization/ airborne methods/ remote sensing
Abstract: Salinization of soil and water is a chronic environmental and agricultural problem in arid regions. In this study of a 91-km (super 2) area in Runnels County, Texas, we integrated high-resolution airborne and ground-based geophysical surveys and chemical analyses of soil and water to identify near-surface salinization and determine its origin. Possible causes of salinization are migration of brine along natural conduits (faults, fractures, joints, and permeable stratigraphic units), infiltration from brine-disposal pits and leaking oil and gas wells, and evaporative concentration of shallow ground water. An airborne geophysical survey of the Hatchel area, where more than 700 oil and gas wells have been drilled since the 1920's, measured magnetic-field intensity and ground conductivity at three electromagnetic frequencies to identify (1) conductivity anomalies caused by salinization and (2) magnetic-field anomalies caused by well casings and other ferrous objects. Water samples were analyzed to verify airborne data and distinguish salinity types. We combined airborne geophysical data with oil- and gas-well locations to identify 107 conductivity anomalies consistent with oil-field salinization. Ground-based geophysical measurements, aerial-photograph interpretations, and record inspections of 54 anomalous sites revealed that at least 42 had oil-field salinization and that 22 might be wells that are leaking or have leaked in the past. We created a geophysical "profile" that captured 20 of the 22 potentially leaking wells identified during field investigations: a site that (1) has a magnetic anomaly or a known well location and (2) has anomalously high conductivity as measured by the high- and intermediate-frequency (56,000- and 7,200-Hz) airborne coils. These results suggest that airborne geophysics can be combined with well locations for identifying most potentially leaking wells without requiring ground investigations at every anomaly. Used alone, airborne methods distinguish natural salinization from oil-field salinization but have difficulty discriminating among oil-field sources (pits, spills, and leaking wells). Used alone, ground-based surveys can map salinization extent and determine whether wells might be leaking, but unknown salinization is missed. In small areas where well locations are known, ground-based surveys can determine which wells might be leaking, and they are an inexpensive alternative to airborne surveys. Airborne methods are most effective in typical oil-field areas of tens to hundreds of square kilometers, where well locations are uncertain or multiple salinity sources are expected. Airborne data can be used to

determine the extent and intensity of salinization, locate source areas, focus ground investigations, and estimate chloride mass in the ground.
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731. **Using geomorphologic and spectral analysis approaches for mapping salinity within an arid environmental context**.
Darwish, K. M. and Wahba, M. M.
Egyptian Journal of Soil Science 48: 241-251 (2008). ISSN: 0302-6701
Keywords: Edko Lake/ soil profiles/ geomorphological methods/ pollution/ Lake Qarun/ mapping/ salinity/ environmental management/ geomorphology/ SAR/ sampling/ soil pollution/ chemical properties/ calcium carbonate/ El Borollus Lake/ environmental geology/ pH
Abstract: Salinization is the process of accumulation of soluble salts in soils, particularly occurring in arid and semi-arid regions, where precipitation is too low to maintain a regular percolation of rainwater through the soil. It is well known that salt concentration in soil has negative impact on crop growth, which results in reduced crop yield. Detecting salinity hazard is an important issue in precision agriculture. The aim of this work has been to carry out salinity mapping within an environmental context in the northern part of Bahariya Oasis (198.0 km (super 2)) in Egypt, where soil salinity appears to be a major threat to agricultural production. In order to map soil salinity in an efficient way a step-wise approach is proposed using remote sensing and topographic data. The area is first subjected to geomorphic analysis for which a stereo-model is generated using satellite data and a digital elevation model is derived from interpolating contours lines. The second step is the application of a band rotation technique to transform near-infrared and red spectral bands to derive a soil line. The Soil line minimizes vegetation influence while maximizing spectral response from bare soil. Soil line values were used to map soil salinity levels. For the purpose of validation soil line values were correlated with topsoil conductivity measurements. Geopedologic modeling gave an overall view of the depth where salinization is active.
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732. **Using helicopter electromagnetic data to predict groundwater quality in fractured crystalline bedrock in a semi-arid region, northeast Brazil**.
De Souza Filho, O. A., Silva, A. M., Remacre, A. Z., Sancevero, S. S., Mccafferty, A. E. and Perrotta, M. M.
Hydrogeology Journal 18: 905-916 (2010). ISSN: 1431-2174
http://dx.doi.org/10.1007/s10040-010-0582-4
Keywords: fractured materials/ water quality/ electrical conductivity/ terrestrial environment/ geophysical surveys/ characterization/ kriging/ semi-arid environment/ salinity/ groundwater/ northeastern Brazil/ Ceara Brazil/ stochastic processes/ electromagnetic methods/ crystalline rocks/ applied geophysics/ helicopter methods/ bedrock/ statistical analysis/ geophysical methods/ prediction/ geostatistics/ measurement/ aquifers/ South America/ desalinization/ surveys/ hydrogeology/ Brazil/ water resources/ water wells
Abstract: Geostatistical modeling, using airborne and borehole electromagnetic data, was used to estimate electrical conductivity in groundwater within fractured paragneisses and migmatites in a semi-arid climate in northeastern Brazil. Despite the geologic heterogeneity of crystalline aquifers, the use of high resolution helicopter electromagnetic (HEM) data enabled the characterization of groundwater electrical conductivity where data from drilled wells were insufficient. The tacit assumption is that HEM measurements can be used to relate rock electrical conductivity to groundwater electrical conductivity. In this study, the HEM data were used as an external drift variable in non-stationary estimation and stochastic simulation to identify the variability of groundwater electrical conductivity. Validation tests, comparing predicted values for groundwater conductivity with measurements in new wells, confirmed the success of these models in locating fresh groundwater sources in crystalline bedrock.
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733. **Analysis of ground-water-quality data of the upper Colorado River Basin,water years 1972-92**.
Apodaca, L. E.
U.S. Geological Survey Water-Resources Investigations Report, 31 p. (1998).
http://pubs.usgs.gov/wri/wri974240/
Keywords: Colorado/ environment/ hydrology/ rivers/ streams/ water resources/ watersheds
Abstract: As part of the U.S. Geological Survey's National Water-Quality Assessment program, an analysis of the existing ground-water-quality data in the Upper Colorado River Basin study unit is necessary to provide information on the historic water-quality conditions. Analysis of the historical data provides information on the availability or lack of data and water-quality issues. The information gathered from the historical data will be used in the design of ground-water-quality studies in the basin. This report includes an analysis of the ground-water data (well and spring data) available for the Upper Colorado River Basin study unit from water years 1972 to 1992 for major cations and anions, metals and selected trace elements, and nutrients. The data used in the analysis of the ground-water quality in the Upper Colorado River Basin study unit were predominantly from the U.S. Geological Survey National Water Information System and the Colorado Department of Public Health and Environment data bases. A total of 2 12 sites representing alluvial aquifers and 187 sites representing bedrock aquifers were used in the analysis. The available data were not ideal for conducting a comprehensive basin wide water quality assessment because of lack of sufficient geographical coverage. Evaluation of the ground-water data in the Upper Colorado River Basin study unit was based on the regional environmental setting, which describes the natural and human factors that can affect the water quality. In this report, the groundwater-quality information is evaluated on the basis of aquifers or potential aquifers (alluvial, Green River Formation, Mesaverde Group, Mancos Shale, Dakota Sandstone, Morrison Formation, Entrada Sandstone, Leadville Limestone, and Precambrian) and land-use classifications for alluvial aquifers. Most of the ground-water-quality data in the study unit were for major cations and anions and dissolved-solids concentrations. The aquifer with the highest median concentrations of major ions was the Mancos Shale. The U.S. Environmental Protection Agency secondary maximum contaminant level of 500 milligrams per liter for dissolved solids in drinking water was exceeded in about 75 percent of the samples from the Mancos Shale aquifer. The guideline by the Food and Agriculture Organization of the United States for irrigation water of 2,000 milligrams per liter was also exceeded by the median concentration from the Mancos Shale aquifer. For sulfate, the U.S. Environmental Protection Agency proposed maximum contaminant level of 500 milligrams per liter for drinking water was exceeded by the median concentration for the Mancos Shale aquifer. A total of 66 percent of the sites in the Mancos Shale aquifer exceeded the proposed maximum contaminant level. Metal and selected trace-element data were available for some sites, but most of these data also were below the detection limit. The median concentrations for iron for the selected aquifers and land-use classifications were below the U.S. Environmental Protection Agency secondary maximum contaminant level of 300 micrograms per liter in drinking water. Median concentration of manganese for the Mancos Shale exceeded the U.S. Environmental Protection Agency secondary maximum contaminant level of 50 micrograms per liter in drinking water. The highest selenium concentrations were in the alluvial aquifer and were associated with rangeland. However, about 22 percent of the selenium values from the Mancos Shale exceeded the U.S. Environmental Protection Agency maximum contaminant level of 50 micrograms per liter in drinking water. Few nutrient data were available for the study unit. The only nutrient species presented in this report were nitrate-plus-nitrite as nitrogen and orthophosphate. Median concentrations for nitrate-plus-nitrite as nitrogen were below the U.S. Environmental Protection Agency maximum contaminant level of 10 milligrams per liter in drinking water except for 0.02 percent of the sites in the alluvial aquifer and 0.03 percent of the sites in the Mancos Shale. Concentrations of orthophosphate did not vary significantly among aquifers or land-use classifications. Historic water-quality data from wells and springs helped to characterize the regional

distribution of ground-water quality information in the Upper Colorado River Basin study unit. The historical ground-water data summarized in this report will be used in the design of a groundwater-quality network. Because ground-water quality issues in the study unit are related to high dissolved solids, sulfate, selenium, and nutrients, this report discusses some of the important findings related to these issues.

734. **Analysis of the Variation Characteristics of Soil Moisture and Soil Salinity --Taken Around Pasture in the Upper Reaches of Heihe River for an Example**.
See record 207 in Surface Water Transport Processes.

735. **Application of electrical conductivity in measuring soluble mineral content of soil**.
Karakouzian, M., Pitchford, A. and Johnson, B.
Proceedings of the Symposium on Engineering Geology and Geotechnical Engineering 33: 129-134 (1998).
Keywords: engineering geology/ soil mechanics/ electrical conductivity/ statistical analysis/ solubility/ measurement/ engineering geology/ Las Vegas Valley/ western United States/ applications/ minerals/ Nevada/ regression analysis
Abstract: Soils with soluble salts occur in arid regions worldwide. Depending on the amount of soluble salts present, treatment of these soils may be needed before construction. Soluble salt content is determined by leaching the soluble minerals from a specimen. One of the ways to estimate soluble salt content is to measure the electrical conductivity of the leachate and correlate the conductivity with the dissolved solids in solution. If specimens are leached with an insufficient amount of water, some of the salt present in the soil may not dissolve, causing the amount of soluble salts to be underestimated. Electrical conductivity measurements also can be used to detect this condition and water can be added until an unsaturated solution is obtained. Then the volume of water used to determine soluble salt content can be adjusted accordingly. Using this approach, five different soils from Las Vegas, Nevada, were evaluated over a series of water-soil dilution ratios from 2:1 to 100:1. In two cases, the 2:1 dilution was adequate, but for the other three it was not. Soil "M" exemplified this best: percent soluble salts increased from 1 percent measured at a 5:1 dilution (indicating a leave-in-place/no action recommendation) to 7 percent at a 100:1 dilution (indicating a removal recommendation). This result illustrates the importance of using an unsaturated dilution for determining soluble salt content.
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736. **Ashley Creek selenium and total dissolved solids TMDL**.
Utah Department of Environmental Quality, Division of Water Quality and Tmdl Section, (2003).
http://www.waterquality.utah.gov/TMDL/Ashley_Creek_TMDL.pdf
Keywords: TMDL/ selenium/ total dissolved solids/ water quality/ Mancos shale/ sewage lagoons/ fisheries/ riparian habitat/ oil wells/ wastewater treatment plants/ snowmelt/ irrigation/ stream flow/ precipitation/ watersheds/ geology/ salinity control
Abstract: This document addresses water quality impairments within the lower Ashley Creek watershed through the establishment of Total Maximum Daily Loads (TMDLs) for Selenium (Se) and Total Dissolved Solids (TDS). The purpose of this TMDL is to improve water quality and protect or restore designated beneficial uses. Lower Ashley Creek, from the confluence with the Green River upstream approximately 8 miles, is listed on the State's 303D list of impaired waters and has been designated as not meeting its warm water fishery beneficial use (3B) due to high concentrations of Se and its agricultural beneficial use (4) due to high concentrations of TDS. The source of impairment originates primarily from seepage from the Ashley Valley Sewage Lagoons through an outcrop of Mancos shale, a naturally occurring geologic formation that borders the east side of Ashley Creek. Permitted point source discharges in the watershed include the Ashley Valley Water Reclamation Facility, a mechanical waste water treatment plant, and five oil wells in the Ashley Oil Field. The Ashley Creek Watershed is located in the northeast corner of the State of Utah and encompasses 393 square miles. Elevations range from over 9,500 feet in the Uinta Mountains to the north, down to 5,000 feet at the confluence with the Green River. Vegetation types are characteristic of the Rocky Mountains and Colorado Plateau with coniferous forests dominating the high elevations, Pinyon-Juniper forests at mid-elevations and sagebrush-grass and agricultural

lands in the valley bottom. Ashley Creek is the primary drainage in the watershed flowing from the Uinta Mountains in the north, through Ashley Valley and into the Green River forty-five miles to the southeast. Flows in Ashley Creek vary widely due to spring snow melt, irrigation diversions, and occasional thunderstorms. During spring runoff stream flows average 195 cubic feet per second (cfs), 24 cfs during irrigation season and 34 cfs during the winter near Jensen above the confluence with the Green River. Approximately 12,000 people reside within the watershed with the majority living in the city of Vernal. The economy of the watershed is based upon tourism, fossil fuel production and agriculture. Recreational opportunities abound on nearby National Forest lands, Dinosaur National Monument and Green River. Because of the natural geologic sources of Se and TDS that underlie Ashley Valley there will always be some Se and TDS non-point source loading into Ashley Creek. However, several projects currently underway within the watershed will improve the water quality and riparian habitat of Ashley Creek. A locally led watershed planning effort, the Ashley Creek Restoration and Stabilization Committee, is addressing chronic flooding, water quality and riparian habitat issues on Ashley Creek. The Army Corps of Engineers is about to begin implementation on a riparian restoration project on Ashley Creek above the Steinaker diversion, the Ashley Valley Sewer Improvement District has recently constructed a new wastewater treatment plant, and the Uintah County Water Conservancy District, in cooperation with the Bureau of Reclamation and Natural Resources Conservation Service, is implementing salinity control projects on irrigated lands throughout the watershed. It is important to recognize that data collection in support of this TMDL is an ongoing effort and that as new data is collected this TMDL will be revised as needed.

737. **Biological drainage characteristics of alkalized desert soils in north-western China**.
Zhao, C., Wang, Y., Song, Y. and Li, B.
Journal of Arid Environments 56: 1-9 (2004).
ISSN: 0140-1963
http://dx.doi.org/10.1016/S0140-1963(03)00005-3
Keywords: alkalized desert soils/ biological drainage/ soil sodicity and SAR
Abstract: Years of intensive irrigated farming in the Oasis area of Xinjiang in north-western China has caused secondary salinization of vast areas of land since the mid 1980s. Soil salinity/sodicity surveys in the area, conducted after the problem surfaced, showed relatively high levels of the sodium adsorption ratio (SAR) in the upper soil layers. In one study, 92% of cored soil samples of the affected fields showed SAR values above 5, while 42% had values above 15. One ameliorative approach, bio-drainage using different desert vegetations, was used to control the high water-tables and reverse the observed salinity/sodicity trends in the border area of the Manas Alluvial Fan. The ground-water table dropped to below 2.28 m in the summer of the fifth year, which was sufficient to prevent secondary salinization. A related plot study showed that *Lycium barbarum* and Puccinellia Chinamponsis consumed large amounts of soil water while leaving most of the salts behind. The salt contents of leaves and young branches were different for different vegetation. Soil profile salt distributions for the deep-rooted and shallow-rooted systems were different in two of the three years after planting. Commercial forestry of L. barbarum and other timber products under current conditions, and without irrigation, appears a viable agricultural alternative that could bring higher returns than for wheat or cotton. Results of this study indicate that both conventional and biological drainage are attractive options for controlling the local hydrology and limiting or diminishing salinity–sodicity trends.
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738. **Clay dispersion characteristics of arid land soils as influenced by exchangeable cation composition electrolyte concentration and clay mineralogy**.
Ali, O. M., Rhoades, J. D. and Noaman, K. I.
Egyptian Journal of Soil Science 27: 223-234 (1987). ISSN: 0302-6701
Keywords: soil/ clay/ electrical conductivity/ terrestrial environment/ clastic sediments/ arid environment/ electrolytes/ adsorption/ sediment/ ion exchange/ hydraulic conductivity/ geochemistry/ soils
Abstract: The dispersion characteristics of five arid land soil were determined at various levels of electrical conductivity, Q (Q= 0.1, 0.4, 1, 3, 5 and 10 d Sm-1), and sodium adsorption ratios, R Na (0, 5, 10, 20 and 40), with either calcium or magnesium as the divalent counter-in. Greater dispersion was observed with Mg as the divalent counter-ion due to higher R Na and lower Q

levels which resulted in Mg systems compared to Ca systems when the soils reacted with comparable R Na and Q treatments. With either divalent cation, clay dispersion increased as R Na and Q decreased. The threshold values of R Na and Q resulting in clay dispersion equivalent to 3% and 5% of the soils total clay contents and for dispersion of 5g clay/ kg soil were determined. In general higher dispersion sensitivities of the soils were observed with Mg as the divalent cation.
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739. **Climate change and ecosystems of the southwestern United States**.
Archer, S. R. and Predick, K. I.
Rangelands 30: 23-28 (2008). ISSN: 0190-0528
http://dx.doi.org/10.2111/1551-501X(2008)30[23:CCAEOT]2.0.CO;2
Keywords: climate change/ water availability/ ecosystems/ nonnative plants/ soil erosion/ precipitation/ land management
Abstract: Arid desert ecosystems of the western United States are particularly susceptible to climate change and climate variability. Plants and animals in this region live near their physiological limits for water and temperature stress. Slight changes in temperature or precipitation regimes or a change in the frequency and magnitude of extreme climatic events could therefore substantially alter the composition, distribution, and abundance of species, as well as the products and services that arid lands provide.
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740. **Climate change impacts on northwestern and intermountain United States rangelands**.
See record 673 in Model Studies.

741. **Colorado River Ecology and Dam Management: Proceedings of a Symposium May 24-25, 1990 Santa Fe, New Mexico**.
See record 212 in Surface Water Transport Processes.

742. **Co-ordinating Catchment Management**.
Parliament of the Commonwealth of Australia, (2000).
http://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=environ/cminq/cmirpt/report/fullrpt.pdf
Keywords: watershed management/ policy/ land degradation/ soil salinity/ water quality/ water supply/ government programs/ saline water

743. **Degradation and recovery processes in arid grazing lands of central Australia. Part 1: soil and land resources**.
See record 575 in Remediation.

744. **Desertification Processes and Impact in Rainfed Agricultural Regions**.
Sanders, D. W.
Climatic Change 9: 33-42 (1986).
Keywords: desertification/ human nonwater activities/ ecological impact/ water development
Abstract: The processes of desertification are reviewed. About one third of the Earth 's land surface lies in the arid and semi-arid regions; this area not only supports 600 million people, but produces much of the world 's grain and a substantial amount of animal produce. Much of this area is now either suffering or is threatened by the processes of desertification. Seven different desertification processes are described: degradation of vegetative cover, wind erosion, water erosion, salinization, soil crusting and compaction, reduction in organic matter, and accumulation of toxic substances are identified and their effects described. It is pointed out that these processes are usually closely interrelated, the one frequently leading to one or more of the others. Whatever the process, the end result is degraded land with a reduced productive capacity. It is concluded that desertification occurs through man's influence on the environment, and that the problems of desertification cannot be solved by considering only physical processes. (Author 's abstract)
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745. **Detailed study of selenium and selected elements in water, bottom sediment, and biota associated with irrigation drainage in the Middle Green River Basin, Utah 1988-90**.
See record 125 in Subsurface Transport Processes.

746. **Developing a geomorphic approach for ranking watersheds for rehabilitation, Zuni Indian Reservation, New Mexico**.
Gellis, A. C., Cheama, A. and Lalio, S. M.
Geomorphology 37: 105-134 (2001).
http://dx.doi.org/10.1016/S0169-555X(00)00065-9
Keywords: erosion control/ arroyos/ watershed rehabilitation/ watershed ranking/ prioritization
Abstract: As a result of past erosion problems on the Zuni Indian Reservation in western New Mexico. The US Congress in 1990 authorized the Zuni Tribe to begin a program for watershed rehabilitation. This paper describes an approach to rank the most appropriate watersheds for rehabilitation for the Zuni Reservation. The approach was based on data collected during a 3-year study on geomorphic and anthropogenic characteristics of the Rio Nutria Watershed, including data on (i) arroyo cross-sectional changes, (ii) erosion-control structures, and (iii) sheetwash erosion. Results of this 3-year study indicated that 61 of 85 channel cross-sections aggraded and channels with lower width-to-depth ratios eroded. Results on assessment of erosion-control structures, some dating back to the 1930s, indicated that 60% of earthen dams and 22% of rock-and-brush structures were breached or flanked in the Rio Nutria watershed. Sheetwash erosion measured on five land-cover sites (sagebrush, pasture, chained pinon and juniper, unchained pinon and juniper, and ponderosa pine) indicated chained pinon and juniper sites and pasture sites had the highest volume-weighted sediment concentrations of 13,000 and 9970 ppm, respectively. Based on interpretations of the 3-year study in the Rio Nutria Watershed, a two-stage approach was developed to rank the most appropriate watersheds for rehabilitation on the Zuni Reservation. In the first stage, the reservation was divided into eight major watersheds, which were ranked according to the most potential for erosion. In the second stage, the watershed with the most potential for erosion was divided into sub-basins, which were ranked according to the most potential for erosion. Quantitative and qualitative information on physical and anthropogenic factors were used at each stage to rank the watersheds. Quantitative physical data included headcut density, percentage of bare ground, percentage of chained area, channel width-to-depth ratio, change in channel density from 1934 to 1988, and sheetwash erosion rates. Qualitative physical data included erosion rankings on the main channels, tributaries and entire basins. Anthropogenic data included density of dirt roads and condition of erosion-control structures. A community survey and agricultural acreage were also used in the selection process. The first stage analysis resulted in the selection of the Rio Nutria Watershed as the most appropriate major watershed for rehabilitation. In the second stage, the Rio Nutria Watershed was: divided into 15 sub-basins; the analysis indicated the highest priority sub-basins for rehabilitation were Benny Draw, Coal Mine Canyon Draw and Garcia Draw.

747. **Differences in mineral ratios between disaggregated and original clay fractions in some South African soils as affected by amendments**.
Buhmann, C., Rapp, I. and Laker, M. C.
Australian Journal of Soil Research 34: 909-923 (1996).
http://www.publish.csiro.au/?act=view_file&file_id=SR9960909.pdf
Keywords: quartz/ smectite/ mica/ feldspar/ electrolyte concentration/ aggregate stability/ flocculation/ infiltration/ suspension/ sodicity
Abstract: Conflicting information is available on the propensity different soil clays exhibit to dispersion. We therefore assessed the relative stability of the clay components of 12 soil samples, from various parts of South Africa, to predominantly physical disruption by a mild disruptive treatment [mechanical shaking for 5 min in distilled water (DW), and after the addition of phosphogypsum (PG; 2% by weight) and polyacrylamide (PAM; 0.04% by weight)]. The soils differed markedly in their physical and chemical properties. Clay fractions were of mixed mineralogy and dominated by kaolinite, illite, or smectite. Comparison of the clay mineral composition of the disaggregated clay with that of the original <2 mu m fraction indicated that the disaggregated clay composition depended on the amendment. In DW, clay-sized quartz and feldspar were disaggregated preferentially over layer silicates. Within the phyllosilicate fraction, the 2:1 clay minerals (mica, smectite)

were on average slightly more easily disaggregated than kaolinite. Goethite was the least easily detached clay component in DW. The increase in quartz and feldspar proportions relative to the other components of the clay fraction was dramatically more pronounced when the soils were mixed with PG. With PAM, however, differences in the nature of the clay fraction between original and disaggregated clay were only marginal. Disruption was not particle-size related, as the minerals of the fine-clay fraction showed no selective increase in any of the treatments. These findings indicate that the most inert members of the clay fraction are most actively involved in the process of disaggregation. PG influenced disaggregation in a manner markedly different from that of PAM. Gypsum preferentially stabilised components with a net negative charge over uncharged species. PAM, in contrast, seemed to affect all clay components equally, independent of charge characteristics.
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748. **Dissolved mineral salts derived from Mancos Shale**.
See record 466 in Geologic and Geochemical Processes.

749. **Dryland salinity in Western Australia: Managing a changing water cycle**.
Taylor, R. J. and Hoxley, G.
Water science and technology 47: 201-207 (2003). ISSN: 0273-1223
Keywords: arid lands/ discharge/ drainage/ dry farming/ dryland farming/ environmental effects/ environmental impact/ floods/ groundwater/ groundwater recharge/ hydrology/ revegetation/ runoff/ saline water/ salinity/ salt water/ surface water/ waterlogging/ western Australia
Abstract: Clearing of agricultural land has resulted in significant changes to the surface and groundwater hydrology. Currently about 10% of agricultural land in Western Australia is affected by dryland salinity and between a quarter and a third of the area is predicted to be lost to salinity before a new hydrological equilibrium is reached. This paper develops a general statement describing the changes to the surface and groundwater hydrology of the wheatbelt of Western Australia between preclearing, the year 2000 and into the future. For typical catchments in the wheatbelt it is estimated that average groundwater recharge and surface runoff have increased about tenfold when comparing the current hydrology to that preclearing. Saline groundwater discharge and flood volumes have also increased significantly. Saline groundwater discharge and associated salt load will probably double in the future in line with the predicted increase in the area of dryland salinity. In addition, future increases in the area of dryland salinity/permanent waterlogging will probably double the volumes in flood events and further increase surface runoff in average years. The outcomes of surface and groundwater management trials have been briefly described to estimate how the hydrology would be modified if the trials were implemented at a catchment scale. These results have been used to formulate possible integrated revegetation and drainage management strategies. The future hydrology and impacts with and without integrated management strategies have been compared.
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750. **Dryland salinity: Early indicators and control measures**.
See record 580 in Remediation.

751. **The dust bowl in the 1970s: Presidential address, 66th annual meeting, Association of American Geographers, San Francisco, August, 1970**.
Borchert, J. R.
Annals, Association of American Geographers 61: 1-22 (1971).
http://dx.doi.org/10.1111/j.1467-8306.1971.tb00762.x
Keywords: grasslands/ drought/ Great Plains/ cycles/ water resources development/ semi-arid climates/ social aspects/ migration/ weather patterns/ economics of scale/ crop response/ wheat/ cattle/ federal government/ irrigation programs/ economic impact/ subhumid climates/ diversification/ management/ rainfall/ municipal water/ soil erosion/ geographical regions/ dust bowl/ crop subsidies/ drought perception
Abstract: Major droughts have periodically struck the Great Plains and bordering prairie areas in cyclical sequences. The midpoints of the past 4 major extensive drought periods were 1892, 1912, 1934 and 1953, and the mean interval between midpoints is 21 years. These rhythmic occurrences are associated with contemporaneous rhythmic shifts of meridional and zonal atmospheric circulation patterns and

moisture delivery on a large scale. Extrapolating from the previous records, a severe drought is indicated for the mid-1970s. During past droughts, farm production has catastrophically declined and severe strains were placed on municipal water systems. The aggregate political, social, economic and geographic effects are most clearly reflected in the fate of the individual farmer and the development of federal programs. While federal programs are designed to save existing farm units, migration out of agriculture, combined with economies of scale and new management practices have resulted in fewer, larger, more diversified farms. Indirect feed grain subsidies and crop diversification have also acted to increase livestock feeding. The economics of federal programs and farm credit are discussed. While rural populations have decreased, urban center populations have increased. Urban water supplies have been severely threatened by the droughts, but planned improvements in municipal water resources have rarely occurred. Future droughts will accelerate all of these trends. It is felt that this region may be offering a preview of the long-term behavior of developed societies as they approach resource ceilings.
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752. **Dynamics of water vapor flux and water separation processes during evaporation from a salty dry soil**.
Gran, M., Carrera, J., Massana, J., Saaltink, M. W., Olivella, S., Ayora, C. and Lloret, A.
Journal of Hydrology (Amsterdam) 396: 215-220 (2011). ISSN: 0022-1694
http://dx.doi.org/10.1016/j.jhydrol.2010.11.011
Keywords: surface and groundwater hydrology
Abstract: Evaporation from a salty soil generates salt accumulation near the surface with the subsequent deterioration of the soil quality. Salinization mechanisms are poorly understood despite their global impact. Vapor flux and solute transport were studied under evaporation conditions. Laboratory experiments consisted of open sand and silt columns initially saturated with epsomite (MgSO4A.7H2O) or halite (NaCl) solutions. Salt precipitation occurred only above the evaporation front, which occupied a very narrow region. Vapor flowed both upwards and downwards from this front. The downward vapor flow condensed further down the column, diluting the solution. This gave rise to two areas: a high salinity area above the evaporation front, and a diluted solution area below it. The effects of thermal, suction and osmotic gradients on water fluxes were studied in order to better understand the underlying mechanisms of this phenomenon.
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753. **Effect of clay minerals on clay dispersion properties of various arid land soils**.
Ali, O. M. and Rhoades, J. D.
Egyptian Journal of Soil Science 27: 195-210 (1987). ISSN: 0302-6701
Keywords: soil/ silicates/ electrical conductivity/ terrestrial environment/ arid environment/ kaolinite/ adsorption/ X-ray diffraction analysis/ clay minerals/ chlorite/ mineral composition/ composition/ sheet silicates/ vermiculite/ chlorite group/ soils/ montmorillonite
Abstract: The effect of clay mineralogy on clay dispersion properties of various arid land soil in calcium-sodium and magnesium sodium systems was evaluated. It was observed that, in the case of Fallbrook I, Fallbrook II, Pachappa and Arlington soil, all the common clay minerals (kaolinite, mica, vermiculite, chlorite and montmorillonite) dispersed whenever disaggregation occurred irrespective of sodium adsorption ratio (R Na) and electrical conductivity (Q) levels. Q in Bonsall soil, kaolinite and mica clays were more dispersive than montmorillonite which, in turn, was more dispersive than hydrobiotite in calcium-sodium chloride solutions. More intense X-ray diffraction peaks were obtained, in general, in the magnesium-sodium system compared to the calcium sodium system, otherwise the results were about the same, with a few exceptions.
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754. **Effect of exchangeable cation and electrolyte concentration on mineralogy of clay dispersed from aggregates**.
Ali, O. M., Yousaf, M. and Rhoades, J. D.
Soil Science Society of America Journal 51: 896-900 (1987). ISSN: 0361-5995
Keywords: clay/ soil/ aggregate/ clastic sediment/ sediment/ stability/ electrolytes/ ion exchange/ geochemistry/ X-ray diffraction analysis
Abstract: The type of clay dispersed from aggregates of various arid land soils as influenced by sodium adsorption ratio (SAR) and electrolyte concentration was evaluated in Ca-Na and Mg-Na systems. It was observed that, in

general, in the case of Fallbrook I, Fallbrook II, Pachappa, and Arlington soils, all the common clay minerals (kaolinite, clay mica, vermiculite and montmorillonite) dispersed whenever disaggregation occurred irrespective of SAR and electrolyte concentration levels. In Bonsall soil, kaolinite and mica clays were apparently more dispersive than montmorillonite, which, in turn, was more dispersive than mixed-layer clays in Ca-NaCl solutions. More intense XRD peaks were obtained, in general, in the Mg-Na system compared with the Ca-Na system. (Authors' abstract)
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755. **Effect of freezing and thawing processes on some physical properties of saline-sodic soils mixed with sewage sludge or fly ash**.
Sahin, U., Angin, I. and Kiziloglu, F. M.
Soil and Tillage Research 99: 254-260 (2008). ISSN: 0167-1987
http://dx.doi.org/10.1016/j.still.2008.03.001
Keywords: bulk density/ fly ash/ freezing-thawing cycles/ permeability/ saline-sodic soils/ sewage sludge/ wet aggregate stability/ freezing/ mechanical permeability/ thawing/ soil mechanics/ aggregate stability/ cation exchange capacity/ electrical conductivity/ experimental study/ freeze-thaw cycle/ laboratory method/ leaching/ saline soil/ sewage/ sludge/ sodic soil/ sodium
Abstract: Dispersion of saline-sodic soils was rather difficult to leach. Therefore, negative effects of freeze-thaw on soil physical properties should be reduced by inexpensive and practical methods. This study investigates the effect of freeze-thaw cycles (3, 6, and 9) on wet aggregate stability, bulk density, and permeability coefficient in three soils with different electrical conductivity and exchangeable sodium percentage levels (soil I: 5.30 dS m-1, 47.51%; soil II: 42.80 dS m-1, 55.45%; soil III: 36.30 dS m-1, 59.34%) which consist of different proportions of sewage sludge and fly ash by volume (10%, 20%, and 30%). The experiment was conducted under laboratory conditions using disturbed and non-cropped soil samples mixed with sewage sludge and fly ash. Soils mixed with sewage sludge produced higher aggregate stability and permeability coefficients and lower bulk density values as compared to the soils mixed with fly ash. Sewage sludge added with a rate of 30% eliminated the negative effects of freeze-thaw processes on wet aggregate stability. Freeze-thaw processes did not affect the bulk density of the soils II and III, which were mixed with sewage sludge. However, fly ash addition decreased the bulk density of these soils very significantly after nine freeze-thaw cycles. Addition of sewage sludge or fly ash with rates of 20% and 30% significantly increased the permeability coefficients in soil I after nine freeze-thaw cycles. Results indicated that addition of sewage sludge and/or fly ash to saline-sodic soils could be alternative way for reducing negative effects of freezing-thawing on soil wet aggregate stability, bulk density, and permeability coefficient. © 2008 Elsevier B.V. All rights reserved.
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756. **Effects of land processes on the salinity of the upper Colorado River Basin: Final project report**.
See record 132 in Subsurface Transport Processes.

757. **Electrical conductivity and saline concentrations in arid land groundwaters**.
Doornkamp, J. C. and Ibrahim, H. a. M.
Quarterly Journal of Engineering Geology 19: 249-250 (1986). ISSN: 0481-2085
Keywords: electrical conductivity/ arid environment/ surveys/ hydrogeology/ salinity/ groundwater
Abstract: Measurements in Bahrain (Doornkamp et al 1980), have shown a strong linear relationship between electrical conductivity and the ionic concentrations of sulphates and chlorides in groundwaters. Indeed, the relationship proved so strong as to imply that electrical conductivity could be used as a surrogate for sulphates and chlorides, and that the two latter could be estimated from the former in field reconnaissance surveys or even site investigations. This is of critical importance to the construction industry, and to agriculture, in hot arid lands. Concrete is known to deteriorate rapidly in the presence of saline groundwater (Fookes & Collis 1975, 1976; Cooke et al 1982), and any quick estimate of the sulphate and chloride levels is of practical value. Field measurements of electrical conductivity can be made rapidly using a portable electrical conductivity meter, while the laboratory analyses of sulphates and chlorides need care and introduce time delays, particularly for the

construction industry, as well as additional costs. What is not known is whether the results obtained in Bahrain provide a universally applicable relationship. Do the regression equations obtained in Bahrain hold good for all hot arid lands? If so, can they be used as a basis for estimating sulphate and chloride concentrations from simple electrical conductivity measurements without the need to resort to laboratory tests? Some standard texts (e.g. Davis & de Wiest 1966) suggest this could be so. To test these questions two further analyses have been carried out. The first is for data collected by the Egyptian Groundwater ... This 250-word extract was created in the absence of an abstract.
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758. **Electrical methods (VES and ERT) for identifying, mapping and monitoring different saline domains in a coastal plain region (Alt Empordà, Northern Spain)**.
See record 679 in Model Studies.

759. **Emerging Issues in Rangeland Ecohydrology: Vegetation Change and the Water Cycle**.
Wilcox, B. P. and Thurow, T. L.
Rangeland Ecology & Management 59: 220-224 (2006). ISSN: 1550-7424
http://dx.doi.org/10.2111/05-090R1.1
Keywords: climate/ feedback/ land use/ landscape/ range management/ vegetation changes
Abstract: Rangelands have undergone—and continue to undergo—rapid change in response to changing land use and climate. A research priority in the emerging science of ecohydrology is an improved understanding of the implications of vegetation change for the water cycle. This paper describes some of the interactions between vegetation and water on rangelands and poses 3 questions that represent high-priority, emerging issues: 1) How do changes in woody plants affect water yield? 2) What are the ecohydrological consequences of invasion by exotic plants? 3) What ecohydrological feedbacks play a role in rangeland degradation processes? To effectively address these questions, we must expand our knowledge of hydrological connectivity and how it changes with scale, accurately identify “hydrologically sensitive” areas on the landscape, carry out detailed studies to learn where plants are accessing water, and investigate feedback loops between vegetation and the water cycle.
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760. **Environmental effects induced by human activities in arid Shiyang River basin, Gansu Province, Northwest China**.
Wang, Q., Shi, J. A., Chen, G. J. and Xue, L. H.
Environmental Geology 43: 219-227 (2002). ISSN: 0943-0105
http://dx.doi.org/10.1007/s00254-002-0647-3
Keywords: environmental effects/ environmental fate/ human nonwater activities/ river basins/ urbanization/ degradation/ water pollution sources/ sustainable development/ arid environment/ water supply/ mechanical change/ natural change/ man-induced effects/ water resources/ groundwater pollution/ freshwater/ environmental policy/ restoration/ protective measures and control/ salinity/ environmental action/ rural development/ dust storms/ freshwater pollution/ recharge/ rivers/ salinization/ water table/ arid lands/ water management/ remediation/ China/ groundwater/ environment management/ Gansu Prov./ legislation
Abstract: Shiyang River basin is located in Hexi Corridor, central-west Gansu Province, Northwest China. It is an area of typical arid to semiarid features. During the last century, especially the last half century, mankind's production activities have caused a series of detrimental environmental effects, which are summarized: water environment change, land desertification and salinization, and vegetation degradation. Changes in the water environment include the surface water system, water quantities, continuous lowering of the groundwater table and degradation of groundwater quality. Vegetation cover in the lower reaches is seriously degenerated, resulting in land desertification, salinization and dust storms. Analysis indicates that the rate of the groundwater table lowering in Shiyang River basin generally exceeds 0.3 m/year, and the mean annual rate of groundwater decrease in Wuwei and Minqing sub-basins reaches 1.11-3.98%. Until 1998, the shortage of groundwater volume was 4.526 x 10 super(8)m super(3). If no effective measures are taken, this figure will be 6.728 x 10 super(8)m super(3) in 2010. Remedial actions include: (1) recovery and protection of the water conservancy function of the mountain forests to ensure the sustainable

development of this recharge area; (2) establishment of an authoritative agency to reasonably allocate the total water resources in Shiyang River basin; and (3) enactment of legislation and economic control to build up a water-saving society in Shiyang River basin.
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761. **Estimation of groundwater evaporation and salt flux from Owens Lake, California, USA**.
See record 134 in Subsurface Transport Processes.

