National Cooperative Soil Survey Newsletter

February 2016
Issue 74

In This Issue—

Soils2026—A Milestone within Grasp 1
USDA CarbonScapes Presented to Global Change Task Force 2
Bighorn Basin Soil Characterization Project 4
Filming at the National Soil Survey Center 5
Region 9 Workshop Discusses Changing SSURGO 6
Update of the National Cooperative Soil Survey Characterization Database Products 8
Ground-Based Solar Panel Arrays and Soil-Penetrating Anchor Systems 9
9th International Soil Classification Seminar and Workshop Held in Mexico 12
NSSC Has a New National Leader of Soil Survey Standards 13
Groundwater Banking Index 14
Nondiscrimination Statement 15

Editor's Note

Issues of this newsletter are available at http://soils.usda.gov/. Under the Soil Survey tab, click on Partnerships, then on NCSS Newsletters, and then on the desired issue number.

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

Soils2026—A Milestone within Grasp

By David Hoover, Acting Director, National Soil Survey Center.

Soil survey in the United States has hit many milestones over its 117-year history. The nation has seen the adoption of Soil Taxonomy, the establishment of the National Cooperative Soil Survey (NCSS), the development of computerized data delivery, and the replacement of published soil surveys by the Web Soil Survey. However, one milestone has still eluded soil scientists: the completion of a soils inventory in all areas of the United States. Even though the extent of the unmapped lands has been decreasing, there are still blank areas on the maps of soil survey progress in the nation. Only about 450 million acres out of a total of 2.3 billion acres of land in the country remain without SSURGO data coverage. The Soils2026 project will help soil scientists finally achieve that monumental milestone!

Soils2026 is a process to complete a soils inventory for all areas of the United States, including Alaska, by 2026. It is an ambitious project that will need the many talents of NRCS and its cooperators for the next 10 years. In the end, it will be a complete national product that provides soils data on all lands. It will contain basic soils information that will be useful to land-use managers, ecologists, and modelers. The data will be available for download and for viewing by many of the methods used today. The Soils2026 product will rely heavily on digital soil mapping (DSM) technology, and the statistical uncertainty of the mapped soils will be analyzed and made available.

To realize what the product will be, it is important to understand what it will not be:

- It is not going to be a traditional SSURGO product on all lands. To deliver that level of soils data could take another 50 years due to the remote nature of most of the unmapped lands.
- It is not going to be done entirely by computer modeling. Digital soil mapping techniques will definitely be used to complete this work, but ground validation will still be essential.
- In many cases, it is not going to be a final product. Rather, it can be used by soil scientists to take the mapping on the land to that next milestone.
    - In some remote areas, the Soils2026 product may stand for decades as the authoritative NCSS soils data set.
    - In other areas, it will help document that a more concentrated digital soil mapping process is needed.
    - In still other areas, it will be analyzed to determine if a traditional soil survey with "boots on the ground" and a lot of holes dug is what is really needed.

In any case, the Soils2026 product will be the springboard to future work.

Leaders of the Soils2026 Digital Soil Mapping Team have been selected. A team of NRCS employees and partners is being developed to plan, complete, and evaluate this huge undertaking. Work will begin in 2016.

While Soils2026 is being developed and completed, other efforts, such as initial mapping projects and significant updates, are going to continue. The Soils2026 data sets, the new initial mapping data, and the update mapping will all be part of the first authoritative data set to cover the entire country.

The strength of the NCSS partnership will be key in completing Soils2026. Early discussions with the leadership of the U.S. Forest Service, Bureau of Land Management, Bureau of Indian Affairs, and National Park Service have focused on determining minimum data standards for Soils2026 mapping, utilizing existing Agency mapping on Federal lands to the largest extent possible, and identifying which interpretations are critical. These discussions will guide the selection of the types of data collected.

Stay tuned to the NCSS Newsletter for updates on Soils2026, and get involved where you can! ■

USDA CarbonScapes Presented to Global Change Task Force

Do you know how many million metric tons (MMT) of soil carbon are in the upper meter of soil in your county? How about the CO_2-equivalents (CO2-e) per hectare for the carbon stock in the upper meter of soil in your home watershed? Would you like to know how many MMT of soil carbon are in the upper meter of soil in your favorite Major Land Resource Area (MLRA)?

