National **C**ooperative **S**oil **S**urvey **Newsletter**

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Issue 63

2013 NCSS National Conference Coming Soon!

The NCSS National Conference will be held from June 16-20 in Annapolis, Maryland. The theme is "Soil Survey—Planning for Soil Health in the Critical Zone." For more information go to http://www.soils.usda.gov/partnerships/ncss/conferences/2013_national/index.html.

In This Issue—

Editor's Note

Issues of this newsletter are available at http://soils.usda.gov/.

You are invited to submit stories for this newsletter to Jenny Sutherland, National Soil Survey Center, Lincoln, NE. Phone—(402) 437–5326; email—jenny.sutherland@lin.usda.gov.

Digital Soil Mapping: A Brief Update

By Tom D'Avello, soil scientist/GIS specialist, NRCS, National Soil Survey Center, Geospatial Research Unit, Morgantown, West Virginia; Suzann Kienast-Brown, soil scientist/GIS and remote sensing specialist, NRCS, Logan, Utah; and Jessica Philippe, soil scientist/GIS specialist, NRCS, Saint Johnsbury, Vermont.

What is digital soil mapping (DSM)?

The Working Group on Digital Soil Mapping (WG-DSM) of the International Union of Soil Sciences (http://www.digitalsoilmapping.org/) defines "digital soil mapping" as "the creation and the population of geographically referenced soil databases generated at a given resolution by using field and laboratory observation methods coupled with environmental data through quantitative relationships." A more basic definition would be the production of maps of soil classes or properties using various environmental data layers and statistical, GIS, and/or remote sensing software.

The inception date of DSM activities could be debated, but we place it with the launch of LANDSAT in 1972 and the development of the Laboratory for the Application of Remote Sensing at Purdue University (http://www.lars.purdue.edu/home/Mission.html). These were the first investigations that attempted to develop relationships between digital data and soil properties and to map their geographic distribution. We have seen much progress over the 40-plus years since that launch.

The widespread availability of GIS and remote sensing software coupled with supporting digital data in raster form has led to the expansion of DSM efforts across the world and within the soil survey program in the U.S. (Boettinger, 2010; McBratney et al., 2003). DSM from the perspective of a field soil scientist was presented in this newsletter 2 years ago (Skovlin, 2011).

How does DSM work?

The basic idea behind DSM is that the factors of soil formation, as described by Jenny (1941) or McBratney et al. (2003), can be represented by spatially explicit digital data, which can then be used to predict soil classes or properties across the landscape. Numerous methods are available for processing, analyzing, classifying, and mapping this digital data.

The techniques for DSM can be broadly classified as unsupervised, supervised, knowledge-based, and geostatistical. The mapping of soil properties is of high interest in the research and modeling community. The realm of the NCSS is primarily focused on mapping traditional soil classes. For the sake of brevity, soil classes are the focus of this article.

Where are some places these techniques have been used by NRCS?

Among the locations where DSM techniques have been used by NRCS for initial soil surveys are North Cascades National Park, Washington; Essex County, Vermont; White Mountain National Forest, New Hampshire and Maine; Mojave Desert, California; East Emery County, Utah; and Boundary Waters Canoe Area, Minnesota. DSM techniques have also been used by NRCS in the update soil survey of the East Shore Area of the Great Salt Lake, Utah.

North Cascades National Park, Washington

Soil scientists used knowledge-based methods with ArcInfo and ArcGIS to predict soil classes in this remote, limited access area (Frazier et al., 2009). This survey was the first effort within the NCSS to systematically employ DSM techniques. The resulting DSM-derived product was used with conventional digital compilation techniques to create the SSURGO product for the park.

East Shore Area of the Great Salt Lake, Utah

Wet and saline soils have been recognized as an important and complex component of wetland ecosystems in arid environments. The analysis and classification of remotely sensed spectral data is an effective method for discerning the spatial and temporal variability of soils. The soil survey update of the East Shore Area of the Great Salt Lake focused on updating soil map units that contained wet and saline soils. The East Shore Area provided a unique environment for the use of remotely sensed spectral data for map unit refinement because of the low relief and large extent of soils that are wet and saline to various degrees. Map units containing wet and saline soils were updated and refined using imagery from Landsat 7. Five classes of surface cover were identified. The classes related to soil wetness, salinity, calcium carbonate concentration, and vegetation cover type. Supervised classification of the imagery was performed using the five classes. The classification results were validated using visual inspection in the field, *a priori* knowledge of the area, and an error matrix. The results of the classification were used to enhance original soil map units and to calculate map unit composition in the final soil mapping process (fig. 1). The updated SSURGO product was published in 2006 (Kienast-Brown and Boettinger, 2007).

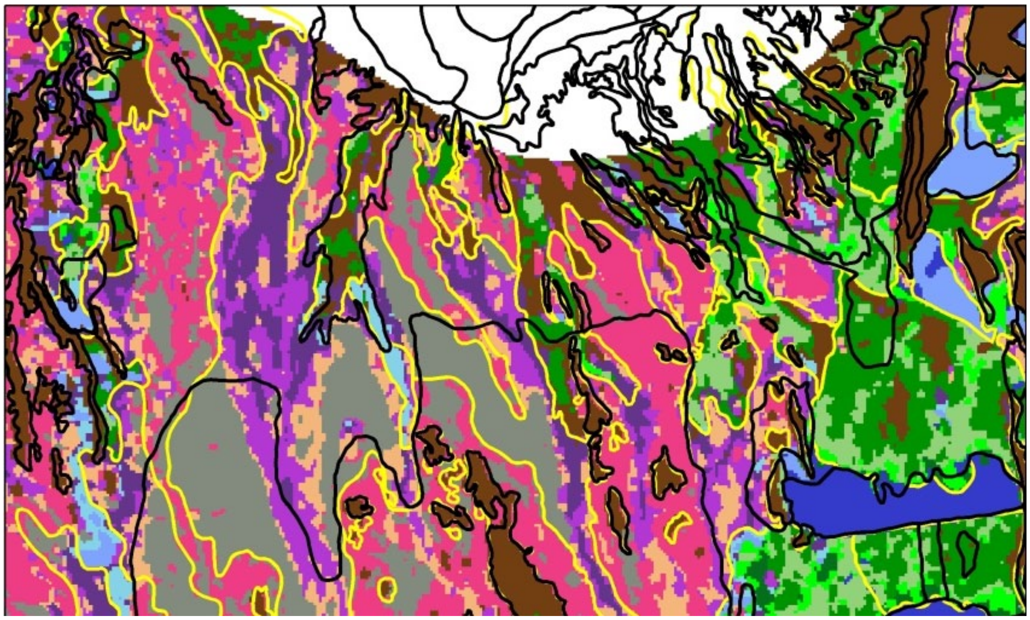


Figure 1.—A subset of the East Shore Area showing the raster-classified image of soil components. The original SSURGO polygons are black (1975), and the updated SSURGO polygons based on the results of the classification are yellow (2006).

Essex County, Vermont

Beginning in 2005, NRCS soil scientists in Vermont collaborated with Dr. Xun Shi of Dartmouth College to develop and implement an automated, knowledge-based approach to soil mapping. Through this effort, ArcSIE (an ArcGIS extension that is now CCE certified) was developed. ArcSIE supports knowledge-based raster soil mapping by creating raster soil maps based on the soil environment model S = f (E), where S is soil, E is the formative environment, and f is the soil-environment relationship. The soil environment is represented by high-quality terrain derivatives created from a LiDAR-based, high-resolution digital elevation model. Soil scientists define the soil-environment relationship using the ArcSIE inference engine. The resulting maps of fuzzy membership represent the similarity at a given pixel to the typical soil formative environment for the target soil class.

In Essex County, the fuzzy membership maps were "hardened" to assign one soil class to each pixel, standard slope classes were integrated, and map units were formed based on extensive field investigations. The resulting raster map was then vectorized and published in the traditional SSURGO format. The survey is considered to be the first initial soil survey completed to SSURGO standards using entirely digital methods and incorporating raster results from automated mapping software.

One of the products from the Essex County survey was a 5-meter raster soil map that provided the information about spatial distribution of components that SSURGO polygons lack (fig. 2). This raster map was correlated as an additional soil survey product to the SSURGO data. It has been fully populated in the NASIS database, while we await a means for publication and distribution.

White Mountain National Forest, New Hampshire and Maine

Soil scientists from the soil survey office in St. Johnsbury, Vermont, are collaborating with the U.S. Forest Service (USFS) on a project to integrate initial soil survey land-type-phase mapping and ecological site inventory on the White Mountain

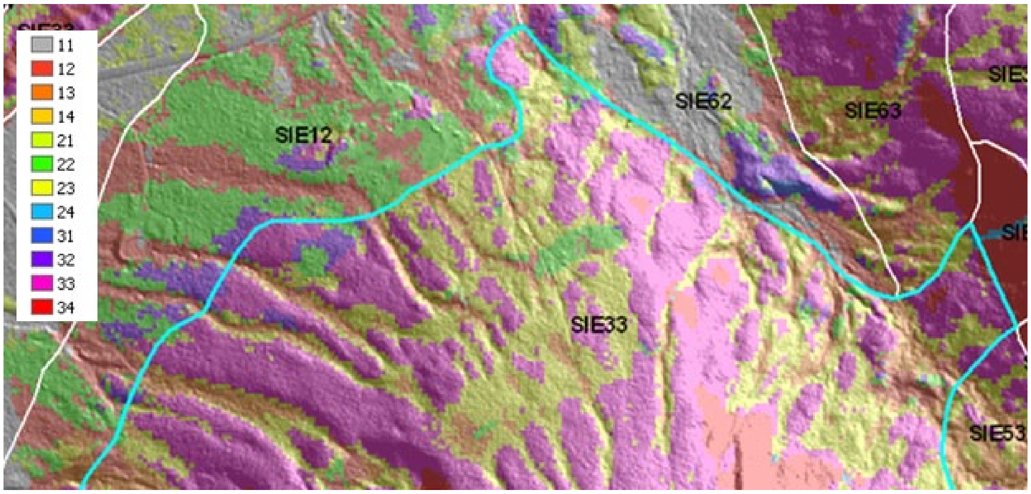


Figure 2.—Raster soil map showing individual soil components as 5-meter pixels (including integrated slope phase). Each raster class can be considered a single component map unit.