762. **Estimation of Water Potential Components of Saline Soils of Great Basin Rangelands**.
Roundy, B. A.
Soil Science Society of America Journal 48(3): 645-650 (1984).
Keywords: water in soils/ conductivity/ salinity
Abstract: A rapid method is described to assess the solute and matric components of the total soil water potential at field water contents of a saline soil in central Nevada. The solute potential is estimated from saturated paste conductivity (ECp) measurements easily made on the conductivity cell of an instant salinity meter and assumes that the salt concentration varies inversely with water content. The method requires determination of the relationship between ECp and the electrical conductivity of the saturated paste extract, ECe. The total water potential is measured with a Peltier psychrometer. Subtraction of the solute potential from the total water potential results in an estimate of matric potential. Matric potentials estimated in this way were similar to those determined by a pressure plate at volumetric water contents greater than 0.09 cu m/cu m soil and soil ECe 's < 15/dSm. The method tends to underestimate solute potentials and overestimate matric potentials of soil with lower soil water contents and higher salinity. These measurements are useful in determining plant adaptability on saline, semiarid rangeland soils. (Author 's abstract)
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763. **Gamma-ray remote sensing of aeolian salt sources in the Murray–Darling Basin, Australia**.
See record 681 in Model Studies.

764. **Geochemistry of saline soils in two arid zones of the Mediterranean basin. I. Geochemistry of the chott Melghir-Mehrouane watershed in Algeria**.
See record 477 in Geologic and Geochemical Processes.

765. **Geographic distribution and factors affecting the distribution of salt desert shrubs in the United States**.
Branson, F. A., Miller, R. F. and Mcqueen, I. S.
Journal of Range Management 20: 287-296 (1967). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/5527/5137
Keywords: shrubs/ vegetation cover/ classification/ salt tolerance/ soil salinity/ soil water/ salt stress
Abstract: Four previously published classifications of intermountain shrub vegetation and a new classification based on maximum salt tolerances and water relationships are presented. Maps show that the geographic range of salt desert shrub species far exceeds the distribution of mappable communities in which these shrubs are dominants. Species differ in their capacity to tolerate soil osmotic stress, but variable results from measurements of osmotic stress in 20 different plant communities indicate that additional factors must be important in determining species present in different habitats. Data obtained by the use of a new method of measuring total soil moisture stress in field samples show that the capacity of different species to remove soil moisture to different maximum stresses appears to determine the kinds of plants that occupy different habitats. Total soil moisture stresses for 14 plant communities sampled ranged from 19 to more than 90 bars.
This citation is from the University of Arizona Institutional Repository.

766. **Geologic Map of the Carbondale Quadrangle, Garfield County, Colorado: Geologic Setting, Description of Map Units, Economic Geology, and References**.
See record 479 in Geologic and Geochemical Processes.

767. **Global variability of daily total suspended solids and their fluxes in rivers**.
See record 242 in Surface Water Transport Processes.

768. **Helena River Salinity Situation Statement**.
Smith, R. A., Bari, M. A., Dixon, R. N. M. and Rowlands, D. W.
Water Resource Technical Series, Department of Water, Government of Western Australia, 190 p. (2007).
http://www.water.wa.gov.au/PublicationStore/first/49389.pdf
Keywords: saline water/ water quality/ water supply/ runoff/ watersheds/ precipitation/ hydrology/ groundwater/ land salinization/ springs/ modeling

769. **Historical stream salinity trends and catchment salt balances in the Murray-Darling Basin, Australia**.
Jolly, I. D., Williamson, Gilfedder, M., Walker, G. R., Morton, R., Robinson, G., Jones, H., Zhang, L., Dowling, T. I., Dyce, P., Nathan, R. J., Nandakumar, N., Clarke, R. and Mcneill, V.
Marine & Freshwater Research 52: 53-63 (2001). ISSN: 1323-1650
http://dx.doi.org/10.1071/MF00018
Keywords: arid lands/ salinity/ sources and fate of pollution/ catchment area/ statistical analysis/ water quality/ Australia/ Murray-Darling Basin/ salinization/ streams
Abstract: This paper summarizes the results from a study of historical stream salinity trends and catchment salt balances within the Murray-Darling Basin, Australia. A broad analysis of stream salinization was necessary to assist prediction of the increase in the effect and extent of dryland salinity across the basin. The sparseness of the water-quality data necessitated the development of an innovative statistical trend technique that also allowed for the high autocorrelation of the stream salinity data which was often present. Results showed the spatial distribution of stream salinization and identified regions of concern. The salinization characteristics of four distinct geographical regions were identified by providing a spatial analysis of catchment salt balances and stream salinity trends. The salinization behaviour of each region was also related to distinct physical processes. The most significant rising trends and catchment salt output/input ratios were in the zone with 500-800 mm year super(-1) rainfall in the southern and eastern dryland region.
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770. **The implementation of soil conservation programmes**.
Sanders, D.
Advances in Vegetation Science 19: 143-151 (2000). ISSN: 0168-8022
http://dx.doi.org/10.1007/978-94-015-9602-2_12
Keywords: soil/ government programs and projects/ monitoring/ degradation/ erosion/ agriculture/ desertification/ evaluation/ conservation/ land management/ soil erosion/ soils/ rangelands/ environmental geology/ deforestation/ land use/ salinization
© *ProQuest*

771. **Intermountain Salt-Desert Shrubland**.
West, N. E.
Temperate Deserts and Semi-Deserts. West, N. E. The Netherlands, Elsevier**:** 375-397 (1983).
http://www.gis.usu.edu/~doug/frws3800/readings/CH14.pdf
Keywords: shrubs/ saline soils/ plant ecology/ plant communities/ aridity/ temperature extremes/ dust/ geology/ topography/ vegetation/ microphytic crusts/ grazing/ wildlife/ land use/ wind erosion/ management practices/ sediment
This citation is from Utah State University.

772. **Limnology of Lake Powell and the Chemistry of the Colorado River**.
See record 502 in Geologic and Geochemical Processes.

773. **Long-term contemporary erosion rates in an arid rangelands environment in western New South Wales, Australia**.
Fanning, P.
Journal of Arid Environments 28: 173-187 (1994). ISSN: 0140-1963
http://dx.doi.org/10.1016/S0140-1963(05)80055-2

Keywords: erosion rates/ soil loss/ arid rangelands/ overgrazing
Abstract: Rates of soil loss were determined using erosion pins on a severely eroded surface in a small (19 km2) arid rangelands catchment in western New South Wales, Australia, over a 10-year period. Rates of up to 209 t ha−1 year−1 on rilled surfaces, 59·5 t ha−1 year−1 on flat surfaces, and 30·6 t ha−1 year−1 on vegetated hummocky surfaces were calculated. The initiation of this erosion is attributed to overgrazing by sheep and rabbits in the late nineteenth century, and its amelioration is precluded by hydraulic factors which prevent the use of reclamation techniques like waterponding.
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774. **Management of Dryland Saline Seeps**.
See record 165 in Subsurface Transport Processes.

775. **Mancos Shale and Plant Community Relationships Analysis of Shale Soil and Vegetation Transects**.
Potter, L. D., Reynolds, R. C., Jr. and Louderbough, E. T.
Journal of Arid Environments 9: 147-166 (1985).
Keywords: vegetation cover/ soil ecology/ plant communities/ gypsum/ soil salinity/ saline sodic soils
Abstract: Analyses of an extensive collection of Mancos shale and derived soils from the western United States showed pH values from 3.4 to 9.4, sulfate concentrations high and widely distributed, and soil solution equilibria of gypsum and sodium-dominated smectite important to soil salinity. In situ soils show little change in pH, conductivity, sulfate, GSI (gypsum saturation index), or sodium values with respect to the shale's from which they were derived. On slopes, vegetative sequences from big sagebrush or blackbrush to shadscale to mat saltbush to greasewood are related to increases of sulfate. Galleta grass is also restricted by high sulfate values. The blackbush to shadscale transition is related to sodium increase. Mat saltbush was found in soils with 17,685 ppm sodium (saturated soil solution) and 4350 ppm sulfate (1:5 extract).
This citation is from AGRICOLA.

776. **Mancos Shale and Plant Community Relationships Field Observations**.
Potter, L. D., Reynolds, R. C., Jr. and Louderbough, E. T.
Journal of Arid Environments 9: 137-146 (1985).
Keywords: plant communities/ vegetation/ Mancos shale/ soil
Abstract: Field observations were made of associated vegetational communities during an extensive programme of collection of Mancos shale samples and derived soils. Vegetative responses in the same climate regime were related to physical and chemical variations of the shale. Sulfuric acid, formed by the oxidation of sulfur compounds, either lowers pH or forms calcium sulfate by alteration of calcium carbonate. Partial dissolution of calcium sulfate results in the formation of sodium sulfate and ion exchange equilibrium with sodium-dominated smectite is attained. The most mesic vegetation occurs when sandstone fragments cap, or are mixed with, Mancos shale soils. Leaching, and transport of weathered shale also removes inhibitive aspects of the Mancos shale materials and favours good vegetational development.
This citation is from AGRICOLA.

777. **Mancos shale literature review on the Colorado Plateau**.
See record 166 in Subsurface Transport Processes.

778. **Mancos shale-associated alluvium**.
See record 257 in Surface Water Transport Processes.

779. **Mapping soil salinity using a combined spectral response index for bare soil and vegetation: A case study in the former lake Texcoco, Mexico**.
See record 694 in Model Studies.

780. **Methodologies and the Practical Aspects of the Bulk Soil EC (σa)—Soil Solution EC (σw) Relations**.
Nadler, A.
Advances in Agronomy. Donald, L. S., Academic Press. Volume 88**:** 273-312 (2005).
http://dx.doi.org/10.1016/S0065-2113(05)88007-1
Keywords: soil water/ soil salinity/ measurement

Abstract: The total concentration of ions present in a solution is a useful indicator for salinity in fields like hydrology, environment, industry, and agriculture. Salinity evaluation in agricultural activity may be connected to research and application processes: osmotic pressure, leaching, water bodies mixing, irrigation management, water pricing, and water allocation. An immediate and simple means for salinity level evaluation is the measurement of the soil (or any other porous media) electrical conductivity (σa). Until the TDR-era, σa and soil volumetric water content (θ) were measured by two separate techniques and inevitably not in the very same spot. The introduction of TDR into soil science enabled the measurement of these two soil properties in exactly the same volume, with the highest accuracy. Moreover, pre-TDR calculation models could be readopted and applied to handle the newly obtained data. This review voluntarily confines itself to the practical aspects of accurately converting σa into σw for different soil types, moisture levels, and solution chemical compositions. Subsequently, a short background description of pre-TDR measurement methods and calculation techniques and the basics of TDR methodology are presented, and three procedures for σa calculations are discussed, of which the Giese-Tiemann stands out as the most recommended. Special attention is given to the once popular Dalton et al. (1984) model. Following are nine presented and compared protocols suggesting ways to evaluate σw from σa, θ, and soil properties. Light is thrown on the extent and significance of the curvilinearity of the σa – σw relations for σw <4 dS m−1. The conclusions sum up those field situations deserving special care along with ideas about further research needed to increase acceptance of the TDR technology for monitoring salinity by farmers. As always, we should remember with respect the contribution of the previous generations (Cremers, Sauer, Spiegler, Laudelout), whose deep theoretical understanding and originality were their main tools for laying the foundations for the better equipped generation that followed to put their ideas into practice.
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781. **Methods for Identifying and Evaluating the Nature and Extent of Non-Point Sources of Pollution**.
U. S. Environmental Protection Agency, Washington, D.C., 261 p. (1973).
http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000H9G3.txt
Keywords: nonpoint source pollution/ agriculture/ forestry/ mining/ construction/ runoff/ erosion/ sediment/ contaminant transport/ pesticides/ nutrients/ soil/ land use/ wildfire/ water quality

782. **Modern sediment yield compared to geologic rates of sediment production in a semi-arid basin, New Mexico: Assessing the human impact**.
See record 506 in Geologic and Geochemical Processes.

783. **Natural salinity of the Colorado River**.
See record 508 in Geologic and Geochemical Processes.

784. **Preliminary Map of the Coterminous United States Showing Depth to and Quality of Shallowest Ground Water Containing More Than 1,000 Parts Per Million Dissolved Solids**.
Feth, J. H. and Et Al.
Hydrologic Investigations, Washington, D. C., 33 p. (1965).
http://pubs.usgs.gov/ha/199/report.pdf
Keywords: groundwater/ dissolved solids/ historical survey
Abstract: In this atlas, mineralized ground water is viewed presently as a source of water in some areas, but in much of the country as a source for future development. Mineralized water underlies large areas of the country, and its importance will grow as present supplies of fresh water are appropriated and developed. The potential uses fall in two main categories: (1) direct use in industrial processes, such as cooling, or for irrigation, where a moderate mineral content may not be a disadvantage; and (2) use after demineralization or dilution to whatever degree may be required by the intended user. It is clearly more efficient to produce and process water of moderate mineralization at points of use, where available in adequate amounts, than it is to process ocean water and pump it many miles from the sea. The Geological Survey, as a part of its responsibility to describe the water

resources of the United States, has surveyed the known occurrences of mineralized ground water in the conterminous United States. The results are shown on the maps (sheets 1 and 2). This atlas was prepared to meet needs for information on the distribution and availability of mineralized water as expressed by Government agencies, private industries, and consultants. The maps are one step- in providing an inventory of mineralized water of the Nation and will serve as a planning guide for further investigations and for development. They are necessarily generalized in many places owing to the complexity of the occurrence of the mineralized water, lack of detailed information for parts of the nation, and the difficulties inherent in attempts to put three-dimensional information on maps.

785. **Price River, San Rafael River, and Muddy Creek TMDLs for total dissolved solids West Colorado watershed management unit, Utah**.
See record 273 in Surface Water Transport Processes.

786. **Price/San Rafael River Basins Salinity Investigation**.
Johnson, B. A. and Riley, J. A.
Salinity in Watercourses and Reservoirs: Proceedings of the 1983 International symposium on State-of-the-Art Control of Salinity [July 13-15, Salt Lake City UT]. French, R. H. Boston, MA, Butterworth Publishers**:** 407-416 (1984).
http://www.rmrs.nau.edu/awa/ripthreatbib/johnson_riley_pricesanrafaelbasins.pdf
Keywords: salt loading/ river salinity/ streamflow/ groundwater/ irrigation/ salinity sources/ agricultural practices/ runoff/ sediment/ salinity control
Abstract: The Price and San Rafael River Basins are located in east-central Utah and annually contribute 434,000 tons of salt to the Colorado River. Historical evidence indicates that agricultural practices are responsible for the greatest contribution. This paper discusses the problem and solutions in more detail.

787. **Properties of Saline Range Soils of the Rio Grande Plain**.
Fanning, C. D. and Thompson, D.
Journal of Range Management 18:190-193 (2006).
https://journals.uair.arizona.edu/index.php/jrm/article/view/5316
Keywords: calcareous soil/ chemical properties/ climax species/ drought/ ecology/ range management/ maverick soil/ overgrazing/ physical properties/ range condition/ reseeding/ Rio Grande River/ saline range soils/ salt removal/ salts/ sodium chloride/ soil properties/ Neuces River/ Frio River/ Texas/ species/ vegetative cover
This citation is from the University of Arizona Institutional Repository.

788. **Results of Chemical Analyses of Soil, Shale, and Soil/Shale Extract from the Mancos Shale Formation in the Gunnison Gorge National Conservation Area, Southwestern Colorado, and at Hanksville, Utah**.
See record 516 in Geologic and Geochemical Processes.

789. **A review of groundwater–surface water interactions in arid/semi-arid wetlands and the consequences of salinity for wetland ecology**.
See record 175 in Subsurface Transport Processes.

790. **The Role of Climatic Variability on Rio Grande Salinity and Water Balances**.
Hogan, J. F. and Phillips, F. M.
2008 American Geophyscial Union Fall Meeting, San Francisco, CA, American Geophysical Union (2007).
Keywords: water reservoirs/ salinity variations/ evaporation/ climatic changes/ drought/ water quality/ freshwater/ solutes/ climatic variability/ Elephantidae/ drought/ rivers/ summer monsoon/ hydrologic analysis/ Rio Grande River/ rainfall runoff/ snowmelt runoff
Abstract: The upper Rio Grande/ Rio Bravo extends ~1,200 km between its headwaters in southern Colorado (USA) and the USA/Mexico border region. Like many arid region rivers, it exhibits reductions in streamflow and degrading water quality with distance downstream as a result of decreasing inflows, increasing evapotranspiration, and the addition of natural

and anthropogenic solutes. From 2000 to 2007 we conducted detailed biannual synoptic sampling of the Rio Grande from its headwaters in Colorado to ~150 km south of El Paso, Texas to evaluate how these processes result in the observed basin-scale water and solute balances. This period coincides with a severe regional drought, as well as the 8th wettest summer monsoon in the region, allowing us to assess how basin processes which control water quality respond to periods of climatic variability. We employed multiple environmental tracers to help identify dominant hydrological processes and the causes of salinization. Our O and H isotopic results indicate that runoff from high-elevation areas in Colorado and northern New Mexico - primarily as snowmelt - is the dominant source of river water, although runoff from summer precipitation can be locally and seasonally significant. This water then exhibits progressive evaporation with distance downstream, with the greatest evaporation occurring at Elephant Butte Reservoir. At the same time, the total dissolved solids content (TDS) increases from less than 50 mg/L in headwaters of Colorado to over 2000 mg/L south of El Paso, Texas. Water balance estimates and our O and H isotope results indicate that evapotranspiration alone is not sufficient to explain the salinization. The results of our synoptic surveys found that salinity did not increase as a simple function of distance downriver but rather occurred in a series of steps, identified as discharge of deep, saline, ground water. During the course of the drought we observed a progressive increase in salt concentrations and more localized increases in O and H isotopes in areas with significant evaporation (e.g from Elephant Butte Reservoir and wetted sandbars in the Albuquerque region).
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791. **The saline deposits of California**.
See record 25 in Rangeland Management Practices and Potential Impact on Salinity.

792. **Salinisation of rivers: An urgent ecological issue**.
Cañedo-Argüelles, M., Kefford, B. J., Piscart, C., Prat, N., Schäfer, R. B. and Schulz, C.-J.
Environmental Pollution 173: 157-167 (2013). ISSN: 0269-7491
http://dx.doi.org/10.1016/j.envpol.2012.10.011
Keywords: secondary salinisation/ river salinization/ mining/ road salts/ irrigation/ osmoregulation/ salinity tolerance/ climate change
Abstract: Secondary salinisation of rivers and streams is a global and growing threat that might be amplified by climate change. It can have many different causes, like irrigation, mining activity or the use of salts as de-icing agents for roads. Freshwater organisms only tolerate certain ranges of water salinity. Therefore secondary salinisation has an impact at the individual, population, community and ecosystem levels, which ultimately leads to a reduction in aquatic biodiversity and compromises the goods and services that rivers and streams provide. Management of secondary salinization should be directed towards integrated catchment strategies (e.g. benefiting from the dilution capacity of the rivers) and identifying threshold salt concentrations to preserve the ecosystem integrity. Future research on the interaction of salinity with other stressors and the impact of salinization on trophic interactions and ecosystem properties is needed and the implications of this issue for human society need to be seriously considered.
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793. **Salinisation: A major threat to water resources in the arid and semi-arid regions of the world**.
Williams, W. D.
Lakes & Reservoirs: Research & Management 4: 85-91 (1999). ISSN: 1440-1770
http://dx.doi.org/10.1046/j.1440-1770.1999.00089.x
Keywords: arid/ dryland salinity/ drylands/ salinization/ salt lakes/ secondary salinisation/ semi-arid/ water resources
Abstract: Semi-arid and arid regions (i.e. drylands with annual mean rainfall between 25 and 500 mm) cover approximately one-third of the world's land area and are inhabited by almost 400 million people. Because they are a resource in short supply, waters in drylands are under increasing human pressures, and many are threatened by rising salinities (salinisation) in particular. Rising salinities result from several causes. The salinities of many large natural salt lakes in drylands are rising as water is diverted from their inflows for irrigation and other uses. The excessive clearance of natural, deep-rooted vegetation from catchments and the discharge of saline agricultural wastewater causes the

salinity of many freshwater lakes, wetlands and rivers to rise. The salinisation of some fresh waters is caused by rising saline groundwaters. And in some regions, increasing climatic aridity may be a cause of salinisation. Whatever the cause, salinisation has significant economic, social and environmental impacts. They are usually deleterious and often irreparable. Decreased biodiversity, changes in the natural character of aquatic ecosystems, and lower productivity are frequent ecological effects. In some dryland countries, salinisation is viewed as the single most important threat to water resources. However, the extent and importance of salinisation as a global threat has been greatly underestimated. Recognition of this is the first step in any attempt to manage it effectively. The aims of the present paper, therefore, are three-fold. First, it aims to define the problem and indicate its extent; second, it aims to outline the causes and effects of salinisation; third, it aims to highlight the social, economic and environmental costs and comment on management responses. An overarching aim is to draw attention to the importance of salinisation as a phenomenon of global significance to waters in drylands.
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794. **Salinity control on BLM-administered public lands in the Colorado River basin: A report to Congress**.
See record 28 in Rangeland Management Practices and Potential Impact on Salinity.

795. **Salinity in watercourses and reservoirs**.
See record 286 in Surface Water Transport Processes.

796. **Salinity management for the landscapes and rivers: The Murray-Darling Basin in Australia**.
Newman, R. J.
Developments in Water Science. Abdulrahman, S. A. and Warren, W. W., Elsevier. Volume 50**:** 141-154 (2003).
http://dx.doi.org/10.1016/S0167-5648(03)80013-8
Keywords: environmental management/ salinity/ rivers/ landscape ecology/ Australia
Abstract: The Australian scene is typified by vast weathered landscapes in an arid climate—the wide brown land. Two centuries of agricultural developments have created massive changes in this landscape that have disturbed the hydrologic balance. Current land-uses are filling the landscape with excessive recharge bringing ancient salts to the surface. Salinity is evolving as a national crisis for the landscape and the rivers. The flat terrain combines with low rainfall and high evaporation to create a natural trap for salts. There is little scope for natural discharge to the sea. The early Australian explorers searched for inland lakes and seas but found only vast salt lakes, which are most often dry. The Murray-Darling Basin in the South East of the continent drains 1/7 of Australia. This Basin generates 40 % of the nation's agricultural production. The twenty major rivers of the Basin provide water for 3 million people and 75% of the nation's irrigated agriculture. The paper describes the extent of the salinity problems considered over the next one hundred years. The early successes of collaborative institutional arrangements within a federated governance system are described. The early solutions have involved engineering works along rivers and in the irrigated regions, however it is increasingly recognised that broad-scale landscape change in the dryland, coupled with reducing demand for water will become necessary for sustainable outcomes over coming decades. The solutions rely on taking a shared responsibility for offsetting the impacts of past planning decisions whilst ensuring full responsibility for future actions. Six governments have established inter-linked salinity strategies involving new funding commitments and onerous compliance conditions.
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797. **Salt loading from efflorescence and suspended sediments in the Price River basin**.
See record 183 in Subsurface Transport Processes.

798. **Soil Investigations in Arid Regions**.
Gusenkov, Y. P. and Kalachev, B.
Soviet Soil Science: 871-879 (1965).
Keywords: water in soils/ hydrometeorology/ desert climate/ prediction-correction method
Abstract: This article discussed investigation of saline soils in arid climates and how these soils should be managed in order to minimize salinity problems. A thorough study of the dynamics of salts in soil is necessary to develop methods for

controlling salinization. Planning of improvement programs for soils of arid regions is governed by the degree and nature of their salinization. The soil map is the main document on which to base predictions on the improvement conditions and recommendations for the most economical and effective control of soil salinization. Since salts differ in toxicity, their maximum permissible concentration in the soil must be determined on the basis of their species composition. (Blecker-Ariz.)
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799. **Soil salinity patterns in *Tamarix* invasions in the Bighorn Basin, Wyoming, USA**.
See record 35 in Rangeland Management Practices and Potential Impact on Salinity.

800. **Soil salinity: A neglected factor in plant ecology and biogeography**.
See record 111 in Rangeland Management Practices and Potential Impact on Biotic Processes.

801. **Spectroscopy of evaporites**.
Howari, F.
Periodico di Mineralogia 71: 191-200 (2002).
ISSN: 0369-8963
http://tetide.geo.uniroma1.it/riviste/permin/testi/V71/31.pdf
Keywords: halides/ terrestrial environment/ optical spectra/ playas/ infrared spectra/ absorption/ sedimentary rocks/ gypsum/ mixing/ chlorides/ calcium carbonate/ spectra/ soil/ chemically precipitated rocks/ sedimentary petrology/ sulfates/ arid environment/ salt crusts/ satellite methods/ evaporites/ distribution/ halite/ nahcolite/ reflectance/ carbonates/ salinization/ remote sensing/ salt
Abstract: The presence of salt crusts can provide information on soil salinization. Spectroscopy and remote sensing of salt crusts are useful for assessing the distribution of salt crusts in barren landscapes of arid regions as well as to evaporite accumulation in playa basins. In this study are reported the results of spectral reflectance measurements in the visible and near infrared region of gypsum, halite, calcium carbonate, sodium bicarbonate, and their mixtures. Spectral analyses have shown that the studied samples have diagnostic absorption features between 1000 to 2500 nm which are consistent with the reported values in the libraries. The positions of the absorption bands were not affected significantly quantities of evaporites per unit area. However, reflectivities increased with increasing the weight fraction of evaporite present. The reflectivity of evaporite was related to the mixing ratios in a non-linear fashion. At certain mixing ratios, the spectral reflectance data from evaporites were similar to those of the endmembers. It is interpreted that this is due to crystals coating. The reflectivity of the mixed calcium carbonate and sodium bicarbonate decrease by increasing the sodium bicarbonate fraction, due to the coating of calcium carbonate by sodium bicarbonate. The data of this study point to a possibility that the presence of gypsum, halite, calcium carbonate, sodium bicarbonate, and their mixtures in salt crusts can be assessed quantitatively by examining the position and intensity of the absorption features. The presence of soil particles may affect these results, and this subject is currently being evaluated.
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802. **Study of salinity production from wildlands of Price River Basin, Utah**.
See record 192 in Subsurface Transport Processes.

803. **Surface-water salinity in the Gunnison River Basin, Colorado, water years 1989 through 2007**.
See record 37 in Rangeland Management Practices and Potential Impact on Salinity.

804. **Transit sources of salinity loading in the San Rafael River, upper Colorado River Basin, Utah**.
See record 198 in Subsurface Transport Processes.

805. **USDA Planning Process for Colorado River Basin Salinity Control**.
Hedlund, J. D.
Salinity in Watercourses and Reservoirs. Proceedings of the 1983 International Symposium on State-of-the-Art Control of Salinity July 13-15, 1983, Salt Lake City, Utah., Salt Lake City, Utah,
Butterworth Publishers (1983).

http://www.rmrs.nau.edu/awa/ripthreatbib/hedlund_usdaplan.pdf
Keywords: water quality control/ control of water on the surface
Abstract: Today, 550,000 acres (222,750 ha) of irrigated land are going out of production each year due to salt buildup in arid land regions of the world. Cooperative planning by USDA with state and federal agencies has been underway since 1973 to reduce salinity problems in the Colorado River Basin. The most important beginning point in any planning effort is to accurately locate and define the magnitude of the problem. Salinity problems are not just a concern for those in the Colorado River Basin. Every state in the West has some high water table problems. Associated with high water table, in many cases, is a soil salinity problem which affects crop production on 10,300,000 irrigated acres (4,171,000 ha). Salt concentrations are increasing steadily in some of the nation 's most productive soils. The rich San Joaquin Valley in California could eventually lose 2 million acres (810,000 ha) to salinization. Other areas with significant problems include the valleys of the Rio Grande and Pecos River, closed river systems in the Great Basin, the Arkansas River, tracts in Texas and Oklahoma, and tributaries of the Upper Missouri. Several ongoing programs (Wellton-Mohawk USDA, and Agricultural Conservation Program USDA) are providing technical and financial assistance to improve irrigation systems and management. Implementation plans will generally include the identification of financial and technical assistance available to the land owner or operator. USDA salinity programs are funded by a variety of authorities. USDA salinity control planning of needed on-farm irrigation improvements on individual units is essentially completed. Implementation is progressing on 3 of the 12 units. The USDA on-farm salinity control program is receiving positive reviews for cost-effectiveness, and the planning experience gained in this activity will be most helpful in formulating and justifying future salinity control programs. (Lantz-PTT)
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806. **Use of native plants on federal lands: policy and practice**.
See record 656 in Remediation.

807. **Vegetation response of a mesquite-mixed brush community to aeration**.
Ruthven, D. C. and Krakauer, K. L.
Rangeland Ecology & Management
57: 34-40 (2004).
http://dx.doi.org/10.2111/1551-5028(2004)057[0034:VROAMB]2.0.CO;2
Keywords: diversity/ herbaceous vegetation/ range improvement/ South Texas/ wildlife habitat/ woody vegetation
Abstract: Responses of plant communities to mechanical treatments such as aeration on semiarid rangelands are not clearly understood. Our objective was to compare woody and herbaceous plant cover, density, and diversity on aerated and nontreated rangelands. Five rangeland sites that were aerated with a double/tandem drum aerator during summer 1998 and 5 sites of nontreated rangeland were selected for study on the Chaparral Wildlife Management Area, La Salle County, Tex. Woody plant cover was estimated using the line-intercept method, and stem density was estimated in 30 x 1.5 m plots in 1999 and 2000. Forb and grass cover and density were estimated in 20 x 50 cm quadrats during spring and fall 1999. Woody and herbaceous plant diversity did not differ between treatments. On aerated sites percent woody plant cover was 4-fold less 1-year after aeration and increased 89% from the first to the second growing-season post treatment. Canopy cover of honey mesquite (*Prosopis glandulosa* Torr.), twisted acacia (*Acacia schaffneri* S. Wats.), and Texas pricklypear (*Opuntia lindheimeri* Engelm.) was greater on non-treated sites. By the second growing season after aeration, density of honey mesquite was greater on aerated sites, whereas Texas pricklypear had declined on aerated sites. Density of spiny hackberry (*Celtis pallida* Torr.) and Texas persimmon (*Diospyros texana* Scheele) was greater on aerated sites during the first growing-season post treatment. Cover and stem density of hog-plum (*Colubrina texana* T. & G.), coma (*Bumelia celastrina* Kunth), and whitebrush [*Aloysia gratissima* (Gill. & Hook.) Tron.] did not differ among aerated and nontreated sites by the first growing season after aeration. Forb cover was greater on aerated sites in spring 1999. Fringed signalgrass [*Brachiaria ciliatissima* (Buckl.) Chase], fall witchgrass [*Digitaria cognata* (Schult.) Pilger], and bristlegrass (*Setaria* spp. Beauv.) cover was greater on aerated sites in spring and fall 1999, whereas purple threeawn (*Aristida purpurea* Nutt.) was greater on nontreated sites. It is

unclear to what degree environmental factors such as pre- and post-treatment climatic conditions and herbivory may have influenced vegetation response to aeration. The rapid regrowth of many woody plants following aeration may require the application of maintenance treatments within a relatively short time period to maintain treatment benefits. Aeration reduced total woody plant cover, increased the density of desirable woody plants, maintained woody plant diversity, increased grass cover, and may be a useful tool in managing South Texas rangelands for white-tailed deer (*Odocoileus virginianus* Boddaert) and cattle.
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808. **Water balance in Rangelands**.
Wilcox, B. P., Breshears, D. D. and Seyfried, M. S.
Encyclopedia of Water Science (2003).
http://agrilifecdn.tamu.edu/wilcox/files/2013/01/waterbudget.pdf
Keywords: water balance/ rangelands/ climate regimes/ moisture
Abstract: Rangelands are found in a variety of climate and moisture regimes and may include natural grasslands, savannas, shrublands, deserts, tundra, alpine ecosystems, marshes, and meadows. Most rangelands, however, are found in relatively dry climates where potential evapotranspiration is significantly greater than precipitation. For this reason, our discussion of water balance on rangelands will be generalized for dryland conditions. In water-limited rangelands, most of the incoming precipitation returns to the atmosphere via evapotranspiration. Of the other components, runoff will account for most of the remaining. Water moving to groundwater is generally relatively small.
This citation is from Texas A&M University.

809. **Water Quality in the Upper Colorado River Basin, 1996-98**.
Spahr, N. E., Apodaca, L. E., Deacon, J. R., Balis, J. B., Bauch, N. J., Smith, M. and Driver, N. E.
U. S. Geological Survey Circular, 33 p. (2000).
http://pubs.usgs.gov/circ/circ1214/pdf/circ1214.pdf
Keywords: water quality/ water supply/ aquatic ecosystems
Abstract: This report summarizes major findings about water quality in the Upper Colorado River Basin that emerged from an assessment conducted between 1996 and 1998 by the U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program. Water quality is discussed in terms of local and regional issues and compared to conditions found in all 36 NAWQA study areas, called Study Units, assessed to date. Findings are also explained in the context of selected national benchmarks, such as those for drinking water quality and the protection of aquatic organisms. The NAWQA Program was not intended to assess the quality of the Nation's drinking water, such as by monitoring water from household taps. Rather, the assessments focus on the quality of the resource itself, thereby complementing many ongoing Federal, State, and local drinking-water monitoring programs. The comparisons made in this report to drinking-water standards and guidelines are only in the context of the available untreated resource. Finally, this report includes information about the status of aquatic communities and the condition of instream habitats as elements of a complete water-quality assessment.

810. **Water Quality: Information on Salinity Control Projects in the Colorado River Basin**.
U. S. General Accounting Office
Report to Congressional Requesters,
27 p. (1995).
http://www.gao.gov/assets/230/221188.pdf
Keywords: salinity control/ water quality/ economics/ land management/ river salinity/ groundwater/ irrigation/ erosion/ saline soils/ management practices

811. **Water-quality data analysis of the upper Gunnison River watershed, Colorado, 1989–99**.
See record 563in Geologic and Geochemical Processes.

812. **Weathering of a gypsum-calcareous mudstone under semi-arid environment at Tabernas, SE Spain; laboratory and field-based experimental approaches**.
See record 564 in Geologic and Geochemical Processes.

813. **Yampa Basin Watershed Plan**.
Colorado Department of Public Health and Environment and Yampa River Basin Partnership, (2002).
http://go.usa.gov/Wree
Keywords: watersheds/ salinity/ environmental management/ water quality/ water resources/ Clean Water Act
Abstract: This Yampa Basin Watershed Plan (Yampa 2008 Plan) is the result of a cooperative effort between the Colorado Department of Public Health and Environment, Water Quality Control Division (WQCD) and the Yampa River Basin Partnership (YRBP). Over the past two years, the WQCD, YRBP, Moffat County, Routt County, City of Craig, and City of Steamboat Springs have actively participated in the preparation and review of this document. Through a joint agreement between WQCD, Routt County, and Moffat County, Montgomery Watson Harza was retained to compile this plan. The Yampa 208 Plan encompasses both Routt and Moffat Counties and updates plans previously prepared in Routt County in 1996 and Moffat County in 1986. The updated Yampa 208 Plan is consistent with the requirements of Section 208 of the Clean Water Act, administered by the WQCD for this basin.

814. **Acacia salicina, *Pinus halepensis* and *Eucalyptus occidentalis* improve soil surface conditions in arid southern Tunisia**.
Jeddi, K., Cortina, J. and Chaieb, M.
Journal of Arid Environments 73: 1005-1013 (2009). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2009.05.005
Keywords: arid areas/ restoration/ soil surface properties/ tree canopy
Abstract: Despite low growth rates, plants in arid areas have a strong ability to modify soil surface properties affecting ecosystem processes and community dynamics. But our knowledge on species effects on soil properties in these areas comes largely from observational studies, increasing the risk of confounding factors and precluding estimations of rates of change. We evaluated changes in soil surface properties underneath *Acacia salicina*, *Pinus halepensis* and *Eucalyptus occidentalis* in a 10-year-old common garden experiment established on a degraded *Stipa tenacissima* steppe in southern Tunisia. The three species tested improved soil properties compared to those of open areas. *Acacia salicina* ranked first as soil modifier as the soil underneath this species showed higher total organic carbon, total nitrogen, available phosphorus, soil CO2 efflux and infiltration rate, and lower soil hydrophobicity than soil in open areas. The richness of vascular plants was higher under *A. salicina* than under the other types of cover. This species showed higher ability to improve microsite conditions and foster succession. Short rotations of *A. salicina* could thus be employed for the restoration of degraded *S. tenacissima* steppes provided that other aspects of its ecology are controlled. *Pinus halepensis* represents a good alternative when native species are a priority, albeit facilitative ability is lower.
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815. **Aerospace video imaging-systems for rangeland management**.
Everitt, J. H., Lulla, K., Escobar, D. E. and Richardson, A. J.
Photogrammetric Engineering and Remote Sensing 56: 343-349 (1990).
http://go.usa.gov/Wrt5
Keywords: aerial photography/ rangeland management/ infrared imagery/ near infrared radiation/ remote sensing
Abstract: An overview on the application of airborne video imagery (VI) for assessment of rangeland resources. Multispectral black-and-white video with visible/NIR sensitivity; color-IR, normal color, and black-and-white MIR; and thermal IR video have been used to detect or distinguish among many rangeland and other natural resource variables such as heavy grazing, drought-stressed grass, phytomass levels, burned areas, soil salinity, plant communities and species, and gopher and ant mounds.

