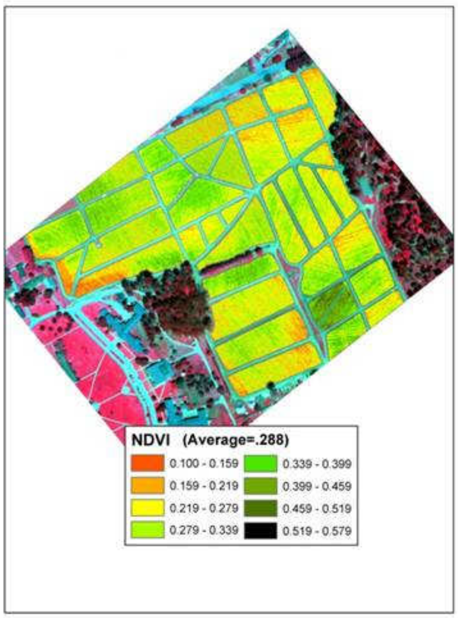
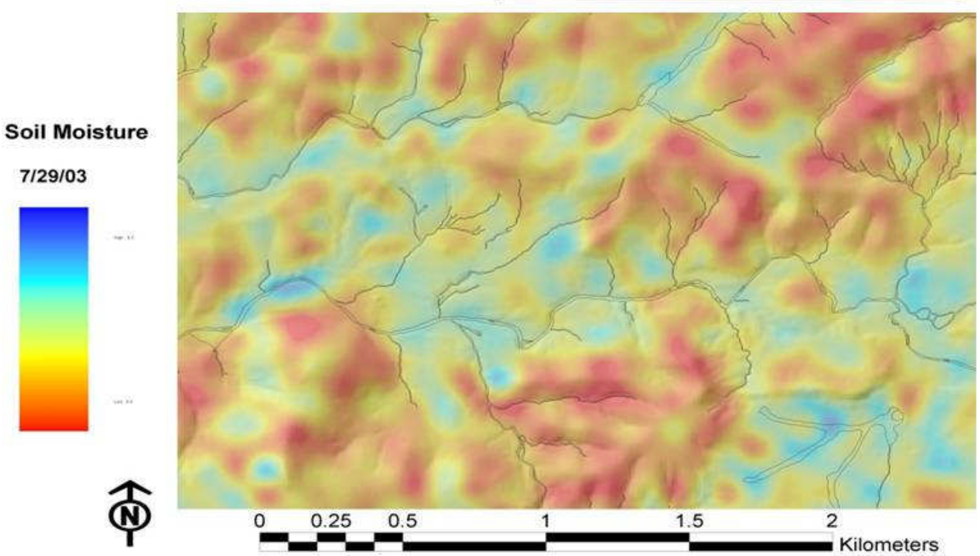
Report of the
USDA ARS Pacific West Area
Remote Sensing Workshop
April 29-30, 2009
Albany, California





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Report of the USDA ARS Pacific West Area Remote Sensing Workshop

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Report of the USDA ARS Pacific West Area Remote Sensing Workshop

1.0 Introduction

The PWA Remote Sensing Workshop was held on 29-30 April 2009 in Albany, California. The workshop was designed to interest PWA scientists using, planning to use, or thinking about using remote sensing (RS). The objectives of this workshop were

1) information sharing, including both applications and state of the science; and
2) planning for future remote sensing research in PWA.

The objectives were addressed through a unique workshop format that included Q&A sessions, facilitated discussions, a poster session, invited speakers and breakout sessions (Appendix I). The attendees included scientists from ARS, NASA, EPA, and Universities (Appendix II).

The intended workshop products were

1) a summary of current remote sensing research in PWA,
2) a strategy to foster inter-unit research collaborations and technology transfer, and
3) ideas for proposals to NASA and initiatives to ARS ONP.

These are discussed in the following sections, supported by Appendices III and IV.