National Forest (WMNF). One of the goals of the project is to produce a component-level, raster soil map that corresponds to ecological sites in a large part of the WMNF. With ongoing support from NRCS, USFS, and U.S. Geological Survey, LiDAR is being flown across the WMNF. The LiDAR will be used to create a detailed soil-landscape model that will aid both NRCS and USFS in developing their respective natural resource inventories.

Mojave Desert, California

Various DSM techniques have been employed for this project (Moore et al., 2010). A particularly useful derivative has been the modeled distribution of soil temperature regimes determined through a monitoring network. The use of quantitative methods to map soil temperature distribution, as demonstrated in the Mojave, would have benefits if applied systematically across the country.

East Emery County, Utah

The survey area for East Emery County, Utah, is about 1.5 million acres of the Colorado Plateau (Major Land Resource Area 35) and the Warm Central Desertic Basins and Plateaus (MLRA 34B). The area is largely managed by the Bureau of Land Management (BLM), and the soils have not been mapped. DSM methods are being used to create a premap of the area for future use when a field campaign can be supported. Digital data layers created from a 10-meter digital elevation model and Landsat-7 spectral data have been combined and classified using an unsupervised classification (ISODATA) in ERDAS Imagine software (fig. 3). A polygon premap is currently being created from the results of the unsupervised classification in combination with other reference layers. A connotative legend based on underlying raster data layers will be created for the polygons to aid in the mapping process. This product will be provided to the BLM along with any previous field documentation completed in the area.

Boundary Waters Canoe Area, Minnesota

The soil survey of the Boundary Waters Canoe Area was initiated in late 2012. This area has restricted-access limitations similar to those in the North Cascades National

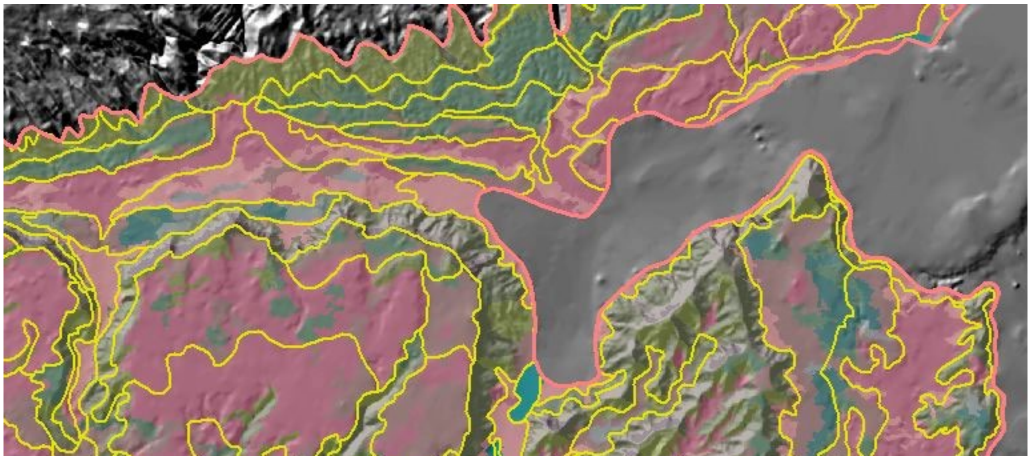


Figure 3.—A subset of East Emery County, Utah, showing premap polygons based on unsupervised classification (raster image shown) and other reference layers.

Park. Many DSM methods are being explored and evaluated as part of this project. The primary goal of this project is to produce and publish a raster map of soil classes across the park. In addition, the effort could spur the drafting of guidelines and the eventual adoption of standards and specifications for DSM within NRCS.

An annotated bibliography that contains a more complete summary of NRCS DSM activities is available.

What are the benefits of DSM?

DSM methods bring a quantitative approach to soil survey. The whole basis of DSM lies in producing a map of either soil classes or properties based on quantitative relationships between data layers representing soil-forming factors. This leads to the ability to evaluate maps produced with DSM methods quantitatively and to report the accuracy or error associated with the maps. This quantitative aspect of soil survey has been hard to achieve in the past. In terms of acceptance in the scientific community, DSM methods are repeatable between soil scientists using the same environmental data layers and algorithms to predict soil classes or properties. Raster products generated through DSM efforts are preferable to modelers and analysts because of the speed and ease of use in GIS software. Additionally, DSM gives the ability to capture, in a consistent and repeatable way, the soil-landscape model that has been carefully nurtured in a soil scientist's head for years. The capture of institutional knowledge is one of the most significant benefits of DSM to those in soil survey.

What are the drawbacks of DSM?

Digital soil maps, and raster maps in particular, can suggest a level of certainty that is not realistic on the ground. Because NRCS does not yet have comprehensive standards for DSM methods or products, we must be careful about documenting the mapping process and inputs and be honest about the weaknesses of DSM. It is easy to get excited by the new maps that can be produced with DSM, but if they do not represent reality, they only have aesthetic value at best.

There is a tendency to approach DSM as an "all or nothing" proposition. DSM may prove to be too time consuming for some parts of a soil survey area, while other parts of the same soil survey area may lend themselves well to predictive soil-landscape relationships and DSM (Hudson, 1990 and 1992; Zhu et al., 2001). Gauging the potential of DSM is part of the process, and a willingness to use different tools to complete a project is a reasonable approach for soil scientists.

It is also very easy to over-promise results with DSM. Digital data layers and software are empowering, but the limitations of this approach must be considered for each project. Limitations in reaching desired results can include a lack of appropriate data layers to properly model classes of interest, a lack of expertise, and a lack of time to thoroughly explore, understand, and apply the most appropriate processing and classification methods. It is important to be realistic about what can be achieved with the available data and skills.

What training is needed?

A certain skill set and level of training is required to successfully implement DSM techniques in soil survey activities. Several DSM courses are available through NRCS. Dwain Daniels, NRCS, Central National Technology Support Center, offers a spatial analysis workshop that provides an introduction to raster data in general and to elevation data in particular. This workshop is offered as instructor-led, distance learning and is considered a prerequisite to all of the DSM classes.

"Introduction to Digital Soil Mapping" is a 3-day class available as instructor-led, distance learning in cooperation with Purdue University. This class focuses on ArcGIS, Spatial Analyst, and knowledge-based techniques. The class is considered a prerequisite to "Digital Soil Mapping with ArcSIE."

"Digital Soil Mapping with ArcSIE" is 3-day, traditional classroom training presented in a workshop setting. In addition to standard exercises with common datasets, students bring their own data and have time to develop models involving soils and landscapes with which they are familiar. The focus for this class is the use of ArcSIE software in the realm of knowledge-based techniques and fuzzy classification.

"Remote Sensing for Soil Survey Applications" is offered as 5-day, traditional classroom training. The focus of the class is on the use of spectral data in soil survey operations. The class teaches step-by-step the process of taking a DSM project from start to finish using ERDAS Imagine software to process and analyze spectral imagery and to couple the imagery with other environmental data layers to model soils. A wide range of techniques are taught, including unsupervised, supervised, fuzzy, and knowledge-based classification.

References

Boettinger, J.L. 2010. Digital soil mapping: Bridging research, production, and environmental application. Volume 2.

Frazier, B.E., T.M. Rodgers, C.A. Briggs, and R.A. Rupp. 2009. Remote area soil proxy modeling technique. Soil Survey Horizons 50(2):62–67.

Hudson, B.D. 1990. Concepts of soil mapping and interpretation. Soil Survey Horizons 31(3):63–72.

Hudson, B.D. 1992. The soil survey as paradigm-based science. Soil Science Society of America Journal 56(3):836–841.

Jenny, H. 1941. Factors of soil formation.

Kienast-Brown, S., and J.L. Boettinger. 2007. Land-cover classification from Landsat imagery for mapping dynamic wet and saline soils. *In* P. Lagacherie, A.B. McBratney, and M. Voltz, editors. Digital soil mapping: An introductory perspective. Developments in Soil Science. Volume 31.

McBratney, A.B., M.L. Mendonça Santos, and B. Minasny. 2003. On digital soil mapping. Geoderma 117(1):3–52.

Moore, A.C., D.W. Howell, C.A. Hadyu-Houdeshell, C. Blinn, J. Hempel, and D. Smith. 2010. Building digital soil mapping capacity in the Natural Resources Conservation Service: Mojave Desert operational initiative. *In* Boettinger, Janis L., David W. Howell, Amanda C. Moore, Alfred E. Hartemink, and Suzann Kienast-Brown, editors. Digital soil mapping: Bridging research, production, and environmental application. pp. 357–367.

Skovlin, J. May 2011. Digital soil mapping: Quantifying the soil-landscape paradigm. National Cooperative Soil Survey Newsletter 55:1–4.