816. **Agglomerating seeds to enhance native seedling emergence and growth**.
Madsen, M. D., Davies, K. W., Svejcar, T. J. and Williams, C. J.
Journal of Applied Ecology 49: 431-438 (2012). ISSN: 0021-8901
http://dx.doi.org/10.1111/j.1365-2664.2012.02118.x
Keywords: facilitation/ native plants/ restoration/ seed coating/ seeding/ seedling emergence/ soil physical crusts
Abstract: 1. Restoration in rangelands is constrained by low establishment of species sown from seed. Non-biotic soil-surface crust is one of the major factors limiting reseeding success by acting as a barrier to seedling emergence. 2. The objective of this study was to determine whether seedling emergence could be improved by agglomerating multiple seeds into a single pellet, so that the seedlings growing from the pellet will collectively generate sufficient force to penetrate the soil crust. To evaluate this technology, we compared seedling emergence and biomass production from agglomerated, single and non-coated seed (control) of *Pseudoroegneria spicata*. In the greenhouse, seeds were sown in either crust-forming clay or non-crusting sandy soil and studied for a 25-day period. Starting seed density was constant across treatments. 3. In the clay soil, seedling emergence from the agglomeration treatment was 1.3 and 1.9 times higher than the single seed coating and control, respectively. In the sandy soil, the agglomeration and single seed coating responded similarly, producing 1·4 times

more seedlings than the control. 4. Biomass production followed a similar trend as plant density. In the clay soil, increased biomass of the agglomeration treatment was not only because of higher plant densities but was also a product of having greater biomass per plant. 5. Synthesis and applications. This short-duration 'proof-of-concept' study indicates that both the seed coating materials used to form the agglomerates and the act of agglomerating the seeds together improve *P. spicata* emergence and plant growth. These results also demonstrate that in the early seedling stage, facilitation outweighs competition in agglomeration plantings. Additional research is needed to verify these results in the field.
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817. **Application of nonequilibrium ecology to management of Mediterranean grasslands**.
George, M. R., Brown, J. R. and Clawson, W. J.
Journal of Range Management 45: 436-440 (1992). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8755/8367
Keywords: annual grasslands/ environmental policy/ range management/ models/ ecological succession/ conservation practices
Abstract: The state and transition model and the ball and cup analogy are used to organize the vegetation dynamics knowledge base for California's annual-dominated Mediterranean grasslands. These models help identify irreversible transitions and alternate stable states. Mechanisms that facilitate movement between successional stable states are categorized as demographic inertia, seedbank and germination, grazing impacts, establishment and competition, fire feedback, and irreversible changes in soil conditions. While theoretical work needs to continue to further describe states and transitions, managers can begin to use existing knowledge to develop management plans with realistic species composition objectives and to select the appropriate tools for reaching objectives.
This citation is from the University of Arizona Institutional Repository.

818. **An appraisal of short duration grazing as a method of veld management**.
Gammon, D. M.
Zimbabwe Journal of Agricultural Research 84: 59-64 (1984).
Keywords: grazing intensity/ grazing management/ rangelands/ range management/ conservation practices

819. **Assessment of best-management practice effects on rangeland stream water quality using multivariate statistical techniques**.
Ellison, C. A., Skinner, Q. D. and Hicks, L. S.
Rangeland Ecology & Management 62: 371-386 (2009). ISSN: 1550-7424
http://dx.doi.org/10.2111/08-026.1
Keywords: Macroinvertebrata/ habitat management/ abiotic factors/ community structure/ environmental indicators/ multivariate statistical techniques/ water quality/ rangeland streams/ Wyoming/ ecological techniques/ mathematical techniques/ aquatic communities/ best management practices/ channels/ dissolved oxygen/ grasslands/ grazing/ livestock/ range management/ rangelands/ riparian grasslands/ slope/ streams/ turbidity/ water temperature/ watersheds/ catchment areas/ pasturing/ range pastures/ water composition and quality/ insects/ Hexapoda/ arthropods/ invertebrates/ animals/ eukaryotes/ North America/ America/ Plecoptera/ watershed management/ agricultural practices/ grazing management/ environmental impact/ aquatic organisms/ aquatic habitat/ ecosystems/ dissolved organic matter/ functional diversity/ drought/ riparian areas/ Colorado
Abstract: Quantifying the effects of watershed improvement efforts is critical to agencies responsible for protecting water resources of the semiarid western United States. A complex water quality data set collected from 1994 to 2004 of upper Muddy Creek Basin was subjected to cluster analysis, discriminant analysis, and canonical correlation analysis to improve understanding of basin fluvial processes and to investigate whether livestock grazing best-management practices (BMPs) improved the water quality of the watershed. Hierarchical agglomerative cluster analysis grouped nine sampling sites into two Clusters based on similarity of biological indices, separating the clusters into aquatic communities more and less tolerant of degraded stream conditions. Discriminant analysis yielded strong spatial and temporal distinctions, providing

important data reduction by rendering seven key parameters (total dissolved solids (TDS), temperature, elevation, slope, 10-dominant taxa, percent collector-gatherers, and percent Plecoptera) for the spatial variation and four parameters (TDS, dissolved oxygen, total taxa, and Community tolerance quotient) for the temporal variation. Canonical correlation analysis identified strong negative relationships among Plecoptera taxa and total taxa with TDS and turbidity in addition to strong positive associations with elevation, slope, and channel substrate weighted embeddedness value. Despite the onset of severe drought midway through the study period, overall reductions of 13% for TDS and a 30%, increase in macroinvertebrate total taxa occurred across years, strongly Suggesting that improvements in water quality were correlated to BMPs that stabilized stream channels and improved the condition of riparian areas.
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820. **Assessment of gully-control structures in the Rio-Nutria watershed, Zuni Reservation, New-Mexico**.
Gellis, A. C., Cheama, A., Laahty, V. and Lalio, S.
Water Resources Bulletin 31: 633-646 (1995).
http://dx.doi.org/10.1111/j.1752-1688.1995.tb03390.x
Keywords: erosion/ gullies/ watershed rehabilitation/ erosion control/ Colorado/ basin
Abstract: During the latter part of the 19th century and the early part of the 20th century, a major cycle of erosion, arroyo cutting, and gullying occurred in the southwestern United States. Since this erosion cycle began, many projects to control erosion, such as the Civilian Conservation Corps projects in the 1930s, were initiated. However, in the Southwestern United States few studies have documented the effect of these structures in reducing erosion or their effect on gully systems. As part of a watershed rehabilitation project on the Zuni Reservation, New Mexico, 47 structures made either of earth or rocks and 23 rock and brush structures were assessed. Sixty percent of the 47 earth or rock structures have breached and relative to dam height, 65 percent of 47 structures are more than 50 percent silted. Of the 23 rock and brush structures, 22 percent have breached or are close to breaching. Reasons for breaching of all structural types may be piping, scour immediately below the structures, large runoff and large drainage area, poor maintenance, headcutting, and active arroyo deepening and widening. In most cases, documentation does not exist on structure design, the specific purpose for a structure, or when these structures were built.
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821. **Assessment of Prescribed Fire as a Conservation Practice**.
Fuhlendorf, S. D., Limb, R. F., Engle, D. M. and Miller, R. F.
Conservation benefits of rangeland practices: assessment, recommendations, and knowledge gaps. Briske, D. D. Lawrence, Kansas, U.S. Dept. of Agriculture, Natural Resources Conservation Service**:** 75-104 (2011).
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045797.pdf
Keywords: prescribed burning/ conservation practices/ rangelands/ environmental impact
Abstract: The Conservation Effects Assessment Program (CEAP) was initiated to determine the extent to which experimental data present in peer-reviewed research literature support the purposes described in the USDA-NRCS Practice Standard for Prescribed Burning (CODE 338). The general and value-laden nature of these purposes makes them extremely difficult to assess against experimental data; therefore, the authors analyzed the research literature to establish the ecological effects of prescribed fire from a broader perspective. Specifically, the research literature available on plants, soil, water, wildlife, arthropods, livestock, fire management, fire behavior, smoke management, socioeconomics, air quality, fire history, and human health were evaluated. These topics were selected based on input from rangeland CEAP teams focused on other conservation practices and initial evaluation of the literature in terms of topics that were covered sufficiently to draw meaningful conclusions. The authors also addressed issues related to spatial scale, temporal scale, and other general descriptions of the body of research and findings were then related to the specific NRCS purposes for the practice of prescribed burning.

822. **Assessment of Range Planting as a Conservation Practice**.
Hardegree, S. P., Jones, T. A., Roundy, B. A., Shaw, N. L. and Monaco, T. A.
Conservation benefits of rangeland practices: assessment, recommendations, and knowledge gaps. Briske, D. D. Lawrence, Kansas, U.S. Dept. of Agriculture, Natural Resources Conservation Service**:** 171-212 (2011).
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045799.pdf
Keywords: conservation practices/ rangelands/ range management/ vegetation/ climatic zones/ planting/ weed control
Abstract: This assessment of the conservation effects of rangeland planting practices is separated into two components: assessment of the direct benefits of specific planting techniques recommended in the range planting standard, and assessment of specific conservation effects of alternative vegetation states. The assessment of rangeland planting techniques involved a survey of 189 range planting studies from the refereed journal literature. These studies were classified as to bioclimatic zone, initial plant community and type of disturbance, plant materials and seed-mix characteristics, seeding rate, site preparation and weed control methodology, planting depth, planting season, experimental design, weather, and relative success criteria. Summary statistics cited in this synthesis were derived from the survey.

823. **An Assessment of Rangeland Activities on Wildlife Populations and Habitats**.
Krausman, P. R., Bleich, V. C., Block, W. M., Naugle, D. E. and Wallace, M. C.
Conservation Benefits of Rangeland Practices: Assessment, Recommendations, and Knowledge Gaps. Briske, D. D. Lawrence, Kansas, U.S. Dept. of Agriculture, Natural Resources Conservation Service**:** 253-290 (2011).
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045801.pdf
Keywords: rangelands/ range management/ grazing/ prescribed burning/ brush control/ conservation practices/ water quality/ mowing/ fences/ planting/ wildlife management/ wildlife habitat
Abstract: Numerous management practices are applied to rangelands in the western United States to enhance wildlife, including prescribed grazing, burning, brush management, mowing, fencing, land clearing, planting, and restoration to benefit soil and water. However, wildlife responses to conservation practices are usually species and even species-habitat specific, meaning not only that each species may respond differently to any specific practice but also that a single species may respond differently to the same practice in different vegetation associations or conditions. The authors' objective was to review peer-reviewed literature to examine how conservation practices influence wildlife and wildlife habitats on rangelands in the United States, with specific reference to the NRCS Conservation Practice Standard for Upland Wildlife Habitat Management. The main purpose of this conservation standard is to treat upland wildlife habitat concerns identified during the conservation planning process that enable movement or provide shelter, cover, and food in proper amounts, locations, and times to sustain wild animals that inhabit uplands during a portion of their life cycle, emphasizing the literature compiled in the bibliography by Maderik et al. (2006) but also considering other articles to provide a more complete review.

824. **Automated Geospatial Watershed Assessment tool**.
Miller, S., Semmens, D., Goodrich, D., Hernandez, M., Miller, R., Kepner, W. and Guertin, D.
Environmental Modelling and Software 22: 365-377 (2007).
http://dx.doi.org/10.1016/j.envsoft.2005.12.004
Keywords: change analysis/ geographic information systems (GIS)/ hydrologic modeling/ KINEROS/ scenario development/ SWAT
Abstract: A toolkit for distributed hydrologic modeling at multiple scales using two independent models within a geographic information system is presented. This open-source, freely available software was developed through a collaborative endeavor involving two Universities and two government agencies. Called the Automated Geospatial Watershed Assessment tool (AGWA), this software is written for the ArcView GIS platform and is distributed as an extension via the Internet. AGWA uses commonly available GIS data layers to fully parameterize, execute, and visualize results from both the Soil and Water Assessment Tool (SWAT) and Kinematic Runoff and Erosion model (KINEROS2). These two distributed hydrologic models operate at different time scales and are suitable for

application across a range of spatial scales. Descriptions of the GIS framework, hydrologic models, spatial analyses and algorithms that control the modeling process are given. Model requirements, limitations on the model applications and calibration techniques are described with examples of the use of AGWA for watershed modeling and assessment at a range of scales.
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825. **Biogeochemical and ecological impacts of livestock grazing in semi-arid southeastern Utah, USA**.
Fernandez, D. P., Neff, J. C. and Reynolds, R. L.
Journal of Arid Environments 72: 777-791 (2008). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2007.10.009
Keywords: magnetic susceptibility/ Moran's index/ nitrogen/ soil organic carbon
Abstract: Relatively few studies have examined the ecological and biogeochemical effects of livestock grazing in southeastern Utah. In this study, we evaluated how grazing has affected soil organic carbon and nitrogen to a depth of 50 cm in grasslands located in relict and actively-grazed sites in the Canyonlands physiographic section of the Colorado Plateau. We also evaluated differences in plant ground cover and the spatial distribution of soil resources. Results show that areas used by domestic livestock have 20% less plant cover and 100% less soil organic carbon and nitrogen compared to relict sites browsed by native ungulates. In actively grazed sites, domestic livestock grazing also appears to lead to clustered, rather than random, spatial distribution of soil resources. Magnetic susceptibility, a proxy for soil stability in this region, suggests that grazing increases soil erosion leading to an increase in the area of nutrient-depleted bare ground. Overall, these results, combined with previous studies in the region, suggest that livestock grazing affects both plant cover and soil fertility with potential long-term implications for the sustainability of grazing operations in this semi-arid landscape.
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826. **Biology and establishment of mountain shrubs on mining disturbances in the Rocky Mountains, USA**.
Paschke, M. W., Redente, E. F. and Brown, S. L.
Land degradation and development 14: 459-480 (2003). ISSN: 1085-3278
http://dx.doi.org/10.1002/ldr.568
Keywords: mined land/ seeding/ shrubland restoration/ topsoil/ transplants/ wildlife habitat
Abstract: The Rocky Mountains of the western United States contain many economically important natural resources. Increasing development of these resources has lead to land degradation, which often requires restoration efforts. A common type of disturbance in this region is mineral extraction and these activities often occur in zones of vegetation dominated by shrubs. These mined lands have proven to be particularly challenging to restore to native shrub cover. Mountain shrubland species such as big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), Saskatoon serviceberry (*Amelanchier alnifolia*), black chokecherry (*Prunus virginiana*), mountain mahogany (*Cercocarpus montanus*), and snowberry (*Symphoricarpos* sp.) are crucial species for wildlife in this region due to the seasonal dependence of many wildlife species on the mountain shrubland zones. The development of successful restoration techniques for these key shrub species is therefore important for the continued and sustainable utilization of natural resources in the Rocky Mountains. The purpose of this literature review is to provide a reference to land managers working on woody plant establishment on mining disturbances in mountain shrublands in the Rocky Mountains. This review covers the biology, ecology, and propagation of six shrub species that are of primary importance for meeting regulatory compliance in this region. Based upon this survey of the published literature, we conclude that successful establishment of these species has most often involved: (1) utilization of local shrub ecotypes, varieties or subspecies in reclamation efforts, (2) protection from browsing during the establishment phase, (3) strategies for avoiding herbaceous competition, and (4)

providing a source of mutualistic soil organisms. Additional specific recommendations for each of these species are discussed. © 2003 John Wiley and Sons, Ltd.
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827. **Broad-Scale Assessment of Rangeland Health, Grand Staircase–Escalante National Monument, USA**.
Miller, M. E.
Rangeland Ecology and Management 61: 249-262 (2008). ISSN: 1550-7424
http://dx.doi.org/10.2111/07-107.1
Keywords: Artemisia tridentata Nuttall/ big sagebrush/ ecological sites/ ecosystem assessment/ rangeland condition/ soil properties
Abstract: Over a 3-yr period, the qualitative assessment protocol "Interpreting Indicators of Rangeland Health" was used to evaluate the status of three ecosystem attributes (soil/site stability, hydrologic function, and biotic integrity) at over 500 locations in and adjacent to Grand Staircase–Escalante National Monument (Utah). Objectives were to provide data and interpretations to support the development of site-specific management strategies and to investigate broad-scale patterns in the status of different rangeland ecological sites. Quantitative data on ground cover, plant community composition, and soil stability were collected to aid the evaluation of qualitative attributes and improve consistency of the assessment process. Ecological sites with potential vegetation dominated by varieties of big sagebrush (*Artemisia tridentata* Nuttall) had the highest frequencies (46.7%–75.0%) of assessments with low ratings (moderate or greater departure from expected reference conditions) for all three ecosystem attributes. In contrast, sites with potential vegetation characterized by Utah juniper (*Juniperus osteosperma* [Torrey] Little) and/or Colorado pinyon (*Pinus edulis* Engelmann) had low frequencies (0.0%–7.8%) of assessments with low ratings for all attributes. Several interacting factors likely contributed to the development of patterns among ecological sites, including 1) potential primary production and thus long-term exposure to production-oriented land uses such as livestock grazing; 2) the presence of unpalatable woody plants capable of increasing and becoming persistent site dominants due to selective herbivory, absence of fire, or succession; 3) soil texture through effects on hydrologic responses to livestock grazing, trampling, and other disturbances; and 4) past management that resulted in high livestock use of ecological sites with sensitive fine-loamy soils following treatments designed to increase forage availability. This case study illustrates an extensive application of an assessment technique that is receiving increasing use worldwide, and results contribute to an understanding of factors contributing to patterns and processes of rangeland degradation.
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828. **Brush Management as a Rangeland Conservation Strategy: A Critical Evaluation**.
Archer, S. R., Davies, K. W., Fulbright, T. E., Mcdaniel, K. C., Wilcox, B. P. and Predick, K. I.
Conservation benefits of rangeland practices: assessment, recommendations, and knowledge gaps. Briske, D. D. Lawrence, Kansas, U.S. Dept. of Agriculture, Natural Resources Conservation Service**:** 105-170 (2011).
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045798.pdf
Keywords: range management/ brush control/ conservation practices/ rangelands
Abstract: The goal of this section is to provide a contemporary, critical evaluation of "brush management" as a conservation tool. The authors begin with a brief review of potential drivers of WP encroachment. An understanding of these drivers will 1) shed light on the causes for the changes observed to date; 2) help to determine if management intervention is realistic; if so, 3) what approaches might be most effective; and 4) when, where, and under what conditions to apply them. They then discuss the ecological role of WPs in rangeland ecosystems and how human perspectives on WPs in rangelands influence management decisions and conservation objectives. The ecological impacts of WP proliferation are then reviewed with the aim of addressing the question. what are the environmental consequences of not managing WPs in rangelands? As it turns out, there are indeed consequences. Many of these have emerged relatively recently and hence are not yet reflected in current management guidelines. Advances in our understanding of the ecological consequences of WP proliferation in rangelands have paralleled changes in both perspectives on and approaches to brush management since the mid-1900s and have influenced how the NRCS has advised landowners. They authors therefore review the evolution of brush management in the

spirit of putting current perspectives into their historical context. The basis for NRCS expectations underlying recommendations in the NRCS Brush Management Conservation Practice Standard matrix (hereafter described as "projected effects") is then evaluated on the basis of a pooling of expectations into five overarching areas: herbaceous cover, production, and diversity; livestock response; watershed function; wildlife response; and fuels management. Evaluations are then followed by recommendations, an itemization of knowledge gaps, and a series of overarching conclusions.

829. **BUDGET: A soil water and salt model (reference manual)**.
Raes, D.,
Belgium, Institute for Land and Water Management, 79 p. (2002).
http://www.biw.kuleuven.be/lbh/lsw/iupware/downloads/elearning/software/budget_manual.pdf
Keywords: soil water/ salt balance/ models/ crops
This citation is from Katholieke Universiteit Leuven.

830. **Burning bluestem range**.
Anderson, K. L., Smith, E. F. and Owensby, C. E.
Journal of Range Management 23: 81-92 (1970). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/5779/5389
Keywords: rangelands/ prescribed burning/ range management/ pasture plants/ pasture management/ grazing management
Abstract: The effect of time of burning on weight gains of steers, botanical composition, herbage yield, and soil moisture relations were investigated over seventeen years. Time of burning in relation to period of growth was important in the reaction of individual species. Cool-season species were reduced by spring burning and the desirable warm-season species were favored. Fire also favored some weedy species which had phenology similar to the desirable warm-season grasses. Herbage yields were reduced by early and mid spring burning but remained the same as unburned when late spring burning was applied. Gains on steers were greatest under mid and late spring burning and least under no burning and early spring burning. Higher gains on steers mid and late spring burned pastures came early in the growing season.
This citation is from the University of Arizona Institutional Repository.

831. **Cattle distribution under intensive herded management**.
Butler, P. J.
Rangelands 22: 21-23 (2006). ISSN: 0190-0528
https://journals.uair.arizona.edu/index.php/rangelands/article/view/11456/10729
Keywords: cattle/ riparian areas/ grazing/ rangeland management
Abstract: Intensive cattle herding is an important tool that can be employed in the proper management of riparian zones which are a highly sensitive and vulnerable rangeland community. It is not the cure-all for poor management and it does not absolve us when we ignore the need to develop structural rangeland improvements such as fences and water developments. However, it may be one of the most effective complementary tools available to us in managing the rangelands of North America.
This citation is from the University of Arizona Institutional Repository.

832. **Cattle grazing influence on a mountain riparian zone**.
Roath, L. R. and Krueger, W. C.
Journal of Range Management 35: 100-103 (1982). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7277/6889
Keywords: grazing/ riparian areas/ herbaceous vegetation/ shrubs
Abstract: A combination of management and physical topographic constraints caused cattle to concentrate on the riparian zone early in the grazing season in 1977 and 1978. A large percentage of cattle days and vegetation utilization on the riparian zone occurred in the first 4 weeks of the grazing period. Utilization on herbaceous vegetation was 76 and 72% in 1977 and 1978, respectively. Impact of grazing on the most prevalent species, Kentucky bluegrass was minimal. Shrub use increased with increased maturity of herbaceous vegetation. Utilization of major shrubs was not excessive in either year, and very likely had no long-term effects on either the abundance or vigor of the shrubs.
This citation is from the University of Arizona Institutional Repository.

833. **Cattle trampling of crested wheatgrass under short-duration grazing**.
Balph, D. F. and Malecheck, J. C.
Journal of Range Management
38: 226-227 (2006).
https://journals.uair.arizona.edu/index.php/jrm/article/view/7842/7454
Keywords: rangelands/ grazing lands/ grazing intensity/ range management/ trampling damage/ *Agropyron cristatum*
Abstract: This paper tests 3 predictions that stem from the hypothesis that Angus heifers avoid stepping on crested wheatgrass (*Agropyron cristatum*) tussocks because the tussocks present an uneven surface upon which to walk: (1) hoofprints are located disproportionately more often in the open spaces between tussocks than on tussocks; (2) the disproportionality persists despite the frequency of hoof prints per unit area; and (3) the more tussocks are elevated above the surrounding substrate, the less they are trampled. The methods relate the observed and expected frequency of hoofprints on tussocks along 2 transects in a crested wheatgrass paddock. The results significantly support all 3 predictions. We conclude that under the conditions that existed, the hoof action hypothesized by some to be of benefit to short-duration grazing pastures was minimal, and so was the hoped-for destruction of standing dead vegetation that deters grazing.
This citation is from the University of Arizona Institutional Repository.

834. **Changes in vegetation structure after long-term grazing in pinyon-juniper ecosystems: Integrating imaging spectroscopy and field studies**.
Harris, A. T., Asner, G. P. and Miller, M. E.
Ecosystems 6: 368-383 (2003).
http://dx.doi.org/10.1007/s10021-003-0168-2
Keywords: grazing/ overgrazing/ land use/ relict areas/ pinyon-juniper/ ecosystems/ imaging spectroscopy/ hyperspectral remote sensing/ woody plant (WP) encroachment/ cryptogamic soil crusts/ national park/ Great Basin/ grassland-forest continuum/ semi-arid woodland/ land degradation/ arid ecosystems/ spatial pattern/ grand-canyon/ relict area
Abstract: We used field studies and imaging spectroscopy to investigate the effect of grazing on vegetation cover in historically grazed and ungrazed high-mesa rangelands of the Grand Staircase-Escalante National Monument, Utah, USA. Airborne hyperspectral remote sensing data coupled with spectral mixture analysis uncovered subtle variations in the key biogeophysical properties of these rangelands: the fractional surface cover of photosynthetic vegetation (PV), nonphotosynthetic vegetation (NPV), and bare soil. The results show that a high-mesa area with long-term grazing management had significantly higher PV (26.3%), lower NPV (54.5%), and lower bare soil (17.2%) cover fractions in comparison to historically ungrazed high-mesa pinyon-juniper rangelands. Geostatistical analyses of remotely sensed PV, NPV, and bare soil were used to analyze differences in ecosystem structure between grazed and ungrazed regions. They showed that PV was spatially autocorrelated over longer distances on grazed areas, whereas NPV and bare soil were spatially autocorrelated over longer distances on ungrazed areas. Field data on the fractional cover of PV, NPV, and bare soil confirmed these remote sensing results locally. Field studies also showed a significantly higher percentage composition of shrubs (27.3%) and forbs (30.2%) and a significantly lower composition of grasses (34.4%) and cacti (1.1%) in grazed areas. No significant difference between grazed and ungrazed mesas was found in percentage composition of trees or in the number of canopies per hectare. Our combined remote sensing and field-based results suggest that grazing has contributed to woody thickening in these pinyon-juniper ecosystems through an increase in shrubs in the understory and intercanopy spaces. These results improve our understanding of broad-scale changes in pinyon-juniper ecosystem structural composition and variability due to long-term grazing.

835. **Characteristics of soil resources and sustainable development in arid northwest China**.
Wang, G. and Cheng, G.
Diqiu Kexue Jinzhan = Advance in Earth Science 14: 492-497 (1999). ISSN: 1001-8166
Keywords: soil/ resources/ terrestrial environment/ arid environment/ agriculture/ desertification/ preventive measures/ natural resources/ northwestern China/ sustainable development/ ecology/ environmental geology/ land use/ salinization
Abstract: The soil types, distribution, physical-chemical status, and nutrient and their changes in the conditions of salinization, desertification and cultivation are analyzed in this paper. The

results indicate that: 1) In the arid area, the distribution of soils shows remarkable vertical and longitude zoning; and 2) In the different conditions, the source functions of soils are varied. The sustainable development of the arid region depends on the features of cultivated soils. The key problem is the rational utilization and defense of land resources and coordination with the ecological environment.
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836. **Characterizing oil field salinization using airborne, surface, and borehole geophysics; an example from the upper Colorado River basin, Texas**.
Paine, J. G. and Collins, E. W.
Environmental Geosciences 17: 193-207 (2010).
ISSN: 1075-9565
http://dx.doi.org/10.1306/eg.06231010011
Keywords: electrical conductivity/ Colorado River basin/ characterization/ well-logging/ observation wells/ environmental analysis/ oil and gas fields/ groundwater/ electromagnetic methods/ drainage basins/ applied geophysics/ water pollution/ environmental geology/ gamma-ray methods/ ground methods/ geophysical methods/ statistical analysis/ pollution/ salinization/ airborne methods/ Texas
Abstract: Multidisciplinary investigations of natural and oil field salinization along the upper Colorado River, Texas, present an opportunity to integrate results from a stream-axis airborne geophysical survey, ground and borehole geophysical surveys, and well drilling and sampling. Airborne electromagnetic (EM) induction measurements along 437 km (272 mi) of river and tributary stream axes identified discrete salinized streambed segments, including several near oil fields. Identification of these salinized streambed segments allowed more intensive and invasive investigations to be focused on the most significant near-river sources of salinity. One of these streambed segments lies adjacent to an oil field, where production began in the 1950s before discharge of coproduced brine into surface pits was prohibited in Texas. Monitor wells drilled after the airborne survey verified groundwater salinization in the oil field but did not adequately delineate salinization nor identify specific salinity source areas. Subsequent ground and borehole geophysical surveys complemented airborne EM induction and well data by establishing lateral and vertical salinization bounds in the oil field, discovering possible salinity source areas, and determining optimal locations for additional wells.
© *ProQuest*

837. **Clay Dispersion and Hydraulic Conductivity of Some Salt-Affected Arid Land Soils**.
Yousaf, M., Ali, O. M. and Rhoades, J. D.
Soil Science Society of America Journal 51: 905-907 (1987).
Keywords: water in soils/ clay dispersion/ hydraulic conductivity
Abstract: Cumulative clay dispersion from four arid land soils were compared with their relative hydraulic conductivities as affected by electrolyte concentration and sodium adsorption ratio (SAR). As electrolyte concentration decreased and SAR increased, clay dispersion increased and hydraulic conductivity decreased correspondingly. Threshold relations between electrolyte concentration and SAR associated with clay dispersion of 5 g clay/kg soil corresponded well with hydraulic conductivity threshold relations. This correspondence between clay dispersion and sodicity-related reductions in soil hydraulic conductivity can be utilized to provide an index based on clay dispersion for screening soils for their sodicity hazard sensitivity and for predicting reductions in soil hydraulic conductivity related to soil and water sodicity. (Author 's abstract)
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838. **Comparative infiltration rates and sediment production on fertilized and grazed blue grama rangeland**.
Wood, M. K., Donart, G. B. and Weltz, M.
Journal of Range Management 39: 371-374 (1986). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8016/7628
Keywords: rangelands/ range management/ grazing management/ infiltration (hydrology)/ sediment yield
Abstract: This study determined the impacts of fertilization and livestock grazing on infiltration rates and sediment production. Infiltration rates and sediment production varied across years, depending on precipitation conditions, but were not different between fertilized and unfertilized rangeland within a year. Livestock production and stocking rates were 2 times greater on fertilized than on nonfertilized rangeland. Soil bulk density was only greater on the fertilized

areas than the control at the end of the grazing period in 1982. Microtopography or roughness was not different between treatments. Increases in plant production mitigated any impacts from increased livestock numbers in fertilized areas.
This citation is from the University of Arizona Institutional Repository.

839. **Conservation benefits of rangeland practices: assessment, recommendations, and knowledge gaps**.
Briske, D. D. and Conservation Effects Assessment Project
Lawrence, Kansas, U.S. Dept. of Agriculture, Natural Resources Conservation Service, 430 p. 2011.
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?&cid=stelprdb1045811
Keywords: range management/ rangelands/ conservation practices
Abstract: This document provides an unprecedented source of evidence-based information to guide the development and assessment of management practices and conservation programs on the nation's rangelands.

840. **Control of saltcedar by subsurface placement of herbicides**.
Hollingsworth, E. B., Quimby, P. C. and Jaramillo, D. C.
Journal of Range Management 32: 288-291 (1979). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/6955/6565
Keywords: rangelands/ range management/ brush control/ herbicides/ deep tillage/ riparian areas
Abstract: A root plow modified for deep subsurface placement of herbicides effectively controlled saltcedar (*Tamarix ramosissima* Ledeb.). One operation, preferably in the spring, which severed the tap root 35 to 60 cm below the soil surface and simultaneously applied any of several herbicides at the same depth increased saltcedar kill by more than 100% over that of root cutting alone. Residual herbicides, including uracils, substituted ureas, 2,3,6-TBA, picloram, dicamba, and karbutilate, applied with the root plow consistently controlled saltcedar with a single treatment. Phenoxy herbicides showed initial activity against saltcedar but did not persist long enough to satisfactorily kill late sprouting, previously quiescent buds. Two arsenicals and dichlobenil were ineffective for saltcedar control.
This citation is from the University of Arizona Institutional Repository.

841. **Cover and floristics of microphytic soil crusts in relation to indices of landscape health**.
Eldridge, D. J. and Koen, T. B.
Plant Ecology 137: 101-114 (1998).
http://dx.doi.org/10.1023/A:1008036214140
Keywords: bryophytes/ cryptogams/ lichens/ rangelands/ semi-arid/ soil crusts
Abstract: An extensive field survey of 282 sites over 500 000 km(2) of rangeland in eastern Australia was carried out to investigate the relationships between cover and floristics of microphytic soil crusts and indices of landscape health. Empirical quadrat-based data were used to calculate three indices of landscape health (soil stability, infiltration capacity and nutrient status) according to the method of Tongway (1994). Analyses were based on a subset of 104 sites from landscapes dominated by red earths and calcareous earths, where the loss of microphytic crust cover is indicative of a loss in soil productive potential. Crust cover and floristics were further compared with an objective but widely used method of assessing rangeland condition based on the use of photostandards. Crust cover was a significant though weak predictor of stability of calcareous earth soils only ($P < 0.001$, R-2 = 0.106). On red earths, cover was a significant descriptor of rangeland condition ($P < 0.001$, R-2 = 0.171). However, overall, the percentage of the soil occupied by soil crusts was regarded a poor predictor of landscape health. Generally, increases in the number of lichen and bryophyte taxa at a site were associated with increasing rangeland condition ($P < 0.001$, R-2 = 0.178), landscape stability ($P = 0.047$, R-2 = 0.027) and nutrient status ($P < 0.001$, R-2 = 0.115), though these relationships varied according to soil type. Canonical Correspondence Analyses indicated that some Lichens and bryophytes were consistently associated with either stable, good condition sites (*Xanthoparmelia* spp., *Catapyrenium lacinulatum*, *Buellia subcoronata*, *Aloina bifrons*, *Riccia lamellosa*, *Fossombronia* spp.) or unstable, poor condition sites (*Heterodea benugleholei*, *Cladonia* spp., *Barbula calycina*, *Bryum spp., Desmatodon convolutus, Eccremidium arcuatum*). The

majority of taxa however had no strong affinity with the four indices of landscape health. When easily recognisable morphological groups of lichens were related to landscape health indices, the group comprising yellow-green foliose lichen was the most strongly associated with stable, healthy sites. The results suggest that disturbances influencing soil stability and soil surface condition such as trampling and fire are likely to lead to changes in the composition of soil crust communities.

842. **Cultural, seasonal, and site effects on pinyon-juniper rangeland plantings**.
Lavin, F., Gomm, F. B. and Johnsen Jr, T. N.
Journal of Range Management 26: 279-285 (1973). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/6211/5821
Keywords: rangelands/ range management/ planting seed/ vegetation cover/ drilling/ soil treatment
Abstract: Planting season and cultural treatment effects on emergence and survival of three range species were determined for two cold, dry pinyon-juniper sites in north central Arizona. Plowing was the most effective seedbed preparation for controlling plant competition. Furrow drilling also eliminated a large amount of competition. Emergence and survival (E & S) of Luna pubescent and Nordan crested wheatgrass averaged highest with fall planting, but summer planting was best for E & S of fourwing saltbush. E & S averaged highest on plowed seedbeds and decreased progressively on undercut, undercut-strip, presprayed, sprayed, and control seedbeds. Surface drilling on tilled seedbeds increased E & S over furrow drilling for fourwing saltbush and usually for Nordan crested wheatgrass. Drilling in wide, shallow furrows increased Luna pubescent wheatgrass E & S. Furrow drilling increased E & S for all species on nontilled seedbeds. There were some significant interactions among treatment combinations. Practical application of results is discussed.
This citation is from the University of Arizona Institutional Repository.

843. **Denitrification and bacterial numbers in riparian soils of a Wyoming mountain watershed**.
Hussey, M. R., Skinner, Q. D., Adams, J. C. and Harvey, A. J.
Journal of Range Management 38: 492-496 (1985). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7909/7521
Keywords: denitrifying bacteria/ watersheds/ sulfate-reducing bacteria/ riparian soils
Abstract: The presence and activity of denitrifying bacteria as well as bacteria capable of reducing sulfate in 1 upland and 5 riparian soils of a mountain watershed in Wyoming were studied. Bacteria were enumerated from soil samples collected during summer along transects placed perpendicular to stream flow. Samples were taken at 3 depths within each plant community. Subsamples were frozen and later utilized to determine denitrification potential. Higher counts of total heterotrophic aerobic bacteria, sulfate-reducing bacteria, denitrifying bacteria, and denitrification potential existed in the upper 5 to 15 cm of soil than at 30 cm. Soils located close to the stream's edge tended to have more bacterial activity than those further from the stream, indicating that these soils may be important areas for nitrate and sulfate reduction. Soil organic matter and water content decreased with depth in all plant communities, and those closer to the stream contained more organic matter and water than those further from the stream.
This citation is from the University of Arizona Institutional Repository.

844. **Detecting Channel Riparian Vegetation Response to Best-Management-Practices Implementation in Ephemeral Streams With the Use of Spot High-Resolution Visible Imagery**.
Kamp, K. V., Rigge, M., Troelstrup, N. H., Smart, A. J. and Wylie, B.
Rangeland Ecology and Management 66: 63-70 (2012). ISSN: 1550-7424
http://dx.doi.org/10.2111/REM-D-11-00153.1
Keywords: grazing/ conservation practices/ stream channel erosion/ channel riparian vegetation/ ephemeral streams/ sediment
Abstract: Heavily grazed riparian areas are commonly subject to channel incision, a lower water table, and reduced vegetation, resulting in sediment delivery above normal regimes. Riparian and in-channel vegetation functions as

a roughness element and dissipates flow energy, maintaining stable channel geometry. Ash Creek, a tributary of the Bad River in western South Dakota contains a high proportion of incised channels, remnants of historically high grazing pressure. Best management practices (BMP), including off-stream watering sources and cross fencing, were implemented throughout the Bad River watershed during an Environmental Protection Agency (EPA) 319 effort to address high sediment loads. We monitored prairie cordgrass (Spartina pectinata Link) establishment within stream channels for 16 yr following BMP implementation. Photos were used to group stream reaches (n=103) subjectively into three classes; absent (estimated <5% cover; n=64), present (estimated 5–40% cover; n=23), and dense (estimated >40% cover; n=16) based on the relative amount of prairie cordgrass during 2010 assessments of ephemeral channels. Reaches containing drainage areas of 0.54 to 692 ha were delineated with the use of 2010 National Agriculture Imagery Program (NAIP) imagery. Normalized difference vegetation index (NDVI) values were extracted from 5 to 39 sample points proportional to reach length using a series of Satellite Pour l'Observation de la Terre (SPOT) satellite imagery. Normalized NDVI (nNDVI) of 2152 sample points were determined from pre- and post-BMP images. Mean nNDVI values for each reach ranged from 0.33 to 1.77. ANOVA revealed significant increase in nNDVI in locations classified as present prairie cordgrass cover following BMP implementation. Establishment of prairie cordgrass following BMP implementation was successfully detected remotely. Riparian vegetation such as prairie cordgrass adds channel roughness that reduces the flow energy responsible for channel degradation.
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845. **Does short-duration grazing work in arid and semiarid regions?**
Bryant, F. C., Dahl, B. E., Pettit, R. D. and Britton, C. M.
Journal of Soil and Water Conservation 44: 290-296 (1989). ISSN: 0022-4561
Keywords: grazing management/ rangelands/ arid regions/ semi-arid zones
This citation is from the Soil and Water Conservation Society.