2.0 Summary of current remote sensing research in PWA

A sampling of current remote sensing research in the PWA region by both ARS and NASA scientists was expressed in the presentations and posters at the workshop (Appendices I and III). To summarize, remote sensing was being used to study

- Rangeland monitoring
- Crop irrigation management
- Insect modeling for decision support
- Estimating conservation benefits on rangelands
- Water dynamics in complex terrain
- Mapping soil moisture
- Determining plant height and distribution
- Weed management
- Monitoring impact of invasive species
- Strawberry production
- Assessing crop water requirements
- Deficit irrigation in orchards
- Nitrogen status of dryland wheat
- Determining rangeland vegetation state
- Climate impact on invasive species
- Post-fire shrub dynamics
- Distribution and abundance of invasive weeds
- Classification of cropping practices
- Salinity assessment

- Crop growth simulation
- Climate change studies
- Modeling of carbon and hydrologic fluxes

This list illustrates the broad utility of RS for ARS research and ultimate application. The presentations and posters associated with these topics are available at the website (http://www.ars.usda.gov/Business/docs.htm?docid=18682).

3.0 Strategy to foster intra- and inter-unit RS research

The attendees were split into four breakout sessions to discuss ideas for fostering intra- and inter-unit RS research. A summary is given here of the responses to the first two questions in Appendix IV.

3.1 How can we best facilitate remote sensing in each unit?

To facilitate RS in each unit, the scientists requested

1) Training, such as short courses, 1-day workshops and in-situ training.
2) A formal means of sharing data, such as a website, listserver or wiki
3) Funding for partnerships to share data, expertise and instrumentation

Other suggestions included:

4) A centralized point for exchange of people and resources
5) Inter-unit and inter-agency (e.g. ARS/NASA) sabbaticals
6) Regular meetings, like the PWA RS Workshop
7) Interactions with graduate and undergraduate students
8) Greater exploitation of the USDA image archive and data-buy
9) More GPS units in the field
10) Standardized data collection, processing and storage
11) Agency (both ARS and NASA) commitment to distributing Level-3 and -4 RS products, where L-3 and L-4 are geophysical parameters and "distributing" means free/easy access to the data

3.2 How can we maximize inter-unit remote sensing research?

To maximize inter-unit RS research collaborations and technology transfer, the scientists requested

1) Institutional support for sharable Unit resources, such as sensors, image processing and expertise
2) GIS Support services, e.g. from ESRI
3) Funding (seed money) for inter-unit cooperative projects
4) Support for new and ongoing networking programs, like EcoTrends (www.ecotrends.info) and STEWARDS http://www.ars.usda.gov/is/AR/archive/aug06/data0806.htm??

Other suggestions included

5) Bringing RS discussions to existing ARS training
6) Posting an inventory of ARS RS capabilities by unit
7) Conducting "how to" software discussions, possibly on-line
8) Making better use of state geospatial extension agents
9) Conducting inter-unit field campaigns

10) Increase opportunities for basic training (e.g. University courses) on RS capabilities

4.0 Ideas for proposals to NASA and initiatives to ARS ONP

The workshop breakout sessions resulted in ideas for research proposals and initiatives in response to the second two questions in Appendix IV. A summary is given here.

4.1 What are some ideas for proposals to NASA and other funding sources?

Regarding research proposals for soft funds, the scientists specifically requested

1) Inter-agency (ARS/NASA) research opportunities targeted to agricultural applications

Suggestions for proposal topics included (not in order)

2) Urban/suburban/exurban research
3) Integrating RS and modeling for watershed management
4) Agricultural applications of lidar, hyperspectral and radar RS
5) Studies of habitability of cities
6) Land cover mapping, expanded to include height, density, and species for agricultural applications
7) Regional distributed evapotranspiration estimation
8) Water table, and related climate, research
9) Strategies for RS acquisition prioritization for agricultural applications
10) Strategies for adapting to climate change, beyond monitoring climate change
11) Carbon credit activities
12) Research on RS of specialty crops
13) Aquatic environment research, including shading, emergent canopies, water depths, salinity, turbidity, flow patterns and gas exchange