If you are interested in any of these questions, you will want to visit http://www.carbonscapes.org/atlas.

USDA CarbonScapes was designed to provide a useful, easy-to-navigate web map that can educate stakeholders and answer their questions about USDA efforts to inventory, model, and map terrestrial biosphere carbon pools across the landscape. The CarbonScapes Atlas presently draws on gSSURGO estimates of soil organic carbon. Soon, however, it will also include Forest Inventory Analysis (FIA) above and below ground Forest C estimates. It is staged for C stock, mass and flux estimates provided by CEAP, and other inventory/modeling sources for cropland and rangeland.

The Explorer function includes many USDA-Carbon-related models and map layers.

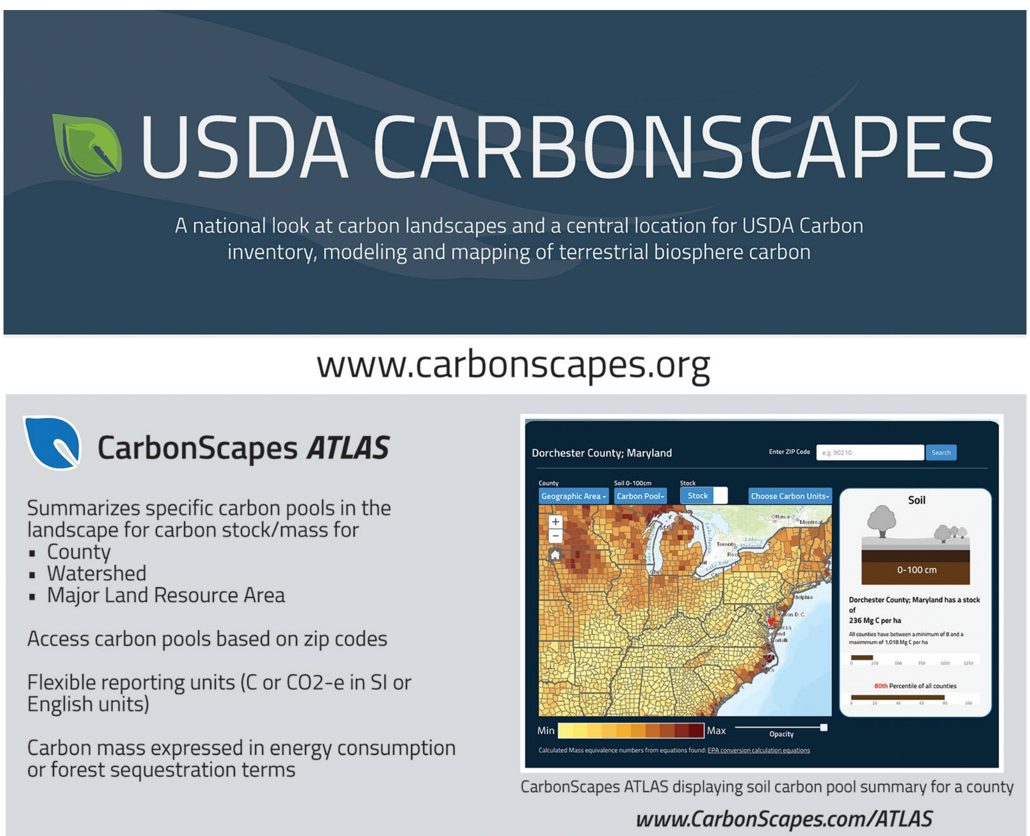
USDA CarbonScapes is a CESU (Cooperative Ecosystem Studies Units) project sponsored by the Climate Change Initiative.

On October 6, the project was reviewed by the USDA Global Change Task Force (GCTF). The review featured a presentation by NSSC Geospatial Research Unit Soil Scientist Sharon W. Waltman and West Virginia University researchers, including Jim Thompson, Division of Crops and Soil Science, and Kurt Donaldson, Maneesh Sharma, and Frank Lafone with the West Virginia GIS Technical Center. The Atlas, Data, and Explorer Tools were introduced and demonstrated for the group of approximately 40 USDA Agency representatives and the USDA Office of the Chief Economist.