846. **Drilling versus imprinting for establishing crested wheatgrass in the sagebrush-bunchgrass steppe**.
Haferkamp, M. R., Ganskopp, D. C., Miller, R. F. and Sneva, F. A.
Journal of Range Management 40: 524-530 (1987). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8189/7801
Keywords: rangelands/ range management/ planting seed/ *Agropyron cristatum*/ drilling
Abstract: Effectiveness of a land imprinter and rangeland drill for establishing 'Nordan' crested wheatgrass (*Agropyron desertorum*) from fall plantings on loose and firm seedbeds was compared in the northern Great Basin in 1982 and 1984. Seedbed treatments applied on a Wyoming big sagebrush (*Artemisia tridentata* subsp. *wyomingensis*)-Thurber needlegrass (*Stipa thurberiana*) habitat type included brushbeating, brushbeating plus disking, and no treatment. Crested wheatgrass seed was planted at 6.7 kg/ha by broadcasting before imprinting broadcasting after imprinting, with a rangeland drill equipped with depth bands and at 3.4 kg/ha with a rangeland drill with deep-furrow openers. Maximum seedling emergence occurred on brushbeat-disked seedbeds planted by broadcasting before imprinting in 1982 (37 m^2) and 1984 (22 m^2) and by drilling with regular openers in 1982 (23 m^2) . Seedling emergence was almost twice as good with imprinting compared to drilling on loose-brushbeat-disked seedbeds, but 2 to 4 times more seedlings emerged from drilling than imprinting on firm-unprepared seedbeds. Maximum yields produced 2 and 3 years after planting averaged 500 to 1,000 kg/ha on brushbeat-disked seedbeds planted by broadcasting before imprinting and regular drilling. Imprinting may be a viable alternative to drilling in this region on loose seedbeds.
This citation is from the University of Arizona Institutional Repository.

847. **Dynamics of cryptogamic soil crusts in a derived grassland in south-eastern Australia**.
Eldridge, D. J., Semple, W. S. and Koen, T. B.
Austral Ecology 25: 232-240 (2000).
http://www.southwestnrm.org.au/sites/default/files/uploads/ihub/eldridge-dj-etal-2000dynamics-cryptogamic-soil-crusts.pdf
Keywords: cryptogams/ derived grasslands/ grazing/ lichens/ mosses/ soil crusts

Abstract: We examined the dynamics of cryptogamic soil crusts in a derived (disclimax) grassland near Orange in south-eastern Australia. Changes in the cover of cryptogamic crusts and floristics and abundance of the constituent species were measured on four treatments with two levels each of grazing and cultivation. Twenty-two lichens, mosses and livenworts were found at the study site and, of these, 13 were collected in the quadrats. Three moss species (*Barbula calycina, Eccremidium arcuatum* and *Bryum pachytheca*) and one lichen species (*Cladonia tessalata*) accounted for 67% of total cover-abundance scores. Generally, cover-abundance was significantly higher in the unvegetated microsites than in the vegetated microsites. Species richness was not significantly different between the four grazing-cultivation treatments but, on average, there were significantly more species in the unvegetated microsites (mean = 3.2 species) than in the vegetated microsites (0.54 species). Grazing and cultivation resulted in significantly greater cover of bare ground and consequently significantly greater crust cover. Averaged across all treatments, approximately half of the area of unvegetated soil was occupied by cryptogams. Overall, the results indicate that lichens and bryophytes are important components of derived temperate grasslands, surviving in even densely vegetated swards. This study suggests that strategics which disturb the soil surface (e.g. grazing and cultivation) will stimulate the abundance and cover of soil crust organisms by increasing the availability of unvegetated microsites.
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848. **Ecohydrology of a resource-conserving semiarid woodland: Effects of scale and disturbance**.
Wilcox, B. P., Breshears, D. D. and Allen, C. D.
Ecological Monographs 73: 223-239 (2003).
http://dx.doi.org/10.1890/0012-9615(2003)073[0223:EOARSW]2.0.CO;2
Keywords: banded vegetation/ dryland hydrology/ ecohydrology/ erosion/ landscape/ ecology/ runoff/ semi-arid hydrology/ vegetation/ patches/ water yield/ pinyon-juniper woodland/ ponderosa pine hillslope/ New Mexico/ soil moisture/ grasslands/forest continuum/ vegetation patterns/ erosion/ prediction/ banded vegetation/ climate variation/ spatial pattern
Abstract: In semiarid landscapes, the linkage between runoff and vegetation is a particularly close one. In this paper we report on the results of a long-term and multiple-scale study of interactions between runoff, erosion, and vegetation in a pi (n) over tilde on-juniper woodland in New Mexico. We use our results to address three knowledge gaps: (1) the temporal scaling relationships between precipitation and runoff; (2) the effects of spatial scale on runoff and erosion, as influenced by vegetation; and (3) the influence of disturbance on these relationships. On the basis of our results, we tested three assumptions that represent current thinking in these areas (as evidenced, for example, by explicit or implicit assumptions embedded in commonly used models). The first assumption, that aggregated precipitation can be used as a surrogate for total runoff in semiarid environments, was not verified by our findings. We found that when runoff is generated mainly by overland flow in these systems, aggregated precipitation amounts alone (by year, season, or individual event) are a poor predictor of runoff amounts. The second assumption, that at the hillslope and smaller scales runoff and erosion are independent of spatial scale, was likewise not verified. We found that the redistribution of water and sediment within the hillslope was substantial and that there was a strong and nonlinear reduction in unit-area runoff and erosion with increasing scale (our scales were slope lengths ranging from I in to 105 in). The third assumption, that disturbance-related increases in runoff and erosion remain constant with time, was partially verified. We found that for low-slope-gradient sites, disturbance led to accelerated runoff and erosion, and these conditions may persist for a decade or longer. On the basis of our findings, we further suggest that (a) disturbance alters the effects of scale on runoff and erosion in a predictable way-scale relationships in degraded areas will be fundamentally different from those in nondegraded areas because more runoff will escape-off site and erosion rates will be much higher; and (b) there exists a slope threshold, below which semiarid landscapes will eventually recover following disturbance and above which there will be no recovery without mitigation or remediation.

849. **Effect of contour dykes and furrows on short-grass prairie**.
Hubbard, W. A. and Smoliak, S.
Journal of Range Management 6: 55-62 (1953).
ISSN: 0022-409X

https://journals.uair.arizona.edu/index.php/jrm/article/view/4525/4136
Keywords: contour furrows/ range management/ soil water/ forage yield/ runoff/ hydraulic structures/ water management
Abstract: Early in the establishment of the Range Experiment Station at Manyberries, in southeastern Alberta, it was realized that moisture was the limiting factor of range forage production. Even though precipitation there is low and evapotranspiration high, the spring runoff is heavy. One method of reducing moisture losses was the spreading of runoff by the use of earth structures. Accordingly, following a survey of work done in western and southwestern United States, several experimental projects in terracing, contour furrowing, and spring flooding structures were established in 1937. The effect of water-spreading devices has been assessed by measuring plant succession and changes of forage yield over a period of twelve years. Most of the water available to the short-grass prairie is from spring rain. As the snow melts great quantities of structures and to increase forage production on limited areas by additional moisture. After 13 years, clippings were made and vegetation analyzed to evaluate the benefit of the work. It was found that contour dykes were of real benefit in increasing the volume of forage produced. The contour furrows became filled with ice and snow during the winter and were of no value in holding or spreading water. All dykes should be seeded down soon after construction to prevent washing and erosion.
This citation is from the University of Arizona Institutional Repository.

850. **The effect of early winter or spring burning on runoff, sediment, and vegetation in the post oak savannah of Texas**.
Garza Jr, N. E. and Blackburn, W. H.
Journal of Range Management 38: 283-287 (1985). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7859/7471
Keywords: prescribed burning/ rangelands/ range management/ runoff/ soil erosion/ vegetation cover
Abstract: A replicated small plot (1.8 m X 22.1 m) study was conducted on the Texas A&M University Native Plant and Animal Conservancy in Brazos County, Texas. The purposes of the study were to determine the effects of seasonal burning on runoff and sediment loss and to describe vegetal differences resulting from the burning treatments. A grass-dominated community and a brush-dominated community were studied. Mean runoff from both communities tended to be greater from unburned plots than from burned plots although differences were seldom significant. Mean sediment export (kg/ha) was similar from the treatments during the 15-month study. However, nonsignificant trends suggested that plots burned in the spring lost less sediment than did unburned plots or those burned in early winter. Most sediment loss occurred during June, September, and November as a result of highly intense thunderstorms. Burning did not adversely affect runoff or sediment. Changes in vegetative composition and vigor did occur and these changes appeared to be compatible with most management objectives. Percent foliar cover of live vegetation was greater on burned than unburned plots; however, total foliar cover was greatest on unburned plots. Burning in early winter favored growth of forbs, whereas spring burning tended to favor the production of grasses.
This citation is from the University of Arizona Institutional Repository.

851. **Effect of grazing on infiltration in a western watershed**.
Thompson, J. R.
Journal of Soil and Water Conservation 23: 63-65 (1968).
Keywords: infiltration/ soil moisture/ erosion/ soil management/ watershed management/ grazing/ infiltration rate/ water conservation/ soil texture/ grazing land/ deserts/ Colorado/ permeability/ percolation/ infiltrometers/ bulk density/ rainfall-runoff relationships/ compacted soils/ desert plants/ induced infiltration/ soil properties
Abstract: Infiltration, runoff, and erosion were measured from test plots on both grazed and ungrazed areas in the Badger Wash area in western Colorado. The area, at an altitude of about 5,000 ft, has sparse desert-type vegetation and shallow soil largely derived from weathered Mancos shale bedrock. During tests made in 1953-54, 1958, and 1963, rainfall at 5-in/hr was applied artificially to each 2.5 sq-ft plot for a 50-min period. The infiltration rate, measured during the last 20 min of the test, was about .15 in./hr greater for grazed than ungrazed areas, but erosion was about 18% higher on grazed areas. Infiltration rate in 1963 was only about 3/4 that for 1958 in both areas although

bulk density and penetrometer tests showed the soil was less compacted in 1963. It is suggested that the reduced infiltration might result from less than normal frost shrink-swell in the winter preceding 1963 and in surface compaction from above-normal summer thunderstorms. If the surface soil could be held in optimum condition, perhaps by use of wetting agents or by controlled soil cracking, normal storm rainfall of .25 to .50 in. might be held where it falls. Additional investigations in the Badger Wash area seem to be warranted.
This citation is from the Soil and Water Conservation Society.

852. **Effect of nitrogen accumulation in *Puccinellia tenuiflora* grassland on the succession of vegetation in Songnen alkaline grassland**.
Chen, G., Sun, G. R., Peng, Y. Z., Ma, D. H., Yue, Z. H., Na, S. H. and Yan, X. F.
Shengtai Xuebao/ Acta Ecologica Sinica 28: 2031-2041 (2008).
Keywords: niche/ nitrogen accumulation/ *Puccinellia tenuiflora*/ salt-alkali soil/ soil enzyme activity/ vegetation succession
Abstract: With the exploitation and utilization of land resources, especially the non-sustainable utilization like overgrazing, the extent of alkalization of Song-Nen grassland has been enlarged and the vegetation has been degraded seriously. The area of preponderant grass *Leymus chinense* (*L. chinense*) also reduced, the height of grass and the extent of closed canopy of grassland decreased, and the alkali spot with very little grass occurred in the grassland. *Puccinellia tenuiflora* (*P. tenuiflora*) could grow in alkalized soil after artificial planting, and ameliorate the alkalized soil. Then *L. chinense* and other plants intruded into the alkalized spot where *P. tenuiflora* had been grown for certain years, making the plant population no longer the singularity population of *P. tenuiflora*. The mechanism about the vegetation of *L. chinense* succeeding in recovery was not only due to the improvement of physical or chemical property of the soil, but also due to the anthropogenic nitrogen deposition, which could cause vegetation-type conversion. But the mechanisms of vegetation succession were not very clear. As to the cause of vegetation succession, there were many hypotheses, such as frequent fire and grazing, but nitrogen deposition had only recently been considered. There were two aims of this study on the growth of *P. tenuiflora*. The first was to reveal that how the *P. tenuiflora* could meliorate the salt-alkali soil, the second was to quantify the changes of niche after the vegetation succession from *P. tenuiflora* to other kinds of plants. Niches of various plants in Song-Nen alkaline grassland were calculated. Comparing with the controlled alkali spot soil, all the evidences from the experiment indicated that *P. tenuiflora* improved the nitrogen nutrition status of salt-alkali soil. There were smaller value of niche separation and bigger value of niche overlap between *P. tenuiflora* and *L. chinense* in one dimension niche space (N content of soil) than those among other species, which indicated that *L. chinense* had stronger competition ability on soil with high nitrogen content. These appear to be the mechanism of *L. chinense* and other plants intruding into the alkalized spot in which *P. tenuiflora* has grown for certain years. As the pioneer plant of meliorating alkalized soil and vegetation restoration, the growth of *P. tenuiflora* could improve the nitrogen mineralization and nitrogen fixation in salt-alkali grassland, and decrease the nitrogen loss with water run-off. Finally, the nitrogen deposition in salt-alkali grassland was improved to the level that other plants (such as *L. chinense*) could grow normally, and the vegetation in alkali spot was restored.
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853. **Effect of prescribed burning on sediment, water yield, and water quality from dozed juniper lands in central Texas**.
Wright, H. A., Churchill, F. M. and Stevens, C.
Journal of Range Management 29: 294-298 (1976). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/6601/6211
Keywords: prescribed burning/ watersheds/ erosion/ runoff/ water quality/ slopes
Abstract: Prescribed burning was applied to six miniwatersheds that were each paired with an unburned watershed. Erosion losses, runoff, and water quality were unaffected on level areas, but adverse effects lasted for 9 to 15 months on moderate slopes and for 15 to 30 or more months on steep slopes. Rates of erosion losses stabilized within 18 months on all slopes when vegetative cover reached 63 to 68%.
This citation is from the University of Arizona Institutional Repository.

854. **Effect of timing of grazing on soil-surface cryptogamic communities in a Great-Basin low-shrub desert - a preliminary-report**.
Marble, J. R. and Harper, K. T.
Great Basin Naturalist 49: 104-107 (1989).
https://ojs.lib.byu.edu/ojs/index.php/wnan/article/view/1677
Keywords: sheep/ cryptogams/ lichens/ plant communities/ rangelands/ botanical composition/ deserts/ algae and seaweeds/ mosses and liverworts/ grazing/ seasonal variation/ runoff/ environmental impact
Abstract: Cover and species richness of vascular and cryptogamic components of the plant community were inventoried in experimental grazing paddocks at the USDA/FS Desert Range Experimental Station, Millard County, Utah. The grazing treatments considered have been applied continuously for over 50 years. The effects of heavy (ca 17 sheep days/acre) grazing treatment applied in two different seasons (early winter versus a split between early and late winter) differed significantly between seasons. Cryptogamic cover and cryptogamic species richness both showed larger decreases under early-late as opposed to early winter only grazing. Vascular plant cover (relative to controls) was also reduced by early-late winter grazing, but not to a significant degree. Late season grazing, likewise, had no significant effect on number of vascular species per transect.
This citation is from Brigham Young University.

855. **Effect of water chemistry and soil amendments on a silt loam soil - Part 1: Infiltration and runoff**.
Flanagan, D. C., Norton, L. D. and Shainberg, I.
Transactions of the ASAE
40: 1549-1554 (1997).
Keywords: rainfall electrolyte concentration/ surface sealing/ polyacrylamide/ furrow erosion/ polyacrylamide/ rainfall/ calcium/ gypsum
Abstract: Infiltration, runoff and soil loss are processes that occur when rainfall and runoff water interact with the structure and physical and chemical bonds of the soil surface. A well-aggregated soil which is strongly resistant to dispersion and aggregate breakdown, and which is fairly porous, will typically have greater infiltration rates and less runoff and soil loss than a poorly aggregated soil that is easily dispersed and which seals and crusts. Soil surface seal formation results from: physical breakdown of soil aggregates due to raindrop impact, and/or chemical dispersion which is dependent upon soil properties and the electrolyte concentration in the surface water solution. This study examined the effect of electrolyte concentration in rainfall and runoff water as well as the effect of different soil surface amendment treatments on infiltration, runoff and soil loss from a typical silt loam soil susceptible to aggregate breakdown and sealing. This article presents the infiltration and runoff results, and a companion article presents the soil erosion results. Rain water electrolyte content was found to have no significant effect on final runoff or infiltration rates. The use of a fluidized bed combustion bottom ash (a byproduct from coal-fired electric power plant emissions desulfurization) soil surface amendment significantly increased infiltration on small interrill areas (41.9 mm/h vs 32.2 mm/h for the control), but was less effective on longer rill plots (20.6 mm/h vs 18.4 mm/h for the control, difference not significant). Addition of a small amount of an anionic polyacrylamide in tap water used as simulated rainfall greatly increased water infiltration into the soil, which may have potential application in sprinkler irrigation systems.
This citation is from the American Society of Agricultural and Biological Engineers.

856. **Effect of water chemistry and soil amendments on a silt loam soil - Part 2: Soil erosion**.
Flanagan, D. C., Norton, L. D. and Shainberg, I.
Transactions of the ASAE
40: 1555-1561 (1997).
Keywords: rainfall electrolyte concentration/ polyacrylamide/ soil loss/ furrow erosion/ infiltration/ polyacrylamide/ runoff
Abstract: This research examined the effect of rainfall and runoff water composition, as well as the effect of different soil surface amendments on infiltration, runoff and soil loss from a silt loam soil which was highly susceptible to aggregate breakdown and sealing. This article describes the soil erosion results, while infiltration and runoff findings are presented in a companion article. The purposes of this study were to test if soil erosion would be reduced by the presence of electrolytes in the erosive water if use of an anionic polyacrylamide (PAM) as a surface spray or in rain water would reduce soil loss, and what the combined effects of high electrolyte concentrations and PAM would be.

The impacts of a soil surface application of 20 kg/ha of an anionic PAM as well as 5 t/ha of a gypsiferous power-plant byproduct on soil loss were determined. Water type applied as rainfall or inflow was deionized, tap, or tap plus 10 ppm of PAM. The soil surface applications of the PAM were effective in controlling rill erosion, even at very high water inflow levels. Pill plot sediment discharge rates from deionized rainfall water applications to an initially dry soil surface were significantly greater than those resulting from rainfall having greater electrolyte concentrations. However when inflow water was added to actively eroding rills, electrolyte concentration had no significant effect on sediment concentration or sediment discharge rate. The presence of PAM in rain water and inflow water acted to enhance soil loss when sufficient runoff was present to transport sediment from the rills.
This citation is from the American Society of Agricultural and Biological Engineers.

857. **Effective mitigation of debris flows at Lemon Dam, La Plata County, Colorado**.
Dewolfe, V. G., Santi, P. M., Ey, J. and Gartner, J. E.
Geomorphology 96: 366-377 (2008). ISSN: 0169-555X
http://dx.doi.org/10.1016/j.geomorph.2007.04.008
Keywords: debris flow/ erosion/ mitigation/ mulch/ seeding
Abstract: Copyright (2008) Elsevier, B.V.

858. **Effects of cattle trampling and mechanical seedbed preparation on grass seedling emergence**.
Winkel, V. K. and Roundy, B. A.
Journal of Range Management 44: 176-180 (1991). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8581/8193
Keywords: trampling damage/ planting seed/ soil compaction/ seedling emergence/ hydrogeology
Abstract: Cattle trampling has been recommended to bury seeds and encourage seedling establishment but has not been compared with traditional seedbed preparation techniques. We compared seedling emergence of broadcast-seeded 'Vaughn' sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.1, 'A-139' blue panic (*Panicum antidotale* Retz.), 'A-68' Lehmann lovegrass (*Eragrostis lehmanniana* Nees), and 'Cochise' atherstone lovegrass (*Eragrostis lehmanniana* Nets X E*. tricophera* Goss and Dur.) on lightly and heavily trampled seedbeds with that on undisturbed, land imprinted, and root-plowed or ripped seedbeds. We seeded and applied the treatments prior to summer rains on a sandy loam soil in southern Arizona for 3 years. In a wet year (1987) when surface soil water was estimated to be available for at least 24 consecutive days, heavy trampling and land imprinting increased emergence of blue panic and land imprinting increased emergence of Cochise lovegrass. In that year, lovegrass emergence was high even on undisturbed plots. In a moderately wet year (1988), surface soil water was available for periods of 6-9 days during seedling emergence and greater disturbance, either by heavy trampling, land imprinting and/or root plowing or ripping produced higher emergence than light trampling and nondisturbance. In a dry year (1989), surface soil water was available for periods of 2-3 days and seedling emergence was low and generally similar for all treatments. Sideoats grama emergence was low all 3 years, but was highest in 1988 when initial thunderstorms were followed closely by subsequent storms. Seedbed disturbance by cattle and mechanical methods may enhance revegetation in the Southwest in years of moderate precipitation but may be unnecessary in wet years or futile in dry years, depending on species and soils.
This citation is from the University of Arizona Institutional Repository.

859. **Effects of converting sagebrush cover to grass on the hydrology of small watersheds at Boco Mountain, Colorado**.
Lusby, G. C.
Geological Survey Water-Supply Paper 1532-J in cooperation with the Bureau of Land Management. (1979).
http://pubs.er.usgs.gov/publication/wsp1532J
Keywords: watersheds/ hydrology/ vegetation/ runoff/ erosion/ sediment/ grasses/ precipitation
Abstract: Changes in runoff and sediment yield caused by changing sagebrush cover to grass cover were studied at four small watersheds in western Colorado during a 9-year period, from 1965 to 1973. Measurements of runoff and sediment yield from the four watersheds were made for 3 years, at which time two watersheds were plowed and seeded to beardless bluebunch wheatgrass. The same

measurements were then continued for an additional 6 years. Measurements indicated that conversion to grass caused a reduction in runoff from summer rainstorms of about 75 percent. Runoff from spring snowmelt increased about 12 percent, and annual runoff from treated watersheds decreased about 20 percent when compared with control watersheds. Sediment yield from the seeded watersheds was reduced by about 80 percent; most of this reduction is related to the decrease in runoff from summer rainstorms. The size of barren interspaces between plants was reduced on the converted watersheds to about 30 percent of those on the untreated watersheds. Linear regression analysis indicates that a reduction of 38 percent in the amount of bare soil resulting from planting grass would result in a decrease of 73 percent in sediment concentration.

860. **The effects of grazing on abiotic and biotic parameters in a semiarid ecosystem: A case study from the Northern Negev Desert, Israel**.
Zaady, E., Yonatan, R., Shachak, M. and Perevolotsky, A.
Arid Land Research and Management
15: 245-261 (2001).
ftp://ftp.blm.gov/pub/blmlibrary/BLMpublications/Minerals/PDFMancos/zaadi01.pdf
Keywords: biomass/ diversity/ organic matter/ productivity/ soil moisture/ soil/ infiltration/ communities/ management practices/ nitrogen/ patches/ erosion/ crusts
Abstract: Livestock grazing is considered a disturbance of both biotic and abiotic parameters that may lead to degradation of rangelands and desertification. We report a case in which grazing was used as a management tool in a rehabilitation Project. The aim of this study was to quantify the effects of grazing on a managed ecological system. To do so, we monitored the diversity and composition of the plant community, herbaceous biomass, soil moisture, soil organic matter, habitat structure and quality of the vegetation for grazers (protein content and digestion). These parameters were monitored on the south and the north slopes, because of the differences in the radiation, which affect the water regime and the vegetation. Monitoring was ill grazed plots and in plots ungrazed for three years. Our results showed that grazing had immediate effects on the plant community and habitat structure. The densities of plant species decreased (similar to 20%), vegetation community, composition was affected (similar to 50 61%) and exposed soil sui:face increased (similar to 50%). A significant decrease was found in total protein content in plants over time from 17-19% in beginning Of the grazing season to 5-6% at the peak of the season. Digestible material was significantly more at the peak of the growing season in the grazed plots (63.7%) compared to the ungrazed plots (57.4%) in the north-facing slope, but not in the south-facing slope. When plant diversity, soil fertility, and soil moisture were considered, no correlation was found in relation to grazing. The significance of the research was that it demonstrated that livestock grazing can be effective as a management tool while imposing limited damage to the ecosystem.

861. **Effects of grazing on cryptogamic crusts in pinyon-juniper woodlands in Grand-Canyon-National-Park**.
Beymer, R. J. and Klopatek, J. M.
American Midland Naturalist
127: 139-148 (1992).
http://dx.doi.org/10.2307/2426329
Keywords: soil crusts/ recovery/ algae/ Utah/ areas
Abstract: Previously grazed pinyon-juniper woodlands in Grand Canyon National Park, northern Arizona, were studied to determine the effects of past and present grazing. The occurrence and biomass of cryptogamic crust were compared for five sites in and around the Park along a continuum from never grazed to recently grazed. All sites were similar in soil characteristics, elevation and overstory dominants. Cryptogamic crust was quantified using visible cover estimates and the chlorophyll a content of the crust as an indicator of biomass. Visible crust cover was reduced almost 80% on grazed (5.2%) as compared to ungrazed (23.3%) sites. Crust biomass, as estimated by chlorophyll a content, was reduced on grazed (3.1-mu-g cm-2) compared to ungrazed (9.9-mu-g cm-2) sites. There were no significant differences in species presence and absence data. Significant correlations existed between cryptogamic crust cover and the composition of the respective vascular plant communities, marked by a reduction of grasses and an increase of bare soil.

862. **Effects of Increased Precipitation and Grazing Management on Northeastern Montana Rangelands**.
Branson, F. A. and Miller, R. F.
Journal of Range Management 34: 3-10 (1981).
https://journals.uair.arizona.edu/index.php/jrm/article/view/7116/6728
Keywords: grazing management/ rain/ range management/ vegetation structure/ rangelands/ forage production
Abstract: To determine possible vegetation changes, 15 plant communities on public lands in the Willow Creek basin near Glasgow, Montana, that were sampled in 1960 were resampled in 1977. Most of the communities showed remarkable improvement in ground cover and forage production. Factors contributing to the changes included: (1) higher precipitation during the period between the first and second sampling than for the lo-year period prior to the first sampling, and (2) possibly, improved management practices, such as land treatments and application of rest-rotation grazing systems. These results are in conflict with the generally held view that western rangelands have deteriorated.
This citation is from the University of Arizona Institutional Repository.

863. **Effects of late season cattle grazing on riparian plant communities**.
Kauffman, J. B., Krueger, W. C. and Vavra, M.
Journal of Range Management 36: 685-691 (1983). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7628/7240
Keywords: grazing/ riparian vegetation/ plant communities
Abstract: Livestock impacts on riparian plant community composition, structure, and productivity were evaluated. After 3 years of comparison between fall grazed and exclosed (nongrazed) areas, 4 plant communities out of 10 sampled displayed some significant species composition and productivity differences. Two meadow types and the Douglas Hawthorne (*Crataegus douglasii*) community type had significant differences in standing phytomass. These also were utilized more heavily than any other communities sampled. Shrub use was generally light except on willow (*Salix* spp.)-dominated gravel bars. On gravel bars, succession appeared to be retarded by livestock grazing. Few differences were recorded in other plant communities sampled, particularly those communities with a forest canopy.
This citation is from the University of Arizona Institutional Repository.

864. **Effects of Livestock Grazing on Infiltration Rates, Edwards Plateau of Texas**.
Mccalla Ii, G. R., Blackburn, W. H. and Merrill, L. B.
Journal of Range Management 37: 265-269 (1984).
https://journals.uair.arizona.edu/index.php/jrm/article/view/7718/7330
Keywords: rangelands/ range management/ grazing management/ infiltration (hydrology)/ soil water
This citation is from the University of Arizona Institutional Repository.

865. **Effects of livestock grazing on physical and chemical properties of sandy soils in Sahelian rangelands**.
Hiernaux, P., Bielders, C. L., Valentin, C., Bationo, A. and Fernandez-Rivera, S.
Journal of Arid Environments 41: 231-245 (1999).
http://dx.doi.org/10.1006/jare.1998.0475
Keywords: Sahel/ livestock trampling/ soil crusting/ bulk density/ nutrient cycling/ soil organic matter
Abstract: The effects of grazing by livestock on soil surface features, bulk density and chemical properties were studied at the completion of a 4-year grazing experiment carried out in Sadore, Niger. Grazing treatments were a factorial arrangement of two stocking rates (62.5 and 125 kg live weight ha(-1)) and four sheep:goat ratios (0:6, 2:4, 4:2 and 6:0 animals per pasture), with two pastures per treatment and two ungrazed controls. Observations were also made in a fallow subjected to 9 years of intense and uncontrolled mixed grazing, and in a site that had been protected from grazing for 15 years. The topsoil was sampled (at depths of 0-2, 2-6, 6-14 and 14-30 cm) below shrub canopy in herbaceous vegetation and in bare soil patches within each of 20 paddocks for determination of pH, organic C, and total N and P concentrations. Soil bulk density was measured in a subset of soil profiles. The areal extent of different types of soil crusts and other soil surface features was assessed in one-half of the paddocks. Grazing resulted in a reduction ($p < 0.01$) and fragmentation of the area of crusted soils.

However, this trend was partially compensated for by an increase of newly formed crusts. As a result, the soil infiltration index slightly increased with moderate grazing, but decreased at higher stocking rates. Compaction due to trampling was observed ih the topsoil beneath the shrub canopy and also in vegetated patches, but only under intense grazing pressure. Soil bulk density was not affected by grazing except for an increase observed below 10 cm depth at the understory of shrubs which is therefore unlikely due to trampling. When compared to the ungrazed control, pH, organic C and N concentrations, and to lesser extent P concentration, decreased after 4 years of grazing. Soil P and pH further decreased after 9 years of very high grazing pressure. However, neither N nor organic C decreased further. (C) 1999 Academic Press.
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866. **Effects of season and stage of rotation cycle on hydrologic condition of rangeland under intensive rotation grazing**.
Warren, S. D., Blackburn, W. H. and Taylor Jr, C. A.
Journal of Range Management 39: 486-491 (1986). ISSN: 0022-409X
http://arc.lib.montana.edu/range-science/item/1307
Keywords: rangelands/ range management/ grazing management/ hydrology/ rotational grazing
Abstract: Infiltration rate and sediment production were measured over a 2-year period on an intensive rotationally grazed pasture. Measurements were taken prior to the movement of livestock onto the pasture, soon after their removal, and approximately midway through the subsequent rest period of each rotation through the system. Midgrass-dominated interspaces were characterized by significantly higher infiltration rates and lower sediment production than shortgrass-dominated interspaces. Infiltration rate declined and sediment production increased following the short-term intense grazing periods inherent in the rotational system. The detrimental effect was significant during periods of drought or winter dormancy, but not during periods of active growth. Soil characteristics relating to higher hydrologic condition were significantly more stable during the growing season, providing greater resistance to and resilience from the damaging impact of livestock activity.
This citation is from the University of Arizona Institutional Repository.

867. **Effects of surface treatment on surface sealing, runoff, and interrill erosion**.
Zhang, X. C., Miller, W. P., Nearing, M. A. and Norton, L. D.
Transactions of the ASAE 41: 989-994 (1998).
http://handle.nal.usda.gov/10113/7156
Keywords: soil amendment/ surface sealing/ water infiltration/ interrill erosion/ simulated rainfall/ soil erosion/ polyacrylamide/ infiltration/ polymers/ desorption/ furrows
Abstract: Surface treatment influences the nature and extent of seal/crust formation, which affects runoff and erosion. This study evaluated the effects and longevity of soil amendments, tillage, and screen cover on runoff and interrill erosion on a Cecil sandy loam (clayey, kaolinitic, thermic Typic Kanhapludult) under natural rainfall conditions. Six field plots (3.5 x 0.9 m) with a slope of 0.06-m m(-1) were used in the study. Three treatments (control, screen covet; crust-breaking shallow tillage) were studied in duplicate in the first two-month period, and another three (control, anionic polyacrylamide (PAM), and phosphogypsum) in a subsequent five-month period. Total runoff and soil loss were 69, 61, and 47 mm and 5.3, 1.6, and 4.3 Mg ha(-1) for the control, screen cover, and tillage treatments, respectively. Compared with control, screen cover reduced soil loss significantly but not runoff while tillage reduced runoff more than sail loss. Total runoff and soil loss for the control, gypsum, and PAM treatments were 146, 48, and 81 mm and 3.1, 2.6, and 2.5 Mg ha(-1), respectively. Runoff was reduced by 67% and 44% for the gypsum and PAM relative to control and soil loss by 16% and 19%, showing gypsum and PAM were more effective in reducing runoff than soil loss. Runoff was significantly reduced in the gypsum and PAM treatments in the five months following surface application. Results showed screen cover and tillage temporally reduced or delayed seal/crust formation, while the effects of gypsum and PAM were more persistent Combined with earlier findings, it appears that a combination of physical and chemical treatments is the best practice for controlling surface sealing and reducing runoff and erosion on this soil.

868. **Effects of water spreading on range vegetation in eastern Montana**.
Houston, W. R.
Journal of Range Management 13: 289-293 (1960). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/5008/4619
Keywords: rangelands/ range management/ vegetation cover/ water management/ flood irrigation/ forage yield
Abstract: A study of vegetational changes on a range waterspreading system near Miles City, Montana, was made between 1951 and 1959. On a western wheatgrass dominated area of clayey soils two durations of water spreading were studied. Only one duration was studied on a blue grama grass dominated area of sandy loam soil. Vegetation composition and cover were sampled by an adaptation of the loop-plot method. Heights of western wheatgrass and herbage production were determined. From 1955 to 1959 herbage production was increased on the western wheatgrass area an average of 62 percent by flooding and 189 percent by temporarily ponding water. On the blue grama area average production was increased 353 percent by flooding. Production on all sites varied greatly between years. Average heights of western wheatgrass plants were considerably increased by flooding on the blue grama area. Water spreading had little consistent effect on heights on the western wheatgrass area. Litter cover on the blue grama area was slightly increased by flooding. There was no noticeable effect of water spreading on litter cover at the western wheatgrass area. At the blue grama area flooding gradually reduced live-plant cover, but at the western wheatgrass area water spreading had little effect on plant cover. At the blue grama area flooding almost reversed the proportions of blue grama grass and western wheatgrass, while on the control the far greater composition of blue grama grass remained unchanged. At the western wheatgrass area flooding caused no change in species proportions. However, on the control site the vegetation changed from predominantly western wheatgrass to an approximately equal mixture of western wheatgrass and blue grama grass. Annual gross return per acre was probably seven to ten times the annual costs of the system per acre.
This citation is from the University of Arizona Institutional Repository.

869. **Environmental hazard of selenium in the Animas La Plata water development project**.
Lemly, A. D.
Ecotoxicology and Environmental Safety 37: 92-96 (1997).
http://dx.doi.org/10.1006/eesa.1997.1529
Keywords: irrigation drainwater/ lepomis-macrochirus/ bluegills/ toxicity/ impacts/ fish
Abstract: A hazard assessment of selenium was conducted for the Animas La Plata Project, a multiple-use water development proposed for Colorado and New Mexico by the United States Bureau of Reclamation. A published protocol for aquatic hazard assessment of selenium was applied to environmental monitoring data to assess current threats to biota in the water supply rivers (Animas, La Plata, and Mancos Rivers). Hazard evaluations were also made for two proposed reservoirs (Ridges Basin and Southern Ute Reservoirs) based on estimated concentrations of selenium. The assessment protocol indicated moderate hazard in the Animas and La Plata Rivers, and high hazard in the Mancos River and both of the proposed reservoirs. These ratings indicate that the risk of selenium poisoning in fish and aquatic birds is substantial. Moreover, the geology and climate of this site make it prone to irrigation-induced selenium contamination of water and biota. The water supplies already contain dangerously high concentrations of selenium that may increase further due to agricultural irrigation drainage. The stage is set for significant environmental problems unless a development scenario can be devised that will effectively reduce ecological risks. (C) 1997 Academic Press.
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870. **Environmental impacts of livestock on US grazing lands**.
Krueger, W. C., Sanderson, M. A., Cropper, J. B., Miller-Goodman, M., Kelley, C. E., Pieper, R. D., Shaver, P. L. and Trlica, M. J.
Issue Paper Council for Agricultural Science and Technology [CAST, Ames, Iowa], 16 p. (2002).

http://oregonstate.edu/dept/range/sites/default/files/l_Impacts_of_Livestock_on_U_S__Grazing_Lands.pdf
Keywords: rangelands/ range management/ grazing management/ environmental impact
Abstract: Grazing lands are the single largest land type in the United States. Thus, the environmental quality and the sustainability of

these lands are important to all citizens. Properly managed grazing lands provide positive environmental benefits, including the provision of clean water supplies, the capacity to sequester atmospheric carbon (C), and the potential to maintain biodiversity. The key issues of concern regarding the environmental impacts of live- stock on both public and private grazing lands are their effects on soil, water quality, riparian areas, and biodiversity (including invasive plant species). Livestock can affect soil quality through compaction, erosion, and changes in the plant community. Water quality impacts of livestock on grazing lands include manure and urine deposited directly into water or on land near surface waters where leaching and surface runoff can transport potential contaminants to streams, ponds, and lakes. Inappropriate grazing practices may accelerate erosion and sediment transport to water, alter stream flow, and disrupt aquatic habitats. Mismanagement of grazing lands can impair the capacity of riparian vegetation to filter contaminants, shade aquatic habitats, and stabilize stream banks and shorelines. Invasive species threaten the productivity, stability, and ecological functioning of some grazing lands. Controlling the spread of invasive species requires the development and application of low-maintenance strategies that are site-specific and focused on the management of plant succession. An important question is the societal commitment to weed management in terms of herbicide use, revegetation with nonnative species, introduction of biological controls, and use of domestic livestock to direct and to maintain a level of plant succession. Livestock grazing on public lands has become a major issue in states with significant areas of public lands. Many rural families depend on federal grazing permits for production of forage used by private live- stock herds. Increased use of public lands in the West has resulted in a number of conflicts between environmentalist groups and livestock permittees. Livestock grazing, however, is one of the few tools available to natural resource managers for developing and maintaining desirable plant community structure, decreasing fuel loads to decrease wildfire risks, and regulating nutrient cycling in the ecosystem. Biodiversity is a key feature of properly functioning ecosystems, and long-term studies on grazing lands indicate that appropriate grazing management can support a relatively high level of plant species diversity. Although increased biological diversity is often a goal stated by natural resource managers, it must be considered in the context of ecosystem stability, sustainability, and the production of goods and services for humans. Increased diversity may result in decreases in certain of these other characteristics. Managers must, therefore, consider trade-offs before policies are implemented and management is changed to increase biodiversity. Much of the grazing land in the East and irrigated pastureland in the West integrates grazing land uses with confined animal feeding. In certain areas, heavy fertilization of grazing lands results in runoff of nutrients or leaching of nutrients into groundwater. Intensifying animal production on grazing lands as an alternative to concentrating confined animal production and feeding operations may not solve certain nutrient management problems. Primary management techniques for decreasing or preventing nonpoint source pollution in grazed watersheds include management of vegetation, grazing, and nutrient application. The environmental impacts of livestock on grazing lands can be prevented, minimized, or ameliorated by control of when, where, how long, and how intensively livestock graze on forages growing within the landscape. In the same way, proper grazing management can result in positive environmental impacts, such as control of fuel to decrease wildfires, sequestration of carbon, and maintenance of biodiversity. The key to sustainability of grazing lands is managing vegetative cover, not only to provide feed for grazing livestock but also to hold soil in place, to filter water, and to recycle nutrients.
This citation is from Oregon State University.