Zhu, A.X., B. Hudson, J. Burt, K. Lubich, and D. Simonson. 2001. Soil mapping using GIS, expert knowledge, and fuzzy logic. Soil Science Society of America Journal 65(5):1463–1472. ■

American Water Resources Association (AWRA) Regional Water Quality Conference

By Dr. Michael Robothom, National Leader for Soil Survey Interpretations, National Soil Survey Center, NRCS, Lincoln, Nebraska.

The American Water Resources Association (AWRA) held their 2013 Spring Specialty Conference: Agricultural Hydrology and Water Quality II in St. Louis, Missouri, from March 25–27, 2013. AWRA is a national organization of professionals from universities, government agencies, and the private sector. Members are committed to the better management of water resources. Over 100 participants braved a late-spring snowstorm to attend the conference, which was sponsored by AWRA and chaired by Dr. Karl W.J. Williard from Southern Illinois University—Carbondale.

NRCS participated in the conference to increase the visibility of the agency, learn more about stakeholder issues and concerns, and highlight the expertise and information that the agency can offer to other professionals working in this important area. I and Dr. Candiss Williams, NRCS research soil scientist, both made oral presentations at the conference. Rebecca Puta, a doctoral student at the University of Nebraska and an Earth Team volunteer, presented a poster on an NRCS funded project.

My talk focused on the use of soils information to support modeling and water quality risk assessment efforts. Dr. Williams reported on the impact of calibrated versus non-calibrated models on quantifying the benefits of conservation practices with special emphasis on research conducted in the Jobos Bay Watershed in Puerto Rico as part of the Conservation Effects Assessment Project (CEAP). Rebecca Puta's poster discussed preliminary results of an ongoing project looking at phosphorus loading capacity and release rates from soils nationwide. Although conference proceedings were not published, selected presentations are available on the AWRA Web site at http://www.awra.org/meetings/Spring2013/. ■

AWRA's 2013
Spring Specialty Conference

AGRICULTURAL HYDROLOGY
AND WATER QUALITY II

NRCS Hosts Senior Scientist from Mexico's National Commission of Forestry

By Jon Hempel, NRCS, Director of the National Soil Survey Center, Lincoln, Nebraska.

During the week of March 11, 2013, Ms. Flor Alejandra Rodriguez, Chief, Improvement of Soils and Technical Assistance Department, National Forestry Commission, Secretariat of Environment and Natural Resources, Mexico, visited the NRCS National Headquarters in Washington, DC, and the National Soil Survey Center in Lincoln, Nebraska. Ms. Rodriguez spent 3 weeks in the United States under the sponsorship of the U.S. Department of State, International Visitor Leadership Program. In addition to the time spent with NRCS, Ms. Rodriquez stopped at several other locations to meet with State and Federal agency staff to better understand conservation programs and activities in the United States. She also met with the mayor of Lincoln as part of her visit.

While in Washington, Ms. Rodriguez was able to meet with the Soil Science Division staff, including David Smith, Director, and Thomas Reinsch, National Leader for World Soil Resources, for an overview of the NRCS Cooperative Soil Survey Program. She also met with Norm Widman, National Agronomist, and Dana Larson, Acting National Range and Grazing Land Ecologist, for an overview of the Ecological Sciences Division program.

While in Lincoln, Ms. Rodriguez was provided an overview of the mission and activities of the National Soil Survey Center. She was able to meet with each of the national leaders, including Michael Robotham, Cam Loerch, Dave Hoover, Susan Andrews, and Larry West, to learn about the ongoing programs of soil survey standards, research and laboratory, interpretations, business systems, and ecosystems and ecological site inventory. Ms. Rodriguez was also briefed on the Global Soil Map project and the continuing work with Mexico to produce consistent soil property information.

At the National Soil Survey Center, Ms. Rodriguez presented a seminar on resource management in Mexico with a focus on ongoing programs to restore degraded lands and implement conservation practices. She also had discussions with NSSC staff on potential collaboration in other areas of soil survey operations and techniques, soil taxonomy, ecological site descriptions, and general conservation planning activities. Her visit provided an opportunity for NSSC staff to better understand soil science and conservation issues facing Mexico and for her to better understand NRCS activities to address such issues. Potential areas of information exchange and cooperation between Comisión Nacionale de Forestal (National Forestry Commission) and the Soil Science Division were discussed for future action. ■

Ecological Site Workshops at the Society for Range Management Meeting

By Joel Brown, natural resources specialist, NRCS, Las Cruces, New Mexico, and Curtis Talbot, rangeland management specialist, National Soil Survey Center, NRCS, Lincoln, Nebraska.

The 66th Annual Meeting, Technical Training, and Trade Show of the Society for Range Management was held February 2–8, 2013, in Oklahoma City, Oklahoma. Several ecological site workshops were held, including (1) Collaborative ESD Development Training (an 8-hour workshop); (2) Moving Forward with Common ESD Standards and Procedures (a 16-hour workshop); (3) Concepts, Classification, Differentiation, and Description of Ecological Sites; (4) Data Mining—Locating and Analyzing Vegetation Data; and (5) Ecological Site Descriptions—Uses and Benefits.

An additional 4-hour ecological site workshop was held specifically for undergraduate students.

The first workshop (Collaborative ESD Development), held on Saturday, February 2nd, was designed as in-depth, technical training for those involved in the development of ecological site descriptions (ESDs) and state-and-transition models (STMs). In particular, the target audience was government agency employees, contractors, and researchers with ESD/STM development responsibilities. Agencies included U.S. Forest Service (USFS), Bureau of Land Management (BLM), Natural Resources Conservation Service (NRCS), Agricultural Research Service (ARS), U.S. Geological Survey (USGS), State agencies, and others. The goals of the workshop were to:

1. Outline the standards and principles of credible and useful ESDs and STMs.
2. Showcase quality ESD development approaches from diverse agencies and partners.
3. Define the roles and opportunities for collaborative ESD development.
4. Demonstrate ESD identification, documentation, and interpretation with field exercises.
5. Create networking opportunities and generate discussion among ESD developers.

Approximately 60 people attended the workshop. In addition to the formal presentations, about a dozen posters illustrated different techniques and examples of collaborative ESD development. The presentations and posters are available on the Jornada Experimental Range Web site at http://jornada.nmsu.edu/.

The second workshop (Moving Forward with Common ESD Standards) was held in 4-hour blocks Monday through Thursday. The first session focused on presenting the standardized methods and procedures defined in the "Interagency Ecological Site Handbook for Rangelands" to be used by BLM, USFS, and NRCS. The methods and procedures are intended to define, delineate, and describe terrestrial ecological sites on rangelands. The handbook was developed to implement the policy outlined in the "Rangeland Interagency Ecological Site Manual." The manual is a policy document that provides direction to BLM, USFS, and NRCS to cooperatively identify and describe rangeland ecological sites for use in inventory, monitoring, evaluation, and management of the Nation's rangelands.

The second workshop featured presenters from NRCS, BLM, USFS, USGS, ARS, and universities and private consultants. The speakers represented every level from field staff to national leadership.

About 50 people participated in the course and received continuing education credits from the Society for Range Management. The material in the course has been modified and is currently being presented as a webinar by the Science and Technology—Grazing Lands Group in Ft. Worth. More than 200 people have signed up to participate in the webinar.

The undergraduate introduction to ecological sites was held on the final afternoon of the meeting and attracted about 30 students. It was offered for 1 hour of university credit. The participants were required to complete a minimum of 3 hours of online coursework prior to the workshop, and a minimum of 5 hours of post-workshop assignments were required for course completion.

The organizers of the undergraduate workshop were Karen Hickman, Oklahoma State University; Karen L. Launchbaugh, University of Idaho; and Mark Moseley, Homer Sanchez, and Pat Shaver, NRCS. The goals of the course were to (1) provide an overview of the history, concepts, and applications of ESDs; (2) provide examples of successful STM development using a variety of data sources; (3) provide examples of successful management applications of ESD and STM concepts; (4) create networking opportunities and generate discussion and understanding; and (5) provide students with the knowledge necessary to define and use ecological site descriptions.

This workshop placed emphasis on understanding ecological site concepts and descriptions as defined by the "Interagency ESD Handbook for Rangelands." The material in the course provided (1) details about the ecological site land classification system, ecological site concepts, and the value of state-and-transition based models; (2) information for strengthening ESDs with legacy data and through data collection and analysis; (3) discussion of the role of rangeland health in ESD development and in application at the site and landscape levels; (4) an overview of the interpretation section of ecological site descriptions; and (5) an opportunity to discuss and review how ESDs can be used to facilitate application and management. The course concluded with a group exercise using a sample ESD to allow for class interaction, discussion, and design. The ESD was used to make habitat management recommendations. The course was very well received and is currently being developed into an online course for undergraduates.

In all, the meeting included 28 hours of ecological site training and workshops and many oral and poster presentations that had development and use of ecological site descriptions as their theme. All workshops were developed and led by members of the Society for Range Management Ecological Site Training Committee, most of whom are current or former employees of NRCS. Even though the amount of travel approved for Federal employees has been significantly reduced from previous years, the workshops were all well attended. Additional ecological site workshops will likely be included at future Society venues to promote development, understanding, and use of ESDs for conservation planning and other natural resource applications. ■

State Mapping Workshop

Laura Burkett and Brandon Bestelmeyer (USDA–ARS Jornada Experimental Range) held a 2-day workshop on state mapping for personnel at the Las Cruces District Office of the Bureau of Land Management (BLM) in March 2013. The workshop consisted of indoor and outdoor instruction and included a hands-on introduction to the mechanics of state mapping. State mapping is the spatial representation of vegetation states within ecological sites. In a sense, a state map is a high resolution (1:4,000–1:5,000 meter) map of vegetation and soils linked to interpretations of vegetation dynamics in ecological site descriptions (ESDs) and especially to state-and-transition models (STMs).