The overarching goals of the project are to:

(1) Bring USDA scientists and USDA models together with ready access to national digital map layers,
(2) Improve assessments of soil and plant carbon sequestration to estimate the greenhouse gas emission offset potential from agricultural lands through modeling scenarios, and
(3) Use Geoplatform principles (OMB Federal Geographic Data Committee http://www.geoplatform.gov) for efficient use and management of Federal geographic or mapped data assets.

For more information about USDA CarbonScapes, please email mike.wilson@lin.usda.gov or Sharon.waltman@wv.usda.gov. You can provide comments about CarbonScapes at http://www.carbonscapes.org. Select “About” and then “User Feedback.” ■



A page of a flyer that is available for download at http://www.carbonscapes.org. (Choose “About” and then “Flyer”.)

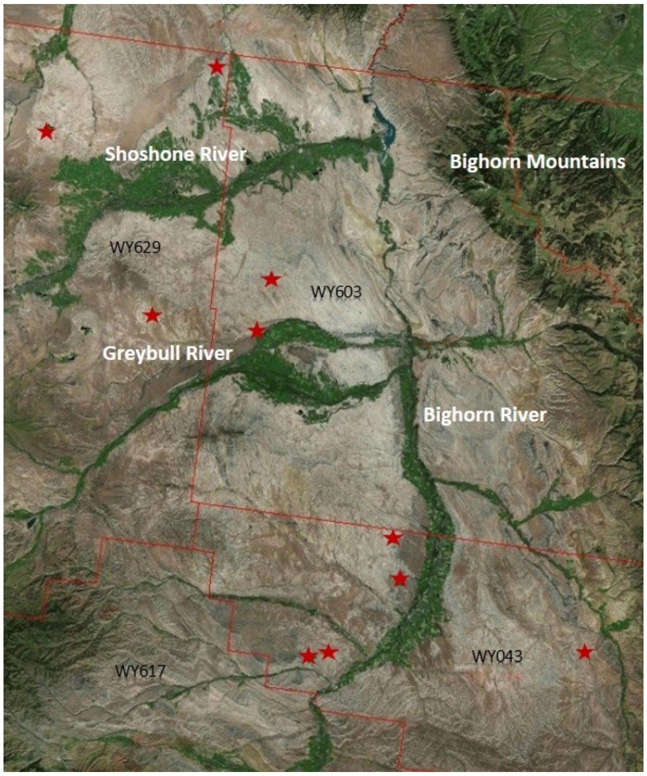
Bighorn Basin Soil Characterization Project

By Daniel Wood, soil survey leader, Powell, Wyoming.

The Powell, Wyoming, Soil Survey Office spent 2 weeks last summer collecting soil samples within the northern portion of MLRA 32–Northern Intermountain Desertic Basins, which includes parts of three initial soil survey areas and one correlated soil survey area. Full characterization sampling was completed for 10 sites.

The Bighorn Basin is a structural intermontane basin in north-central Wyoming. It is flanked by the Absaroka Range to the west, the Bighorn Mountains to the East, and the Owl Creek Mountains to the south. Major rivers in the basin include the Shoshone, Greybull, and Bighorn.

This project was initiated as part of the effort to harmonize internal joins between older mapping (and assigned ecological sites) and current soil survey mapping on rangeland. It was discovered that many of the soils previously mapped as Torriorthents, Torrifluvents, Haplocambids, and Haplargids had potentially diagnostic natric, calcic, and gypsic horizons. If these soil properties were recognized, the soils would be interpretively different.



Location of the 10 sampling sites in the Bighorn Basin, Wyoming.

Breaking ground at one of the sampling sites. Isabelle Giuliani digs the pit while Soil Survey Leader Daniel Wood and Area Resource Soil Scientist Dan Mattke prepare for sampling.

Existing lab data for the four soil survey areas is very limited. Only 16 sites have been sampled within the roughly 5,650,000 acres of the combined survey areas. Most of the sites are in Park County Area, Wyoming, Eastern Part (WY629). In addition, most existing lab data was collected more than 35 years ago.

Sample sites were selected using data exported from NASIS in combination with field reconnaissance. Trenches were excavated using a backhoe. All of the sampled soils included distinct to prominent clay films on ped faces, and all but one soil had identifiable accumulations of secondary calcium carbonate. Furthermore, half of the soils had visible accumulations of gypsum and half had visible accumulations of other salts.