4.2 What are new RS initiatives for ONP new funding?

Regarding RS initiatives for ARS-funded opportunities, a first start would be to compile, revise and resubmit the initiatives written by ARS locations already. One low-cost, high-impact initiative was suggested: to add lidar instrumentation to the ongoing USDA National Agricultural Imagery Program (NAIP) http://www.fsa.usda.gov/FSA/apfoapp?area=home&subject=prog&topic=nai acquisitions. Other suggested initiatives focused on (not in order)

1) Drought in the West
2) Fire vulnerability, fuel loads and structure of forests
3) Invasive plants, expanded to the entire PWA region
4) Ecosystem services, modeled with assimilated RS data
5) Investigate effects of degraded water reuse
6) Track changing cropping patterns
7) Urban/agricultural interface
8) Turf grass
9) Weed and insect real-time reporting system
10) Translation of RS research to commercial applications
11) Water management

12) Calibration and validation of RS products
13) Global change – water supply, invasive species, soil moisture.

5.0 Conclusions and Recommendations:

The objectives of this workshop were information sharing and planning for future remote sensing research in PWA. The breakout sessions were used to solicit ideas and recommendations. Several recommendations were common to all four breakout sessions and/or received positive feedback in the subsequent plenary session. The workshop follow-on activities are summarized here.

5.1 Workshop follow-on activities

1) Provide training in RS science, such as short courses, 1-day workshops and in-situ training.
2) Develop a formal means of sharing data, such as a website, listserver, or wiki.
3) Fund partnerships to share data, expertise and instrumentation.
4) Provide institutional support for sharable Unit resources, such as sensors, image processing and expertise.
5) GIS Support services, e.g. from ESRI.
6) Provide seed money for inter-unit cooperative projects.
7) Support new networking programs like EcoTrends and STEWARDS.
8) Develop an inter-agency research opportunity (co-funded by ARS & NASA) targeted to agricultural applications.
9) Compile, revise and resubmit existing ARS initiatives.
10) Investigate the addition of lidar instrumentation to the ongoing USDA NAIP acquisitions.

ARS research initiatives should be encouraged by ARS Office of National Programs (ONP) based on the match of current RS research (Section 2.0) and proposed research (Sections 4.1 and 4.2) with known funding opportunities. ARS Scientists are willing to work with the National Program Leader (NPL) to draft strong initiatives.

Appendix I. Workshop Agenda

29 April Wednesday		
1-4pm	**Kick-off:** Opportunities for interaction were offered as follows: 1-2pm MODIS and ASTER Q&A – Facilitators French and Hook 2-3pm Ground-based remote sensing Q&A – Facilitators Clarke, Marks, Seyfried and Holifield Collins 3-4pm Facilitated discussion on 2 topics (held in parallel): Cropland research – Facilitators Johnson, Hunsaker and Walthall Wildland research – Facilitators Bubenheim, Carruthers and Moran	
4-6pm	**Poster Session:** The poster session focused on critical research related to remote sensing.	
30 April Thursday		
8am-noon	Andrew Hammond, PWA	Introduction (10 min)
	Glenn Bethel, USDA FAS	USDA Remote Sensing Applications and Image Library (60 min)
	NASA and ARS scientists presented examples of NASA/ARS collaborations (15 min each)	
	Charlie Walthall, USDA ARS	Opportunities and Challenges for Remote Sensing Research
	Simon Hook, NASA JPL	Areas of Potential Collaboration with JPL
	Chris Potter, NASA Ames	Remote Sensing and Ecosystem Modeling of Western Rangeland Production and Water Dynamics
	Lee Johnson, NASA Ames	Satellite Mapping for Irrigation Management
	Marc Kramer, NASA Ames	Spatially explicit plant and insect modeling for decision support
	Andy French, USDA ARS	Satellite Land Surface Temperature & Emissivity
	Mark Weltz, USDA ARS	Estimating Conservation Benefits on Western Rangelands.
	Mark Seyfried, USDA ARS	Remote Sensing and Complex Terrain
	Susan Moran, USDA ARS	Satellite Mapping and Modeling Rangeland Soil Moisture
	Danny Marks, USDA ARS	LIDAR-Derived Canopy Structure for Environmental Assessment & Modeling
1-3pm	**Breakout sessions:** Breakouts will be organized to develop a strategy for remote sensing research in PWA based on our critical research needs. Breakout discussion questions: • How can we best facilitate remote sensing in each unit? • How can we maximize inter-unit research collaborations and technology transfer? • What are some ideas for proposals to NASA Applied Sciences Program and other funding sources? • What are new RS initiatives to send to ONP to have on hand in case opportunities for new funding arise?	
3-5pm	**Plenary session:** Breakout summaries. Assign writing tasks for workshop minutes and define action items.	