State mapping starts with spatial data from the Soil Survey Geographic Database (SSURGO) and the associated soil map unit (SMU) narratives and tabular data. The soil survey is overlain on digital orthophoto quarter quadrangles or other imagery. Each SMU component is spatially correlated to one ecological site within each soil map unit polygon for a study area (fig. 1). Next, the state mapping technician becomes familiar with the properties of each soil component within each SMU and their correlated ecological sites, ESDs, and STMs. This information, alongside existing spatial data layers (such as vegetation maps, digital elevation models, and georeferenced ground data, including photos and boundaries), is used to delineate state polygons (fig. 2). SMU polygon lines are preserved during delineation such that state polygons are child polygons of soil map unit polygons. In this way, a direct connection to SSURGO is preserved. Existing spatial data and georeferenced field traverse data are used to attribute each state polygon with an ecological site name and a three-digit state code (fig. 3). The first number in the state code represents the dominant ecological state within the polygon of interest (the state that occupies the most area within the polygon). The second digit represents the second dominant

Figure 1.—Original SSURGO soil survey spatial data layer overlain on DOQQs.

Figure 2.—Ecological state map units delineated on the soil survey map. Each state map polygon is a child polygon of the soil survey map unit polygon.

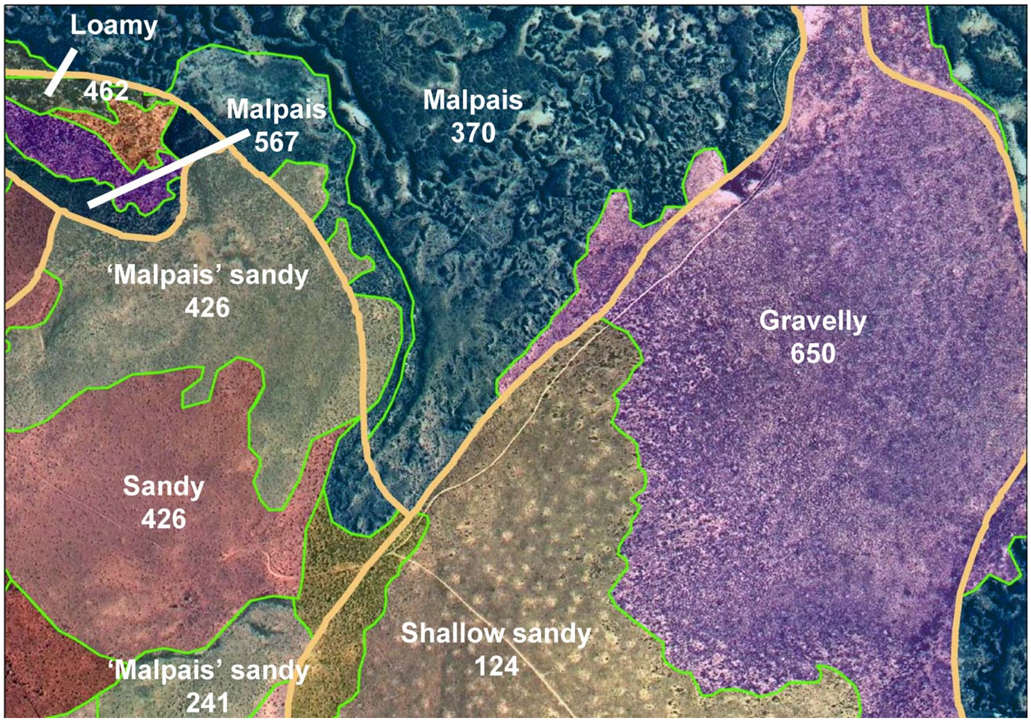


Figure 3.—Each polygon is assigned an ecological site name and a 3-digit state map code. Each number in the state code represents an ecological state. Numbers are listed in order of dominance within a given polygon. Zeros follow where only one or two states are represented in a polygon. For example, the polygon labeled Gravelly 650 is best characterized by the Gravelly ecological site (R042XB010NM) and dominated by the shrubland (6) state. The second-most common state is the shrub-dominated (5) state. Because there are no other states in this polygon, the third digit is a zero.

state, and the third digit represents the third dominant state. Zeros are inserted in cases where only one or two states occur in a polygon. The final state map provides a spatially explicit delineation of ecological sites and ecological states and can be used to link management plans to the content of ESDs and STMs.

The first day of the workshop introduced participants to the conceptual linkages between ESDs and state maps. The evolution of state mapping from 2003 to the present was explained. Also described was the future direction of state mapping. Brandon, Laura, and BLM range management specialists provided examples of how state maps have been used for planning restoration treatments, assessing vegetation change, and designing monitoring programs. Participants were introduced to the technical aspects of state mapping and then spent the afternoon in the field collecting traverse data for use in digitizing and attributing example state maps. The fieldwork facilitated an understanding of the connection between the digital state map and field-based information about ecological sites.

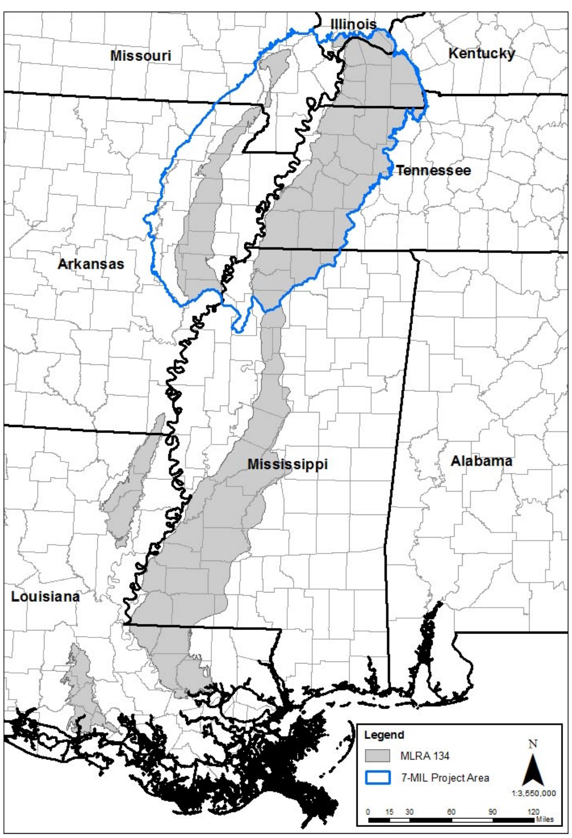
The second day of the workshop included discussions of potential sources of error during the state mapping process and discussions of BLM's future needs for state mapping. Field data collected on the first day were reviewed, and then participants obtained hands-on instruction in the mechanics of state mapping. Each person was able to edit, manipulate, query, and attribute the state mapping geodatabase using traverse data, georeferenced ground data, and other spatial data layers (e.g., boundaries, geology, management, landforms, roads, vegetation maps, and soil maps).

Feedback from workshop participants was positive. One participant wrote, “I can say that pre-training I was … still skeptical. Post training I have walked away with a much better understanding of the thought processes, business practices, and science behind the state mapping.” Not only did the workshop help participants understand state mapping, it also encouraged an interest in soils: “I got a message today…telling me how much they loved state mapping...now that they understand it, they have been digging away with the teams soils person and wanted to affirm that the training was really good for them and tomorrow they are taking an auger... .” ■

Developing Ecological Sites: A Multistate Endeavor

In support of the expanding use of ecological site descriptions in the eastern United States, a multistate technical team comprised of NRCS soil scientists and ecologists gathered in Millington, Tennessee, to expedite the development of region-wide descriptions within the Southern Mississippi Valley Loess Uplands (Major Land Resource Area 134). The field review was hosted by the soil survey office in Milan, Tennessee, and led by Barry Hart, ecological site inventory (ESI) specialist, and Caleb Gulley, soil survey office leader. Also present were ESI Specialists Karrie Pennington (Stoneville, MS) and Charles Stemmans (Opelousas, LA); Soil Survey Office Leaders Rachel Stout-Evans (Metcalfe, MS) and Burnell Muse (Denham Springs, LA); Senior Regional Soil Scientists Edgar Mersiovsky (Littlerock, AR) and Scott Anderson (Auburn, AL); Soil Survey Regional Director Charles Love (Auburn, AL); ESI Quality Assurance Specialist Michelle Clendenin (Raleigh, NC); and Rangeland Management Specialist Curtis Talbot (Lincoln, NE).

The development of ecological site descriptions for the area will support vitally important conservation planning. The planning targets natural resource concerns for wildlife and water quality associated with the Mississippi River Basin Healthy Watershed Landscape Initiative. At the meeting, a soil-site key for the entire MLRA was developed and approved by the technical team. Vegetation inventories from the tristate area (Tennessee-Mississippi-Louisiana) are anticipated to proceed in concert beginning this year. Close coordination and cooperation among a number of resource professionals is critically important to the project’s success, especially due to the geographical extent and complexity of the area. MLRA 134 extends nearly 500 miles from north to south. It extends from the extreme southern end of Illinois into southern Louisiana with disjunctive subregions west of the area’s physiographic core. ■



Ground-Penetrating Radar 2013

By Jim Doolittle, research soil scientist, National Soil Survey Center, NRCS.

Ground-penetrating radar (GPR) has been used by soil scientists for decades. Recently, NRCS soil scientists have used GPR to make bathymetric measurements in support of mapping subaqueous soils and to investigate the thickness of peat in support of technical soil services.