Lab analyses results from the Kellogg Soil Survey Laboratory are expected in March 2016. Information gained in this study will improve the quality and credibility of the three ongoing soil surveys, the adjoining published surveys, benchmark soils, and ecological site development by providing consistent identification, classification, correlation, and interpretive values of the soils within MLRA 32. Staff who participated in the sampling included Daniel Wood, MLRA soil survey office leader; Isabelle Giuliani, soil scientist; Marji Patz, ecological site specialist; Dan Mattke, area resource soil scientist; Philip Goodin, Pathways summer intern; and Jane Karinen, soil data quality specialist. ■

Filming at the National Soil Survey Center

By Linda Greene, EarthTeam volunteer, public affairs specialist, National Soil Survey Center.

Filmmaker Buz Kloot and film editor Lizbet Palmer brought some excitement to the National Soil Survey Center in Lincoln, Nebraska. They spent a week filming videos that highlight the National Soil Survey Center and four of its staff, including both their personal stories as well as their work in support of the Center's mission. Kloot and Palmer are no strangers to telling the story of soils. They were the creative minds behind the NRCS series produced for the "International Year of the Soils." It was logical that they be chosen to do something similar but a little different. Kloot and Palmer decided to focus on individual staff members and have them tell their personal stories and describe how they found themselves working with soil at the Center. Kloot's "stars" were Henry Ferguson, Candiss Williams, Janis Lang, and Skye Wills.

Henry Ferguson is a soil scientist with duties primarily involving soil data management. He was interviewed and filmed for a day on the University of Nebraska's East Campus. Often referred to as the Center's "Renaissance Man," Ferguson has a great many interests both inside and outside the office. It was a challenge to discuss all of them. You can learn more viewing the finished product.

Candiss Williams is a research soil scientist. Filming of Williams included field aerial shots involving a drone. Williams told her story of growing up in a family that has a three-generation legacy of working with soils.

Janis Lang is a physical science technician in the Kellogg Soil Survey Laboratory and also an accomplished and nationally recognized painter. Her paintings have been on display in museums and galleries across the country. They have been displayed not only for their beauty but also for their unique use of soils as paint. Her paintings that were commissioned for the Lewis and Clarke Bicentennial still appear in publications.

Skye Wills is a soil scientist with a passion for tall plains grasses. Wills shares her story of working in many areas of the country and on several projects. She has the unique ability of making complex information understandable, including dynamic soil properties.

Visit this link to view the videos:

https://www.youtube.com/watch?v=blA_jwzQj08&list=PL4J8PxoprpGYaBZbFDjfCexZg_PK9z43V&index=1. ■

Region 9 Workshop Discusses Changing SSURGO

By Drew Kinney, Regional Director, Soil Survey Regional Office 9, Temple, Texas.

President Kennedy once said, "Change is the law of life. And those who look only to the past or present are certain to miss the future." This quote carries a prominence in the context of SSURGO, in particular the vector model of SSURGO. The vector model is based on polygons, which are loosely defined as "a plane figure that is bounded by a finite chain of straight line segments closing in a loop to form a closed chain."* Soil mapping and the vector model have served this country extremely well over the past 116+ years. The technologies and concepts used to create the vector model have morphed over the years from plane tables and alidades to satellites, spectroscopy, and digital elevation models. The vector model still works, but can we make it better? What is the future of SSURGO and the vector model? What changes are in store?

One change is the conversion of SSURGO from a vector-based model to a raster-based model. A raster is a grid of equal-sized cells or pixels with each cell representing a soil component or property. Raster-based mapping was the impetus for the Region 9 operations meeting held in College Station, Texas, on February 2nd and 3rd. The workshop was moderated by Maxine Levin, National Leader for Interpretations, NSSC; Dave Hoover, Acting Director of NSSC; Wade Bott, state soil scientist, North Dakota; and Tom D'Avello, GIS specialist, Geospatial Research Unit, Morgantown, West Virginia. The Region 9 soil scientists and ecological site specialists, the Texas State Soil Scientist, and the Texas resource soil scientists participated in the workshop. Special guests were Dr. Dave Lindbo, Director of the Soil Science Division, and Ken Scheffe, soil scientist, National Soil Survey Center. Also attending were staff from the Marfa, Texas, Soil Survey Office in Region 8. The Marfa staff have been working on a raster-based map in MLRA 42 for several years.