871. **Estimating annual rainfall threshold for establishment of tree species in water-limited ecosystems using tree-ring data**.
López, B. C., Holmgren, M., Sabaté, S. and Gracia, C. A.
Journal of Arid Environments 72: 602-611 (2008). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2007.10.012
Keywords: ENSO/ Prosopis pallida/ Prosopis chilensis/ rainfall pulse/ recruitment/ semi-arid
Abstract: In arid and semi-arid ecosystems, water availability is discontinuous, highly variable, and characterized by discrete pulse events separated by long periods of limited resource availability. Plant recruitment in these ecosystems is also episodic and dependent on the water available during and after these

discrete rainfall events. Precipitation thresholds for plant establishment have been estimated mainly for herbaceous plants and tree seedlings, but extrapolation of short-term results based on seedlings to natural tree populations is difficult. Nevertheless, estimations of water availability thresholds for tree recruitment are essential for successful policies on forest conservation and restoration. We propose a methodology to estimate precipitation thresholds for adult tree populations using tree-ring series and precipitation data. We used this methodology with two Prosopis species from South America: Prosopis pallida and Prosopis chilensis. Results indicate a precipitation threshold of around 85 mm for the establishment of P. pallida trees, whereas the threshold for P. chilensis is likely to be much higher.
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872. **Estimating twig and foliage biomass of sagebrush, bitterbrush, and rabbitbrush in the Great Basin**.
Dean, S., Burkhardt, J. W. and Meeuwig, R. O.
Journal of Range Management 34: 224-227 (1981). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7177/6789
Keywords: leaves/ biomass/ shrubs/ models/ *Artemisia*
Abstract: Shrub crown characteristics useful in regression equations for predicting two biomass components (annual production and fine fuels) were identified for six shrubs common to the Great Basin. Shrub characteristics most useful in these equations were maximum and minimum crown diameter, and crown denseness and depth. Prediction equations were developed for each species or subspecies included in this study. Additionally, biomass equations were developed for combined species or subspecies of morphological similarity within the *Artemisia* genus.
This citation is from the University of Arizona Institutional Repository.

873. **Evaluating strategies for ranching in the 21st century: Successfully managing rangeland for wildlife and livestock**.
Anderson, A. and Mccuistion, K. C.
Rangelands 30: 8-14 (2008). ISSN: 1551-501X
http://dx.doi.org/10.2111/1551-501X(2008)30[8:ESFRIT]2.0.CO;2
Keywords: habitat management/ grazing/ wildlife/ rangeland management/ economics
Abstract: This article presents a review of the literature concerning the management of rangeland habitat for upland game birds and large wild ungulates in conjunction with cattle grazing. Topics include livestock grazing factors such as stocking rate, grazing systems, fire, deferment, rest, utilization, and range condition and their impact on wildlife species that currently provide major economic opportunities for ranchers. Managing rangeland for both wildlife and cattle is a strategy worthy of careful consideration for ranch managers in the 21st Century. Managing rangeland for the benefit of both wildlife and livestock is an achievable strategy for ranchers and other rangeland managers. Although specific tactics vary depending on the wildlife species, flexible stocking rates, flexible grazing systems, patch burning, adequate water, and protecting environmentally sensitive areas are some of the management practices that generally provide adequate habitat for many wildlife species. These approaches also have proven successful and are widely recommended by rangeland management professionals for successful grazing livestock management. The resulting opportunity for deriving income from managing rangelands for both livestock and wildlife is currently providing ranchers with an opportunity to diversify sources of income. This strategy can also reduce risk in the dynamic and volatile marketplace.
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874. **Evaluation of pinyon-juniper conversion to grassland**.
Aro, R. S.
Journal of Range Management 24: 188-197 (1971). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/5921/5531
Keywords: pinyon-juniper woodland/ grassland establishment/ burning/ dozing/ chaining/ seeding
Abstract: Conversion techniques applied to public lands in Colorado, Utah, Arizona, and New Mexico provided the basis for an evaluation of several methods. Burning was the most effective and the least expensive method studied. Dozing of trees into windrows, followed by seeding of grasses in the cleared areas, was the best mechanical approach examined, but requires careful site selection and economic

evaluation. Chaining was the most widely used, but the least effective technique for converting pinyon-juniper woodland to grassland.
This citation is from the University of Arizona Institutional Repository.

875. **Evaporative flux from a shallow watertable; the influence of a vapour-liquid phase transition**.
Gowing, J. W., Konukcu, F. and Rose, D. A.
Journal of Hydrology 321: 77-89 (2006). ISSN: 0022-1694
http://dx.doi.org/10.1016/j.jhydrol.2005.07.035
Keywords: soils/ liquid phase/ experimental studies/ terrestrial environment/ gaseous phase/ textures/ arid environment/ drainage/ semi-arid environment/ rates/ capillary water/ groundwater/ temperature/ irrigation/ laboratory studies/ water table/ evaporation/ shallow depth/ phase equilibria/ theoretical models/ hydrogeology/ water regimes/ soils/ salinization
Abstract: Evaporation from bare soil in arid and semi-arid regions is characterised by vapour transport in the upper part and liquid transport in the lower part of the soil profile. Under such conditions, both phases must be taken into account to describe the movement of water in and the evaporation from soil above a watertable. This requires location of the evaporation front, defined as the plane at which phase transformation occurs. In this study we develop a pseudo steady-state model to locate the evaporation front and then to predict the rate of evaporation under isothermal conditions. The model was tested using laboratory experiments and then developed to encompass different soil textures, salinities, watertable depths and evaporative demands. There was good agreement between the measured and simulated depths of the evaporation front and rates of evaporation. The lighter the soil texture, the deeper was the simulated evaporation front. Under salt-saturated conditions, the simulated evaporation front was deeper by a factor of 1.11, irrespective of soil type. The lower the evaporative demand, the shallower were the depth of the evaporation front and the depth of salinisation, even for deep groundwater. The depth of the evaporation front influences the rate of salinisation and the depth at which salt accumulates. It is therefore an important consideration in drainage design for irrigated systems in arid and semi-arid regions where salt control is often required. However, in practice, the assumption of isothermal conditions is a simplification because the extreme temperature gradient that exists close to the soil surface leads to a more complex situation.
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876. **An Evidence-Based Assessment of Prescribed Grazing Practices**.
Briske, D. D., Derner, J. D., Milchunas, D. G. and Tate, K. W.
Conservation benefits of rangeland practices: assessment, recommendations, and knowledge gaps. Briske, D. D. Lawrence, Kansas, U.S. Dept. of Agriculture, Natural Resources Conservation Service**:** 21-74 (2011).
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045796.pdf
Keywords: conservation practices/ grazing management/ water quality/ riparian areas/ soil erosion/ erosion control/ rangelands/ forage yield
Abstract: This chapter evaluates the ecological effectiveness of the major purposes and purported benefits for prescribed grazing as described in the USDA-NRCS National Conservation Practice Guidelines. This standard defines prescribed grazing as managing the harvest of vegetation with grazing and/ or browsing animals that is often applied as one component of a broader conservation management system to achieve one or more of the following purposes: Improve or maintain desired species composition and vigor of plant communities; Improve or maintain quantity and quality of forage for grazing and browsing animals' health and productivity; Improve or maintain surface and/or subsurface water quality and quantity; Improve or maintain riparian and watershed function; Reduce accelerated soil erosion and maintain or improve soil condition; Improve or maintain the quantity and quality of food and/or cover available for wildlife; Manage fine fuel loads to achieve desired conditions.

877. **Executive Summary: The Next Generation of Conservation Practice Standards**.
Briske, D. D.
Conservation Benefits of Rangeland Practices: Assessment, Recommendations, and Knowledge Gaps. Briske, D. D. Lawrence, Kansas, U.S. Dept. of Agriculture, Natural Resources Conservation Service**:** 9-20 (2011).

http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045792.pdf
Keywords: rangelands/ conservation practices/ environmental policy

878. **Factors influencing infiltrability of semiarid mountain slopes**.
Wilcox, B. P., Wood, M. K. and Tromble, J. M.
Journal of Range Management 41: 197-206 (1988). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8240/7852
Keywords: infiltration (hydrology)/ semi-arid soils/ soil transport processes/ soil morphology
Abstract: The objective of this research was to determine the effects of selected vegetation, soil, rock, and slope variables on infiltration of semiarid rangelands with slope gradients ranging from 0-70%. Analyses were made on 2 sets of data collected a year apart in the Guadalupe Mountains of New Mexico and consisted of Pearson and partial correlation analysis of the dependent infiltration variables and independent site variables. In addition, infiltration was regressed against uncorrelated factors produced by factor analysis. Vegetal cover and biomass strongly influenced infiltration. The relative importance of grasses, shrubs or litter was dependent on their respective abundance, especially grass. Soil depth also limited infiltration especially as soil water storage became satisfied. Infiltrability was negatively correlated with rock cover and the smallest rock size fragments were the most negatively related. When the effects of vegetal cover and slope were removed (using partial correlation analysis) however, the median sized rock fragments (26-150 mm) were positively related to infiltrability, and the smallest rock fragments (2-12 mm) were negatively related. Partial correlation analysis also suggested a positive correlation between infiltrability and slope gradient.
This citation is from the University of Arizona Institutional Repository.

879. **Fire and vegetation type effects on soil hydrophobicity and infiltration in the sagebrush-steppe: I. Field analysis**.
Glenn, N. F. and Finley, C. D.
Journal of Arid Environments 74: 653-659 (2010). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2009.11.009
Keywords: burn severity/ infiltration/ rangelands/ semi-arid/ soil water repellency
Abstract: Soil water repellency, infiltration, and fire severity were evaluated at 235 locations within a sagebrush-steppe ecosystem in southern Idaho, USA, after a 78,000 ha wildfire. Fire frequency in the sagebrush-steppe has increased dramatically in the last century due to the proliferation of introduced annual weeds. Wildfire in shrub-steppe can increase runoff and erosion by decreasing vegetation cover and increasing soil hydrophobicity. Soil water repellency was measured with the water drop penetration time (WDPT) test and relative infiltration rates were measured by the mini-disc infiltrometer (MDI). Shrub-dominated locations showed highest water repellency in areas of moderate fire severity and infiltration rate was inversely related to distance from individual sagebrush plants. Highest water repellency in grass-dominated areas was also associated with moderate fire severity. Likewise, the lowest relative mean infiltration rates occurred in shrub-dominated or grass-dominated areas of moderate fire severity. These findings indicate that land management strategies should be targeted towards moderate fire severity areas.
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880. **Fire and vegetation type effects on soil hydrophobicity and infiltration in the sagebrush-steppe: II. Hyperspectral analysis**.
Finley, C. D. and Glenn, N. F.
Journal of Arid Environments 74: 660-666 (2010). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2009.11.010
Keywords: fire severity/ hydrophobicity/ Mixture tuned match filtering (MTMF)/ Semiarid spectral angle mapper (SAM)/ spectroscopy
Abstract: Hyperspectral remote sensing methods were developed to identify and differentiate post-fire characteristics in burned sagebrush-steppe. This shrub-steppe environment is typical of the Intermountain West, where wildfire intervals are frequent. After a 78,000 ha wildfire in 2005 in southern Idaho, soil water repellency and fire severity were evaluated with field and airborne spectroscopy measurements. A hyperspectral analysis correctly identified bare ground, low and high fire severity grass areas and low fire severity shrub areas, with accuracies between 74 and 92%. The differentiation of moderate and high fire severity areas was ambiguous, resulting in accuracies between 39 and 54%. The

hyperspectral analysis of soil water repellency resulted in a representative map of its distribution with an accuracy of 65%. The analysis techniques conducted in this project signify spectroscopy to be beneficial for differentiating soil characteristics and fire severity classes in burned shrub-steppe areas, where the mostly bare, spectrally homogenous soils exhibit subtle but significant changes in reflectance. The spatial representation of post-fire soil and vegetation conditions may provide a better understanding of post-fire vegetation and surficial processes (water and wind erosion) in shrub-steppe.
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881. **Fire, Plant Invasions, and Erosion Events on Western Rangelands**.
Pierson, F. B., Williams, C. J., Hardegree, S. P., Weltz, M. A., Stone, J. J. and Clark, P. E.
Rangeland Ecology and Management 64: 439-449 (2011). ISSN: 1550-7424
http://dx.doi.org/10.2111/REM-D-09-00147.1
Keywords: cheatgrass/ grass-fire cycle/ pinyon-juniper/ sagebrush steppe/ soil loss
Abstract: Millions of hectares of rangeland in the western United States have been invaded by annual and woody plants that have increased the role of wildland fire. Altered fire regimes pose significant implications for runoff and erosion. In this paper we synthesize what is known about fire impacts on rangeland hydrology and erosion, and how that knowledge advances understanding of hydrologic risks associated with landscape scale plant community transitions and altered fire regimes. The increased role of wildland fire on western rangeland exposes landscapes to amplified runoff and erosion over short- and long-term windows of time and increases the risk of damage to soil and water resources, property, and human lives during extreme events. Amplified runoff and erosion postfire are a function of storm characteristics and fire-induced changes in site conditions (i.e., ground cover, soil water repellency, aggregate stability, and surface roughness) that define site susceptibility. We suggest that overall postfire hydrologic vulnerability be considered in a probabilistic framework that predicts hydrologic response for a range of potential storms and site susceptibilities and that identifies the hydrologic response magnitudes at which damage to values-at-risk are likely to occur. We identify key knowledge gaps that limit advancement of predictive technologies to address the increased role of wildland fire across rangeland landscapes. Our review of literature suggests quantifying interactions of varying rainfall intensity and key measures of site susceptibility, temporal variability in strength/influence of soil water repellency, and spatial scaling of postfire runoff and erosion remain paramount areas for future research to address hydrologic effects associated with the increased role of wildland fire on western rangelands.
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882. **Flash grazing and trampling: effects on infiltration rates and sediment yield on a selected New Mexico range site**.
Weltz, M., Wood, M. K. and Parker, E. E.
Journal of Arid Environments 16: 95-100 (1989). ISSN: 0140-1963
Keywords: grazing management/ grazing intensity/ infiltration (hydrology)/ soil water/ range management/ conservation practices/ soil erosion/ range management/ rangelands/ trampling damage
Abstract: This study evaluated the influence of flash grazing and livestock trampling on selected hydrologic variables, on the Rio Bonito watershed in central New Mexico. Mean terminal infiltration rates, after flash grazing and trampling, were only 25% of the rates before applying livestock to the sites in May. By August, the rates were only 32% of those before. Infiltration rates significantly decreased from May to August in untreated plots, but there was no significant difference after treatment by livestock from May to August. Sediment production was 10 times higher after treatment in May than before treatment, and was 13 times higher in August. Results from this study suggest that flash grazing and hoof action or trampling, that occur as a result of grazing systems, may decrease infiltration rates and increase sediment yields. Resting a pasture 110 days in the summer was not enough time for the plants within the enclosure to return to pretreatment levels.
This citation is from AGRICOLA.

883. **Forage Kochia Germination Response to Temperate, Water Stress, and Specific Ions**.
Romo, J. T. and Haferkamp, M. R.
Agronomy Journal 79: 27-30 (1987).

http://oregonstate.edu/dept/eoarc/sites/default/files/publication/315.pdf
Keywords: Kochia prostrata (L.) Scrad./ fruits/ polyethylene glycol/ potassium chloride/ range seeding/ seed/ sodium chloride
This citation is from the American Society of Agronomy.

884. **Forage kochia: to seed or not to seed**.
Clements, C. D., Gray, K. J. and Young, J. A.
Rangelands 19: 29-31 (2006). ISSN: 0190-0528
https://journals.uair.arizona.edu/index.php/rangelands/article/view/11343/10616
Keywords: Kochia prostrata/ rangeland vegetation/ forage
Abstract: This review focuses on 'Immigrant' forage kochia (Kochia prostrata) as a reclamation candidate for degraded habitats. We also want to encourage resource managers to be aware of the important role this plant can play on arid rangelands.
This citation is from the University of Arizona Institutional Repository.

885. **Fremont River watershed water quality management plan**.
Utah Department of Environmental Quality
Utah Division of Water Quality, (2002).
http://www.waterquality.utah.gov/TMDL/FREMONT_WQMP.pdf
Keywords: watershed management/ TMDL/ water quality/ land use/ monitoring
Abstract: This document presents a Water Quality Management Plan for the Fremont River watershed located in south-central Utah. The Fremont River watershed Steering Committee developed this Water Quality Management Plan with assistance from Millennium Science & Engineering (MSE), and their subcontractors. The Utah Division of Water Quality (DWQ) contracted MSE to assess water quality impairments of the Fremont River watershed, quantify loadings for limiting water quality parameters, develop Total Maximum Daily Loads, and assist the Fremont River watershed Steering Committee to develop this Water Quality Management Plan. Many private individuals, agencies, and consultants contributed to these efforts. A list of contributors is provided in Appendix A. This Water Quality Management Plan was developed for the upper and lower Fremont River watershed. The upper Fremont River begins at the headwaters in Fishlake National Forest and extends to the eastern boundary of Capitol Reef National Park. The lower Fremont River begins at the eastern boundary of Capitol Reef National Park and ends at the confluence with the Dirty Devil River. Section 1 of the Water Quality Management Plan introduces the EPA Total Maximum Daily Load (TMDL) process, the water quality impairments of the Fremont River watershed, and Utah's Watershed Approach. Section 2 contains a description of the Fremont River watershed, including specifics about the history of the watershed, climate, geology, soils, land use, land cover, and hydrology. Section 3 describes the current water quality-monitoring program for the Fremont River watershed. An assessment of the water quality of the Fremont River watershed is discussed in detail in Section 4 and includes an explanation of the applicable water quality standards. Section 4 also describes the significant sources of point and nonpoint pollution, loading calculations for each source, water quality goals and targets, in addition to Best Management Practices (BMPs) and Best Available Technologies (BATs) to attain the established water quality goals and targets. Section 5 contains the TMDL portion of the Water Quality Management Plan. Section 5 is designed to be a stand-alone document that details the technical analysis, water quality goals and endpoints, and TMDLs for the parameters of concern. Load allocations are described in terms of Waste Load Allocations (WLAs) for point sources, Load Allocations (LAs) for nonpoint sources, and a Margin of Safety (MOS). Project Implementation Plans (PIPs) are presented in Section 6. These PIPs set forth potential projects, waterbody prioritization, and the estimated costs for implementing management measures. Section 7 addresses the implications of future land use on water quality and the implementation of management practices. A water quality-monitoring plan is recommended in Section 8 to measure the effectiveness of watershed management modifications. Conclusions and recommendations are presented in Section 9. Section 10 is a comprehensive list of references cited in this document.

886. **Grazing effects on runoff and vegetation on western South Dakota rangeland**.
Hanson, C. L., Kuhlman, A. R., Erickson, C. J. and Lewis, J. K.
Journal of Range Management 23: 418-420 (1970). ISSN: 0022-409X

https://journals.uair.arizona.edu/index.php/jrm/article/view/5862/5472
Keywords: runoff/ vegetation cover/ rangelands/ range management/ grazing management
Abstract: Four 2-acre watersheds were established in 1962 on each of three pastures that had been grazed at different intensities (heavy, moderate and light) since 1942. These watersheds were located at the Cottonwood Range Field Station, Cottonwood, South Dakota. The mean seasonal runoff from May 14 through October 31 for 1963 through 1967 was 0.79, 0.56 and 0.42 inch for the heavily, moderately and lightly used watersheds, respectively. The mean weight of live and dead standing crop of vegetation plus mulch in late July was 1,752, 2,092 and 3,700 pounds per acre for the heavily, moderately and lightly used watersheds, respectively.
This citation is from the University of Arizona Institutional Repository.

887. **Grazing systems on the Edwards Plateau of Texas: Are they worth the trouble? I. Soil and vegetation response**.
Taylor Jr, C. A., Garza Jr, N. E. and Brooks, T. D.
Rangelands 15: 53-57 (1993). ISSN: 0190-0528
https://journals.uair.arizona.edu/index.php/rangelands/article/view/11137/10410
Keywords: grazing management/ rangelands/ range management/ vegetation cover/ soil erosion/ conservation practices
This citation is from the University of Arizona Institutional Repository.

888. **Grazing systems on the Edwards Plateau of Texas: Are they worth the trouble? II. Livestock response**.
Taylor Jr, C. A., Garza Jr, N. E. and Brooks, T. D.
Rangelands 15: 57-60 (1993). ISSN: 0190-0528
https://journals.uair.arizona.edu/index.php/rangelands/article/download/11138/10411
Keywords: grazing management/ rangelands/ range management/ vegetation cover/ soil erosion/ conservation practices
This citation is from the University of Arizona Institutional Repository.

889. **Grazing Systems: Their Influence on Infiltration Rates in the Rolling Plains of Texas**.
Wood, M. K. and Blackburn, W. H.
Journal of Range Management 34: 331-335 (1981). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7205/6817
Keywords: grazing management/ infiltration (hydrology)/ range management/ soil water
Abstract: Water infiltration rates into soils after 30 min in shrub canopy areas and in shortgrass interspaces on the Rolling Plains were similar across grazing treatments of heavy and moderate stocking, continuous grazing; rested and grazed deferred-rotation; rested and grazed high intensity, low frequency (HILF); and two livestock exclosures which had been grazed for 20 years. The mid-grass interspace infiltration rates for the deferred-rotation treatments approached rates in the exclosures and exceeded rates in the heavily stocked, continuously grazed, and grazed HILF pastures. Infiltration rates in the HILF grazing treatments were similar to those of the heavily stocked, continuously and moderately stocked continuously grazed pastures. Infiltration rates in the rested HILF pasture were similar to those of the deferred-rotation pastures; however, the grazed HILF pasture had rates lower than the deferred-rotation pasture rates or rates of the exclosures. Aggregate stability, organic matter content, mulch, standing crop, bulk density, and ground cover significantly influenced infiltration rates.
This citation is from the University of Arizona Institutional Repository.

890. **Green needlegrass seedling morphology in relation to planting depth**.
Fulbright, T. E., Wilson, A. M. and Redente, E. F.
Journal of Range Management 38: 266-270 (1985). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/viewFile/7853/7465
Keywords: planting seed/ *Nassella viridula*/ range management/ disturbed soils/ land restoration
Abstract: Green needlegrass (*Stipa viridula* Trin.) is commonly used in range seedings and revegetation of disturbed lands in the northern Great Plains. This study was conducted to determine the influence of planting depth, seed source, and temperature on morphology and

emergence of green needlegrass seedlings. Seeds from 2 sources were planted at depths of 1.5, 3.0, 4.5, 6.0, and 7.5 cm in pots filled with sandy loam soil. Pots were placed in growth chambers adjusted for either a 20/15° C (15 h light/9 h dark) temperature regime or a 25/20° C regime. Coleoptile length increased with planting depth, while seminal primary root length, adventitious root length, and number of adventitious roots decreased with planting depth. 'SD-93' seedlings had shorter subcoleoptile internodes, longer coleoptiles, and better root development than 'Lodorm' seedlings. Seedlings grown under the warmer temperature regime had better root development than seedlings grown under the cooler regime, but reach of the coleoptile above planting depth was not as great. Results indicated that green needlegrass generally should not be planted at depths greater than 3.0 cm because of lower percent emergence, rate of emergence, and poor root development when seedlings emerged from greater depths.
This citation is from the University of Arizona Institutional Repository.

891. **Hatch winterfat: a quality shrub for ranges and wildlands**.
Stevens, R. and Monsen, S. B.
Rangelands 10: 104-105 (2006).
ISSN: 0190-0528
https://journals.uair.arizona.edu/index.php/rangelands/article/view/10378/9649
Keywords: Hatch winterfat/ seeding/ revegetation/ forage
Abstract: A superior strain of winterfat called 'Hatch' was recently released for planting semiarid range and wildland sites within the Intermountain West. 'Hatch' was selected for its ability to establish, persist, and provide winter forage in the sagebrush and pinyon-juniper communities. Big game and livestock have demonstrated a preference for 'Hatch' over other accessions tested. The cultivar has excellent winter hardiness and drought tolerance. This article provides details on origin and study sites, seeding, field and greenhouse plantings, and where seed can obtained.
This citation is from the University of Arizona Institutional Repository.

892. **Hillslope characteristics and particle size composition of surficial armoring on a semiarid watershed in the Southwestern United States**.
Canfield, H. E., Lopes, V. L. and Goodrich, D. C.
Catena (Giessen) 44: 1-11 (2001).
ISSN: 0341-8162
http://dx.doi.org/10.1016/S0341-8162(00)00154-5
Keywords: Arizona/ armoring/ Basin and Range Province/ Cochise County/ controls/ deflation/ digital terrain models/ erosion/ fluvial sedimentation/ geomorphology/ grain size/ granulometry/ hydrology/ Lucky Hills 104 Watershed/ rangelands/ scale factor/ sediment transport/ sedimentation/ sediments/ semi-arid environment/ size distribution/ slopes/ soils/ southwestern United States/ spatial variations/ stream sediments/ terrestrial environment/ United States/ Walnut Gulch/ wind erosion/ wind transport/ winds
Abstract: Distributed process-based hydrologic models have been used to describe and predict the movement of sediment on small watersheds. However, to parameterize these models requires an understanding of the spatial variability of erosion processes and the particle sizes of the sediment being moved. In this study, a high resolution digital elevation model (DEM) and detailed sediment particle sampling allowed a comparison of hillslope characteristics and particle sizes of surficial armoring in a semiarid watershed. Individual particle size classes on hillslopes are correlated with the underlying sediment type, local slope, aspect, and area draining through a grid element. The strongest correlations are between the underlying sediment and overlying sediment. However, the distribution of the particle size classes is consistent with a hydrodynamic explanation for sorting. In particular, increased area draining through a grid node and increased slope are correlated with higher concentrations of the 16-64-mm particle size class. Both the coarsest and finest particle size classes are significantly correlated with the aspect of flow from a grid cell, with increased coarse particles and decreased fines on east-facing slopes. These spatial differences with aspect are attributed to dry season prevailing winds. These observations about process and spatial distribution are useful in predicting the spatial distribution of particles on the watershed for applications such as distributed hydrologic models.

893. **Hydraulic conductivity in a pinon-juniper woodland: Influence of vegetation**.
Wilcox, B. P., Breshears, D. D. and Turin, H. J.
Soil Science Society of America Journal 67: 1243-1249 (2003).
http://go.usa.gov/WrJT
Keywords: semi-arid woodland/ New Mexico/ sagebrush rangelands/ spatial data/ variability/ sediment production/ simulated rainfall/ infiltration/ rates/ soil moisture/ erosion/ runoff
Abstract: In semiarid environments, vegetation affects surface runoff either by altering surface characteristics (e.g., surface roughness, litter absorption) or subsurface characteristics (e.g., hydraulic conductivity). Previous observations of runoff within a pinon-juniper [*Pinus edulis* Englem. and *Juniperus monosperma* (Englem.) Sarg.] woodland led us to hypothesize that hydraulic conductivity differs between vegetation types. Using ponded and tension infiltrometers, we measured saturated (K-s) and unsaturated [K(h)] hydraulic conductivity at three levels of a nested hierarchy: the patch (canopy and intercanopy), the unit (juniper canopy, pinon canopy, vegetated intercanopy, and bare intercanopy), and the intercanopy locus (grass, biological soil crust, bare spot). Differences were smaller than expected and generally not significant. Canopy and intercanopy K, values were comparable with the exception of a small number of exceedingly high readings under the juniper canopy-a difference we attribute to higher surface macroporosity beneath juniper canopies. The unsaturated hydraulic conductivity, K(h), values were higher for canopy soils than for intercanopy soils, although differences were small. At the unit level, the only significant differences were for K(h) between juniper or pinon canopies vs. bare interspaces. Median K values for vegetated intercanopy areas were intermediate between but not significantly different from those for canopies and bare areas. There were no significant differences between grass, biological soil crust, and bare spots within the herbaceous intercanopy area. Overall, the observed differences in K between canopy and intercanopy patches do not account for differences in runoff observed previously.

894. **Hydrologic and Biotic Effects of Grazing Versus Nongrazing Near Grand Junction, Colorado**.
Lusby, G. C.
USGS Professional Paper, Denver, CO, U.S. Geological Survey, pp. B232-B236. (1970).
https://journals.uair.arizona.edu/index.php/jrm/article/download/5821/5431
Keywords: rangelands/ range management/ grazing management/ hydrology/ soil erosion/ runoff/ watershed management/ rain/ vegetation cover
Abstract: The effect of grazing on the hydrology of salt-desert type rangeland has been studied near Grand Junction, Colorado for the past 14 years. Measurements of precipitation, runoff, erosion, and vegetation have been made in four pairs of watersheds. One of each pair has been grazed by cattle and sheep as is normal in the region, and the other has not been used since the beginning of the study. Measurements made 10 years apart show that all four grazed watersheds have had a slight increase in the amount of bare soil and rock and a decrease in ground cover; cover on ungrazed watersheds has remained essentially unchanged. Runoff in the ungrazed watersheds has been about 30 percent less than in the grazed watersheds and sediment yield has been about 45 percent less. The greatest change in each of the relationships occurred about 3 years after livestock were excluded from one watershed of each of the pairs. Preliminary studies indicate that within areas of similar physiography, runoff is directly related to the percentage of bare soil present on a watershed.

895. **Hydrologic characteristics of vegetation types as affected by prescribed burning**.
Hester, J. W., Thurow, T. L. and Taylor Jr, C. A.
Journal of Range Management 50: 199-204 (1997). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/9201
Keywords: prescribed burning/ rangelands/ range management/ hydrology/ conservation practices
Abstract: The objective of this study was to determine how rangeland hydrology of oak, juniper, bunchgrass and shortgrass vegetation types is altered by fire. The research was conducted at the Sonora Agricultural Experiment Station on the Edwards Plateau, Texas. Infiltration rate and interrill erosion were measured using a driptype rainfall simulator.

Terminal infiltration rates of unburned areas were significantly greater on sites dominated by oak (*Quercus virginiana* Mill.) (200 mm hour-1) or juniper (*Juniperus ashei* Buchh.) (183 mm hour-1) than on sites dominated by bunchgrass (146 mm hour-1) or shortgrass (105 mm hour-1). Terminal infiltration rates on burned areas were significantly reduced on sites dominated by bunchgrass (110 mm hour-1), shortgrass (76 mm hour-1), and on oak sites that were cut and burned (129 mm hour-1). Soil organic matter content (r = .61), total organic cover (r = .59), and aggregate stability (r = 53) were the variables most strongly correlated with infiltration rate. Measured soil structure properties were not altered by fire, therefore, differences in infiltration rate between unburned and burned treatments were attributable to variations in the amount of cover. The terminal infiltration rate of cut and burned juniper sites (162 mm hour-1) was not changed significantly after the Rre because the associated good soil structure properties allowed rapid infiltration even after cover was removed. Good soil structure properties were also pre sent on the oak sites, but the infiltration rate significantly decreased as a result of the temporary hydrophobic nature of the soil on this site after burning. Prior to burning, interrill erosion was much lower under the tree sites (oak = 2 kg ha-1; juniper = 34 kg ha-1) than on bunchgrass (300 kg ha-1) or shortgrass (1,299 kg ha-1) sites. After burning, interrill erosion significantly increased for all vegetation types (shortgrass = 5,766 kg ha-1; bunchgrass = 4,463 kg ha-1; oak = 4,500 kg ha-1; juniper = 1,926 kg ha-1). Total organic cover (r = -.74) and bulk density at O-30 mm (r = .46) were most strongly correlated with interrill erosion.
This citation is from the University of Arizona Institutional Repository.

896. **Hydrologic Response to Mechanical Shredding in a Juniper Woodland**.
Cline, N. L., Roundy, B. A., Pierson, F. B., Kormos, P. and Williams, C. J.
Rangeland Ecology and Management 63: 467-477 (2010). ISSN: 1550-7424
http://dx.doi.org/10.2111/REM-D-09-00196.1
Keywords: juniper control/ mechanical shredding/ runoff/ sediment/ infiltration
Abstract: We investigated soil compaction and hydrologic responses from mechanically shredding Utah juniper (*Juniperus ostesperma* [Torr.] Little) to control fuels in a sagebrush/bunchgrass plant community (*Artemisia nova* A. Nelson, *Artemisia tridentata* Nutt. subsp. *wyomingensis* Beetle & Young/*Pseudoroegneria spicata* [Pursh] A. Löve*, Poa secunda* J. Presl) on a gravelly loam soil with a 15% slope in the Onaqui Mountains of Utah. Rain simulations were applied on 0.5-m2 runoff plots at 64 mm ·h−1 (dry run: soil initially dry) and 102 mm·h−1 (wet run: soil initially wet). Runoff and sediment were collected from runoff plots placed in five blocks, each containing four microsites (juniper mound, shrub mound, vegetation-free or bare interspace, and grass interspace) with undisturbed or tracked treatments for each microsite type and a residue-covered treatment for grass and bare interspace microsites. Soil penetration resistance was measured at the hill slope scale, and canopy and ground cover were measured at the hill slope and runoff plot scale. Although shredding trees at a density of 453 trees ha-1 reduced perennial foliar cover by 20.5%, shredded tree residue covered 40% of the ground surface and reduced non–foliar-covered bare ground and rock by 17%. Tire tracks from the shredding operation covered 15% of the hill slope and increased penetration resistance. For the wet run, infiltration rates of grass interspaces were significantly decreased (39.8 vs. 66.1 mm h-1) by tire tracks, but infiltration rates on juniper mounds and bare interspaces were unchanged. Bare interspace plots covered with residue had significantly higher infiltration rates (81.9 vs. 26.7 mm h-1 and lower sediment yields (38.6 vs. 313 g m-2) than those without residue. Because hydrologic responses to treatments are site- and scale-dependent, determination of shredding effects on other sites and at hill slope or larger scales will best guide management actions.
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897. **Hydrological and erosion response of a badlands system in semiarid SE Spain**.
Canton, Y., Domingo, F., Sole-Benet, A. and Puigdefabregas, J.
Journal of Hydrology 252: 65-84 (2001). ISSN: 0022-1694
http://dx.doi.org/10.1016/S0022-1694(01)00450-4
Keywords: Spain/ badlands/ catchment hydrodynamics/ deserts/ drainage basins/ eolian features/ erosion/ erosion features/ erosion rates/ geomorphology/ hydrology/ landscapes/ moisture/ monitoring/ rainfall/ runoff/ semi-arid environment/ soils/ southeastern Spain/

Tabernas Spain/ terrestrial environment/ water erosion/ water regimes
Abstract: A long term monitoring program is being conducted to study runoff and erosion processes in a semiarid badlands environment (Tabernas Desert, SE Spain). The first six years of data from an instrumented experimental area with nested microcatchments are presented. The overall area is composed of a complex mosaic of soil surfaces with contrast hydrological and erosion behaviour. At microcatchment scale, runoff and erosion are controlled by the types of soil surfaces: small bare microcatchments had the highest runoff coefficients and the highest erosion rates, while those completely covered by vegetation had the lowest. Rainfall intensity significantly affected water and sediment budgets. The effect of antecedent soil moisture could only be observed when soil was near saturation and a few millimetres of additional rainfall were sufficient to produce Horton-type runoff, but it was very difficult to separate this from the effect of surface crusts formed in the first minutes of rainfall. Most of the rainfall events were below the threshold for producing runoff although they were important for sediment preparation through weathering. Small magnitude, low-intensity rainfall events along with protective plant cover over half of the total surface, are the main factors explaining low overall erosion rates at microcatchment scale.