Appendix II. List of Attendees

Anderson, Lars	ARS Davis CA
Baxter, Jan	EPA
Bethel,Glenn	USDA FAS
Bubenheim, Dave	NASA Ames
Carruthers, Ray	ARS Albany CA
Clarke, Tom	ARS Maricopa AZ
Conn, Jeff	ARS Fairbanks AK
Cooley, Michael	ARS Albany CA
Corwin, Dennis	ARS Riverside CA
Dumbauld, Bret	ARS Corvallis OR
Fielding, Dennis	ARS Fairbanks AK
French, Andrew	ARS Maricopa AZ
Fryberger, Teresa	NASA Hdqtrs.
Grewell, Brenda	ARS Davis CA
Goodrich, Dave	ARS Tucson AZ
Hammond, Andrew	ARS PWA
Hodge, Don	EPA
Holifield Collins, Chandra	ARS Tucson AZ
Hook, Simon	NASA JPL
Hunsaker, Doug	ARS Maricopa AZ
Johnson, Lee	NASA Ames
Kramer, Marc	UC Santa Cruz CA
Laird, Veronica	ARS PWA
Long, Dan	ARS Adams OR
Mandrell, Robert	ARS Albany CA
Marks, Danny	ARS Boise ID
Martin, Frank	ARS Salinas CA
Matteri, Bob	ARS PWA
Moffet, Corey	ARS Dubois ID
Moran, Susan	ARS Tucson AZ
Mueller-Warrant, George	ARS Corvallis OR
Pantoja, Alberto	ARS Fairbanks AK
Potter, Chris	NASA Ames
Scheffner, Ed	NASA Ames
Schierenbeck, Kristina	ARS Reno NV
Seefeldt, Steven	ARS Fairbanks AK
Smith, Lincoln	ARS Albany CA
Spencer, David	UC Davis CA
Sugg, Zach	UA Tucson AZ
Swope, Sarah	ARS Reno NV
Tetrault, Bob	USDA FAS

Thorp, Kelly	ARS Maricopa AZ
Vaughan, Peter	ARS Riverside CA
Walthall, Charlie	ARS ONP
Wang, Dong	ARS Riverside CA
Weltz, Mark	ARS Reno NV

Appendix III. Workshop Poster Session

The Workshop Poster Session focused on critical research related to remote sensing.