Subaqueous Soils on Ice

During the winter months, Thom Villars (resource soil scientist, USDA–NRCS, White River Junction, Vermont) often spends several days studying subaqueous soils using GPR on the ice-covered bays and inlets of Lake Champlain in northwestern Vermont. In past winters, Thom completed GPR surveys of Missisquoi and Maquam Bays. This winter, with the assistance of the National Soil Survey Center and the U.S. Fish and Wildlife Service, Thom completed a GPR survey across the inner basin of St. Albans Bay. The purpose of these investigations is to document differences in substrates and subaqueous soil-landscape units. Knowledge of the near-shore, submersed environments of Lake Champlain and its bays is needed to address pressing concerns over water quality, sedimentation, eutrophication, and toxic algae blooms.

Subaqueous soils are known to vary as a function of submersed landform and water depth (Rabenhorst and Stolt, 2012). However, information on shallow water habits is limited. Among the challenges faced in mapping subaqueous soils are the inability to observe subaqueous land surfaces and the lack of high-quality imagery and topographic (bathymetric) information that is so commonly used in traditional soil surveys (Rabenhorst and Stolt, 2012). Bathymetric maps are used to establish subaqueous soil-landscape units, which are identified on the basis of bathymetry, slope, landscape shape, sediment type, and geographical location. Knowledge of the distribution of different subaqueous soil-landscape units can help partition diverse, shallow, submersed environments into more homogenous units and can improve the characterization and management of these ecosystems.

In 1 day, using a mobile GPR platform operated by the U.S Fish and Wildlife Service (fig. 1), Thom collected more than 39 kilometers of continuous GPR profile data

Figure 1.—The mobile GPR platform used to complete a GPR survey across St. Albans Bay.

across the inner basin (1,761 acres) of St. Albans Bay. This data collection resulted in more than 124,000 georeferenced bathymetric measurements interpreted from radar profiles. A three-dimensional (3D) rendition of a georeferenced radar profile is shown in figure 2. In this rendition, depth measurements are expressed in meters. This 3D

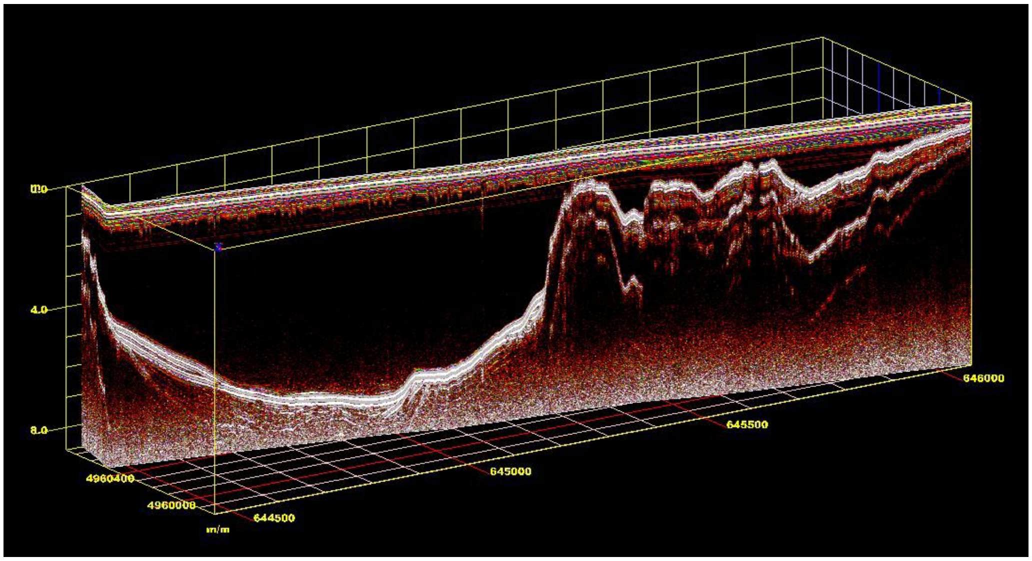


Figure 2.—A 3D rendition of a georeferenced radar profile showing the depth to bottom sediments and differences in submerged sediment types.

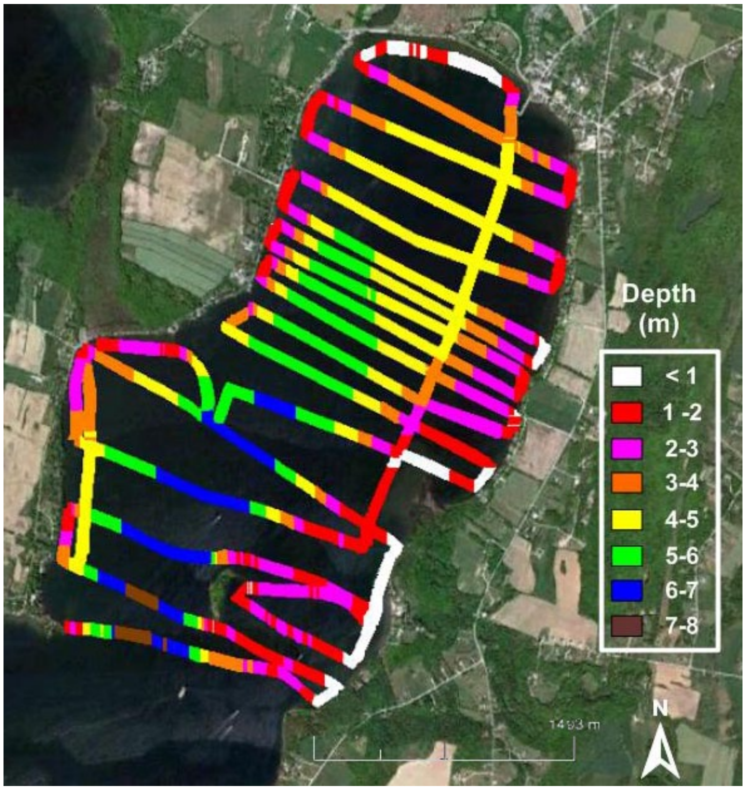


Figure 3.—A Google Earth image showing the locations of GPR traverses and the interpreted water depths (in meters) across the portion of St. Albans Bay that was surveyed with GPR.

rendition clearly shows variations in the depth and topography of the bay's floor as well as differences in submerged sediment types. Based on the interpreted GPR data, the average water depth within the inner basin of St. Albans Bay is 3.5 meters, with a range of 0.0 to 7.7 meters.

As a means of display, the georeferenced radar data can be easily imported into Google Earth. Figure 3 is a Goggle Earth image showing the locations of the GPR traverse lines that were completed in St. Albans Bay. Each traverse line is color coded based on the interpreted depth to the water bottom. Using a contouring and surface modeling software package (Surfer), several 2D bathymetric maps of St. Albans Bay's inner basin were developed. On the 2D bathymetric map shown in figure 4, a segmented line has been used to identify the presently accepted lower water depth limit for subaqueous soils (2.5 meters). This depth limit has been proposed because it is assumed to represent the normal maximum depth to which most emergent vegetation will grow.

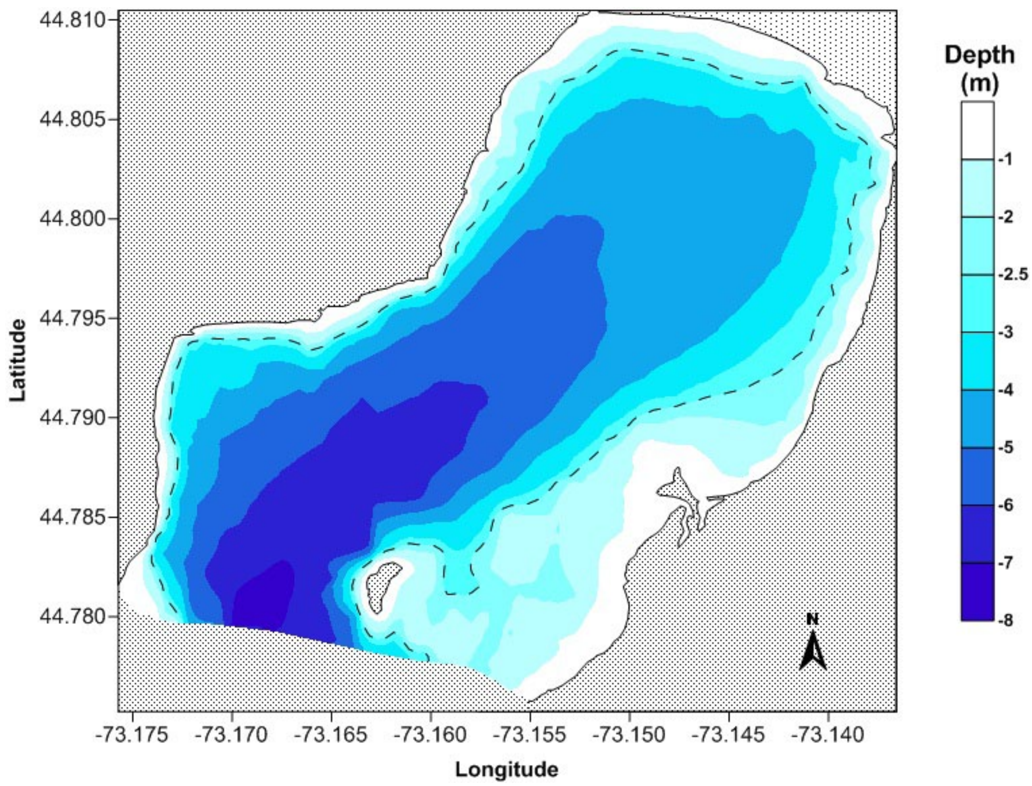


Figure 4.—A two-dimensional plot showing the interpreted bathymetry for the portion of St. Albans Bay surveyed with GPR.