898. **Identifying oil-field salinity sources with airborne and ground-based geophysics; a West Texas example**.
Paine, J. G., Mayorga, J. S. and Saunders, G. P.
Bulletin of the South Texas Geological Society 39: 9-18 (1998). ISSN: 0561-077X
Keywords: electrical conductivity/ terrestrial environment/ geophysical surveys/ petroleum/ salinity/ salt water/ seepage/ groundwater/ Hatchel Quadrangle/ conductivity/ sampling/ electromagnetic methods/ environmental geology/ soil/ pollutants/ arid environment/ geophysical methods/ agriculture/ pollution/ magnetic methods/ Texas/ brines/ surveys/ salinization/ airborne methods
Abstract: Salinization of soil and water is an environmental and agricultural concern in many arid regions. Because the electrical conductivity of soil and water increases with salinity, electromagnetic methods offer the promise of noninvasively identifying salinized areas. We integrated airborne and ground-based geophysical surveys, water and soil sampling, and chemical analyses to locate concentrations of saline water and determine whether oil-field salinity sources can be distinguished from natural and agricultural sources. We tested these integrated methods in a 91-km (super 2) area in Runnels County, Texas, where natural, oil-field, and agricultural salinity sources exist. A high-resolution airborne electromagnetic and magnetometer survey measured (a) electrical conductivity increases in the ground that might be caused by salinization and (b) magnetic anomalies caused by well casings and other ferrous objects. The airborne data, locations of known oil and gas wells, and soil and geologic maps were analyzed to produce a list of sites having a signature consistent with an oil-field salinity source. Ground-based geophysical measurements at a representative subset of these sites suggested likely oil-field sources (brine pits or leaking wells) at 60 to 70 percent of the sites. The combined airborne and ground-based results provide a basis for defining a generic geophysical "profile" of a leaking well: a site that has (a) a magnetic anomaly or a known well location and (b) anomalously high conductivity as measured by both shallow-sensing 56,000-Hz airborne coils and deeper-sensing 7,200-Hz coils. Ground surveys complemented the airborne data in the search for salinity sources. Although the airborne survey rapidly investigated a large area, located salinized areas, and helped distinguish oil-field sources from natural or agricultural ones, leaking wells and brine pits had similar signatures. Ground-based measurements distinguished brine pits from leaking wells, but without the airborne data, many salinized areas would have been easily missed and ground measurements would have lacked a regional context. Airborne methods are most effective in typical oil-field-size areas of tens to hundreds of square kilometers, where well locations are uncertain, multiple salinity sources are expected, and the extent of salt-water infiltration is poorly known. In these areas, airborne data can help locate salinity concentrations, determine the extent of salinization, and improve the efficiency of follow-up ground investigations.
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899. **Imaging spectroscopy of changing Earth's surface: a major step toward the quantitative monitoring of land degradation and desertification**.
Pinet, P. C., Kaufmann, C. and Hill, J.
Comptes Rendus Geoscience 338: 1042-1048 (2006). ISSN: 1631-0713
http://dx.doi.org/10.1016/j.crte.2006.09.012
Keywords: reflectance spectroscopy/ hyperspectral observation/ surface monitoring/ geology/ biogeochemistry
Abstract: Imaging spectroscopy makes direct identification of surface materials possible in a spatial context based on diagnostic visible and near-infrared properties. Advanced methodologies permit the deconvolution of complex surface signatures. It opens a number of possibilities for characterizing and monitoring mineralogical and/or biogeochemical surface properties and changes, particularly in the field of land desertification, where understanding of processes involve the quantitative description of the interplay between soils and vegetation components. To cite this article: P.C. Pinet et al., C. R. Geoscience 338 (2006).
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900. **The impact of shade on establishment of shrubs adapted to the high light irradiation of semi-arid environments**.
Jefferson, L. V. and Pennacchio, M.
Journal of Arid Environments 63: 706-716 (2005). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2005.04.004
Keywords: Enchylaena tomentosa/ *Maireana brevifolia*/ *Maireana georgei*/ light/ competition/ canopy
Abstract: Light may be an important limiting resource that influences community structure of chenopod shrublands. As part of a larger study that aimed to determine the factors that influence chenopod community structure, the focus of this study was the influence of plant canopy on the growth and establishment of smaller plants. We therefore measured the height and cover of three chenopods (*Enchylaena tomentosa*, *Maireana brevifolia* and *Maireana georgei*) when growing within and outside of the canopy of *Atriplex bunburyana* under field conditions. All three chenopods had lower cover and *E. tomentosa* was taller when growing within the canopy of *A. bunburyana* in comparison to those growing outside of the canopy. The chenopods were then grown under three artificial shade regimes. Plant height, cover, biomass, relative leaf area and photosynthetic surface area measurements showed that each species responded differently to shade. *E. tomentosa* biomass was facilitated by shade. This was inferred by an increase in total plant biomass. *M. brevifolia*, in contrast, tolerated shade by increasing above-ground biomass allocation*. M. georgei* was adversely affected by the shade regimes: root biomass decreased in response to shade. Competition for light is, therefore, likely to influence chenopod community structure of semi-arid and arid environments.
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901. **Impacting diffuse salt production from rangelands within the Upper Colorado River Basin**.
Gifford, G. F., Hawkins, R. H. and Jurinak, J. J.
First International Rangeland Congress, Denver, Colorado, USA,
Society for Range Management (1978).
Keywords: arid zones/ chemical composition/ control methods/ grasslands/ plant communities/ rangeland soils/ runoff/ saline soils/ salinity/ salts/ salt land/ salts in soil/ sedimentation/ soil conservation/ soil types/ soil types (ecological)/ water conservation/ water resources/ watersheds/ arid regions/ *Atriplex gardneri*/ catchment areas/ salinity balance/ United States/ atriplex/ chenopodiaceae/ caryophyllales/ dicotyledons/ angiosperms/ spermatophyta/ plants/ eukaryotes/ halogeton/ *Atriplex confertifolia*/ *Atriplex corrugata*/ *Halogeton glomeratus*/ Utah
Abstract: Results of a 3-yr study in the Prize River Basin, Utah, on land processes involved in diffuse salinity production are reviewed. The basin is a major source of salinity to the Colorado River. Among plant spp., most salt/g dry wt. of foliage and stems was delivered by *Atriplex corrugata*, *A. gardneri, Halogeton glomeratus* and *A. confertifolia*. Of the total annual salt load of the Prize River, about 3.5% was contributed by vegetation (<0.01-0.02%), overland flow and microchannels on marine shale's, indicating the importance of other diffuse sources for total salt load. Range management practices best suited to rather saline marine shale's include gully plugs and contour furrowing, but these measures are mainly of use to control run-off and reduce sediment production, rather than improve plant

cover. The impact of such measures on salt production was not clear. On sites not on marine shale's, salt production potentials were low and manipulation of vegetation had little significance for potential salt loading.
© *CABI*

902. **Implementing ecologically based invasive plant management: Lessons from a century of demonstration projects in Park Valley, Utah**.
Morris, L. R., Monaco, T. A., Call, C. A., Sheley, R. L. and Ralphs, M.
Rangelands 33: 2-9 (2011). ISSN: 1551-501X
http://dx.doi.org/10.2111/1551-501X-33.2.2
Keywords: invasive plants/ rangeland management/ plant succession
Abstract: The area-wide EBIPM project aims to promote "science based solutions for invasive annual grasses." In 2008, local ranchers, the ARS, the Natural Resources Conservation Service (NRCS), Box Elder County Extension, the Utah Association of Conservation Districts, and Utah State University teamed up to demonstrate the effectiveness of EBIPM principles at large scales. These ecological principles are based upon a successional management framework that relates the three primary causes of succession, which include site availability, species availability, and species performance to modify and to reduce invasive annual grass dominance and promote the transition of lands toward desirable perennial communities. The EBIPM project does not require unique, untested, and unfamiliar practices. Instead, it applies familiar management techniques (e.g., targeted grazing, herbicide application, and seeding) in a way that is intended systematically to direct succession on the landscape.
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903. **Increasing range production from fodder shrubs in low rainfall areas**.
Abu-Zanat, M. W., Ruyle, G. B. and Abdel-Hamid, N. F.
Journal of Arid Environments 59: 205-216 (2004). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2003.12.011
Keywords: Atriplex halimus/ *Atriplex nummularia*/ arid lands/ browse production/ cutting/ rain-use efficiency/ survival
Abstract: Field experiments were conducted at the University of Jordan Research Station at Al-Muwaqqar village to develop a simple technique for establishing *Atriplex* seedlings, and to evaluate the browse production under natural precipitation compared with shrubs receiving additional harvested water. Overall survival of the transplants after three growing seasons averaged 67% under strictly rainfed conditions compared to 95% when additional harvested water of 39 mm was applied. Production of grazable browse of 3-year old shrubs averaged 380 and 1151 kg DM (dry matter) ha−1 without and with additional water, respectively. Rain use efficiency averaged 1.14 and 4.48 kg DM ha−1 year−1 mm−1 for strictly rainfed conditions and additional harvested water, respectively. Intensity of cutting had a highly significant effect on the potential of shrub regrowth. Cutting shrubs at a height of 15 and 30 cm above ground level reduced regrowth substantially, whereas cutting at 45 cm enhanced the amount of regrowth. The different cutting intensities had no significant effect on survival of the severed shrubs, which indicates the high tolerance of saltbushes to cutting or browsing. Water-harvesting contour furrows are reasonable for establishing saltbush plantations in low rainfall areas (100–200 mm). Additional harvested water in small amounts from macro-catchments had a substantial effect on shrub survival, biomass production and water use efficiency.
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904. **Infiltration, penetration resistance and microphytic crust composition in contrasted microsites within a Mediterranean semi-arid steppe**.
Maestre, F. T., Huesca, M., Zaady, E., Bautista, S. and Cortina, J.
Soil Biology & Biochemistry 34: 895-898 (2002).
http://dx.doi.org/10.1016/S0038-0717(02)00021-4
Keywords: infiltration/ microphytic crusts/ microsite/ surface soil compaction/ semi-arid steppe/ *Stipa tenacissima*/ soil/ landscapes/ Israel
Abstract: In semi-arid areas with sparse vegetation cover, runoff generated in the open areas is crucial for the maintenance of vegetated patches. Microphytic crusts play a major role in this redistribution of water, thus influencing ecosystem functioning and dynamics. We investigated the effects of alpha grass (*Stipa tenacissima* L.) on the composition of the microphytic crusts, surface soil compaction, and infiltration in a semi-arid steppe of SE Spain.

The microphytic crust composition differed between the upslope of *S. tenacissima* tussocks (tussock microsites) and the inter-tussock areas with sparse vascular plant cover (open microsites), with more moss cover in the tussock microsite, and more cyanobacteria and lichens in the open microsite. The surface soil compaction was higher in the open microsite. Variables related with infiltration showed a clear microsite effect, with higher infiltration rate and less time required by first drop to percolate in the tussock microsite. Partial correlation analysis showed a significant negative relationship between the cyanobacteria cover and the infiltration rate, and both the cyanobacteria cover and the percentage of bare soil showed a significant positive relationship with the time required for first drop to percolate. Our results reinforce the idea that open microsites act as sources of water for S. tenacissima tussocks. This study helps to understand the interactions between microphytic crusts and vascular plants in semi-arid environments. (C) 2002 Elsevier Science Ltd. All rights reserved.

905. **Influence of chaining pinyon-juniper on watershed values in Utah: Project report**.
Gifford, G. F., Logan, Utah, Utah Agricultural Experiment Station, 159 p. (1971).
http://archive.org/details/influenceofchain5722giff
Keywords: pinyon-juniper ecosystems/ soil moisture/ water table/ watersheds/ chaining
Abstract: Objectives : A. To determine the water budget of natural stands of pinyon-juniper and adjacent areas which have been cleared and/or seeded. B. To determine the effects of vegetation conversion on soil physical properties and soil stability. C. To ecologically evaluate sites before and after as to composition and production of vegetation. D. To evaluate the economics of conversion practices in terms of the watershed values and multiple use relations. E. To obtain data necessary for determination of hydrologic soil cover complexes on the study sites. Introductory Comment; This report is concerned with additional data analysis and compilation which has resulted since the project report dated April 1, 1972. As before, the report will provide information to supplement previous reports as well as indicate progress to date.

906. **Influence of grazing on channel morphology of intermittent streams**.
George, M. R., Larsen, R. E., Mcdougald, N. K., Tate, J. D., Gerlach, J. D. and Fulgham, K. O.
Journal of Range Management 55: 551-557 (2002). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/9756
Keywords: rivers/ stream channels/ geomorphology/ ephemeral streams/ bank erosion/ grazing intensity/ watershed management/ grazing management/ riparian areas/ vegetation cover
Abstract: Alteration of stream channel morphology by cattle and associated streambank erosion is a concern on rangeland watersheds. The objective of this study was to determine changes in stream channel morphology in response to 5 grazing treatments applied to 0.4 ha pastures and replicated on 3 intermittent streams at the San Joaquin Experimental Range in the central Sierra Nevada foothills of California. Baseline stream channel morphology parameters were determined along 10 transects in each pasture in June 1994. Seasonal grazing treatments (no grazing, wet season moderate, wet season concentrated, dry season moderate, and dry season concentrated) were repeated annually over 4 years beginning in July 1994. Stream channel morphology parameters were measured annually from 1995-1998. When stream morphological responses were averaged across years, there were no detectable effects of grazing on the parameters measured. Year effects and their interaction with grazing were significant, primarily for stream morphological parameters that included channel depth in their measurement or calculation. Channel depth increased significantly in the ungrazed controls, but did not change due to any grazing treatment. These results indicate that grazing had little effect on the morphology of these bedrock limited, intermittent stream channels.
This citation is from the University of Arizona Institutional Repository.

907. **Influence of sampling strategy on detecting preferential flow paths in water-repellent sand**.
Ritsema, C. J. and Dekker, L. W.
Journal of Hydrology 177: 33-45 (1996).
http://dx.doi.org/10.1016/0022-1694(95)02795-5
Keywords: wetting front instability/ layered soils/ infiltration/ models/ transport

Abstract: Rapid response tensiometers or TDR (time domain reflectometry) probes in soil profiles, or early arrival of solutes in groundwater or drainwater after a rain event, provide direct evidence of preferential flow in soils, However, little information about the amount and magnitude of preferential flow paths is obtained by such measurement methods. Here, two intensively sampled vertical trenches illustrate the effect of sample spacing and the effect of sample size on the detection of preferential flow paths. In a water-repellent sandy soil, a sample spacing of up to 22 cm over a distance of several metres is just sufficient to collect information about preferential flow paths. Using larger sample spacings, the water content distributions apparently became more horizontally stratified. Increasing the sample size by pooling pairs of adjacent 100 cm(3) soil samples over a distance of several metres, still allowed the detection of preferential flow paths. Preferential flow paths were no longer observed for larger sample sizes. Enlarging the sample size reduces the calculated standard deviation and coefficient of variation. As preferential flow paths may vary in space and time, so the optimal number of samples to detect these paths in vertical trenches may vary, indicating that sampling strategies need to be flexible in design.
© *Elsevier*

908. **Integrated Vegetation Management Handbook (H-1740-2)**.
U. S. Bureau of Land Management
Bureau of Land Management Handbook, 103 p. (2008).
http://www.blm.gov/pgdata/etc/medialib/blm/wo/Information_Resources_Management/policy/blm_handbook.Par.59510.File.dat/H-1740-2.pdf
Keywords: vegetation management/ rangeland management/ native plants/ land treatments/ rangeland condition

909. **Integration of SWAP and MODFLOW-2000 for modeling groundwater dynamics in shallow water table areas**.
Xu, X., Huang, G., Zhan, H., Qu, Z. and Huang, Q.
Journal of Hydrology 412–413: 170-181 (2012).
ISSN: 0022-1694
http://dx.doi.org/10.1016/j.jhydrol.2011.07.002
Keywords: groundwater modeling/ vadose zone/ recharge/ evapotranspiration/ MODFLOW/ SWAP package/ China/ Yellow River basin

Abstract: Summary Reasonable estimates of groundwater recharge and discharge through evapotranspiration is critical for sustainable water resources management in shallow water table areas. The hydrologic processes are highly interactive between the vadose zone and groundwater under shallow water table conditions. In traditional groundwater flow models, the recharge and evapotranspiration fluxes are often oversimplified as a simple sink/source term. However, the recharge and evapotranspiration are observed to vary with topography, soil type, land use, and water management practices. Additionally, they are known to vary temporally and spatially and are difficult to estimate, especially in arid and semi-arid regions. Thus, it is important to devise an appropriate method to estimate the recharge and evapotranspiration fluxes in groundwater modeling. In this study, a Soil–Water–Atmosphere–Plant (SWAP) package was integrated into a groundwater flow model (MODFLOW) in such a way that the SWAP package calculates vertical flux for MODFLOW, while MODFLOW provides averaged water table depth to determine the bottom boundary condition for SWAP zones. The SWAP zones in MODFLOW are derived from a combination of topology, soil type, land use, water management practices using geographic information systems (GIS). Then the MODFLOW with SWAP package was tested using a two-dimensional saturated–unsaturated water table recharge experiment. Results showed that the simulated water table elevations matched well with the observed ones except at the early period during which they were slightly higher than the observed ones, probably due to neglecting lateral diffusion in the unsaturated zone. Finally, we applied MODFLOW with SWAP package to simulate a regional groundwater flow problem in Hetao Irrigation District, upper Yellow River basin of North China. The simulation results validated the applicability of the developed MODFLOW with SWAP package for practical regional groundwater modeling.
© *Elsevier*

910. **Introduction to the Conservation effects assessment Project and the rangeland Literature synthesis**.
Briske, D. D., Jolley, L. W., Duriancik, L. F. and Dobrowolski, J. P.
Conservation benefits of rangeland practices: assessment, recommendations, and knowledge

gaps. Briske, D. D. Lawrence, Kansas, U.S. Dept. of Agriculture, Natural Resources Conservation Service**:** 1-8 (2011).
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045795.pdf
Keywords: range management/ rangelands/ conservation practices
Abstract: The rangeland literature synthesis was specifically organized around a series of testable questions derived from the stated purposes or outcomes of seven major conservation practices as identified in the NRCS National Conservation Practice Standards. These conservation practices were selected for assessment based on their prominence in the conservation planning environment, the extent and frequency with which they are applied, and the amount of incentive payments allocated to them. Rigorous literature syntheses established the portion of experimental studies that supported, refuted, or were insufficient to assess the benefits of these conservation practices. Two additional chapters emphasizing landscape ecology and socioeconomic issues, including ecosystem services, were developed on the basis of their anticipated importance to future conservation programs and planning. These final two chapters were organized to be crosscutting among all seven conservation practice standards: Prescribed Grazing; Prescribed Burning; Brush Management; Range Planting; Riparian Herbaceous Cover; Upland Wildlife Habitat Management; Herbaceous Weed Control; Landscape Analysis (cross-cutting chapter; Socioeconomics and Ecosystem Services (cross-cutting chapter).

911. **In-use activity measurements for off-road motorcycles and all-terrain vehicles**.
Durbin, T. D., Smith, M. R., Wilson, R. D. and Rhee, S. H.
Transportation Research Part D-Transport and Environment 9: 209-219 (2004).
http://dx.doi.org/doi:10.1016/j.trd.2004.01.003
Keywords: off-road motorcycles/ recreational travel/ off-road vehicles/ disturbance
Abstract: Off-road recreation vehicles are an important source of emissions and make a disproportionately high contribution to the emissions inventory. Here 58 off-road motorcycles and 39 all-terrain vehicles (ATVs) were instrumented to collect activity data. The activity data for motorcycles and ATVs varied significantly depending on the type of terrain, the type of off highway vehicle, and personal riding habits. The most rapid transitions in speed were typically observed for motorcycles operated on motocross tracks or in trail riding. Over similar terrain, motorcycles had slightly higher top speeds than the ATVs. The highest observed speeds were for motorcycles in open terrain riding conditions. Interestingly, average speeds were comparable between different types of terrain. (C) 2004 Elsevier Ltd. All rights reserved.

912. **Invasive Plant Management on Anticipated Conservation Benefits: A Scientific Assessment**.
Sheley, R. L., James, J. J., Rinella, M. J., Blumenthal, D. and Ditomaso, J. M.
Conservation Benefits of Rangeland Practices: Assessment, Recommendations, and Knowledge Gaps. Briske, D. D. Lawrence, Kansas, U.S. Dept. of Agriculture, Natural Resources Conservation Service**:** 291-336 (2011).
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045802.pdf
Keywords: invasive species/ rangelands/ range management/ weed control/ conservation practices/ riparian areas/ wildlife habitat/ forage
Abstract: Invasive plant species have many negative impacts on rangelands throughout the world, and can displace desirable species, alter ecological processes, reduce wildlife habitat, degrade riparian systems, and decrease productivity. To address this issue, federal agencies and private land managers have developed and implemented integrated pest management (IPM) programs on rangeland. This chapter provides a comprehensive assessment of the degree to which IPM is achieving several commonly anticipated and desired benefits. A comprehensive review of peer-reviewed literature was used to assess the efficacy of various invasive plant management practices for each of nine conservation purposes developed for the Natural Resources Conservation Service (NRCS) conservation practice standard of herbaceous weed control. In contrast to the other conservation practice standards, this one was developed simultaneously with the Conservation Effects Assessment Program, so the stated purposes do not directly match those in the new standard. This new conservation practice standard is defined as the removal or control of herbaceous weeds including invasive, noxious, and prohibited plants. The writing team developed

the following conservation purposes at the request of the NRCS for this chapter: 1) protect noninfested rangeland; 2) enhance quantity and quality of commodities; improve forage accessibility, quality and quantity for livestock; 3) control undesirable vegetation; 4) create a desired plant community; 5) change underlying causes of weed invasion; 6) restore desired vegetative cover to protect soils, control erosion, reduce sediment, improve water quality and quantity, and enhance stream flow; 7) maintain or enhance wildlife habitat including that associated with threatened and endangered species; 8) protect life and property from wildfire hazards; and 9) minimize negative impacts of pest control on soil resources, water resources, air resources, plant resources, and animal resources. The chapter also contains a section detailing recommendation and knowledge gaps, and conclusions addressing this conservation practice.

913. **Irrigation of a Saline-Sodic Site in the Sudan Gezira. II-Salt Movement and Sodicity Changes**.
Ali, M. A. and Fadl, O. a. A.
Tropical Agriculture 54(3): 279-283 (1977).
Keywords: use of water of impaired quality/ water in soils/ conservation in agricultural use
Abstract: Experiments were conducted in the Sudan Gezira in an attempt to reclaim land of impaired quality. The area is one of high salinity where most of the good lands have already been brought into production. Any expansion of agriculture will have to be on lands with high sodic and saline contents. The experiments involved observations of salt movement in the area of the Gezira where a fruit and vegetable garden is planned. Two small plots were selected, irrigated with water from the Blue Nile, and planted with alfalfa. This crop was chosen for its moderate tolerance to salinity and ability to furnish the farmer with some returns while the land was being reclaimed. Composite auger samples were collected in 10 centimeter steps at different dates for one of the two plots. Soluble salts were determined. Exchangeable sodium percentage was investigated while the chlorides, carbonates and bicarbonates were directly measured in the extract and the sulphates were obtained by difference. The results are presented and show that irrigation with Blue Nile Water and cropping with alfalfa caused a net downward movement of salts. (Jamail-Arizona)
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914. **A Landscape Approach to Rangeland Conservation Practices**.
Bestelmeyer, B. T., Brown, J. R., Fuhlendorf, S. D., Fults, G. A. and Wu, X. B.
Conservation Benefits of Rangeland Practices: Assessment, Recommendations, and Knowledge Gaps. Briske, D. D. Lawrence, Kansas, U.S. Dept. of Agriculture, Natural Resources Conservation Service**:** 337-370 (2011).
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045803.pdf
Keywords: rangelands/ range management/ conservation practices/ landscape ecology
Abstract: In this synthesis, the authors promote the development of a systematic approach by which the NRCS and other agencies can evaluate both the local and landscape context of practices—that is, where they occur in a landscape and region and the varying processes and constraints associated with those locations. They further emphasize that this approach should include increased attention to spatial pattern as an attribute that contains valuable information, in addition to averages or sums of variables (such as plant cover) that are typically emphasized. Collectively, the information provided by this “landscape perspective” could enable planners to increase successful application, use federal resources more efficiently, and assess more effectively the consequences of practices. The empirical basis for these assertions within the rangeland conservation literature is weaker than for other chapters due to limited development of landscape perspectives in rangeland ecology and the consequent paucity of studies.

915. **Linkages Between Riparian Characteristics, Ungulate Grazing, and Geomorphology and Nutrient Cycling in Montane Grassland Streams**.
Van Horn, D. J., White, C. S., Martinez, E. A., Hernandez, C., Merrill, J. P., Parmenter, R. R. and Dahm, C. N.
Rangeland Ecology and Management 65: 475-485 (2012). ISSN: 1550-7424
http://dx.doi.org/10.2111/REM-D-10-00170.1
Keywords: grazing exclusion/ nutrient cycling/ riparian soil chemistry/ riparian vegetation/ stream geomorphology/ water quality
Abstract: Catchment characteristics and disturbances control the conditions and processes found in stream ecosystems. We examined nutrient cycling linkages between

riparian soils and adjacent streams and the impacts of the removal of ungulate grazing on these ecosystems and processes at six grazing exclosure sites in the Valles Caldera National Preserve, NM, USA. The exclusion of native and domestic ungulate grazers for 3 yr significantly increased the riparian aboveground biomass of standing vegetation (273±155 in grazed vs. 400± 178 g.m−2 in exclosures) and litter (58±75 in grazed vs. 110± 76 g.m−2 in exclosures) (P=0.003 and 0.006, respectively). Except for an increase in total soil phosphorous (P) at three of the six sites, soil nutrient values were minimally affected by grazing after five growing seasons. Within the six sites studied, no connection was found between 0–15-cm depth soils, which were P-limited based on stoichiometric ratios, and stream nutrient availability or limitation, which were nitrogen limited. Stream geomorphology was not significantly altered by 5 yr of grazing exclusion. The elimination of grazing suppressed instream nutrient processing with significantly longer NH4 uptake lengths (P=0.003). These results suggest the exclusion of ungulate grazing impacts terrestrial characteristics (increased standing vegetative biomass) that are linked to ecosystem services provided by adjacent aquatic ecosystems (reduced N-uptake). Management plans should carefully balance the positive effect of grazing on stream nutrient processing and retention reported here with the well-documented grazing-related loss of other ecosystem services such as decreased fish and aquatic invertebrate habitat and effects on water-quality parameters such as turbidity and water temperature.
© *Elsevier*

916. **Linking geomorphology and hydrodynamics: a case study from Peninsula Valdes, Patagonia, Argentina**.
Alvarez, M., Weiler, N. E. and Hernandez, M. A.
Hydrogeology Journal 18: 473-486 (2010).
ISSN: 1431-2174
http://dx.doi.org/10.1007/s10040-009-0528-x
Keywords: earth sciences/ hydrology/ Landsat/ ER Mapper
Abstract: A case study is presented to assess the relevance of geomorphology in hydrogeological phenomena in an arid coastal area in the Argentinean extra-Andean Patagonia (Peninsula Valdes) with an average rainfall of 232mm/year and a soil moisture deficit of about 472mm/year. Various geomorphic units were identified by interpreting Landsat 7 satellite images processed with ER Mapper software and then surveyed in the field, as well as by geological characterization. The hydrodynamic analysis was based on a survey of 89 wells, the construction of equipotential maps, and the interpretation of pumping-test results by a non-equilibrium method. The hydrochemical characterization was based on chemical tests analyzed with the Easy_Quim 6.0 application. The combination of geomorphological, geological, hydrodynamic and hydrochemical elements allowed the definition of hydromorphological units that are typical of recharge, circulation and discharge areas, the latter both for coastal and inland areas in wetlands (salt pans) with elevations to -40m relative to sea level. These units and the criteria used for their definition allow immediate recognition of hydrogeological phenomena in arid regions such as the extra-Andean Patagonia, with low information density but with near-optimal satellite imaging of landforms due to the lack of vegetation cover.
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917. **Liquid mulch based on poly(vinyl alcohol). PVA-soil interaction**.
Chiellini, E., Cinelli, P., D'antone, S., Ilieva, V. I., Magni, S., Miele, S. and Pampana, S.
Macromolecular Symposia 197: 133-142 (2003).
http://dx.doi.org/10.1002/masy.200350713
Keywords: lignocellulosic/ mulch/ renewable resources/ soil/ polyvinyl-alcohol/ common bermudagrass/ polyacrylamide/ stabilization/ infiltration/ irrigation/ erosion
Abstract: This study is meant to provide a contribution in recent developments of biodegradable polymeric materials applied in agricultural practices with particular reference to the mulching segment. Special attention has been devoted to material based on renewable resources or utilization of waste products from agro-industrial activities, thus suggesting cost-effective and environmentally sound solutions to specific social needs. In the present contribution PVA solubility at room temperature has been improved by premixing with chemical additives and proteic materials. Waste materials from ethanol production by corn fermentation and from wood industries have been used as, respectively starch-based and lignocellulosic additives. The prepared formulations were applied on the soil by conventional spraying agricultural equipment. Time of permanence of

the film formed on the soil was monitored as well as the effect on corn growth and yield production. Finally, in order to investigate the final fate of the PVA applied on the soil, a test was performed in lysimeters, with half of the lysimeters cropped with maize plants. PVA amount applied for the mulching test was in order of 5-10 g PVA/1 m(2); under those conditions it resulted completely absorbed and no presence of PVA was recorded in the leached solutions.
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918. **Livestock Grazing Management and Water Quality Protection (State of the Art Reference Document)**.
Moore, E., Janes, E., Kinsinger, F., Pitney, K. and Sainsbury, J.
148 p. (1979).
http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9100V30K.txt
Keywords: range management/ grazing management/ water quality/ conservation practices/ government programs and projects/ environmental policy
Abstract: This document emphasizes summarization of research, prevention and control techniques, and criteria for preventing or minimizing water pollution. It presents. an overview of rangeland utilization and treatment related to water quality and selected management practices and techniques for the protection of water quality in rangeland management. The document is intended to be an aid for dealing with non point source pollution control. It is designed to farm the technical basis to assist managers in making rangeland decisions that minimize impacts on water quality. It is also intended to serve as a first step in developing a definitive basis for water quality management planning for this import ant non point source of water pollution.

919. **Livestock impacts on riparian ecosystems and streamside management implications: A review**.
Kauffman, J. B. and Krueger, W. C.
Journal of Range Management 37: 430-438 (1984). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/7758/7370
Keywords: grazing/ riparian vegetation/ plant communities/ ecosystems/ conservation practices
Abstract: Riparian vegetation has been defined as vegetation rooted at the water's edge. Quite often, however, the stream influences vegetation in many ways and well beyond the water line. In lotic systems, the stream is not only responsible for increased water availability, but also for the soil deposition, unique microclimate, increased productivity, and the many consequential, self-perpetuating biotic factors associated with riparian zones. These factors all contribute in the formation of a unique assemblage of plant communities quite distinct from upland communities surrounding the riparian zone. Therefore, along streambanks, other lotic systems, and even ephemeral drainages, riparian ecosystems could best be defined as those assemblages of plant, animal, and aquatic communities whose presence can be either directly or indirectly attributed to factors that are stream-induced or related. Public grazing lands must be managed on a true multiple use basis that recognizes and evaluates the biological potential of each ecological zone in relation to the present and future needs of society. This literature review covers: Importance of Riparian/Stream Ecosystems; Livestock Riparian Relationships; and Management of Riparian Ecosystems. It is concluded that management strategies that recognize all resource values must be designed to maintain or restore the integrity of riparian communities.
This citation is from the University of Arizona Institutional Repository.

920. **Longitudinal-Vertical Hydrodynamics and Transport with Chemical Equilibria for Lake Powell and Lake Mead**.
Edinger, J. E., Buchak, E. M. and Merritt, D. H.
Salinity in Watercourses and Reservoirs. Proceedings of the 1983 International Symposium on State-of-the-Art Control of Salinity July 13-15, 1983, Salt Lake City, Utah. Butterworth Publishers, Boston, Massachusetts. 1984. p 213-222, 5 fig, 1 tab, 6 ref. (1983).
Keywords: lakes/ sources and fate of pollution/ LARM/ models
Abstract: Versions of the LARM longitudinal and vertical hydrodynamic and transport model have been set up to study the time-varying seasonal circulation, heat and salinity transport of Lake Powell and Lake Mead. The model has been coupled with the calcium carbonate and sulfate equilibria to determine the temporal and spatial distribution, as well as the amount, of the precipitation of calcium carbonate. Lake Mead

data show that there are gypsum or CaSO4 sources along the reservoir that can add calcium and sulfate to the system and shift the carbonate balance. This is accommodated in the chemical balance by transporting sulfates along with calcium, inorganic carbon and net charge. For Lake Mead, the sulfate is removed from the definition of net charge since it is no longer conservative and is included in the charge balance, for computation of the equilibria and CaCO3 saturation. By modeling the equilibrium relations over the entire volume of the reservoir, the change in concentration due to precipitation and dissolution over a year or more can be evaluated. Simulations at different reservoir levels, and inflow and outflow conditions will enable determination of their effects on changes in total dissolved solids. The results can then be included in the Colorado River Simulation System, providing another improvement in the predictive techniques. (Lantz-PTT)
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921. **Long-term impact of agricultural practices on biological soil crusts and their hydrological processes in a semiarid landscape**.
Zaady, E., Arbel, S., Barkai, D. and Sarig, S.
Journal of Arid Environments 90: 5-11 (2013).
ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2012.10.021
Keywords: chlorophyll/ hydraulic conductivity/ LTER/ polysaccharide/ runoff
Abstract: The natural landscapes of semiarid areas worldwide comprise a series of scattered patches of shrubs within a matrix of biologically crusted soils (BSC). As BSCs are considered ecosystem engineers the relationships between the BSC and the shrub patches determine system functioning. The objective of our study was to investigate long-term effects of agricultural practices on biological soil crusts and their influence on hydrological aspects of a semiarid ecosystem. During 1991, we experimentally simulated five of the area's agricultural practices; 1) Scraping – the topsoil was removed to a depth of 2 cm, 2) Spraying – phototrophic organisms were chemically killed with herbicide, 3) Mowing – perennial vegetation was cut and spread to simulate grazing practices, 4) Car track – a heavy roller was used to simulate car-tracks, 5) Control – undisturbed natural plots. Sixteen years later, in 2007, these agricultural practices were found to have a long-term effect on the crusted soil surface and the related soil-surface properties. Mowing and car-track treatments led to decreased overland runoff and increased hydraulic conductivity, whereas scraping and spraying treatments led to increased overland runoff production and decreased hydraulic conductivity. We conclude that the practices had a long-term residual impact on BSC succession and related soil surface properties, which affected the hydrological processes and system functioning.
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922. **Long-term plant community development as influenced by revegetation techniques**.
Newman, G. J. and Redente, E. F.
Journal of Range Management 54: 717-724 (2001).
ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/viewFile/9679/9291
Keywords: fertilization/ irrigation/ reclamation/ restoration/ seed mixtures/ seeding/ succession/ community development/ plant communities/ restoration ecology/ revegetation/ United States/ *Artemisia tridentata*
Abstract: A revegetation techniques study was imitated during the fall of 1976 in northwestern Colorado in a disturbed sagebrush (*Artemisia tridentata* Nutt.) community. The study included 2 irrigation treatments, three seed mixtures, 2 seeding techniques, and 2 fertilization treatments. Short-term results were published and conclusions were made regarding the initial success of each treatment. The objective of the current study was to determine the effects of each treatment on plant community production, species composition, and species diversity after 20 years of plant community development. Among irrigated plots, the native seed mixture produced greater aboveground biomass compared to an introduced mixture and a mixture of both native and introduced species (combination seed mixture). The native seed mixture also resulted in greater total species richness than the introduced mixture when averaging over all other treatments. Altered seeding rate ratios among life forms as well as altered seeding methods (drill versus broadcast seeding) did not significantly alter plant community development after 20 years. However, a single application of nitrogen and phosphorus significantly increased grass production on plots seeded to the combination seed mixture. All revegetation plots have remained grass-dominated. However, shrub

biomass was greater in the native and combination mixtures than in the introduced mixture under initial irrigated conditions in part due to successful establishment and growth of four-wing saltbush (*Atriplex canescens* Pursh Nutt.). Thus, the seed mixtures evaluated in this study have resulted in distinctly different plant communities and demonstrate that such initial treatments can influence long-term plant community development on severely disturbed rangelands. Broadcast seeding a native seed mixture that has been irrigated for 2 growing seasons without fertilization appears to be an effective long-term combination of cultural revegetation practices.
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923. **Long-Term Successional Trends Following Western Juniper Cutting**.
Bates, J. D., Miller, R. F. and Svejcar, T.
Rangeland Ecology and Management 58: 533-541 (2005). ISSN: 1550-7424
http://dx.doi.org/10.2111/1551-5028(2005)58[533:LSTFWJ]2.0.CO;2
Keywords: juniper control/ plant succession/ herbaceous cover/ plant communities
Abstract: Western juniper (*Juniperus occidentalis* spp. *occidentalis* Hook.) expansion into sagebrush steppe plant communities in the northern Great Basin has diminished shrub-steppe productivity and diversity. Chainsaw cutting of western juniper woodlands is a commonly applied practice for removing tree interference and restoring understory composition. Studies reporting understory response following juniper cutting have been limited to early successional stages. This study assessed successional dynamics spanning 13 years following tree cutting. Total herbaceous standing crop and cover increased significantly in the CUT. Total standing crop was 10 times greater in the CUT vs. WOODLAND. Herbaceous standing crop and cover, and densities of perennial grasses in the CUT did not change between 1996 and 2004 indicating that by the 5th year after cutting, remaining open areas had been occupied. In the early successional stages, perennial bunchgrasses and Sandberg's bluegrass were dominant. By the 5th year after treatment, cheatgrass had supplanted Sandberg's bluegrass and was codominant with perennial bunchgrasses. In 2003 and 2004, perennial bunchgrasses dominated herbaceous productivity in the CUT, representing nearly 90% of total herbaceous standing crop. A pretreatment density of 2–3 perennial bunchgrasses m−2 appeared to be sufficient to permit natural recovery after juniper control. Perennial bunchgrass density peaked in the 6th year after treatment and the results suggested that 10–12 plants m−2 were sufficient to fully occupy the site and dominate herbaceous composition in subsequent years. In the CUT, juniper rapidly reestablished from seed and from the presence of seedlings not controlled in the initial treatment. The shifts in herbaceous composition across years suggests that long term monitoring is important for evaluating plant community response to juniper control and to develop appropriate post treatment management to promote continued site improvement.
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924. **Mechanical Renovation of Shortgrass Prairie for Increased Herbage Production**.
Griffith, L. W., Schuman, G. E., Rauzi, F. and Baumgartner, R. E.
Journal of Range Management 38: 7-10 (1985).
https://journals.uair.arizona.edu/index.php/jrm/article/view/7791/7403
Keywords: rangelands/ range management/ forage yield/ conservation practices
Abstract: A study to determine the effects of single ripping, double ripping, and contour furrowing treatments was conducted on shortgrass rangeland in southeastern Wyoming from 1979-1982. The mechanical treatments changed species composition and increased total forage production over the control. Western wheatgrass (*Agropyron smithii* Rydb.) exhibited increased production on the treated areas compared to the control. Blue grama [*Bouteloua grucilis* (H.B.K.) Lag. ex Griffiths] production was significantly lower on the double ripping (1981 and 1982) and the contour furrow (1981) treatments than on the control. Needle-and-thread (*Stipa comata* Trin. & Rupr.) exhibited an increasing trend on the single and double ripping treatment over the control treatment ail 4 years. Forbs also showed his trend in 1979,1980 and 1981 on all renovation treatments, however little difference in forb production was evident in 1982. Total production differences were the greatest in the first year of renovation (1979) and in 1980 when the annual precipitation was below the long-term average. Increased livestock carrying capacities would result in payback of the renovation costs in 4 years.

