WATER RESOURCES RESEARCH, VOL. 37, NO. 11, PAGES 2825–2829, NOVEMBER 2001

Geographic database, Reynolds Creek Experimental Watershed, Idaho, United States

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Abstract. The Reynolds Creek Experimental Watershed (RCEW) exhibits spatial variability typical of the intermountain region. We provide a geographic database to provide continuous spatial coverage of landscape properties that may be useful for distributed hydrological modeling or other kinds of spatial analyses and to provide a spatial context for point measurements that have been part of the long-term monitoring described in companion papers. All data are available as separate geographic information system (GIS) layers which can be selected independently according to need. The base map for all the RCEW GIS layers is a 30 m resolution digital elevation model. Data are available in either vector or raster format where appropriate via the U.S. Department of Agriculture, Agricultural Research Service, Northwest Watershed Research Center anonymous ftp site ftp.nwrc.ars.usda.gov.

1. Introduction

The Reynolds Creek Experimental Watershed (RCEW), typical of much of the intermountain region of the western United States, exhibits considerable spatial heterogeneity. The RCEW may be thought of as a spatial mosaic of local environments in which the relative impact of different hydrologic processes varies spatially and temporally [*Seyfried and Wilcox*, 1995]. The long-term, spatially discrete or point data that have been collected in different environments within the RCEW describe and quantify the hydrologic processes dominant within local environments. Spatially continuous data, such as topography, are needed to incorporate the effects of local environmental variability into a physically meaningful, integrated hydrologic description of the RCEW. The approaches to performing this integration should be useful in a variety of settings. In this paper we describe the available spatially continuous data, provide a geographic context for the spatially discrete data that are described in other reports, and give an overview of what is contained in the spatial data layers and how they were derived.

2. Spatially Continuous Data

2.1. Topography

A digital elevation model (DEM) is the base map for all other data layers described. It is projected in universal transverse Mercator coordinates (zone 11) using the 1927 North American Datum and the Clarke 1866 ellipsoid. The DEM was derived from U.S. Geological Survey contours (1:24,000 scale) which were analyzed by a commercial company (Peerless Management Systems, Springfield, Oregon) to produce a raster map with cells of 10 m × 10 m. These data were resampled using the nearest-neighbor technique to produce a 30 m resolution DEM. The DEM, as provided, was designed to provide a 1 km "buffer" around the watershed boundary. It is a rectangle 15.960 km in the east-west direction and 29.970 km in north-south direction, which requires 532 columns and 999 rows of 30.0 m pixels. The corner coordinates are listed in Table 1.

The overall relief in the watershed is over 1100 m with the highest elevations in the south [*Slaughter et al.*, this issue, Plate 1]. Perennial streamflow is generated at the highest elevations in the south and northwest parts of the RCEW where deep, late-lying snowpacks are the source of most water. The topography is generally rugged except in the broad valley floor in the north central part of the watershed. Local slope and aspect strongly influence the hydrology of the RCEW by controlling incoming solar radiation and snow deposition patterns.

2.2. Watersheds

Long-term data exist for 13 weirs, including the outlet, in the RCEW [*Pierson et al.*, this issue]. These range in areal extent from 23,866 ha to 1 ha and total relief from 1140 m to 8 m [*Slaughter et al.*, this issue, Plate 3b]. The lower boundary of each experimental watershed is defined by the weir location. Stream channel delineations and the RCEW boundary were determined from the DEM using the TOPAZ program [*Garbrecht and Martz*, 1997a, 1997b; *Martz and Garbrecht*, 1993]. This method was also used to delineate the subwatershed boundaries above the Tollgate, Dobson, Reynolds Mountain East, Reynolds Mountain West, Salmon Creek, Macks Creek, Murphy Creek, and Summit subwatersheds. The subwatersheds above the Lower Sheep Creek and Upper Sheep Creek weirs, which are smaller than those listed above, were digitized from high-resolution topographic maps derived from aerial photography. For the two smallest subwatersheds, above the Nancy Gulch and Flats weirs, the boundaries were surveyed using a GPS receiver. We determined the watershed boundaries visually and then circumnavigated the boundary twice with the GPS system recording continuously. The final boundary is an interpolation of those two walks. The horizontal error of the GPS unit in continuous mode is about ±5 m.