List of Posters

#	Presenter	Title
1	Ray Carruthers	Decision Support for Western Weed Management
2	Zachary Sugg	Hydrologic Impacts of a Native to Exotic Vegetation Transition in a Semiarid Grassland
3	Frank Martin	Remote Sensing in Strawberry Production
4	Dong Wang	Satellite-based Near Real-time Assessment of Water Requirement of California Crops
5	Mark Seyfried	Efforts at Quantitative Remote Sensing for Applications in the Intermountain West
6	Dong Wang	Infrared Canopy Temperatures of Early Maturing Peach Trees Under Deficit Irrigation
7	Dan Long	Combined Spectral Index for Sensing the Nitrogen Status of Dryland Wheat
8	Doug Hunsaker	Remote Sensing for Crop and Water Management in Irrigated Agriculture
9	Chandra Holifield Collins	A Remote Sensing Approach for Determining Vegetation States Within Ecological Sites in Semi-Arid Rangelands (Proposed Research)
10	Alberto Pantoja	Potential Use of GIS to Determine Farming Impact in Climate and Climate Impact on Invasive Species in Alaska
11	Corey Moffet	Postfire Shrub Dynamics Determined from Very Large Scale Aerial (VLSA) Imagery
12	Sarah Swope	Mapping the Distribution and Abundance on the Invasive Weed Centaurea Solstitalis Using Hyperspectral Imagery
13	George Mueller-Warrant	Landsat and MODIS Imagery for Remote Sensing Classification of Cropping Practices in Western Oregon
14	Dennis Corwin	Salinity Assessment of the Red River Valley Using MODIS and Electromagnetic Induction Direction Soil Sampling: Phase I
15	Dennis Corwin	Protocols for Mapping Soil Salinity (and Other Soil Properties) at Field Scale Using EMI ECa-Directed Soil Sampling
16	Kelly Thorp	Driving a Crop Growth Simulation Using Canopy Spectral Reflectance Estimates of Leaf Area Index
17	M. Susan Moran	Long-term Geospatial Data Sets at USDA Experimental Sites for Climate Change Studies
18	Christopher Potter	Remote Sensing and Modeling of Carbon and Hydrologic Fluxes in Northern California Watersheds

Appendix IV: Report-out from Breakout Sessions

Breakout Sessions were asked to address four questions:

1) How can we best facilitate remote sensing in each unit?
2) How can we maximize inter-unit research collaborations and technology transfer?
3) What are some ideas for proposals to NASA Applied Sciences Program and other funding sources?
4) What are new RS initiatives to send to ONP to have on hand in case opportunities for new funding arise?

1. How can we best facilitate remote sensing in each unit?

a. Provide training
   i. e.g. short course, 1 week or less, conducted by ARS personnel, focused topics;
   ii. e.g. 1-day workshops – training;
   iii. e.g. Site-specific training (i.e.- training for more than one person at an ARS location)
      training topics: e.g. downloading satellite imagery or efficient image classification in ENVI or Imagine or other GIS/remote sensing software package

b. Provide a formal means for sharing data, expertise and instrumentation,
   i. e.g. a collaborative tool such as facebook, linked-in or wiki
   ii. e.g. a website or list-server
   iii. e.g. On-site visit by ARS & NASA remote sensing experts, both sides make presentations to explore remote sensing project ideas, not just one-way;
   iv. we need a list of potential NASA collaborators and contacts and key people in RS for information

c. Fund partnerships for sharing data, expertise and instrumentation; Find resources to support RS research

d. Have a centralized point, from which there can be an exchange of people and resources.
   i. It was suggested that the best way to do this is through a research unit or resource hub
   ii. And/Or designate an Area 'go-to' person

e. Inter-unit and inter-agency sabbaticals for both scientists and technicians

f. Regular meetings with Inter-ARS presentation exchange, like the PWA RS Workshop April 2009

g. Interactions with graduate and undergraduate students

h. Exploit USDA sources of high spatial resolution data
   i. e.g. the resources summarized by USDA-FAS, Glenn Bethel

i. More GPS units in the field, in the hands of scientists and technicians

j. Standardize the collection, processing, and storage of data within and across units

k. Agencies should commit to providing and distributing Level-3 and -4 products from satellite sensors, where "L4" refers to things that can be measured in the real world and "distributed" means easy/free access to the data