This citation is from the University of Arizona Institutional Repository.

925. **Microbiotic crust influence on unsaturated hydraulic conductivity**.
Williams, J. D., Dobrowolski, J. P. and West, N. E.
Arid Soil Research and Rehabilitation 13: 145-154 (1999).
http://go.usa.gov/WrSB
Keywords: aridland processes/ biocrusts/ cryptobiotic crusts/ cryptogamic crusts/ microphytic crusts/ rangeland soils
Abstract: Microbiotic crusts occur extensively in I rangeland soils. Developed by filaments of cyanobacteria and algae, and thalli of lichen and moss entanglement of soil particles, they create a physical discontinuity in the surface profile with greater concentrations of clay, silt, and potentially hydrophobic organic matter. These conditions potentially contribute to variability in soil hydrology of arid land and should be considered in the development of hydrologic and erosion models. However, there is limited manipulative research examining the functional relationships between soil and microbiotic crusts. We investigated the influence of cyanobacterial-dominated microbiotic crust on measured hydraulic conductivity (K) in a sandy loan soil at a southeastern Utah site. Using a tension infiltrometer, we determined K under three surface treatments: undisturbed, chemically killed (representing dead microphytes within the crust), and removed (scalped) microbiotic crusts. We applied treatments to spatially interspersed intact surface soils within shrub interspaces. Microbiotic crusts at this site and in this stage of successional development had no discernible influence on K. This finding supports results from research conducted in a variety of soils from sandy to silt dominated with a range of microbiotic development. Because this research was site and time specific, and because the role of microbiotic crusts in the environment continues to be debated, additional research is warranted to determine how Stage of development of microbiotic crust influences soil hydrology.

926. **Modeling Effects of Brush Management on the Rangeland Water Budget: Edwards Plateau, Texas**.
Afinowicz, J. D., Munster, C. L. and Wilcox, B. P.
Journal of the American Water Resources Association 41: 181-193 (2005).
http://dx.doi.org/10.1111/j.1752-1688.2005.tb03727.x
Keywords: base flow/ basins/ evaluation/ evapotranspiration/ field tests/ hydrologic budget/ hydrologic data/ hydrologic models/ karst/ numerical simulations/ rangelands/ recharge/ simulation/ slopes/ soil/ subsurface flow/ surface runoff/ water budget/ watersheds/ flow rates/ plateaus
Abstract: The Soil and Water Assessment Tool (SWAT) was used to evaluate the influence of woody plants on water budgets of semiarid rangelands in karst terrain. The model was configured for the hydrologic evaluation of the North Fork of the Upper Guadalupe River watershed and was calibrated and verified using measured flow data. Nash and Sutcliffe fit efficiencies for daily and monthly verification periods were 0.09 and 0.50, respectively. Streamflow, baseflow, and evapotranspiration (ET) rates were comparable to published field data. Simulated deep recharge was considerably higher than the published values for the Edwards Plateau. The model was then used to simulate conditions with existing brush cover and four different brush removal scenarios. Scenarios were created to represent existing brush and the removal of brush from only locations that were either covered by heavy brush, were on a moderate slope, or were in shallow soils. Resulting data was compared to previous studies of both field experiments and model simulations. Maximum brush removal resulted in a reduction in ET equal to 31.94 mm/yr depth over the entire basin, or 46.62 mm/yr depth over the treated area. Removal of heavy brush cover resulted in the greatest changes in evapotranspiration, surface runoff, baseflow, and deep recharge. Slope was found to have the greatest effect on lateral subsurface flow.
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927. **Multicomponent geochemical transport modeling using the HYDRUS computer software packages**.
Simunek, J., Jacques, D., Van Genuchten, M. T. and Mallants, D.
International Salinity Forum. Managing Soils and Water: Science, Technology, and Soil Issues, Riverside CA (2005).
Keywords: models/ geochemistry/ soil transport processes/ saline water/ computer software
Abstract: The authors present two new comprehensive simulation tools based on the HYDRUS-1D software package. While the UNSATCHEM module (directly incorporated into HYDRUS-1D) is restricted to a specific chemical system involving the transport and reactions of major ions (thus making the program relatively easy to use), HP1 (HYDRUS1D-PHREEQC) accounts for an unprecedented range of instantaneous and kinetic chemical and biological reactions, including complexation, cation exchange, surface complexation, precipitation-dissolution, and/or redox reactions (thus requiring users to be more familiar with the chemistry involved).

928. **Natural Flow And Salt Computation Methods Natural Flow And Salt Computation Methods**.
Prairie, J. and Callejo, R.
Reclamation: Managing Water in the West, 112 p. (2005).
http://digitalcommons.usu.edu/govdocs/135
Keywords: salinity/ measurement/ soil transport processes/ hydrogeology
Abstract: This paper documents the steps taken to compute natural flow and salt in the Upper and Lower Colorado River Basins from 1971-1995. Natural flow and salt data are hydrologic input data required in the CRSS planning model. The methods used to compute natural flow and salt described in this paper have changed from previous methods as a result of recent research. This research found data and methodological inconsistency in past methods to compute natural flow and salt was compared to data and methods used in the CRSS planning model (Prairie and Fulp, 1999). To assure the computation of natural flow and salt is consistent with the use of natural flow and salt in the CRSS planning model, the new methods to compute natural flow and salt throughout the Colorado River Basin as described in this paper were adopted by the Bureau of Reclamation.
This citation is from Utah State University.

929. **Nitrates in South Dakota range soils**.
White, E. M. and Moore, D. G.
Journal of Range Management 25: 27-29 (1972). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/6009/5619
Keywords: nitrate/ soil/ grazing/ rangeland
Abstract: The nitrate contents and distributions were found to be similar in some South Dakota range soils with and without alfalfa and from over-grazed and lightly grazed range. Less than 3 ppm NO3- N was found except for 8 ppm in shale substrata below the normal depth of moisture penetration.
This citation is from the University of Arizona Institutional Repository.

930. **Nutrient dynamics of rangeland burns in southeastern Arizona**.
Emmerich, W. E.
Journal of Range Management 52: 606-614 (1999). ISSN: 0022-409X
http://handle.nal.usda.gov/10113/6147
Keywords: range management/ prescribed burning/ runoff/ biomass/ losses from soil/ gravelly soils/ sandy loam soils/ rainfall simulators/ potassium/ nitrogen/ phosphorus/ plant litter/ nutrients
Abstract: Burning of vegetation generally increases surface runoff and erosion and potentially can change the nutrient dynamics of an ecosystem with loss of nutrients. Nitrogen, phosphorus, and potassium nutrient status of soil and aboveground biomass were determined before fall and spring burns and 1 year later at 2 different soil and vegetation type locations in southeastern Arizona. The evaluations were repeated in subsequent years to evaluate a year effect. Potential nutrient loss in surface runoff and sediment was assessed with rainfall simulations conducted immediately after prescribed burns and after a second burn one year later. Nutrient loss in the runoff water and sediment from burned areas was compared to paired unburned. The soil contained >98% of the total nutrient and was not significantly influenced by the burn treatment. The nutrient concentrations in the regrowth biomass were

generally greater. Immediately after the first burn, nutrient loss in surface runoff and sediment was not affected by the burn treatment, but one location was greater than the other. After 1 year and a second burn, nutrient losses on the burn treatment were significantly greater than the unburned treatment and similar between locations. The nutrient loss in surface runoff was primarily associated with the sediment and influenced by an interaction between biomass and soil. The nutrient loss in runoff and sediment was small compared to the nutrient in the aboveground biomass and insignificant compared to the soil nutrient. The implication is that increased surface nutrient loss from burning could take place for many years before a significant amount of nutrient would be lost from the large soil pool and change the nutrient status of the ecosystem. Year and season were also important factors influencing nutrients in the soil, biomass, and in runoff and sediment losses, irrespective of a burn treatment effect.
This citation is from the University of Arizona Institutional Repository.

931. **Oak tree and grazing impacts on soil properties and nutrients in a California oak woodland**.
Dahlgren, R. A., Singer, M. J. and Huang, X.
Biogeochemistry 39: 45-64 (1997).
http://dx.doi.org/10.1023/A:1005812621312
Keywords: grazing/ nutrient cycling/ oak woodlands/ organic matter/ soil/ properties/ rangelands/ nitrogen mineralization/ savanna trees/ environment/ availability/ dynamics/ plant/ productivity/ regeneration/ variability/ ecosystems
Abstract: There is great interest in understanding how rangeland management practices affect the long-term sustainability of California oak woodland ecosystems through their influence on nutrient cycling. This study examines the effects of oak trees and low to moderate intensity grazing on soil properties and nutrient pools in a blue oak (*Quercus douglasii* H.&A.) woodland in the Sierra Nevada foothills of northern California. Four combinations of vegetation and management were investigated: oak with grazing, oak without grazing, open grasslands with grazing, and open grasslands without grazing. Results indicate that oak trees create islands of enhanced fertility through organic matter incorporation and nutrient cycling. Compared to adjacent grasslands, soils beneath the oak canopy have a lower bulk density, higher pH, and greater concentrations of organic carbon, nitrogen, total and available P, and exchangeable Ca, Mg, and K, especially in the upper soil horizons (0-35 cm). In contrast, the light grazing utilized at this site had minimal effects on soil properties which included an increase in the bulk density of the surface horizon and an increase in available P throughout the entire soil profile. While low to moderate intensity grazing has little effect at this study site, there could be much larger impacts under the more intensive grazing practices utilized on many rangelands. The lack of oak regeneration and oak tree removal to enhance forage production may eventually lead to large losses of nutrients and soil fertility from these ecosystems. Results of this study have important implications for predicting how management practices may potentially affect oak regeneration, water quality, and ecosystem sustainability.

932. **Off-road vehicles on public land**.
Sheridan, D. and Carroll, A.
Council of Environmental Quality, (1979).
http://wilderness.org/resource/road-vehicles-public-land
Keywords: all terrain vehicles/ rangelands/ disturbed soils/ land use/ range management/ environmental impact/ soil erosion/ environmental policy
Abstract: Off-road vehicles are an extremely touchy issue. In fact, of the several issues which arise out of public land use decisions-grazing, surface mining, water diversion, forest cutting, and wilderness designation - none, in this author's experience, is as volatile as off-road vehicles. Even the term itself, off-road vehicles or ORVs, is subject to controversy. More often than not the term is used to cover all motorized vehicles which travel off-road for recreational purposes. Snowmobilers, however, object to being lumped into a general category labeled ORVers. A review of the environmental costs, federal response, states response, and what is to be done is presented in this work.

933. **Outline of Ground-Water Hydrology with Definitions**.
Meinzer, O. E.
Geological Survey Water Supply Paper, Washington, D.C., 71 p. (1923).
http://pubs.er.usgs.gov/publication/wsp494

Keywords: groundwater/ hydrology/ subsurface flow
Abstract: The facts or truths on which groundwater hydrology or any other branch of science is based are immutable, but they are not fully known -- indeed, they are known in only small fragments. The concepts of a science are based on the facts or truths that are known or believed to exist. The more fully and accurately the facts of the science are known the more definite and satisfactory are its concepts. This document is an attempt to assemble terms in more or less current use and to set down the best possible definitions.

934. **Pelletized cyanobacterial soil amendments: Laboratory testing for survival, escapability, and nitrogen fixation**.
Buttars, S. M., St Clair, L. L., Johansen, J. R., Sray, J. C., Payne, M. C., Webb, B. L., Terry, R. E., Pendleton, B. K. and Warren, S. D.
Arid Soil Research and Rehabilitation 12: 165-178 (1998).
http://dx.doi.org/10.1080/15324989809381506
Keywords: alginate/ arid soils/ cryptogamic crust/ cyanobacteria/ inoculation/ *Microcoleus vaginatus*/ reclamation/ microphytic crust influence/ cryptogamic crusts/ national park/ recovery/ communities/ Utah/ fire/ aggregation/ rangelands/ erosion
Abstract: The escape and growth of *Microcoleus vaginatus* from alginate pellets onto soil crusts under controlled laboratory conditions were examined. Soil crust samples were collected and placed in petri dishes. Selected samples were sterilized, and three treatments were established: 75 g m(-2) Microcoleus pellets added to sterilized soil, 75 g m(-2) blank pellets added to sterilized soil, and unsterilized soil with no additions. Chlorophyll a readings were significantly higher in unsterilized soils. Microcoleus biovolumes were highest in sterilized inoculated soils and significantly higher than sterilized untreated soils. Microcoleus filament density was significantly higher in Microcoleus-inoculated soils than in the other two treatments. Nitrogen fixation activity was recorded in unsterilized soils after only I month, and rates increased as the experiment progressed. Microcoleus-inoculated soils had significant nitrogen-fixing activity during the last sampling period.
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935. **Physically based hydrologic modeling: 1. A terrain-based model for investigative purposes**.
Grayson, R. B., Moore, I. D. and Mcmahon, T. A.
Water Resources Research 28: 2639-2658 (1992). ISSN: 0043-1397
http://dx.doi.org/10.1029/92WR01258
Keywords: rangelands/ hydrology/ models/ watersheds/ overland flow/ runoff/ soil water
Abstract: THALES, a simple distributed parameter hydrologic model is presented and applied to two catchments in Australia and the United States, each with different dominant hydrologic responses. The model simulates Hortonian overland flow and runoff from saturated source areas and is used to identify some of the barriers to modeling the hydrology of small catchments. At Wagga Wagga in New South Wales, Australia, runoff is produced from saturated source areas, whereas on the Lucky Hills catchments at Walnut Gulch in Arizona, Hortonian overland flow processes dominate. Simulations at Wagga Wagga are based on published parameters and field data measured as part of an intensive field program and result in a relatively poor fit of the outflow hydrographs for a series of storms. The simulated position and growth of saturated areas coincides with the limited available information, indicating that at least the gross effects of subsurface water movement are being represented. For the Lucky Hills catchments, the hydrographs at the catchment outlet and points within the catchment are simulated for a storm series. The results are highly dependent on the parameter values, which are poorly defined, highlighting the lack of measured field data and lack of methodology for the collection of data at a scale appropriate for such models. The model structure is also shown to have a major influence on the output. The influence of simulating surface flow as sheet flow or rill flow or through a series of ephemeral gullies, as well as the choice of the surface roughness parameter and antecedent soil water conditions, is shown to have a profound effect on the distributed flow depth and velocity predictions. By fitting model parameters, a simulation assuming Hortonian overland flow produced similar results at the catchment outlet to those based on partial area runoff. These results are of concern since it is common to calibrate and verify hydrologic models based on the accuracy with which the catchment outflow is predicted. The internal estimates of flow characteristics

following such a calibration often provide the input to sediment and nutrient transport models. Models such as THALES produce an enormous amount of information and have the theoretical potential to provide a “universal” tool for the representation of hydrologic response. However, problems of verification and validation of such models are acute. These problems relate to the difficulty in measuring/deriving parameters a priori, measurement of the catchment response in sufficient detail for testing, and the validity of the fundamental assumptions and algorithms used in model development.
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936. **Plant species on salt-affected soil at Cheyenne Bottoms, Kansas**.
Aschenbach, T. A. and Kindscher, K.
Transactions of the Kansas Academy of Science 109: 207-213 (2006). ISSN: 0022-8443
http://dx.doi.org/10.1660/0022-8443(2006)109[207:PSOSSA]2.0.CO;2
Keywords: brine contamination/ Cheyenne Bottoms/ restoration/ saline-sodic soils/ salinity/ salt tolerance
Abstract: Soil salinity and vegetative cover were investigated at Cheyenne Bottoms Preserve, Kansas in an effort to identify and document the plant species present on naturally occurring salt- and sodium-affected soil. Soil salinity (as indicated by electrical and sodium adsorption ratio (SAR) were measured from nine soil conductivity, ECe) samples collected to a depth of 20 cm in June 1998. Vegetative cover was visually estimated in June and September 1998. A total of 20 plant species were encountered at five soil sampling locations on soils classified as saline, saline-sodic, or sodic. Dominant species observed include *Agropyron smithii*, *Distichlis spicata*, *Euphorbia geyeri*, *Poa arida*, and *Sporobolus airoides*. While most species encountered during this study exhibited greater vegetative cover on non-saline soils, all of the dominant species, except *A. smithii*, exhibited greater cover on salt-affected soil compared to non-saline soil. Comparable salinity levels and species found in areas that have been degraded through oil and gas production activities suggest that the dominant species observed in this study deserve further attention as potential candidates for the restoration of salt-affected areas.
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937. **Plot numbers required to determine infiltration rates and sediment production on rangelands in south central New Mexico**.
Wood, M. K.
Journal of Range Management 40: 259-263 (1987). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8125/7737
Keywords: rangelands/ grazing management/ range management/ infiltration (hydrology)/ sediment yield
Abstract: Many studies have been made, and continue to be conducted, to determine infiltration rates and sediment production on rangelands. Most of these studies use small sample plots (<2 m^2). This study determined the number of sample plots required to achieve confidence intervals of +/-10, +/-20 and +/-30% of the sample mean at 80, 90, and 95% probability levels. For 80 and 90% probability levels, 20% of the mean could be achieved with 1 to 5 plots for infiltration rates, and as low as 1 or as many as 263 plots for sediment production. For dry soil moisture conditions, infiltration rates could be estimated with 4 or 5 plots, with 10 to 12 plots needed for field capacity conditions to achieve 10% of the mean with 95% confidence. Achieving 10% of the mean with 95% confidence was not considered practical for sediment production.
This citation is from the University of Arizona Institutional Repository.

938. **Postfire succession in big sagebrush steppe with livestock grazing**.
Bates, J. D., Davies, K. W., Rhodes, E. C., Sharp, R. and Bates, J. D.
Rangeland Ecology and Management 62: 98-110 (2009). ISSN: 1550-7424
http://dx.doi.org/10.2111/08-096
Keywords: prescribed fire/ forage/ grazing/ plant communities/ rangeland management
Abstract: Prescribed fire in rangeland ecosystems is applied for a variety of management objectives, including enhancing productivity of forage species for domestic livestock. In the big sagebrush (*Artemisia tridentata* Nutt.) steppe of the western United States, fire has been a natural and prescribed disturbance, temporarily shifting vegetation from shrub--grass codominance to grass dominance. There is limited information on the impacts of grazing to community dynamics following fire in big sagebrush steppe. This study evaluated cattle grazing impacts over four growing

seasons after prescribed fire on Wyoming big sagebrush (*Artemisia tridentata* subsp. *Wyomingensis* [Beetle & Young] Welsh) steppe in eastern Oregon. Treatments included no grazing on burned and unburned sagebrush steppe, two summer-grazing applications after fire, and two spring-grazing applications after fire. Treatment plots were burned in fall 2002. Grazing trials were applied from 2003 to 2005. Vegetation dynamics in the treatments were evaluated by quantifying herbaceous canopy cover, density, annual yield, and perennial grass seed yield. Seed production was greater in the ungrazed burn treatments than in all burn--grazed treatments; however, these differences did not affect community recovery after fire. Other herbaceous response variables (cover, density, composition, and annual yield), bare ground, and soil surface litter did not differ among grazed and ungrazed burn treatments. All burn treatments (grazed and ungrazed) had greater herbaceous cover, herbaceous standing crop, herbaceous annual yield, and grass seed production than the unburned treatment by the second or third year after fire. The results demonstrated that properly applied livestock grazing after low-severity, prescribed fire will not hinder the recovery of herbaceous plant communities in Wyoming big sagebrush steppe. © *Elsevier*

939. **Preferential flow in water repellent sandy soils: principles and modeling implications**.
Ritsema, C. J. and Dekker, L. W.
Journal of Hydrology 231: 308-319 (2000). http://dx.doi.org/10.1016/S0022-1694(00)00203-1
Keywords: preferential flow and transport/ water repellency/ modeling/ sandy soil/ Time domain reflectometry
Abstract: Leaching risks of surface-applied agrichemicals in water repellent soils can only be quantified with an acceptable degree of accuracy if knowledge of the underlying processes, principles and an appropriate simulation model are available. The present study aimed to investigate water flow and solute transport processes in the unsaturated zone of a water repellent sandy soil, and to indicate consequences for modeling. Soil blocks with a length, width and depth of 1.2, 0.6, and 0.52 m, respectively, were sampled in the Ouddorp water repellent sandy soil to investigate three-dimensional soil water content distributions. Preferential how patterns were clearly visible in soil blocks sampled after distinct rain events. Additional TDR measurements revealed that preferential pathways develop rapidly during severe rain storms, causing infiltrating water to be preferentially transported to the deeper subsoil. Further, preferred pathways recurred at the same sites during all rain events. Simulations with a two-dimensional flow and transport model indicate that preferential how paths will only form during infiltration into dry water repellent soils, i.e. in the range below the critical soil moisture content. Based upon the obtained results, indications are given on how to incorporate this preferential flow and transport process in current one-dimensional simulation models. (C) 2000 Elsevier Science B.V. All rights reserved.

940. **Prescribed burning effects in Central California chaparral**.
Florence, S. R. and Florence, M. A.
Rangelands 10: 138-140 (1988). ISSN: 0190-0528
https://journals.uair.arizona.edu/index.php/rangelands/article/view/10391/9662
Keywords: chaparral/ prescribed fire/ wildlife habitat/ forage/ rangeland management
Abstract: Since 1979, more than 20,000 acres of chaparral have been burned on public lands administered by the Bureau of Land Management in central California. The per acre cost of these burns has ranged from two or three dollars per acre for large, winter hazard reduction burns to about 47 dollars per acre forsome wildlife habitat improvement burns requiring mechanical pretreatment. Since chaparral vegetation has been recognized as requiring fire to rejuvenate itself, fire should function as a natural force in order to perpetuate these communities. Currently, prescribed burning is necessary to reduce hazardous fuel levels to prevent catastrophic wildfires and decrease erosion. Opening up dense brush fields also improves wildlife habitat and increases livestock forage. Most chaparral areas should be managed to promote species diversity and regeneration of sprouters and obligate seeders in coordination with management goals. Since the season of the burn and intensity of fire affects plant species response, burns can be timed to maximize the desired response.
This citation is from the University of Arizona Institutional Repository.

941. **Principles of Intensive Range Improvements**.
Herbel, C. H.
Journal of Range Management
36: 140-144 (1983).
https://journals.uair.arizona.edu/index.php/jrm/article/view/7488/7100
Keywords: rangeland management/ conservation practices/ native plant communities
Abstract: Our expanding population is demanding more productivity and other contributions from our rangelands. Range science is concerned with the plants, animals, soils, and waters on rangelands, particularly the interaction of these factors. Native plant communities should only be used as guides to determine site potential. Extensive practices on rangelands include manipulation of animals and burning. Intensive practices include control of unwanted plants, revegetation, and fertilization. When properly conducted, intensive manipulation practices often result in much higher production than before treatment. Each land manager determines the desired level of productivity based on economic, cultural, political, and social factors, and the availability of technology. The most effective method for control of unwanted plants varies with the sites, the species, and the degree of infestation. Revegetation may be required where desirable vegetation has been depleted by past grazing abuses, droughts, and encroachment of unwanted plants. Water is generally the primary factor limiting plant growth but when that need has been satisfied, additional plant nutrients such as nitrogen and phosphorus may be useful. The more costly practices are riskier and require higher management inputs, but the potential benefits are great. With changing technology or favorable economic conditions, the range manager may decide to intensify his range improvement efforts.
This citation is from the University of Arizona Institutional Repository.

942. **Production waters associated with the Ferron coalbed methane fields, central Utah: chemical and isotopic composition and volumes**.
Rice, C. A.
International Journal of Coal Geology
56: 141-169 (2003).
http://pubs.er.usgs.gov/publication/70024959
Keywords: coalbed methane/ Ferron Sandstone member/ produced water/ mancos shale/ stable isotopes/ sandstone/ basin
Abstract: This study investigated the composition of water co-produced with coalbed methane (CBM) from the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in east-central Utah to better understand coalbed methane reservoirs. The Ferron coalbed methane play currently has more than 600 wells producing an average of 240 bbl/day/well water. Water samples collected from 28 wellheads in three fields (Buzzards Bench, Drunkards Wash, and Helper State) of the northeast-southwest trending play were analyzed for chemical and stable isotopic composition. Water produced from coalbed methane wells is a Na-Cl-HCO3 type. Water from the Drunkards Wash field has the lowest total dissolved solids (TDS) (6300 mg/l) increasing in value to the southeast and northeast. In the Helper State field, about 6 miles northeast, water has the highest total dissolved solids (43,000 mg/l), and major ion abundance indicates the possible influence of evaporite dissolution or mixing with a saline brine. In the southern Buzzards Bench field, water has variable total dissolved solids that are not correlated with depth or spatial distance. Significant differences in the relative compositions are present between the three fields implying varying origins of solutes and/or different water-rock interactions along multiple flow paths. Stable isotopic values of water from the Ferron range from +0.9parts per thousand to -11.4parts per thousand delta(18)O and -32parts per thousand to -90parts per thousand delta(2)H and plot below the global meteoric water line (GMWL) on a line near, but above values of present-day meteoric water. isotopic values of Ferron water are consistent with modification of meteoric water along a flow path by mixing with an evolved seawater brine and/or interaction with carbonate minerals. Analysis of isotopic values versus chloride (conservative element) and total dissolved solids concentrations indicates that recharge water in the Buzzards Bench area is distinct from recharge water in Drunkards Wash and is about 3degreesC warmer. These variations in isotopes along with compositional variations imply that the Ferron reservoir is heterogeneous and compartmentalized, and that multiple flow paths may exist. Crown Copyright (C) 2003 Published by Elsevier B.V. All rights reserved.

943. **Quantifying the impact of groundwater depth on evapotranspiration in a semi-arid grassland region**.
Soylu, M. E., Istanbulluoglu, E., Lenters, J. D. and Wang, T.
Hydrology and Earth System Sciences 15: 787-806 (2011). ISSN: 1027-5606
http://dx.doi.org/10.5194/hess-15-787-2011
Keywords: data sets/ deep groundwaters/ ecohydrology/ field observations/ flux model/ groundwater level/ Hydrus-1D/ integrated biosphere simulators/ land surface/ land surface models/ land-surface process/ model formulation/ Nebraska/ numerical models/ parameterizations/ pressure-based/ Richards equation/ riparian zones/ semi arid/ semi-arid grasslands/ shallow groundwater/ soil hydraulic parameters/ soil hydraulic properties/ soil layer/ soil moisture model/ soil parameters/ soil textures/ water table depths/ aquifers/ climate models/ computer simulation/ evapotranspiration/ groundwater resources/ hydraulics/ moisture determination/ parameterization/ rain/ soil moisture/ solute transport/ surface chemistry/ surface measurement/ textures/ water content/ water supply/ geologic models/ capillarity/ data set/ ecohydrology/ grassland/ hydraulic property/ numerical model/ riparian zone/ semiarid region/ soil texture/ soil water/ water depth/ water table
Abstract: Interactions between shallow groundwater and land surface processes play an important role in the ecohydrology of riparian zones. Some recent land surface models (LSMs) incorporate groundwater-land surface interactions using parameterizations at varying levels of detail. In this paper, we examine the sensitivity of land surface evapotranspiration (ET) to water table depth, soil texture, and two commonly used soil hydraulic parameter datasets using four models with varying levels of complexity. The selected models are Hydrus-1D, which solves the pressure-based Richards equation, the Integrated Biosphere Simulator (IBIS), which simulates interactions among multiple soil layers using a (water-content) variant of the Richards equation, and two forms of a steady-state capillary flux model coupled with a single-bucket soil moisture model. These models are first evaluated using field observations of climate, soil moisture, and groundwater levels at a semi-arid site in south-central Nebraska, USA. All four models are found to compare reasonably well with observations, particularly when the effects of groundwater are included. We then examine the sensitivity of modelled ET to water table depth for various model formulations, node spacing's, and soil textures (using soil hydraulic parameter values from two different sources, namely Rawls and Clapp-Hornberger). The results indicate a strong influence of soil texture and water table depth on groundwater contributions to ET. Furthermore, differences in texture-specific, class-averaged soil parameters obtained from the two literature sources lead to large differences in the simulated depth and thickness of the "critical zone" (i.e., the zone within which variations in water table depth strongly impact surface ET). Depending on the depth-to-groundwater, this can also lead to large discrepancies in simulated ET (in some cases by more than a factor of two). When the Clapp-Hornberger soil parameter dataset is used, the critical zone becomes significantly deeper, and surface ET rates become much higher, resulting in a stronger influence of deep groundwater on the land surface energy and water balance. In general, we find that the simulated sensitivity of ET to the choice of soil hydraulic parameter dataset is greater than the sensitivity to soil texture defined within each dataset, or even to the choice of model formulation. Thus, our findings underscore the need for future modelling and field-based studies to improve the predictability of groundwater-land surface interactions in numerical models, particularly as it relates to the parameterization of soil hydraulic properties. © Author(s) 2011.
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944. **The rancher's ALMANAC**.
Johnson, M. V. V., Finzel, J. A., Spanel, D., Weltz, M., Sanchez, H. and Kiniry, J. R.
Rangelands 33: 10-16 (2011). ISSN: 1551-501X
http://dx.doi.org/10.2111/1551-501X-33.2.10
Keywords: models/ Conservation Effects Assessment Project/ rangeland condition
Abstract: The mathematical Agricultural Land Management Alternatives with Numerical Assessment Criteria (ALMANAC) Model simulates short- and long-term western rangeland vegetation response to various conservation strategies. The model was chosen by the Rangeland Conservation Effects Assessment Program to assess rangeland health across the western United States. Here we demonstrate the model's accuracy as

compared to NRCS Ecological Site Description data at sites in Nevada, Utah, and California. The model is free and available to the public. The USDA–ARS Grassland, Soil, and Water Research Lab at Temple, Texas (http://www.ars.usda.gov/spa/gswrl), conducts free seminars on input parameter development and ALMANAC simulation training.
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945. **Ranches evaluate contour furrows for livestock grazing**.
Lacey, J. R., Mowbray, J. E. and Wight, J. R.
Rangelands 3: 59-60 (1981).
http://db.nr.usu.edu/qlc/pdf/R24139.pdf
Keywords: contour furrows/ conservation practices/ erosion/ runoff/ grazing/ herbage production/ rangeland management
Abstract: Contour furrowing is a land-surface treatment that has been used to increase herbage production and reduce runoff and erosion on western rangelands. In southeastern Montana, this mechanical treatment increased herbage production by as much as 165% on panspots range sites. Panspots are 'areas of silty, clayey, or sandy soils in complex with shallow depressions of hard clays or other nearly impervious materials at or near the surface." Although the Bureau of Land Management contour furrowed 36,000 acres of Montana rangeland during the 1960's and early 1970's, only a few Montana ranchers have used this rangeland treatment. The purpose of this article is to identify livestock management problems on the contour-furrowed rangelands and to recommend practices to minimize the problems. 15 ranchers were interviewed concerning their experience with livestock grazing in contour-furrowed pastures. All of the 15 ranchers interviewed rated contour furrowing as a worthwhile rangeland treatment, and 13 of the ranchers wanted the BLM to do more contour furrowing on their allotments even though they felt that furrows increased the incidence of livestock losses because animals got trapped on their backs. This suggests that the ranchers felt the extra forage production from furrowing offset the management problems. However, none of the ranchers had done any significant amount of contour furrowing on his own land. Unfortunately, livestock losses could not be counted because actual use records were not available and because actual causes of death had not been determined. Most of the ranchers changed kind or class of livestock in order to minimize the management problems. Yearling cattle appeared to be well-suited to grazing contour-furrowed pastures, whereas sheep were poorly suited during certain seasons. The furrows seemed to cause fewer management problems as they aged and became shallower. Although the evidence is circumstantial, contour furrows do seem to cause management problems from grazing livestock, especially sheep. The results of this study suggest that the livestock problems associated with grazing contour furrows can be greatly reduced or eliminated by management practices that include: (1) modifying the furrow structure toward a shallow, flat-bottomed type furrow; (2) leaving islands of nonfurrowed areas interspaced with the furrows to provide a place for animals to rest; and (3) controlling the season of use and kind and class of grazing animal. In the past, emphasis has been on forage production and runoff as affected by contour furrowing. In the future, more consideration should be given to better utilization of this increased forage supply through furrow construction and grazing management.
This citation is from Utah State University.

946. **Range Reseeding Success on the Tonto National Forest, Arizona**.
Judd, B. I.
Journal of Range Management 19: 296-301 (1966). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/5435/5045
Keywords: seeding/ rangeland management/ revegetation
Abstract: Longevity of range plantings is important to those interested in range restoration by this means. An analysis of plantings of 1945 and 1946 through 1965 provide information on longevity for four different environments on the Tonto National Forest of central Arizona. Protective brush mulch was highly important for stand establishment under the conditions of these tests.
This citation is from the University of Arizona Institutional Repository.

947. **Rangeland condition: Its meaning and use**.
Ludwig, J. A. and Bastin, G. N., Australian Collaborative Rangelands Information System (ACRIS) Management Committee, 8 p. (2008).
http://www.environment.gov.au/land/publications/acris/pubs/rangeland-condition-meaning-use.pdf
Keywords: rangeland condition/ monitoring/ ACRIS
Abstract: A Discussion Paper prepared for the Australian Collaborative Rangelands Information System (ACRIS) Management Committee.

948. **Rangeland Conservation and Shrub Encroachment: New Perspectives on an Old Problem**.
Archer, S. R.
Wild Rangelands, John Wiley & Sons, Ltd**:** 53-97 (2009).
http://dx.doi.org/10.1002/9781444317091.ch4
Keywords: rangeland conservation/ shrub encroachment/ woody plant (WP) encroachment/ terrestrial net primary productivity (NPP)/ forage production/ livestock safety/ WP effects/ stream flow/ groundwater recharge/ conservation biology
Abstract: This chapter contains sections: Why has woody plant abundance increased on rangelands?; Traditional perspectives on woody plant encroachment; Emerging perspectives on woody plant encroachment; Brush management in the twenty-first century; and Woody plants in future environments.
© *Wiley Online Library*

949. **Rangeland health attributes and indicators for qualitative assessment**.
Pyke, D. A., Herrick, J. E., Shaver, P. and Pellant, M.
Journal of Range Management 55: 584-597 (2002). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/9760/9372
Keywords: ecosystems/ site stability/ soil stability/ hydrologic function/ biotic integrity/ assessments/ rangeland health
Abstract: Panels of experts from the Society for Range Management and the National Research Council proposed that status of rangeland ecosystems could be ascertained by evaluating an ecological site's potential to conserve soil resources and by a series of indicators for ecosystem processes and site stability. Using these recommendations as a starting point, we developed a rapid, qualitative method for assessing a moment-in-time status of rangelands. Evaluators rate 17 indicators to assess 3 ecosystem attributes (soil and site stability, hydrologic function, and biotic integrity) for a given location. Indicators include rills, water flow patterns, pedestals and terracettes, bare ground, gullies, wind scour and depositional areas, litter movement, soil resistance to erosion, soil surface loss or degradation, plant composition relative to infiltration, soil compaction, plant functional/structural groups, plant mortality, litter amount, annual production, invasive plants, and reproductive capability. In this paper, we detail the development and evolution of the technique and introduce a modified ecological reference worksheet that documents the expected presence and amount of each indicator on the ecological site. In addition, we review the intended applications for this technique and clarify the differences between assessment and monitoring that lead us to recommend this technique be used for moment-in-time assessments and not be used for temporal monitoring of rangeland status. Lastly, we propose a mechanism for adapting and modifying this technique to reflect improvements in understanding of ecosystem processes. We support the need for quantitative measures for monitoring rangeland health and propose some measures that we believe may address some of the 17 indicators.
This citation is from the University of Arizona Institutional Repository.

950. **Rangeland vegetation-hydrologic interactions**.
Wood, M. K.
Vegetation Science Applications in Rangeland Analysis Management. Tueller, P. T. Boston, MA; Dordrecht, Netherlands, Kluwer Academic Publishers**:** 469-491 (1988).
http://dx.doi.org/10.1007/978-94-009-3085-8_19
Keywords: rangelands/ vegetation cover/ hydrogeology/ hydrology
Abstract: Hydrologic resources are closely tied to an area's climate and rangelands encompass many different climatic zones. Approximately 40% of the world's land surface is classified as rangeland, and more than 80% is within arid and semiarid zones. Hydrologic processes are influenced greatly by the kinds and amounts of plants growing on rangelands. Important plant features include growth forms, phytomass,

density, distribution, leaf-area index, height, age, and more. Plants probably have their greatest influence on infiltration rates and these rates influence several other processes in the hydrologic cycle, including runoff, erosion, and permeability. An important key for meeting future water needs in many places throughout the world is water control and efficient use on rangelands.