Paper number 2001WR000414.

Table 1. Corner Coordinates for Reynolds Creek Experimental Watershed DEM Layer

Map Corner	Longitude	Latitude	Easting, m	Northing, m
NE	116°40′26.8″W	43°19′7.1″N	526,425	4,796,345
NW	116°52′15.4″W	43°19′18.5″N	510,465	4,796,345
SE	116°40′32.0″W	43°03′5.6″N	526,425	4,766,375
SW	116°52′17.4″W	43°03′07.0″N	510,465	4,766,375

2.3. Roads and Land Ownership

As is typical of western rangelands, most of the land in the RCEW is publically owned, the largest portion being federal land managed by the U.S. Department of the Interior Bureau of Land Management (BLM) for livestock grazing. State lands are managed much like the surrounding BLM land. Private land in the valley is irrigated farmland (mostly hay), and the remainder is primarily used for grazing with some logging in the southwestern part of the watershed.

The roads in the RCEW are, with the exception of about 4 km at the northern entrance, unpaved. Some roads were located by driving over the road using a GPS in a continuous mode. Others were taken off an orthophotograph of the watershed. Road quality varies considerably within the RCEW. High clearance and/or four-wheel drive is required in some places even in summer. Access is limited in winter and spring by snow and mud.

2.4. Vegetation

Four vegetation layers are provided, two based on field survey and two based on analysis of satellite imagery. The vegetation of the RCEW was surveyed in detail between 1963 and 1965. Field mapping was done on color aerial photographs at a scale of 1:12,000 and transferred to 1:24,000 scale base maps. Final drafting was done by the National Resources Conservation Service Western Cartographic Unit. We digitized the original 0.91 m by 1.22 m mylar map. Delineations at the watershed boundary were adjusted because of small changes in the boundary derived from the DEM.

Vegetation was differentiated in terms of detailed plant communities. Common names are used in this report as in the original map (see *Seyfried et al.*, [2000] for scientific names). In addition, each spatial delineation was assigned a plant cover class representing 0–25, 26–50, 51–75, or 76–100% vegetative cover as determined by ocular examination. The resulting map