2. **How can we maximize inter-unit research collaborations and technology transfer?**
    a. Provide institutional support for Unit "resources", where resources include
        i. valuable, unique sensors
        ii. post-flight processing
        iii. expertise
    b. Provide institutional support for GIS, including
        i. buy helpdesk support from ESRI
        ii. expand national or area-wide IT support on GIS
        iii. explore on-line resources
    c. Encourage inter-Unit cooperative projects, with ideas such as
        i. hold back funds at Area level to fund these; competitive fund distribution
        ii. offer EOY funds for projects instead of equipment
        iii. Small seed money ($8-10k)
    d. Support ongoing (and initiate new) networking programs, like Stewards and EcoTrends, with ideas such as
        i. going after USDA competitive grants for about $200K to distribute data
        ii. talking with USDA program managers to be sure there is a call for proposals of this sort
    e. Expand RS discussions, with ideas such as
        i. Piggyback discussions about RS on existing ARS training, as a formal, planned activity
    f. It would be helpful to post, in a central place, an inventory of ARS (by unit) remote sensing capabilities categorized by 1) hardware, 2) software and 3) expertise
    g. Conduct 'how-to' software discussions, possibly as on-line web groups
    h. Utilize state geospatial extension agents
    i. Inter-unit field campaigns
    j. ARS needs to increase opportunities, encouragement, and funding for basic training across scientific personnel (for example, courses available at San Jose State) in a broad array of remote sensing capabilities, from the genome through the landscape.

3. **What are some ideas for proposals to NASA Applied Sciences Program and other funding sources?**
    a. Targeted intra-agency RFPs; Create a mechanism for targeted applications; Collaborations and proposals with NASA need development in all categories; Capitalize on the long-term mission of ARS and NASA
    b. Urban/suburban/exurban research, recommended at the regional scale where users could be identified

c. More watershed proposals that provide better integration (as is developing very well on Laguna de Santa Rosa model by Carruthers and NASA collaborators Potter and Bubenheim). A user interface for these models also needs to be developed.
d. Focus on use of lidar, hyperspectral and radar because these are the upcoming sensors; Discussions about how proposals could provide greater availability of IR and LIDAR
e. Habitability of a city: we should model photon, heat and mass transport in a city; could be applied to non-urban settings as well; focus on adaptability and forecasts
f. Describe landcover of U.S., defined to include height, cover, density, species and functional group; approach: multisensory (lidar, radar, optical) using both spectra, surface features and time
g. Regional evapotranspiration studies
h. Regional water table research for Red River Valley & related climate change research
i. Strategies for coping with cloudy skies while using remote sensing, e.g.- strategies for remote sensing acquisition prioritization
j. Pro-active strategies for adapting to climate change, i.e.- go beyond monitoring climate change
k. Carbon credit activities
l. Specialty crops
m. In aquatic environments, remote methods are needed for monitoring surface temperature, reflectance and roughness; shading from the canopy; detection of emergent canopies; plant temperature; temperature at different water depths; salinity; turbidity; flow patterns using fluorescent dyes; and gas exchange.
n. In terrestrial environments, needs include better methods to detect species differences, vegetational migrations, plant characteristics, and biotic and abiotic stresses; higher resolution data; higher frequency of data collection; higher spectral content and more extensive model development.

4. What are new RS intitiatives to send to ONP to have on hand in case opportunities for new funding arise?

a. We need to develop both national and regional initiatives to the Office of National Programs for increasing development and use of remote sensing abilities; first start: Compile, revise and resubmit the initiatives written by ARS locations already
b. Have lidar instrumentation added to USDA NAIP acquisitions
c. Research ability to assess/predict drought in the West
d. Study fire vulnerability, fuel loads and structure of forests
e. Write a comprehensive initiative on invasive plants and expand to the PWA region from the unit-level research
f. Focus on data assimilation of remote sensing for ecosystem services, more specifically carbon, water and air quality

g. Investigate degraded water reuse and monitoring of water reuse.
h. Methods for tracking changes in cropping patterns
i. Urban-Agriculture interface research
j. Turf grass
k. Weed and insect real-time reporting systems
l. Translation of RS research to commercial applications
m. Water management projects in the western US (especially in California)
n. Calibration and validation of RS products
o. In the area of Global Change, remote sensing capabilities are needed for better water supply forecasting and to predict or detect climatic changes that can result in conditions that increase invasions, i.e. soil moisture and temperature. Could be coupled with a specific project.