As a further extension of radar interpretations, the submerged sediments of St. Albans Bay were differentiated on the basis of radar facies analysis. A radar facies is a mappable 3D unit that is composed of GPR reflections whose parameters (internal reflection patterns and characteristics) differ from adjoining units. Three major facies were tentatively identified within the surveyed portions of St. Albans Bay: stratified sandy and coarse-loamy deposits, lacustrine deposits, and rock. Figure 5 shows the location and relative extent of each of these radar facies within the inner basin of St. Albans Bay.

Over freshwaters, GPR is an expedient and effective tool to obtain information on water depths, bottom topography, sediment types, and thickness. Computer simulations and tentative interpretations based on GPR can be used to direct coring, sampling, and describing the subaqueous soils. Throughout the process, radar interpretations are continuously confirmed and modified.

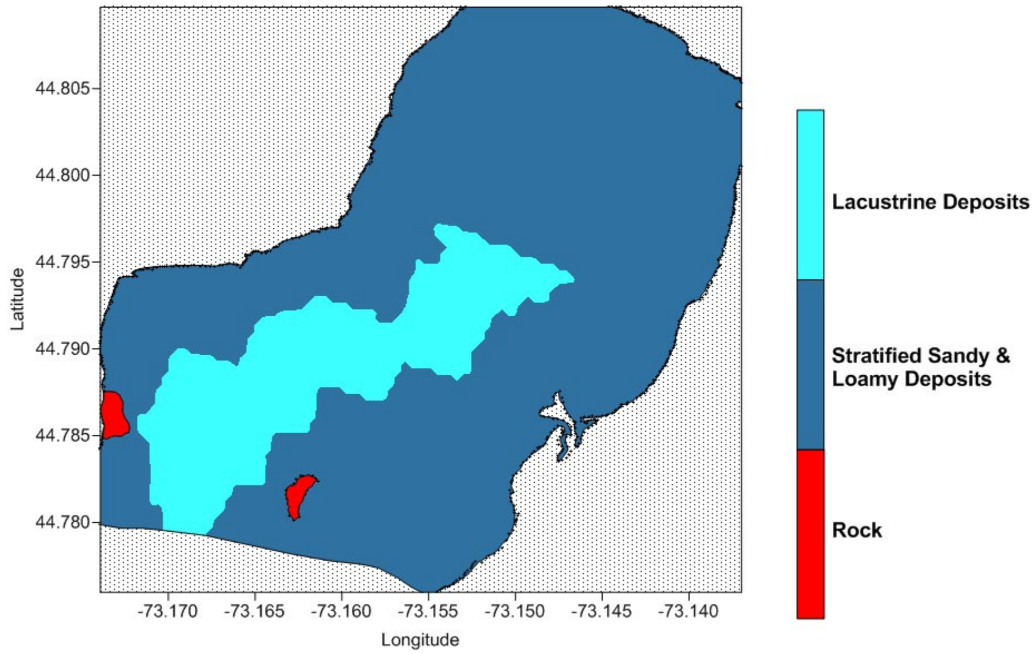


Figure 5.—A map of the tentatively named radar facies identified in the inner basin of St. Albans Bay.

For Peat Sakes!

A prerequisite for the effective use and management of cranberry beds is knowledge of the thickness, distribution, and volume of organic soil materials. The thickness of organic soil materials in cranberry beds is typically determined by probe-based methods. Because probe-based methods are slow, tedious, and expensive to conduct, observations are limited and provide only sparse coverage. Although relatively accurate, probe-based measurements contain ambiguity caused by pushing the probe too far and into the mineral substrate, nonvertical soundings, topographic irregularities along the base of the organic soil materials, lateral variations in composition of the organic soil materials, and operator errors (Parsekian et al., 2012; Rosa et al., 2009). Today, new and improved technologies are being used to inventory and map cranberry beds.

Ground-penetrating radar (GPR) has been used for over 30 years to inventory and map peatlands. In many peatlands, GPR provides continuous streams of high-resolution subsurface information, which aids interpretations and supplements the sparse information obtained by traditional probe-based methods. Compared to traditional methods, GPR requires significantly less time and effort to obtain similar information on the thickness, volume, and structural geometry of peatlands (Jol and Smith, 1995). The continuous profiling capability of GPR provides a large number of observations that can complement the fewer, more widely spaced, probe-based measurements. Consequently, the use of GPR often yields more accurate estimates of the thickness of organic soil materials and more detailed information on the hydropedological framework of peatlands (Nolan et al., 2008; Rosa et al., 2009; and Wastiaux et al., 2000).

In Plymouth County, Massachusetts, Glenn Stanisewski (resource soil scientist, USDA–NRCS, West Wareham, Massachusetts) routinely uses GPR to determine the thickness and volume of organic soil materials and characterize the internal structure of cranberry beds. Glenn was recently assigned the task of completing a high-intensity GPR survey of two cranberry beds for a wetland restoration project. The objectives of the investigation were to determine the depth of organic materials and the locations of any deep, kettle holes beneath the beds. The information was needed for planning a wetland restoration project intended to recreate a natural stream channel across the wetland.

Multiple GPR traverses were completed by carrying a 70 MHz antenna back and forth across each cranberry bed (fig. 6). Multiple GPR profiles of the subsurface were obtained. Figure 7 is a three-dimensional (3D) rendition of a radar profile from the cranberry beds. In this rendition, the depth scale is expressed in meters. The

Figure 6.—Glenn Stanisewski conducting a GPR survey with a 70 MHz antenna across a cranberry bed in Plymouth County, Massachusetts.

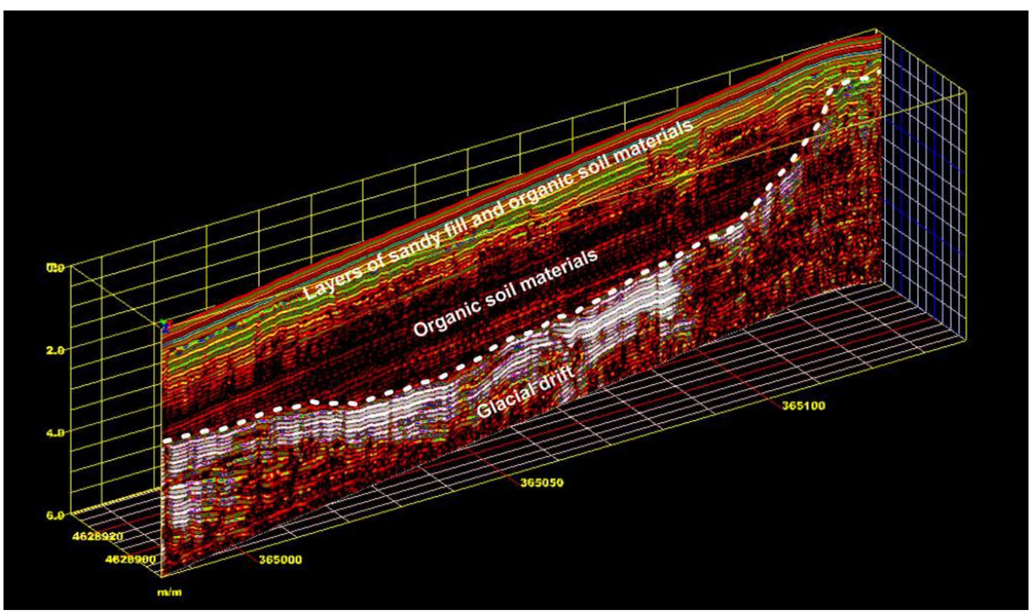


Figure 7.—A 3D rendition of a radar profile from the cranberry bed. The thickness of organic soil materials is identified by the white, segmented line.

horizontal scale is expressed in the Universal Transverse Mercator (UTM) geographic coordinate system. A white, segmented line has been used to highlight the interpreted organic/mineral soil interface. Cranberry beds have surface layers of sandy fill materials, which have been added to the original surface as a management practice. In beds that have been in production for longer than several decades, the surface layer consists of thick (40 to 130 centimeters), alternating layers of sand and organic materials (Turenne, 2013). These relatively thick, alternating layers of sandy fill and organic soil materials are evident in the upper part of the 3D rendition.

Based on radar depth measurements, a two-dimensional (2D) simulation of the cranberry beds was created. This simulation (fig. 8) shows the interpreted depth to the glacial drift beneath each cranberry bed. This simulation is based on over 64,600 radar depth measurements. In figure 8, the approximate locations of two constructed dikes are also shown. Within the investigated cranberry beds, the estimated thickness of the sandy fill and organic soil materials is 2.7 meters, with a range of 0.71 meter to 7.26 meters.