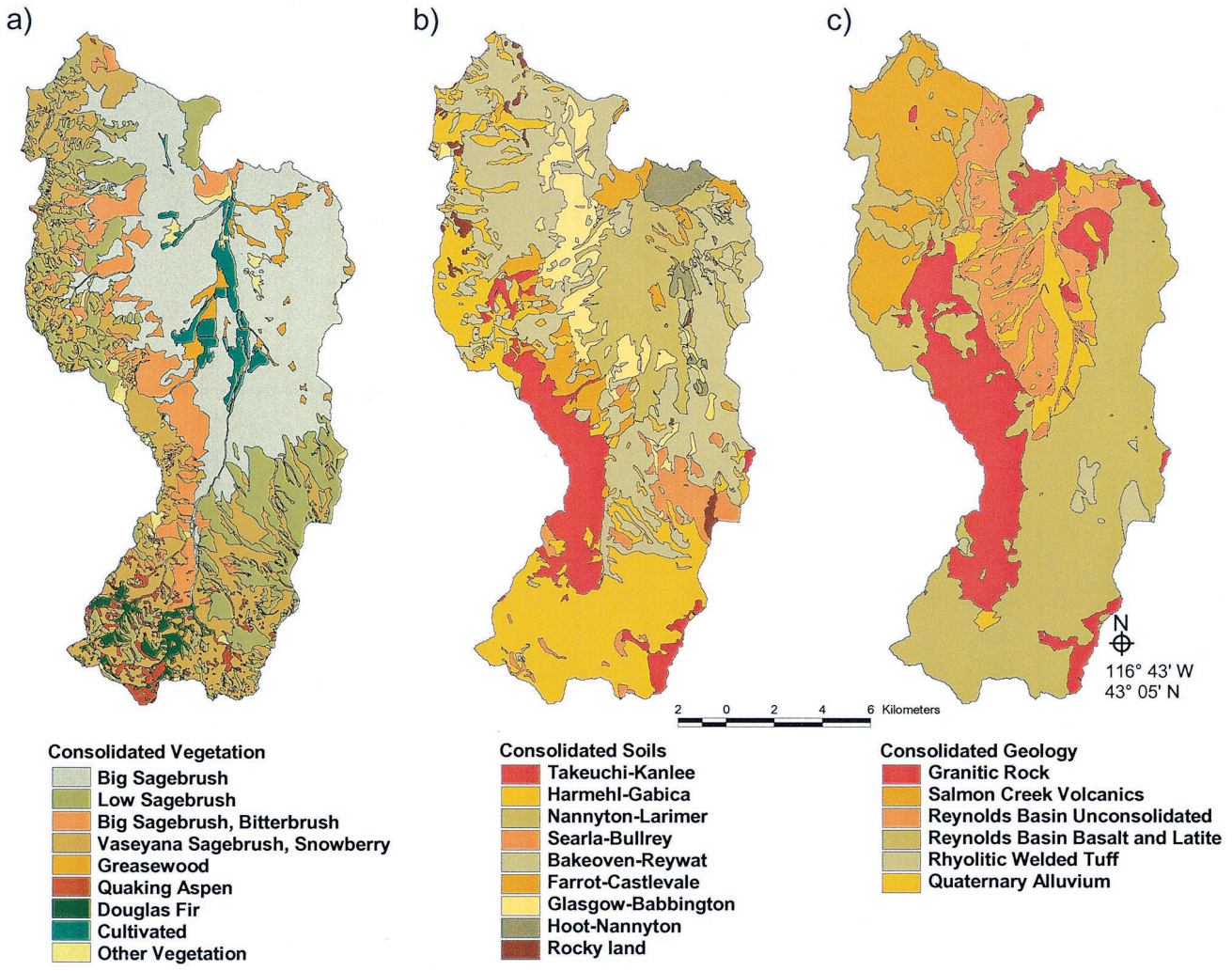

Plate 1. Resource inventories consolidated from digitized detailed surveys illustrating (a) consolidated vegetation, (b) consolidated soils, and (c) consolidated geology. Mapping units listed in the legends are described in detail by *Seyfried et al.* [2000].