This Digital Soil Mapping Workshop was the fourth workshop held this year. One more will be held in Auburn, Alabama, this summer.

Dave Hoover started off the workshop with an overview of digital soils information and rasters. Dave pointed out this is not the Agency's "first rodeo" with raster-based soils information. SCS used soil raster data in the 70s, and a few long-term soils staff remember using GRASS software, which was raster-based. Dave also mentioned that NRCS is not the only entity working with raster-based soils data. Princeton University has developed a program called Probabilistic Remapping of SSURGO, dSSURGO (a.k.a. Polaris). Polaris is a 30-m raster soil map of the U.S. ("30-m" indicates that each pixel represents 30 m^2 and each pixel contains one soil component).

Tom D'Avello provided a detailed explanation of some of the terms and definitions used in raster mapping. Tom also discussed the raster data mode's strengths and weaknesses and the capabilities of rasters for modeling in 3D and 4D (3D with the dimension of time). Rasters are the preferred type of data for computer-based modeling.

Dr. Lynn Loomis, MLRA soil survey office leader in Marfa, Texas, led a discussion on how digital soil mapping is being conducted in MLRA 42. Of particular interest were his suggestions on training needs. Lynn strongly recommended learning the cLHS package from the R statistics software. Dave White, soil scientist, Las Cruces, New Mexico, has written a paper on how to use the cLHS package. Lynn emphasized that the digital soil mapping approach has a steep learning curve and that some leeway by management (at least a year) is needed to accommodate this process. The Marfa soil survey office is using a knowledge-based approach to map ecological sites and then link those sites to soil components.

The Marfa office has noticed the following advantages:

(1) Improvement in existing SSURGO polygons because of better accounting of components,
(2) Adjustments that make interpretations more realistic for conservation planning,
(3) Production of a raster map with NASIS interpretations and soil properties tied to individual raster pixels, and
(4) Production of raster maps of the many covariates used in the digital mapping process.

The five Texas resource soil scientists provided valuable commentary on the potentials of a digital raster soil map. They commented that current soil maps need a soil scientist to explain them and that SSURGO is often viewed incorrectly. Soil polygons are often viewed as homogenous areas, when in reality that is not the case. This misinterpretation is not foreign to NRCS planners. A raster map is generally more easily understood than a soil polygon because rasters tend to display either a soil component or a soil property as a gradient across the landscape. Polygons display a single homogenous interpretation across the landscape. They require the user to infer properties that may exist in a polygon, which can lead to misinterpretation.

The last part of the meeting was a field demonstration of the visible near infra-red (VisNIR) penetrometer developed at Texas A&M and the Portable X-ray Fluorescence Spectrometry sensor (PXRF).

Jason Ackerman, Texas A&M University, demonstrated the VisNIR penetrometer. The VisNIR can create continuous-depth profiles of soil clay content, soil organic carbon, soil inorganic carbon, cation-exchange capacity, and iron content. It may also have the ability to estimate clay minerology. The VisNIR was mounted on a modified

Jason Ackerman demonstrating the VisNIR penetrometer.

Giddings Probe. The data collected with the VisNIR closely agreed with data from a lab sample. The VisNIR penetrometer should be available in the next 4 or 5 years. The current cost estimate for this setup is around 8,000 dollars. The cost will increase after the equipment is "hardened up" for field use.

Dr. David Weindorf, Texas Tech University, demonstrated the PXRF sensor. The PXRF can be used to identify high-valent elements, such as heavy metals. It has a potential for use in urban mapping projects.

Overall, the meeting was a great success and improved morale over the toil of doing SDJR! The soil scientists in Region 9 view the raster soil mapping as a challenge and are excited for the future. This project will meet Soil Science Division priorities by advancing the use of technology and keeping soils relevant. Our soil scientists plan to take this one step further and make soils preeminent.