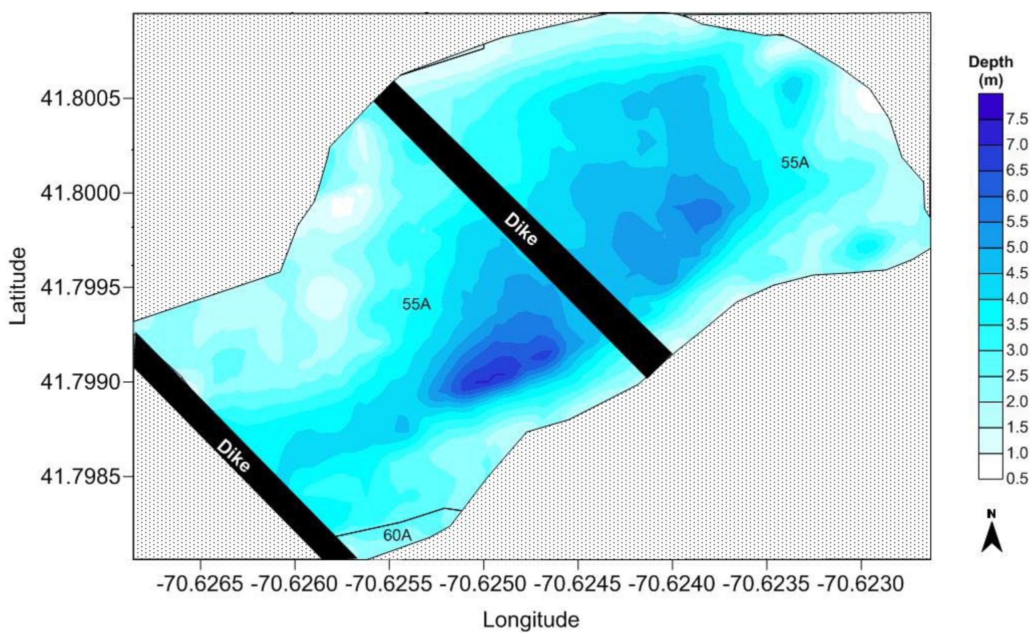


Figure 8.—A 2D simulation of the investigated cranberry beds depicting the interpreted thickness of sandy fill and organic soil materials.

In figure 8, relatively extensive shelves of thinner sandy fill and organic soil materials are evident in both the western and eastern portions of the cranberry beds as well as in the peripheral areas. The imagery suggests the locations of two deeper, peat-filled kettle holes. In addition, the deeper portions of the organic deposits form a sinuous, interconnected lineation that mimics a natural stream channel across these beds. This information will be useful in planning the wetland restoration project.

References

Jol, H.M., and D.G. Smith. 1995. Ground penetrating radar surveys of peatlands for oilfield pipelines in Canada. Journal of Applied Geophysics 34:109–123.

Nolan, J.T., A.D. Parsekian, L.D. Slater, and P.H. Glasner. 2008. Geophysical characterization of the Red Lake Peatland Complex, northern Minnesota. *In* Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems 21(2):1044–1047.

Parsekian, A.D., L. Slater, D. Ntarlagiannis, J. Nolan, S.S. Sebesteyen, R.K. Kolka, and P.J. Hanson. 2012. Uncertainty in peat volume and soil carbon estimated using ground-penetrating radar. Soil Science Society of America Journal 76:1911–1918.

Rabenhorst, M.C., and M.H. Stolt. 2012. Subaqueous soils: Pedogenesis, mapping, and applications. *In* Lin, H., editor. Hydropedology: Synergistic integration of soil science and hydrology. pp. 173–204.

Rosa, E., M. Larocque, S. Pellerin, S. Gagné, and B. Fournier. 2009. Determining the number of manual measurements required to improve peat thickness estimations by ground penetrating radar. Earth Surface Processes and Landforms 34:377–383.

Turenne, J. 2013. Cranberry bed soil map units. http://nesoil.com/muds/cransoil.htm

Wastiaux, C., L. Halleux, R. Schumacker, M. Streel, and J.M. Jacqmotte. 2000. Development of the Hautes-Fagnes Peat Bogs (Belgium): New perspectives using ground-penetrating radar. Suo 51(3):115–120. ■

Geophysical Investigations at Prehistoric Archaeological Sites

By Wes Tuttle, geophysical soil scientist, National Soil Survey Center, NRCS.

Geophysical investigations have yielded interesting information at a prehistoric archaeological site on the flood plains along the Mississippi River (fig. 1). Rachel Stout-Evans, NRCS soil survey project leader in Metcalfe, Mississippi, has been taking full advantage of geophysical tools to explore a culturally rich area for clues into the past of earlier Native Americans. Rachel and NRCS Archaeologist Cliff Jenkins (Jackson, Mississippi) have been conducting investigations using modern, noninvasive techniques, such as electromagnetic induction (EMI), to explore potential archaeological sites and re-examine known sites.

Figure 1.—The tallest mound at the Lake George site. The mound observable in this wooded area is thought to have been constructed during the Crippen Point phase (1000-1200 A.D.). This mound is referred to as a "platform" mound. It is approximately 55 feet in height and is centrally located within the site.

The electromagnetic induction (EMI) survey was conducted using the Geonics EM38 meter, which measures changes in apparent conductivity across the site. A Trimble AG-114 GPS receiver was used to georeference measurements of apparent conductivity. The data was later processed and analyzed to yield a spatial map showing changes in apparent conductivity. The changes in apparent conductivity were associated with changes in soil characteristics across the site. Several of the observed anomalous features and changes in apparent conductivity spatial patterns were associated with mound building, burials, and potential habitation sites.

Electromagnetic Induction (EMI)

EMI tools use electromagnetic energy to measure the apparent conductivity of earthen materials. Electromagnetic induction measures vertical and lateral variations in apparent electrical conductivity. Values of apparent conductivity are seldom diagnostic in themselves. However, relative values and lateral and vertical variations in apparent conductivity can be used to infer changes in soils and soil properties. Interpretations are based on the identification of spatial patterns within data sets. Computer simulations of EMI data are normally used to assist in making interpretations, and ground-truth measurements are required to verify the interpretations. EMI has been used to identify areas with high concentrations of sodium and salts (saline seeps), assist with depth-to-bedrock determinations, identify areas with higher concentrations of clay, locate ancient stream channels, aid in burial detection, locate septic fields, locate dissolution features in karst topography, discern differing lithologies in reclaimed mine spoil areas, detect plumes from waste storage facilities, and aid in archaeological investigations.

Site

The investigations were conducted at the Lake George/Holly Bluff archaeological site, located just southeast of the community of Rolling Fork, Mississippi, in Yazoo County. More than 25 mounds have been identified at the site. Looting, erosion, and cultivation have extensively damaged the mounds over the years. The largest mound is approximately 55 feet above the surrounding landscape. Many burials have been unearthed and documented during archaeological investigations at the site in recent years. EMI techniques were used at the site to help verify subsurface artifacts, burials, and relict structures and to identify other areas of interest. EMI and ground-penetrating radar have proven to be valuable noninvasive tools that allow multiple observations with a minimal amount of earth disturbance. Ground truthing is needed to confirm observable changes in apparent conductivity as it relates to soil properties.

Results

The tools worked very well in predicting textural changes across the survey area. Higher apparent conductivity was associated with increased clay and moisture in the soil profile (fig. 2). Soil borings in areas of higher apparent conductivity revealed an increase in clay and moisture. Areas with dominantly coarser soil textures were associated with lower apparent conductivity. The planar landscape across some portions of the site did not suggest any changes in soil properties across the area, but EMI spatial patterns suggested otherwise. Soil borings verified changes in EMI spatial patterns and changes in soil properties with the presence of subsurface prehistoric archaeological features. Additional studies are planned using geophysical tools to aid in archaeological investigations as well as to study changes in soil properties across the landscapes.

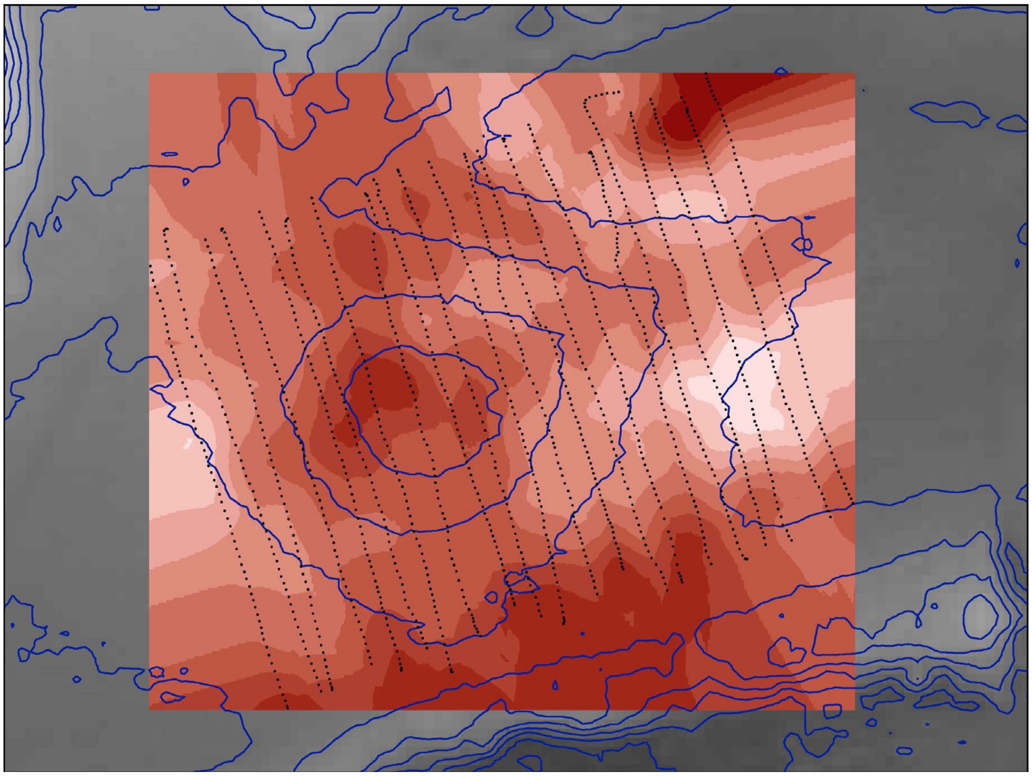


Figure 2.—ArcGIS presentation of spatial apparent conductivity patterns at the site. Redder colors are associated with higher apparent conductivity. The location of a relict mound structure can be observed in the near center of the figure (two nearly concentric rings). The blue lines depict changes in elevation from LiDAR data. The georeferenced survey lines (dotted) can be observed.