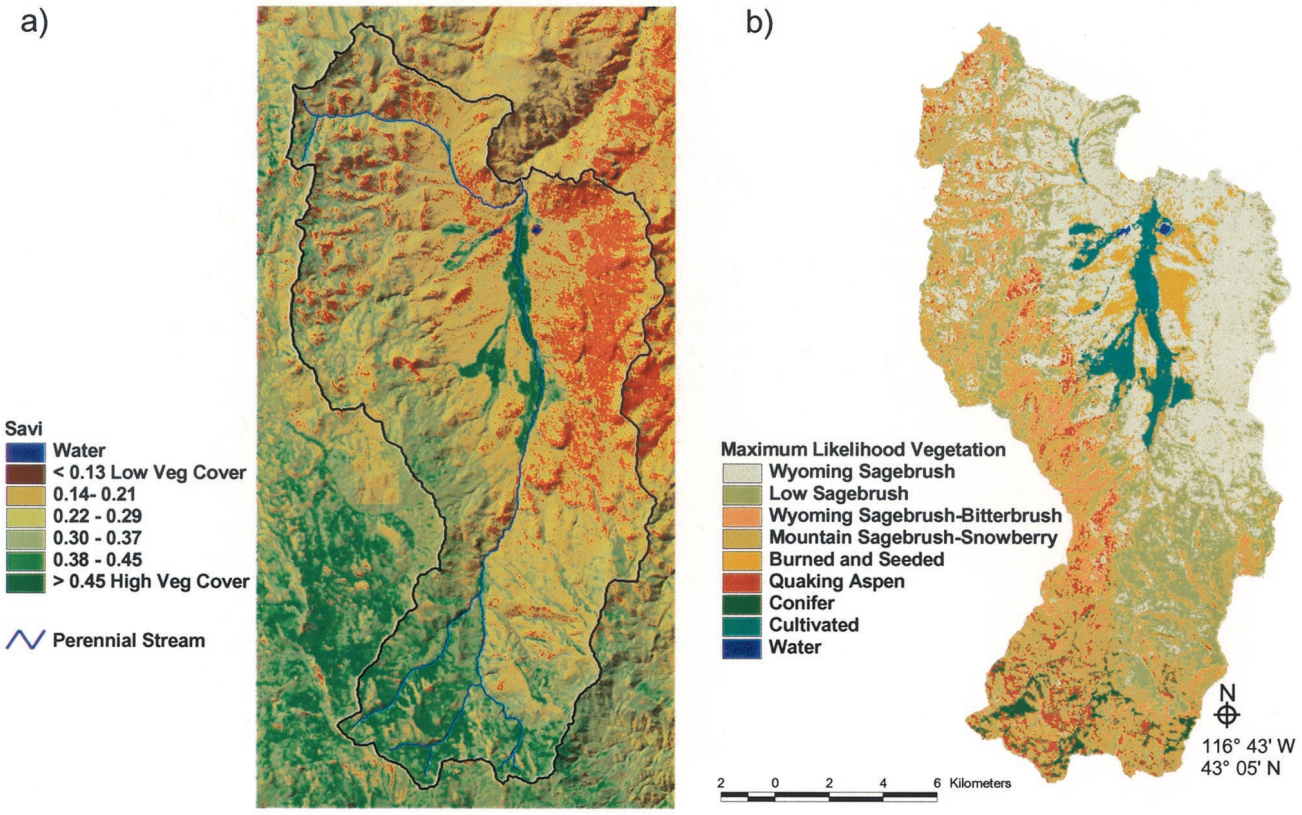

Plate 2. Vegetation descriptions derived from satellite imagery showing (a) soil adjusted vegetation index with shaded relief and (b) maximum likelihood classification of dominant vegetation types [*Shiflet*, 1994; *Seyfried et al.*, 2000].

contains 90 different vegetation mapping units, 136 different plant community–cover class combinations mapped in 970 different delineations.

We produced another map (Plate 1a), based on the original, in which plant communities were consolidated on the basis of the predominant species into nine mapping units which follow closely the rangeland cover types described by *Shiflet* [1994]. The original map was modified slightly to accommodate changes in sagebrush classification over the past 30 years [*Seyfried et al.*, 2000].

The satellite-derived layers are based on a topographically corrected Landsat thematic mapper image at 30 m resolution. The first (Plate 2a) image-derived layer is of the soil adjusted vegetation index (SAVI) [*Huete*, 1988]. This provides information describing the relative density of green plant cover. The SAVI image (Plate 2a) is overlaid on a shaded relief map to provide an indication of the relationship between topography and vegetation cover. The second (Plate 2b) is a supervised maximum likelihood classification of the RCEW using categories similar to those in the consolidated field layer. Extensive ground verification resulted in an overall mapping accuracy of 85%, with most of the errors attributed to a failure to distinguish between different sagebrush communities [*Clark et al.*, 2001].

2.5. Soils

The soil survey of the RCEW was contracted to the Soil Conservation Service (SCS). Mapping was done on 1:20,000 scale using color aerial photographs. The work was completed in 1966. In order to facilitate publication, standard policies for classification and correlation were relaxed, and some tentative series names were retained. No attempt has been made to correlate the soils mapped in 1966 with current soil descriptions.

The delineations on the soil map are composed of one or more named soils modified by surface texture or slope. The original soils map contains 30 soil series and 197 soil mapping units. Because of the complexity of a map containing so many delineations, we prepared a soil map composed of soil associations, which are groupings of soils with common parent material (geology), climate, and physiography. This consolidated map provides insight into the range of soil conditions and how they are distributed on the watershed. Each mapping unit is described in some detail by *Seyfried et al.* [2000]. A list of soil properties associated with each soil series available in the database along with a listing of all soil series is included.

2.6. Geology

The geology of the RCEW was mapped by D. McIntyre (as part of his Ph.D. requirement at Washington State University). Field mapping took place during the summers of 1961, 1962, and 1963. Mapping was done partly on 1:20,000 scale black and white aerial photographs and partly on 1:12,000 scale color aerial photographs. This was transferred to 1:24,000 scale base maps. Final drafting was done by the Western Cartographic Unit of the SCS. The original map (stored on a 91 cm by 122 cm mylar sheet) was digitized and made part of the data set. The map and an extensive description of the geologic units delineated along with some related observations were subsequently published [*McIntyre*, 1972].