References

* Wikipedia. 2016. Polygon. https://en.m.wikipedia.org/wiki/Polygon#Properties Accessed 2/25/16. ■

Update of the National Cooperative Soil Survey Characterization Database Products

The NCSS Soil Characterization Database is available in Microsoft Access format and File Geodatabase format (http://ncsslabdatamart.sc.egov.usda.gov/). Both formats have been updated. Currently, data for 392,711 samples from 62,923 pedons associated with 62,780 sites are being distributed in the Microsoft Access database.

The Google Fusion maps that show the locations of sampled points and of sampled pedons with geochemical data have also been updated. ■

Map showing the locations of sampled points (https://www.google.com/fusiontables/embedviz?q=select+col6+from+1xQmHpmrdLQYgAZBihmE-r-Js1UQJJlutMaFpd-1s&viz=MAP&h=false&lat=34.5182472450708&lng=-108.43798966324148&t=1&z=3&l=col6&y=2&tmplt=3&hml=TWO_COL_LAT_LNG**).**

Ground-Based Solar Panel Arrays and Soil-Penetrating Anchor Systems

By Robert R. Dobos, NRCS soil scientist, National Soil Survey Center.

Solar power is a viable alternative energy option in many areas of the United States. For the most effective and durable deployment, certain site and soil characteristics are needed. Soil interpretations for this use were addressed in a recent session of "Science of Interpretations," a class provided by the National Soil Survey Center. A set of criteria germane to solar panel arrays was developed during the session. About the same time, a solar panel array was installed at the USDA George Washington Carver Center in Beltsville, Maryland.

Ground-based solar panel arrays are sets of photovoltaic panels that are not installed on buildings or poles. The installations consist of a racking system that holds the panel in the desired orientation and the foundation structures that hold the racking system to the ground. Two basic methods are used to hold the systems to the ground. One method employs driven piles, screw augers, or concrete piers that penetrate the soil to provide a stable foundation. The ease of installation and general site suitability of soil-penetrating anchoring systems depends on such soil characteristics as rock fragment content, soil depth, soil strength, soil corrosivity, shrink-swell tendencies, and drainage. The other basic anchoring system uses precast ballasted footings or ballasted trays on the soil surface to keep the arrays from moving. The site considerations that impact both basic systems are slope gradient and aspect, wind speed and direction, land surface shape, flooding, and ponding. Other factors that contribute to the function of a solar power array include daily hours of sunlight, sun angle (latitude), and shading from hills, trees, or buildings.

Soil-penetrating anchoring systems can be used where the soil conditions are suitable. Installation of these systems requires power equipment for hauling components and either driving piles, turning helices, or boring holes to install the anchoring apparatus.

Figure 1.—Installation of a ground-based soil-penetrating solar panel array.

The depth of soil available for placing the anchors is critical to the stability of the structure. Several types of soil features can restrict the soil depth, including permafrost (permanently frozen soil layer), hard bedrock, and thick, cemented pans.

A soil may be limited as a site if it contains stones or cobbles. Stones and cobbles impede workability of the soil, the use of machinery, and site reclamation. Even where rock fragment content is low, the fragments can scratch off protective coatings on steel anchor devices.

Some soils can cause excessive steel corrosion. Accelerated corrosion is related to soil resistivity, pH, sulfates, and water tables. The presence of sulfides or of certain minerals, such as easily weatherable pyrite, can cause a high degree of corrosion in metals. The possibility of corrosion is greater for extensive installations that intersect soil boundaries or soil horizons than for installations that are in one kind of soil or in one soil horizon. Steel corrosion may be especially problematic for solar panel arrays because of the electrical fields created while power is being generated.

Some soils exhibit a remarkable change in volume with drying and rewetting. Excessive shrinking and swelling between depths of 25 and 100 cm can cause foundations to shift and stresses to be placed on the solar panel racks. Similarly, frost heaving can cause piles to shift and stresses to build up in the superstructure. The ability of a soil to support a load, such as a vehicle or heavy equipment, is also important during installation and maintenance of the solar panel array.

The slope gradient of the land surface and the direction the land surface faces are critical features. Steep slopes impede the use of heavy machinery, the placement of the solar panels, and maintenance. On south-facing slopes, some slope gradient may be beneficial to the solar panel array because it allows the rows to be placed closer together. North-facing slopes are undesirable, especially if they are steep. The shape of the slope is also a consideration. The most desirable shape is a planar surface.