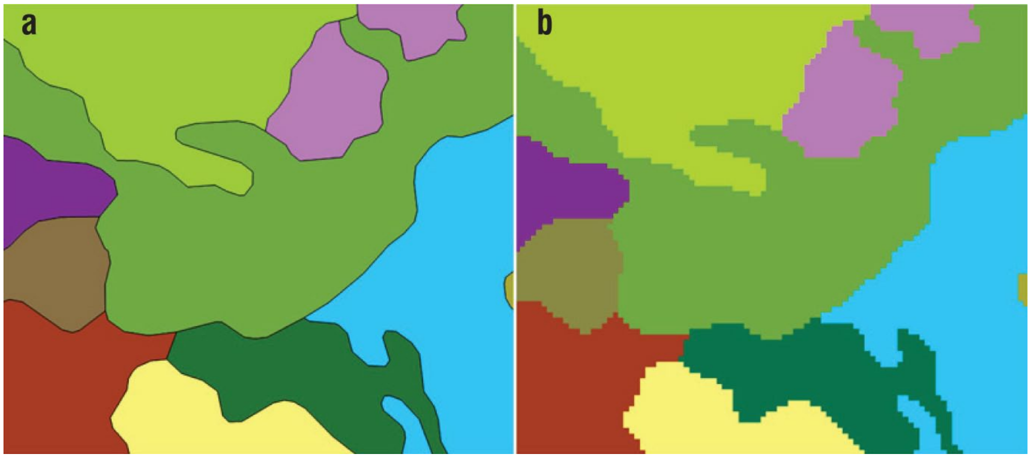
EMI has gained wide acceptance over the past few years. Multiple applications of EMI within NRCS have proven to be beneficial. EMI shows potential for expanded applications when used in combination with knowledge of soils and soil properties. The future of EMI within NRCS appears to be bright as more applications are discovered. ■

Gridded Soil Survey Geographic (gSSURGO) Database

By Linda Greene, ACES enrollee, NRCS, National Soil Survey Center, Lincoln, Nebraska.

The popular Soil Survey Geographic (SSURGO) Database is available online from the Web Soil Survey, but it is not easily used at national, regional, and statewide scopes for resource planning and analysis of soils data. USDA–NRCS has therefore added a new product designed to improve access to soils information about large land areas. The new product, called gSSURGO ("g" for "gridded"), provides detailed soil survey mapping in raster format with "ready to map" attributes organized in statewide tiles for desktop GIS. The design should be especially helpful to the simulation modeling community. In addition, the raster format allows GIS visualization of highly detailed soils themes for an entire State in a matter of seconds.

The gSSURGO Database is derived from the official Soil Survey Geographic Database for fiscal year 2013 and was prepared by merging the traditional vector-



(a) An example of the traditional vector-based SSURGO map unit polygon format at 1:6,000 map scale; (b) the corresponding new raster-based gridded SSURGO (gSSURGO) 10-meter map unit format.

based SSURGO digital map data and tabular data into statewide extents, adding a statewide gridded map layer derived from the vector layer, and adding a new value-added look-up table database containing "ready to map" attributes.

The new "ready to map" themes contain a variety of data, including soil organic carbon, available water storage, National Commodity Crop Productivity Index, root-zone depth of commodity crops, available water storage within the root-zone depth, drought-vulnerable soil landscapes, and potential wetland soil landscapes, just to name a few.

For details and a description of how to obtain datasets, go to the gSSURGO Web site at http://soils.usda.gov/survey/geography/ssurgo/description_gssurgo.html.

The gSSURGO Database is available from the Geospatial Data Gateway at http://datagateway.nrcs.usda.gov/. It can be downloaded by ftp or ordered on CD or DVD. ■

Soil Science on YouTube

By Tammy Cheever, information technology specialist, NRCS, National Soil Survey Center, Lincoln, Nebraska.

The Soil Science Division has its very own YouTube channel at http://www.youtube.com/user/nrcsnssc. With very little promotion, our YouTube videos have been viewed 8,499 times so far this calendar year and 20,554 times since June 2011. The National Soil Survey Center is in the process of transcribing and closed captioning all of its videos and webinars.

Webinars

National Soil Survey Handbook (05/2013)
National Ecological Site Handbook (part 1) (04/2012)
National Ecological Site Handbook (part 2) (04/2012)
Freshwater Subaqueous Soil Survey Investigations and Applications (04/2012)
VNIR: Potential for Additional Data Collection Beyond Rapid Carbon (09/2011)
Train the Trainer Refresher (06/2011)
Land Evaluation (LE) Part of LESA (09/2011)
Ecological Sites: An Executive Summary for State Leadership (12/2011)

Evaluation of Conservation Performance in Cropland Regions (03/2013)
Soil Organic Matter Response to Soil Management Practices (03/2013)
Vesicular Soil Horizon (12/2012)
TSS Activity Reporting (11/2012)
New Data Collection Apps for Mobile Devices (11/2012)
IRIS Tube Technology (01/2013)
Spatial Disaggregation (02/2013)
Soil Property Maps from STATSGO2 (02/2012)
Java Newhall Simulation Model (07/2012)
NGMC Web Services (09/2012)
Hydric Soils and the Farm Bill (03/2012)
LE Part of FPPA Forms (09/2011)
SA Part of FPPA Forms (09/2011)
Update on the National Commodity Crop Productivity Index (10/2011)
Training Plans and OJT for SSO and FO (08/2011)
Soil Survey Laboratory Data (01/2012)
SC-OSD Database (02/2011)
Role of MLRA SSO in ESI (03/2011)
NASIS and WSS Updates (04/2011)
The Interpretations Group (02/2011)
Ecological Sites and the MLRA SSO Leader (12/2011)

Videos

How to Use the Field Book for Describing and Sampling Soils (02/2013)
Video for Students of Soil Technology—Measurement and Data Evaluation (09/2012)
Kellogg Soil Survey Laboratory (08/2012)
1991 Newhall Simulation Model Run for Gudmundsen Ranch in Nebraska using 1982–2002 Climate Record (07/2012)
Water Movement in Soil (12/2011)
Captioned Particle-size Analysis by Hydrometer (07/2011)
Particle-size Analysis by Hydrometer (07/2011)
Soil Science Institute at KSU June 2011 (06/2011) ■

NRCS Participates at the International LiDAR Mapping Forum

The International LiDAR Mapping Forum was held in Denver, Colorado, February 11–13, 2013. The event attracted over 850 registered attendees from over 30 countries and included an exhibition of 70 vendors showcasing new systems and software. This 3-day technical conference and exhibition focused on airborne and bathymetric LiDAR, with a particular emphasis on mobile mapping systems. The conference provided an opportunity to learn about the latest advances in technology and hear about industry changes from industry experts.

William Marken (acting NRCS National Elevation Leader) and Steven Nechero (NGCE Geospatial Data Management Branch Chief) of the National Geospatial Center of Excellence (NGCE) attended the forum. NGCE is a part of the Soil Science and Resource Assessment (SSRA) deputy area of the United States Department of Agriculture, Natural Resources Conservation Service. NRCS interests in the forum included data capture systems, techniques for data fusion and classification, techniques for data processing, integration of imagery and elevation technologies, and contact with technical experts to explore opportunities for NRCS to take advantage of the new technologies.

NGCE presented the NRCS National Elevation Program and applications at the field level in a 40-minute time slot on Wednesday, February 13. The presentation was well received, and SSRA–NGCE was contacted by several partners and vendors that had suggestions on how to enhance the map and data services NGCE is developing for NRCS. Dr. David F. Maune, who completed the NRCS Elevation Study in 2010, attended the session. He complimented NRCS on the successful implementation of the National Elevation Program based on recommendations from the study.

Two major emerging technologies discussed at the conference were Waveform LiDAR and Flash LiDAR. There was also significant discussion on the LiDAR validation suite and micro unmanned aerial vehicles (UAVs) following a presentation by Lewis Graham, President and CTO of GeoCue Corporation and LiDAR Division Director, American Society for Photogrammetry and Remote Sensing (ASPRS).

During the conference, personnel from NGCE met with the NRCS State GIS specialist in Colorado, Chris Mueller, and several liaisons from the U.S. Geological Survey to discuss partnerships and LiDAR applications. Carol Griffin, USGS liaison for Colorado, is organizing a workshop this summer on the application of LiDAR in the San Luis Valley. The San Luis Valley LiDAR project is a highly successful partnership of Federal and local agencies designed to acquire, integrate, and deploy LiDAR products and services for conservation and environmental analysis. NRCS was a major contributor to this project along with the U.S. Geological Survey, National Park Service, U.S. Fish and Wildlife Service, Bureau of Land Management, and U.S. Forest Service.

The major takeaways from the conference were twofold: (1) LiDAR is a mature mapping technology, and (2) airborne LiDAR mapping systems provide 3D information for the surface of the earth, including terrain surface models, vegetation characteristics, and manmade features.

The NRCS Elevation Program is on track to provide this key technology to NRCS GIS users at all levels (field, State, regional, and national). For additional information on NRCS LiDAR technologies and strategies, please contact William Marken (william.marken@ftw.usda.gov) or Steven Nechero (steven.nechero@ftw.usda.gov). ■

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