951. **Rangeland watershed water budget and grazing cattle waste nutrient cycling**.
Powell, J., Crow, F. R. and Wagner, D. G., Ada, Oklahoma, U.S. Environmental Protection Agency, 333 p. (1983).
http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9100NBM7.txt
Keywords: runoff/ nonpoint source pollution/ grazing/ watersheds/ tall grass prairie/ sediment/ vegetation/ cattle manure/ soil water content
Abstract: This research project was designed to determine baseline data concerning the source, movement, concentration and factors affecting nonpoint pollutants in runoff from a representative 60-hectare, tallgrass prairie watershed grazed by cattle in North Central Oklahoma. Measurements were made to determine precipitation and runoff amounts and concentrations of sediment, nitrogen, phosphorus, potassium, BOD, COD and TOC. Concentrations of N, P, K, Ca and structural carbohydrates were determined in live and standing dead vegetation and dung collected periodically from different locations on the watershed. Stocking density and grazing pressure were calculated. Independent site factors were used in regression equations to predict plant species abundance, live and standing dead vegetation biomass, utilization and dung pat density and biomass. The amount of nonpoint source pollution contributed to receiving waters by runoff from the watershed was comparable to that from tallgrass prairie watersheds in other parts of the United States and was minimal when compared to other nonpoint sources of pollution. Significant runoff occurred in every season, but spring was the season with the greatest potential runoff and potential pollution because precipitation and soil water content were greatest and ground cover was lowest at this time. Sediment was the most significant pollutant. Direct overland movement of dung into stream channels was minimal because standing vegetation and ground litter.

952. **Redberry juniper canopy cover dynamics on western Texas rangelands**.
Ueckert, D. N., Phillips, R. A., Petersen, J. L., Ben Wu, X. and Waldron, D. F.
Journal of Range Management 54: 603-610 (2001). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/9661/9273
Keywords: plant ecology/ canopy cover/ juniper/ brush control/ livestock
Abstract: Knowledge of the rate woody plant canopy cover increases is essential for understanding the ecology of rangeland plant communities, determining the economic feasibility of brush management practices, and for scheduling initial and maintenance control practices. We determined rates of change in redberry juniper (*Juniperus pinchotii* Sudw.) canopy cover from the mid 1950s through the late 1990s at 5 locations in western Texas on rangeland that had been chained or grubbed for juniper control and on adjacent untreated areas. Juniper cover was estimated from aerial photographs by the line intercept method using a 10- × monocular lens with a vernier. Juniper cover increased at 0.35 ± 0.06 percentage units year-1 on untreated sites and at 1.01 ± 0.07 percentage units year-1 following chaining or grubbing. Juniper cover returned to pre-treatment levels in an average of 20 years (range 11 to 25) following chaining or grubbing. Herbage production on untreated rangeland was predicted to decline slowly (2.4 to 5.0 kg ha^-1 year^-1) as juniper cover increased from 6 to 14% and rapidly (>8 kg ha^-1 year^-1) as juniper cover increased from 30 to 38%. Herbage production was predicted to decline at a constantly increasing rate following mechanical control of juniper, from <2 kg ha^-1 year^-1 in year 1 to 23 kg ha^-1 year^-1 in year 29. Potential additional livestock carrying capacity due to juniper control would be under estimated by more than 40%, assuming forage production without treatment remained constant during the entire planning horizon of an economic analysis. To avoid significant reductions in livestock carrying capacity, redberry juniper control should be implemented before its canopy cover exceeds about 20%.
This citation is from the University of Arizona Institutional Repository.

953. **Renewable Resource Improvements and Treatments**.
U. S. Bureau of Land Management, (2008).
http://www.blm.gov/pgdata/etc/medialib/blm/wo/Information_Resources_Management/policy/blm_manual.Par.95813.File.dat/MS-1740.pdf
Keywords: land management/ policy/ native plants
Abstract: This release has been updated to include additional policy on maintaining and restoring native plant community diversity, resiliency, and productivity. The purpose of this updated manual is for identifying objectives, policies and standards that are common and apply to planning, analyzing, constructing, maintaining, replacing and or modifying renewable resource improvements and treatments for the forestry, range management, riparian management, soil, water, air, fish, wildlife, threatened and endangered species, wild horse and burro, invasive species, hazardous fuels reduction, emergency stabilization, and burned area rehabilitation programs to achieve management objectives on BLM managed lands. Objectives, policies, and standards applicable to only one program can be found in program-specific Manual Sections and Handbooks.

954. **The role of antelope trampling on scarp erosion in a hyper-arid environment, Skeleton Coast, Namibia**.
Boelhouwers, J. and Scheepers, T.
Journal of Arid Environments 58: 545-557 (2004). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2003.11.006
Keywords: animal trampling/ antelope/ scarp erosion/ Namibia/ hyper-arid environment
Abstract: The role of animal trampling in a hyper-arid environment is evaluated. Field observations on fluvial terraces of the Uniab fan in Namibia suggest that animal impact on level surfaces with gravel armouring is minimal. However, animal trampling along tracks across scarp slopes results in scarp recess and initiate cutback development. With continued growth ephemeral fluvial processes become more dominant and obscure the animal impact. Animal trampling effects are pronounced in hyper-arid environments due to the low rates of other slope processes. However, it is argued that large herd migration may have contributed significantly to cutback development in other environments, especially in Africa, but may be very difficult to substantiate by landform analysis.
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955. **The role of cyanobacterial exopolysaccharides in structuring desert microbial crusts**.
Mazor, G., Kidron, G. J., Vonshak, A. and Abeliovich, A.
FEMS Microbiology Ecology 21: 121-130 (1996).
http://dx.doi.org/10.1016/0168-6496(96)00050-5
Keywords: cyanobacteria/ Microcoleus/ microbial crusts/ exopolysaccharides/ western Negev/ algae/ stabilization/ soil/ water
Abstract: Microbial crusts are present on surfaces of soils throughout the world. A key feature of these crusts in arid zones is the abundance of filamentous sheath-forming and polysaccharide-excreting cyanobacteria. Several isolates of cyanobacteria were prepared from crust samples (Nizzana sand dunes, north-western Negev Desert, Israel). Optimal growth conditions for two such isolates of *Microcoleus* sp. were defined, and the role of the excreted polysaccharides in affecting the hydrological properties of crust-covered sand dunes was studied. Experiments with the native crust microbial population demonstrated the possibility of net primary productivity at both high relative air humidities and low moisture content.
© *Elsevier*

956. **Role of smectite dehydration in the migration of metals in the Mancos Shale adjacent to the Cerrillos Pluton, New Mexico**.
Nadeau, P. H.
Circum-Pacific Clay Minerals Society, 19th annual meeting, Hilo, HI, United States, Aug. 8-14, 1982 (1982).
Keywords: Cerrillos/ Cerrillos Pluton/ clastic rocks/ clay mineralogy/ clay minerals/ Cretaceous/ dehydration/ geochemistry/ intrusions/ Mancos Shale/ Mesozoic/ metals/ migration of elements/ mineral data/ New Mexico/ plutons/ sedimentary rocks/ shale/ sheet silicates/ silicates/ smectite/ trace elements/ United States
© *ProQuest*

957. **Sand fences for control of wind erosion and dust emission at Owens Lake, CA: 2. Design and wind-tunnel simulation**.
White, B. R., Cho, H. M. and Gill, T. E.
Proceedings of the 11th International Conference on Wind Engineering, Lubbock, TX (2003).
Keywords: sand fences/ wind erosion/ dust

958. **The Savory grazing method**.
Savory, A. and Parsons, S. D.
Rangelands 2: 234-237 (1980). ISSN: 0190-0528
https://journals.uair.arizona.edu/index.php/rangelands/article/view/10004/9616
Keywords: rangelands/ range management/ grazing management
This citation is from the University of Arizona Institutional Repository.

959. **A Scientific Assessment of the Effectiveness of Riparian Management Practices**.
George, M. R., Jackson, R. D., Boyd, C. S. and Tate, K. W.
Conservation benefits of rangeland practices: assessment, recommendations, and knowledge gaps. Briske, D. D. Lawrence, Kansas, U.S. Dept. of Agriculture, Natural Resources Conservation Service**:** 213-252 (2011).
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045800.pdf
Keywords: riparian areas/ conservation practices/ range management/ wildlife habitat/ water quantity/ hydrology/ water quality/ bank erosion/ streambank stability/ biogeochemical cycles/ species diversity/ watershed management
Abstract: This chapter evaluates the ecological effectiveness of the major purposes and expected benefits of 21 riparian management practices as described in the US Department of Agriculture, Natural Resources Conservation Service (USDA NRCS), National Conservation Practice Guidelines. The ecological benefits described in the standards for these practices include the following: Wildlife habitat; Water quantity and quality; Stream bank and soil stability; Carbon storage; Plant and animal diversity.

960. **Sculpting Brush Mechanically: Current State of the Art**.
Wiedemann, H. T.
Rangelands 29: 10-17 (2007). ISSN: 1551-501X
http://dx.doi.org/10.2111/1551-501X(2007)29[10:SBMCSO]2.0.CO;2
Keywords: brush sculpting/ brush control/ resource management
Abstract: Range scientists, resource management agencies, and landowners are now recognizing that woody plants have both tangible and intrinsic values. This recognition, smaller-sized land holdings, and various other reasons, have brought about the current paradigm of brush sculpting. Brush sculpting is a concept in which brush-infested rangeland is sculpted for multiple uses, including wildlife and endangered species habitat, watershed management, runoff control, recreation, and landscape enhancement, as well as traditional livestock grazing. These factors have influenced current mechanical brush control methods and devices in many ways. Each is discussed in this article.
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961. **Seasonal grazing impact on cryptogamic crusts in a cold desert ecosystem**.
Memmott, K. L., Anderson, V. J. and Monsen, S. B.
Journal of Range Management 51: 547-550 (1998).
https://journals.uair.arizona.edu/index.php/jrm/article/view/9355/8967
Keywords: lichens/ moss/ shrubs/ cattle/ erosion control/ soil crusts/ pinyon-juniper/ national park/ Utah/ recovery
Abstract: Since settlement, cattle grazing has been a major cause of soil disturbance in cold desert ecosystems. The objective of this study was to determine the impact of cattle grazing in different seasons on cryptogamic soil crusts. This study was conducted adjacent to the Brigham Young University Skaggs Research Ranch, near Malta, Ida. Five areas of a crested wheatgrass pasture each interplanted with shrubs were evaluated. Each of the 5 areas was subdivided into 4 paddocks; a control paddock remained ungrazed, while the other 3 paddocks were grazed in either spring, summer, or winter. Each of the 1.2-ha grazed paddocks was grazed annually in the same season for 2 consecutive years by 10 cows for 4 consecutive days. Percent of the soil surface covered by litter,

vascular plant bases, and cryptogams was measured using a 10-pin, point sampling frame. Mosses were the main component of the cryptogamic soil crusts under all grazing treatments. Winter grazing had no effect on the moss component of the crusts while spring and summer grazing reduced mosses. While winter grazing had significantly less impact on the lichen component of crusts relative to spring and summer grazing, there was a 50% reduction relative to the control plots. Total cryptogamic cover in the control paddocks averaged 27.6%; winter grazed paddocks 27.4%; summer grazed paddocks 14.4%; and spring grazed paddocks 10.6%. Controlled winter grazing has minimal impact on the total cryptogamic plant cover that protect soil surfaces on cold desert range ecosystems.
This citation is from the University of Arizona Institutional Repository.

962. **Short duration grazing in central New Mexico: effects on infiltration rates**.
Weltz, M. and Wood, M. K.
Journal of Range Management 39: 365-368 (1986). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8014/7626
Keywords: grazing management/ grazing intensity/ infiltration (hydrology)/ soil water/ range management/ conservation practices
Abstract: The objectives of this study were to determine the influence of short duration grazing, continuous grazing, and grazing exclusion on infiltration rates on 2 range sites in southcentral and eastcentral New Mexico. Short duration grazing had no beneficial effect on the hydrology of 2 different range sites. The terminal infiltration rates of both short duration grazing systems, after the cattle had grazed the area, were about one-half the terminal infiltration rate of the same area before the cattle grazed the area. Cattle distribution within the different grazing treatments had no effect on infiltration rates at 0.4, 0.8, and 1.2 km away from water for a moderate continuous, heavy continuous, and a short duration grazing system. Moderate continuous grazing was superior to heavy continuous grazing and short duration grazing, based on the hydrologic variables evaluated.
This citation is from the University of Arizona Institutional Repository.

963. **Short-duration grazing in central New Mexico: effects on sediment production**.
Weltz, M. and Wood, M. K.
Journal of Soil and Water Conservation 41: 262-266 (1986). ISSN: 0022-4561
Keywords: grazing management/ grazing intensity/ infiltration (hydrology)/ soil water/ range management/ conservation practices/ sediment transport/ erosion control/ soil erosion
Abstract: This study was conducted to determine the influences of short-duration grazing, continuous grazing, and grazing exclusion from cattle on soil erosion as expressed by sediment concentration and total suspended sediment on two range sites in New Mexico. Sediment concentration was the same for all treatments near Ft. Stanton. But total sediment production was greater on all grazed treatments than on the exclosure; there were no differences among grazed treatments. Doubling the stocking rate and applying a short duration system near Ft. Sumner resulted in significantly greater sediment concentration. Total sediment production in the grazed, short-duration pasture was triple that in the moderate, continuous pasture. These increases were attributed to reduced biomass and increased bare ground. Reduced plant biomass and groundcover offset any benefits from increased soil surface roughness and destroyed crusts.
This citation is from the Soil and Water Conservation Society.

964. **Short-duration grazing: Experiences from the Edwards Plateau region in Texas**.
Taylor, C. A.
Journal of Soil and Water Conservation 44: 297-302 (1989). ISSN: 0022-4561
Keywords: grazing management/ range management/ short-duration grazing
This citation is from the Soil and Water Conservation Society.

965. **Shrub control and streamflow on rangelands: A process based viewpoint**.
Wilcox, B. P.
Journal of Range Management 55: 318-326 (2002). ISSN: 0022-409X
http://www.ose.state.nm.us/PDF/ISC/Tier-2%20Final/NMSU/Wilcox%202002.pdf
Keywords: water yield/ range hydrology/ runoff/ shrub control/ ecohydrology/ streamflow/ semi-arid

Abstract: In this paper, the linkage between streamflow and shrub cover on rangelands is examined, with a focus on the extensive Texas rangelands dominated by mesquite and juniper. The conclusions drawn are consistent with results from field studies and with our understanding of runoff processes from rangelands. Whether and how shrub control will affect streamflow depends on shrub characteristics, precipitation, soils, and geology. Precipitation is perhaps the most fundamental of these factors: there is little if any real potential for increasing streamflow where annual precipitation is below about 500 mm. For areas in which precipitation is sufficient, a crucial indicator that there is potential for increasing streamflow through shrub control is the presence of springs or groundwater flow to streams. These conditions often occur at locations where soils are shallow and underlain by fractured parent material. Under such conditions, reducing shrub cover may increase streamflows because water that would otherwise be lost through interception by the canopy instead moves into the soil and quickly travels beyond the root zone. If, on the other hand, there is no obvious subsurface connection between the hillslope and the stream channel and when runoff occurs it occurs as overland flow, shrub control will have little if any influence on streamflow. In assessing the potential for shrub control to increase streamflow, the runoff generation process should be explicitly identified. An improved understanding of the linkages between shrubs and streamflow on rangelands will require additional research on (1) hillslope hydrologic processes and how these are altered by shrub cover (2) groundwater-surface water interactions and (3) hydrologic scale relationships from the patch to the hillslope to the landscape levels.

966. **Simulating leaching of potassium in a sandy soil using simple and complex models**.
Kolahchi, Z. and Jalali, M.
Agricultural Water Management 85: 85-94 (2006). ISSN: 0378-3774
http://dx.doi.org/10.1016/j.agwat.2006.03.011
Keywords: LEACHM model/ wineglass model/ potassium/ breakthrough curves/ adsorption coefficient
Abstract: The objective of this study was to assess the applicability of the Burn's-type model (simple model) and LEACHM (complex model) for describing potassium (K+) leaching in soil. Movement of K+ in a sandy soil using leaching column was examined. Pulse of K+ was applied to the column and then eluted with calcium chloride (CaCl2) solutions of various concentrations (3–15 mM CaCl2). Breakthrough curves for K+ indicated that after the initial adsorption, the concentration of K+ in the leachate would decrease rapidly with K+ retained strongly, so giving an extended tail. The LEACHM model was able to predict approximately the extent of K+ retardation, but K+ was leached a little later than simulated particularly at 5, 10 and 15 mM calcium (Ca2+) concentrations and the model was not able to predict effectively the slow rate of desorption of K+ from the column. Simulations using Wineglass model, described the location of the peak only in some cases and underestimated tailing. Also, the pulse of K+ was simulated to appear a little earlier and less tailed than that measured. Possible causes for the differences between the measured and simulated curves are as follows: the inability of the models to account for kinetically controlled chemical processes, assumption of a constant adsorption coefficient which is not valid as the adsorption coefficient changes as the concentration of K+ and Ca2+ changes during the leaching. The models could be useful tool to simulate leaching of K+ from agricultural land in regions with low quality water for irrigation and to forecast information in decision-making for environmental management.
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967. **Social and Economic Assessment of Rangeland Conservation Practices**.
Tanaka, J. A., Brunson, M. and Torell, L. A.
Conservation Benefits of Rangelands Practices. Briske, D. D., USDA Natural Resources Conservation Service**:** 371-422 (2011).
http://go.usa.gov/WrhH
Keywords: conservation practices/ ecosystem goods and services/ economics/ social effects
Abstract: Rangelands provide a wide variety of ecosystem goods and services, and the conservation practices implemented on them produce a variety of direct and indirect economic and social effects. This chapter examines the literature related to the economic and social aspects of ecosystem services impacted by the conservation practices of the Natural Resources Conservation Service (NRCS) of prescribed grazing, prescribed burning, brush management,

upland wildlife habitat, riparian management, and range planting. In addition, the authors examine the social and economic aspects of invasive species management that cross different conservation practices. At the time of this synthesis, invasive species management was not a specific conservation practice, but the NRCS recently created a new conservation practice titled Herbaceous Weed Management that is evaluated in a separate chapter of this document. Valuation of ecosystem goods and services potentially impacted by the specified conservation practices, particularly those services for which markets do not exist, is also examined.

968. **Soil erosion thresholds and alternative states in northeastern Patagonian rangelands**.
Chartier, M. P. and Rostagno, C. M.
Rangeland Ecology & Management 59: 616-624 (2006). ISSN: 1551-5028
http://dx.doi.org/10.2111/06-009R.1
Keywords: soil erosion/ rangelands/ range management
Abstract: In semiarid rangelands, continuous grazing may decrease vegetation cover, accelerating soil erosion and eventually causing a transition to an alternative, degraded state. State-and-transition models invoke process-based explanations of alternative states, but there are few examples that use empirical data on key factors and processes. We used rainfall simulation to determine 1) the relationships between soil surface characteristics and interrill erosion in 3 spatially related plant communities: stable grass with scattered shrubs (GS), degraded grass with scattered shrubs (DGS), and degraded shrub steppes (DSS), and 2) the site conservation threshold (SCT) of this rangeland. We also analyzed the effect of past erosion on soil and vegetation characteristics. In the GS, sediment production and sediment concentration were significantly lower ($p < 0.05$) than in the DGS and the DSS. The main soil protection factors in the GS and in the DGS were perennial grass and litter cover, while in the DSS, gravel cover became the main soil protection factor. The SCT, the point at which the rate of soil erosion increases markedly, corresponded to a plant-and-litter cover close to 90% and occurred within the DGS. Although this plant community may reverse back to the conserved GS, long-term accelerated erosion may result in enough soil loss to trigger irreversible changes and prompt the transition to the DSS. The threshold underlying this transition would be reached when the A horizon is severely reduced by erosion. Under these conditions, the soil hydrological properties are affected irreversibly, preventing perennial grass establishment. While the GS represents a resource conserving plant community, desirable for both forage production and soil protection, the DSS represents a dysfunctional state with a minimum forage value. The DGS represents an unstable and transitional community that, without management intervention to halt soil erosion, will likely change into the DSS.
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969. **Spectral characteristics of cyanobacteria soil crust in semiarid environments**.
Karnieli, A., Kidron, G. J., Glaesser, C. and Ben-Dor, E.
Remote Sensing of Environment 69: 67-75 (1999).
http://dx.doi.org/10.1016/S0034-4257(98)00110-2
Keywords: reflectance spectra/ sand dunes/ semi-arid/ cyanobacteria/ lichens/ Negev Desert
Abstract: Large areas of sand fields in and semiarid regions are covered by cyanobacteria soil crusts. The objective of this article is to analyze (systematically throughout the VIS, NIR, and the SWIR regions of the spectrum) the unique spectral features of cyanobacteria crust relative to bare sands mid under different moisture conditions. It was found that: 1) When biogenic soil crusts a-re wet, their NDVI value can reach 0.30 units due to their photosynthetic activity; 2) the chaser the red edge inflection point is to the longer wavelengths, the higher the relative abundance and distribution of the microphytic community; 3) the phycobilin pigments, which are unique to cyanobactria, contribute to higher reflectance in the blue region relative to the sand substrate; 4) a crust index based on this uncommon spectral feature can be useful for detecting and mapping, from remote sensing imagery, different lithologic/morphologic units; 5) although most dune sand areas are generally made of quartz, other notable features appear on their spectra. In the study area, there are absorption features

representing minerals (iron oxides at 860 nm and clay minerals at 2200 nm) and biogenic crusts (chlorophyll at 670 nm and organic matter at 1720 nm, 2180 mn, and 2309 nm). (C) Elsevier Science Inc.
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970. **State and transition models for rangelands. 2. Ecology as a basis for rangeland management - Performance criteria for testing models**.
Brown, J. R.
Tropical Grasslands 28: 206-213 (1994).
http://www.tropicalgrasslands.info/public/journals/4/Historic/Tropical%20Grasslands%20Journal%20archive/PDFs/Vol_28_1994/Vol_28_04_94_pp206_213.pdf
Keywords: interspecific competition/ subtropical savanna/ landscape ecology/ field experiments/ stable states/ succession/ Texas/ mechanisms/ threshold/ communities
Abstract: The objectives of this paper are to: propose criteria for testing the applicability of models for rangeland management; and test 2 competing models using those criteria. Predicting change accurately, detecting change, relevance to management and facilitating communication re the performance criteria. Competing models are the range condition model derived from Clementsian ecology and the state and transition model based on non-equilibrium ecology. The ability of competing models to predict ecosystem change is assessed in terms of ecosystem organising processes and attributes such as competition, resistance and resilience, temporal thresholds and feedback. The ability to detect change is viewed in terms of detection at the community and landscape scales. Relevance to management and communication are assessed within the context of effectively communicating the effects of management decisions on ecosystem processes to both traditional and non-traditional decision makers and a larger public constituency. Although the state and transition model is the most acceptable of the 2 competing models based on the criteria, improvements are needed. Most notable is the need for a spatial component in the application of the model for management purposes, and the need for attention to improved communication with a wide range of resource users.

971. **A strategic assessment of recreational use areas for off-road vehicles in the coastal zone of KwaZulu-Natal, South Africa**.
Celliers, L., Moffett, T., James, N. C. and Mann, B. Q.
Ocean & Coastal Management 47: 123-140 (2004).
http://dx.doi.org/10.1016/j.ocecoaman.2004.02.001
Keywords: all terrain vehicles/ disturbed soils/ environmental impact/ motorized recreation/ environmental policy/ recreational areas
Abstract: In January 2002, the Minister of the Department of Environmental Affairs and Tourism of the South African government promulgated new regulations controlling the use of off-road vehicles in the coastal zone of South Africa. The new regulations provided for a general prohibition on the recreational use of off-road vehicles (ORVs) in the coastal zone as well as providing procedure for approving the use of vehicles in the coastal zone under specific circumstances. The regulations now specify that recreational use of ORVs can only take place in designated recreational use areas (RUAs). This paper described the process of developing a cohesive strategy for the siting of RUAs in the coastal zone of KwaZulu-Natal. This strategy was developed to avoid ad hoc application for areas that might be unsuitable (environmentally or socially) for ORV use. Potential RUAs was identified using seven principles that disqualified areas not suitable, and subjecting the potential RUAs to a number of other considerations. The seven principles are sufficiently generic to be applied to the other three coastal provinces of South Africa and probably further afield. This strategy identified a network of ecologically and socially justifiable RUAs along the coast of KwaZulu-Natal. These areas will not be designated automatically but each area will need to be further scrutinized by an environmental impact assessment. (C) 2004 Elsevier Ltd. All rights reserved.

972. **The strategic landscape investment model: a tool for mapping optimal environmental expenditure**.
Hajkowicz, S., Perraud, J. M., Dawes, W. and Derose, R.
Environmental Modelling & Software 20: 1251-1262 (2005). ISSN: 1364-8152
http://dx.doi.org/10.1016/j.envsoft.2004.08.009
Keywords: landscape optimisation/ investment analysis

Abstract: This paper presents the strategic landscape investment model (SLIM). This tool can be used to map optimal landscape treatment patterns at regional scales. Developed for New South Wales (NSW) in Australia, SLIM aims to maximise an indexed measure of environmental benefit within a budget constraint. The attributes considered include salinity, water yield, nitrogen run-off, phosphorus run-off, stream sediment concentrations, soil erosion and carbon sequestration. The modelling is undertaken spatially with a roughly 1 km2 grid covering NSW. With estimates of costs and benefits, maps of marginal environmental benefit per dollar expended can be constructed. These maps are used to define an optimal treatment pattern within the confines of a program budget. SLIM is demonstrated through an analysis of perennial pasture establishment on NSW grazing lands. It was found that the optimal treatment area is around 4% of the total treatable area, demonstrating the importance of careful investment targeting. Through sensitivity analysis it is found that the location of optimal landscape treatment patterns is relatively robust under numerous attribute weighting scenarios. The paper explores the strengths and weaknesses of SLIM considering how improved analytic capabilities could be added to future revisions.
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973. **Survey of livestock influences on stream and riparian ecosystems in the western United States**.
Belsky, A. J., Matzke, A. and Uselman, S.
Journal of Soil and Water Conservation 54: 419-431 (1999).
Keywords: riparian areas/ grazing management/ water quality/ rivers/ erosion control/ hydrology/ ecosystem management/ western United States
Abstract: This paper summarizes the major effects of livestock grazing on stream and riparian ecosystems in the arid West. We focused primarily on results from peer reviewed, experimental studies, and secondarily on comparative studies of grazed vs. naturally or historically protected areas. Results were summarized in tabular form. Livestock grazing was found to negatively affect water quality and seasonal quantity, stream channel morphology, hydrology, riparian zone soils, instream and streambank vegetation, and aquatic and riparian wildlife. No positive environmental impacts were found. Livestock were also found to cause negative impacts at the landscape and regional levels. Although it is sometimes difficult to draw generalizations from the many studies, due in part to differences in methodology and environmental variability among study sites, most recent scientific studies document that livestock grazing continues to be detrimental to stream and riparian ecosystems in the West.

974. **Susceptibility to rangeland health disturbance stresses (review draft)**.
Leonard, S. G. and Karl, M. G.,
Interior Columbia Basin Ecosystem Management Project Science Integration Team Terrestrial Staff Range Task Group, (1995).
http://www.icbemp.gov/science/leonard5.pdf
Keywords: rangeland health/ disturbance stressors/ soil properties/ climate/ precipitation

975. **Thinning semiarid forests amplifies wind erosion comparably to wildfire: Implications for restoration and soil stability**.
Whicker, J. J., Pinder Iii, J. E. and Breshears, D. D.
Journal of Arid Environments 72: 494-508 (2008). ISSN: 0140-1963
http://dx.doi.org/10.1016/j.jaridenv.2007.08.006
Keywords: environmental disturbance/ forest fire/ forest thinning/ restoration/ soil stability/ wind erosion
Abstract: Semiarid forests across the western USA and elsewhere are being thinned to reduce risk from fire, restore previous ecological conditions, and/or salvage trees from recently burned areas. Prescriptions and monitoring for thinning generally focus on biotic characteristics of vegetation, like tree density, rather than abiotic characteristics of soils and their loss, which are usually only considered in association with water erosion. Recent studies indicate that sediment transport by wind in forests is substantial and can exceed water transport, yet forest wind erosion responses to tree thinning and/or burning are unknown. We measured wind-driven horizontal dust flux, a metric related to wind erosion, with respect to presence/absence of fire and/or thinning in a ponderosa pine (*Pinus ponderosa*) forest in northern New Mexico, USA. Passive dust collectors at several sampling heights documented elevated dust fluxes at sites that were burned and/or thinned. Unexpectedly, thinned sites had erosion rates as large as burned sites, documenting significant restoration

impacts on soil stability. Thinning and fire impacts on dust flux were correlated with remaining tree or ground cover. The results highlight that dust fluxes provide a readily measurable metric of soil stability that should be integrated into prescription and monitoring plans for forest restoration and thinning.
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976. **Transport of multiple tracers in variably saturated humid region structured soils and semi-arid region laminated sediments**.
Mayes, M. A., Jardine, P. M., Mehlhorn, T. L., Bjornstad, B. N., Ladd, J. L. and Zachara, J. M.
Journal of Hydrology 275: 141-161 (2003).
ISSN: 0022-1694
http://dx.doi.org/10.1016/S0022-1694(03)00039-8
Keywords: breakthrough curves/ diffusion/ equilibrium/ preferential flow/ unsaturated zone
Abstract: The processes governing physical nonequilibrium (PNE)—coupled preferential flow and matrix diffusion—are diverse between humid and semi-arid regions, and are directly related to climate and rock/sediment type, and indirectly related to subsequent soil profile development. The fate and transport of contaminants in these variably saturated undisturbed media is largely a function of the influence of PNE processes. Large cores of laminated silts and sands were collected from the US Department of Energy Pacific Northwest National Laboratory (PNNL) in semi-arid south central Washington. Additional cores of weathered, fractured interbedded limestone and shale saprolite were collected from the Oak Ridge National Laboratory (ORNL) in humid eastern Tennessee. PNNL cores were collected parallel (FBP) and perpendicular (FXB) to bedding, and the ORNL core was 30° to bedding. Saturated and unsaturated transport experiments were performed using multiple nonreactive tracers that had different diffusion coefficients (Br^-, PFBA, and PIPES), in order to identify the influence of PNE on the fate and transport of solutes. In the ORNL structured saprolite, solute transport was governed by coupled preferential flow and matrix diffusion, as evidenced by tracer separation and highly asymmetric breakthrough curves (BTC). BTCs became more symmetric as preferential flowpaths became inactive during drainage. Tracer separation persisted during unsaturated flow suggesting the continued importance of nonequilibrium mass transfer between flowpaths and the immobile water that was held in the soil matrix. No evidence of PNE was observed under near-saturated conditions in the semi-arid region (PNNL) laminated silts and sands. Unsaturated flow in cores with discontinuous layering resulted in preferential flow and the development of perched, immobile water as evidenced by early breakthrough and separation of tracers. Conversely, transport parallel to laterally continuous beds did not result in preferential flow, the development of perched water, or tracer separation regardless of water content. These observations suggested that desaturation had two effects: (1) grain size variations between individual beds resulted in different antecedent water contents, and (2) the exchange of water and solutes between individual sedimentary beds was subsequently inhibited. Under unsaturated conditions, these effects may promote either stable lateral flow, or unstable vertical finger flow coupled with the development of perched, immobile water.
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977. **Treatment effects on performance of N-fixing lichens in disturbed soil crusts of the Colorado Plateau**.
Davidson, D. W., Bowker, M., George, D., Phillips, S. L. and Belnap, J.
Ecological Applications 12: 1391-1405 (2002).
http://dx.doi.org/10.1890/1051-0761(2002)012%5B1391:TEOPON%5D2.0.CO;2
Keywords: biological soil crusts/ Collema/ Colorado Plateau/ cryptobiotic crusts/ cyanobacteria/ lichens/ microbiotic crusts/ *Microcoleus vaginatus*/ microtopography/ nutrients/ Utah/ microbiotic crusts/ deserts/ stabilization/ plants
Abstract: Biological soil crusts arrest soil erosion and supply nitrogen to ecosystems. To understand their recovery from disturbance, we studied performances of *Collema* spp. lichens relative to four experimental treatments plus microtopography of soil pedicels, oriented north-northwest to south-southeast in crusts. At sites in Needles (NDLS) and Island in the Sky (ISKY) districts of Canyonlands National Park, lichens were transplanted to NNW, SSE, ENE, WSW, and TOP pedicel faces and exposed to a full-factorial, randomized block experiment with four treatments: nutrient addition (P and K), soil stabilization with polyacrylamide resin (PAM), added cyanobacterial fiber, and biweekly watering. After 14.5 mo (NDLS) and 24 mo

(ISKY), both visual rankings of lichen condition and measures of chlorophyll fluorescence were generally higher at ISKY than on more fertile but less stable soils at NDLS. On ENE and NNW pedicel faces, both these values and nitrogenase activity (NDLS only) exceeded corresponding values on WSW and SSE faces. Treatment effects were site specific and largely negative at NDLS; both nutrient and cyanobacterial addition led to poorer lichen condition, and added nutrients led to reduced fluorescence, Responses to nutrients may have been mediated partly by disturbance of. unstable soils and by competition with cyanobacteria. In a separate experiment investigating recruitment responses to adding fungal spores or Nostoc cells, rates of Collema establishment responded significantly to the former but not the latter. Low establishment overall suggests that natural recruitment may occur mainly from iscidia or thallus fragments not spores. Measured simultaneously on artificial soil pedicels at NDLS and ISKY, both deposition and erosion declined at NDLS across the four pedicel microaspects as: WSW > SSE > NNW > ENE (or ENE > NNW), during fall and spring trials. Patterns were similar at ISKY, but WSW SSE for spring deposition, and deposition did not differ by microaspect in fall. Greater deposition at ISKY, despite higher abundance of cyanobacteria, may be explained by stronger wind velocities. Together, microtopographic differences in erosion, microclimate, and nutrient regimes help explain variable lichen performance, but microtopography influenced lichen performance more consistently than did any treatment. Demonstrated effects of pedicel development in crust recovery concur with prior surveys showing greatest microbial biomass and/or cover on ENE and NNW exposures at various spatial scales.

978. **A user's guide for estimating allowable use of tracked vehicles on non-wooded military training lands**.
Diersing, V. E., Shaw, R. B., Warren, S. D. and Novak, E. W.
Journal of Soil and Water Conservation 43: 191-195 (1988).
Keywords: all terrain vehicles/ disturbed soils/ environmental policy/ soil degradation/ land use planning
Abstract: To avoid excessive soil erosion and insure the continued availability of U.S. Military training lands, there must be a basis for estimating allowable levels of sustained tracked vehicle use. The allowable use management objective can be attained by establishing permanent line transects in areas representative of each ecological response unit. The point-intercept method is employed along each line transect to determine botanical composition, amounts of ground and campy cover for untracked and tracked points, and percent of the surface tracked and untracked. Soil samples are collected to determine soil erodibility. Slope lengths and gradients are measured. For each vehicle type, estimates are made of the average cross-country distance traveled per day (surface average is computed by adding the width of the tracks times distance traveled). Estimates are made of the average number of years for tracked areas to regrow vegetation cover equivalent in C-value for the universal soil loss equation to untracked areas and the average number of years that a track mark remains visible. With this information and using the USLE, maximum allowable use can be estimated for each ecological response unit. Allowable use is calculated in tracked vehicle days per year (TVD8/year) for military trainers and percent surface disturbance for land managers. Land managers verify that allowable use is not exceeded by measuring the percentage of the surface that appears tracked. Adjustments in allowable use are based on trends in the amount of ground cover (detected by short-term monitoring) and by observing changes in botanical composition (detected by long-term monitoring).

979. **Vegetation Changes as a Result of Soil Ripping on the Rio Puerco in New Mexico**.
Aldon, E. F. and Garcia, G.
Journal of Range Management
25: 381-383 (1972).
https://journals.uair.arizona.edu/index.php/jrm/article/view/6099
Keywords: runoff/ soil ripping/ forage production/ New Mexico
Abstract: Soil ripping in 1963 effectively reduced runoff on the San Luis watershed of the Rio Puerto, New Mexico, and caused a favorable shift in forage production from galleta to alkali sacaton. Ripping effects on runoff are short-lived, but forage production patterns may persist for 10 years.
This citation is from the University of Arizona Institutional Repository.

980. **Vegetation response to increased stocking rates in short-duration grazing**.
Ralphs, M. H., Kothmann, M. M. and Taylor, C. A.
Journal of Range Management 43: 104-108 (1990). ISSN: 0022-409X
https://journals.uair.arizona.edu/index.php/jrm/article/view/8453
Keywords: grazing management/ grazing intensity/ range management/ vegetation cover/ stocking rate
Abstract: Short-duration grazing (SDG) has been purported to increase forage production and utilization compared to other grazing systems, and thus can sustain higher stocking rates. This study was designed to determine if standing crop could be maintained as stocking rates increased. Four stocking rate treatments ranging from the recommended rate for moderate continuous grazing to 2.5 times the recommended rate were applied in a simulated 8- pasture SDG system. There was little change in frequency and composition of short-grasses over the study, but mid-grass frequency and composition both declined. Standing crop of all major forage classes declined as stocking rates increased. However, the rate of decline was less than proportional to the increase in stocking rate during the growing season. By fall, standing crop was inversely proportional to stocking rate, leading us to conclude that standing crop could not be maintained at the higher stocking rates. Low standing crop in the fall indicated a potential shortage of forage at the high stocking rates during the winter.
This citation is from the University of Arizona Institutional Repository.

981. **Vegetation Treatments on Bureau of Land Management Lands in 17 Western States: Final Biological Assessment**.
U. S. Bureau of Land Management, Bureau of Land Management, 539 p. (2007).
http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/veis.Par.81642.File.dat/Final%20Biological%20Assessment%20%20%28June%202007%29.pdf
Keywords: vegetation/ rangelands/ range management/ government programs and projects/ conservation practices
Abstract: This Biological Assessment contains four main parts: a description of the proposed action and treatment methods proposed for use on public lands throughout the western U.S.; procedures that the BLM field offices will follow during consultation to ensure compliance with the ESA and mitigation identified in the PEIS and PER; background information on all plant and animal species that occur or are likely to occur within the project area that are federally listed as threatened or endangered, or that are proposed for federal listing under the ESA as of April 2005; and a discussion of the potential effects of the proposed action on these species.

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