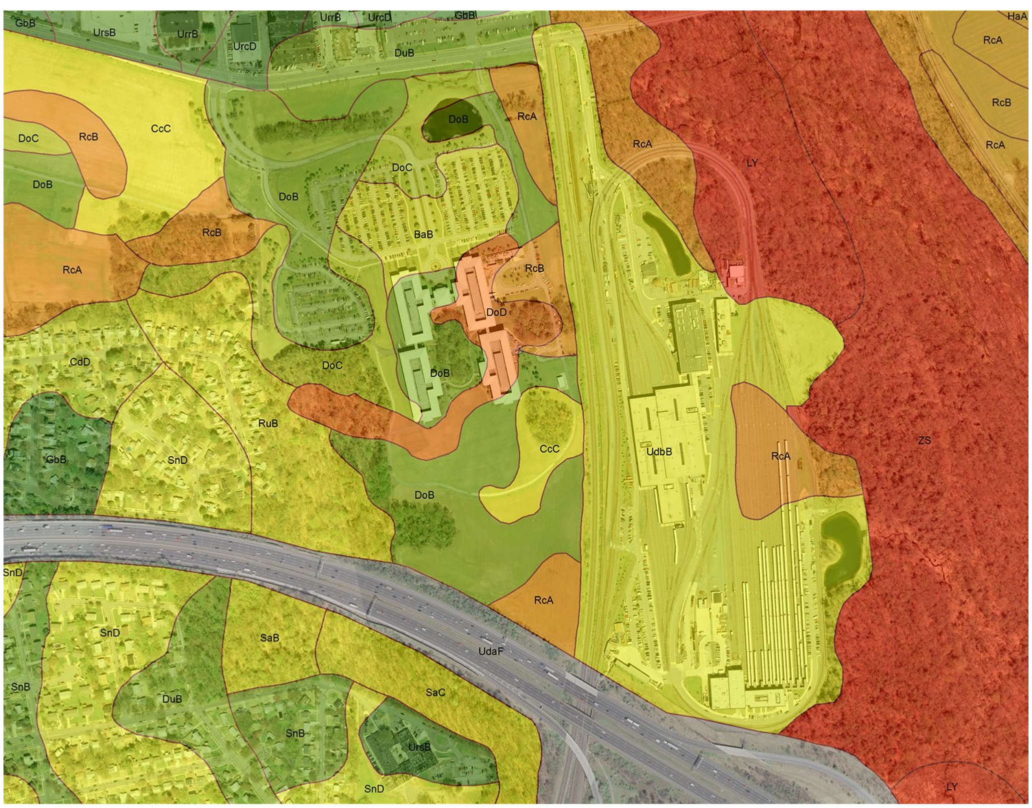


Figure 2.—Thematic map for solar panel arrays in the environs of the George Washington Carver Center.

Strongly concave or convex areas are more difficult to use. Some positions on the landscape, such as convex areas at or near the crests of hills and ridges, are more susceptible to higher wind pressures than others.

Soils that are subject to ponding or flooding have restrictions that limit the installation and function of solar panel arrays. Ponding and flooding limit access to structures, and high water levels reduce soil strength and can cause electrical problems. Flooding also has the potential to cause damage due to moving debris and water. In addition to ponding and flooding, some soils are shallow to a saturated zone. Soils having a shallow depth to a water table may become waterlogged and boggy during periods of heavy precipitation and are slow to drain. Soil strength and stability are affected, as well as the ability of the soil to support vehicles.

Sites in areas that have been excavated and reclaimed may be susceptible to differential settling, which can shift parts of the array out of optimal alignment. Other parts of the landscape, such as brownfields, may have buried toxic materials that can be disturbed during the installation of the array. These sites should be not be selected.

The map in figure 2 was produced using the Soil Interpretations engine in the National Soil Information System for the tabular data, gridded SSURGO for the spatial data, and imagery from the Geospatial Data Gateway. In general, greener areas on the map are less limited and redder areas are more limited. The major limiting feature in this area is the depth to a seasonal high water.

Figure 3 is a Google Map showing where the array was eventually installed (the horizontal lines to the west of the railyard). The placement is good in terms of the land resource available.

Figure 3.—Placement of the solar panel array at the George Washington Carver Center.