Table 2. Spatial Data Layers Available on Website in Addition to the Digital Elevation Model Base Layer Described in Text

Resource Inventory	Satellite-Derived	Cultural Features	Hydrologic Features	Instrument Locations
Detailed vegetation	vegetation cover (MLC)[a]	land ownership	perennial streams	long-term weirs
Consolidated vegetation	soil adjusted vegetation index (SAVI)	roads	intermittent streams	climate stations
Detailed soils			subwatershed boundaries	discontinued precipitation gauges
Consolidated soils			RCEW boundary	current (1996) precipitation gauges
Detailed geology				snow courses
Consolidated geology				neutron access tubes
				soil temperature lysimeters

[a]MLC is maximum likelihood classification.

The RCEW lies in an erosionally modified structural basin surrounded by structural and topographic high areas. Volcanic and sedimentary rocks of late tertiary age overlie a granitic "basement" of Cretaceous age which is exposed at different locations in the watershed. The stratigraphy has been subdivided and mapped in the following five sequences from oldest to youngest: granitic rocks, Salmon Creek Volcanics, the Reynolds Basin Group, the rhyolitic welded ash flow tuffs, and Quaternary stream valley alluvium. These were further divided into 22 subgroupings in the original map. As with the vegetation and soils we prepared a consolidated map based on hydrologically significant geologic aggregations. Description of the mapping units is presented by *Seyfried et al*. [2000].

3. Spatially Discrete (Point) Data

The spatially discrete data are listed by *Slaughter et al*. [this issue]. All data collection sites were located using a precision lightweight global positioning system (GPS) receiver (PLGR+, Rockwell International, Cedar Rapids, Iowa) which was not subject to selective availability. Data were recorded for each site on at least two occasions with the instrument on "average" mode collecting at least 100 points. Our experience is that these instruments are accurate within 3–4 m in the horizontal dimension and 6–7 m in the vertical dimension. In addition to the GPS-determined coordinates the coordinates of the DEM cell in which the sites are located are provided. Each data collection site is identified by a six-digit number that is related to the location in the watershed.

4. Data Availability

The 22 data layers shown in Table 2 and an electronic copy of a more detailed description of the RCEW geographic data [*Seyfried et al*., 2000] are available from the anonymous ftp site ftp.nwrc.ars.usda.gov maintained by the U.S. Department of Agriculture Agricultural Research Service, Northwest Watershed Research Center in Boise, Idaho, United States. A detailed description of data formats, access information, licensing, and disclaimers are presented by *Slaughter et al*. [this issue].

5. Examples of Data Use

These data may be used for a variety of applications related to distributed hydrologic modeling and the spatial description of landscape properties. *Goyal et al*. [1999] used the vegetation and soil layers with digital elevation data and satellite imagery to evaluate the effects of surface roughness, topography, and vegetation on radar backscatter in airborne synthetic aperture radar (SAR) images. They showed that the native vegetation for most of the RCEW has no significant effect on L-band SAR backscatter. As anticipated, topography had a large effect on SAR backscatter, but they found that surface roughness, as determined from soils data, is correlated with topography and confounds the effect. Incorporation of this information into a more general topographic correction algorithm resulted in a significant reduction in unexplained backscatter variability.

In another example, *Seyfried* [1998] used the SAVI and soil layer to supplement soil water content data collected over a range of scales within the RCEW. Strong between-soil series contrasts were demonstrated. In addition, a correlation between soil series, soil water content, and SAVI was shown. This was used to infer soil water content patterns over much larger areas than could be done simply from direct measurement.

Acknowledgments. We would like to acknowledge the contribution of Gordon Stevenson toward this effort. He compiled the soil, vegetation, and geology information presented in this report. Much of what we have done he initiated and conceived several years before GIS made it so much easier. Greg Johnson was part of the early GIS work and was responsible for collecting the precipitation network information. Mark Murdock and Ron Hartzman collected much of the GPS information.

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(Received September 6, 2000; revised March 7, 2001;
accepted April 16, 2001.)