References

Brooks, W., and J. Dunlop. 2013. NABCEP PV installation professional resource guide. North American Board of Certified Energy Practitioners. http://www.nabcep.org/wp-content/uploads/2013/08/NABCEP-PV-Guide-7-16-13-W.pdf.

Canada, S. 2012. Corrosion impacts on steel piles. Solarpro. Solarprofessional.com.

DCE Solar. 2014. A guide to safely installing solar panel arrays to any property type. http://www.dcesolar.com/downloads/. Accessed 6/10/15.

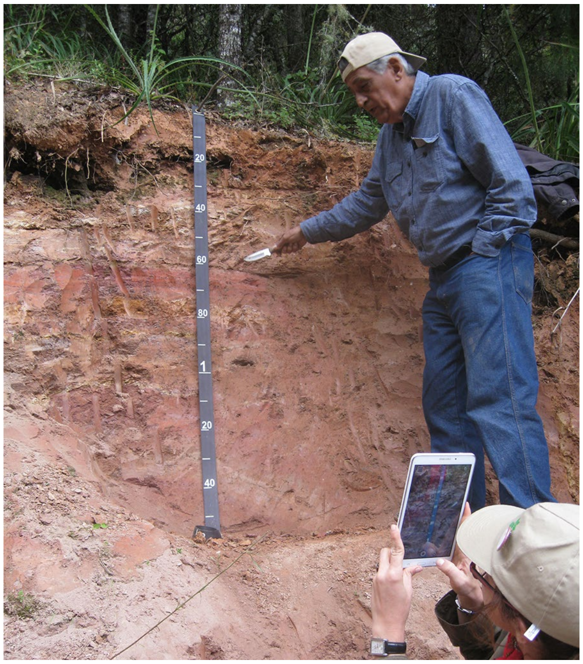
Environmental Protection Agency. Screening sites for solar PV potential. Emphasis on redevelopment of potentially contaminated sites, underutilized sites, or rooftops. Available online as of January 30th, 2014: http://www.epa.gov/renewableenergyland/docs/solar_decision_tree.pdf.

Romanoff, M. 1962. Corrosion of steel pilings in soils. Journal of Research of the National Bureau of Standards, Volume 66C, No. 3. ■

9th International Soil Classification Seminar and Workshop Held in Mexico

The 9th International Soil Classification Seminar and Workshop was held at the National Autonomous University of Mexico, Juriquilla Campus, October 5–10, 2015. Thomas Reinsch, NRCS Soil Science Division, National Leader, World Soil Resources, participated as a co-instructor and presented the paper “Challenges and Use of Soil Taxonomy and Progress on Developing a Universal Soil Classification” at the International University of Soil Science Meeting (Reunión Internacional Universitaria de Ciencias del Suelo 2015 [RIUCS 2015]).

Participants during the field tour for the 9th Annual International Soil Classification Seminar and Workshop.



Alberto Hernández describing soil-forming processes.

In addition to lectures, the workshop included practical exercises and a field trip to examine soils. At each stop, soil-forming factors and processes and soil classification, use, and quality were discussed. Participants were provided descriptions and data for the sites. There were approximately 20 participants in the seminar and workshop and 40 on the field trip. A concurrent workshop was held on soil quality indicators. Thursday evening, a townhall meeting was held in San Juaquin to discuss the vital role of soils in society and to share local culture. Approximately 100 people attended. Dr. Winfried Blum participated as a representative of the International Union of Soil Science. ■

NSSC Has a New National Leader for Soil Survey Standards

By Curtis Monger, National Leader for Soil Survey Standards, National Soil Survey Center.

Nine months ago, I left my job as a professor of pedology at New Mexico State University and started my new job as National Leader for Soil Survey Standards. Being new at any job carries a liability ("….there's so much to learn"). But being new can also offer opportunities ("….tell me again, why are we doing this?"). Being a professor of soils and environmental science and working with graduate students was great. But working day-to-day with the Standards Staff, all of whom know a lot more about a lot of things than I do, is a whole new dimension.

Like most readers of this newsletter, I enjoy walking the natural landscape and thinking about it scientifically. And like many of us, I had a teacher who showed me how exciting soil science could be. For me, the teacher was Robert Anderson at Hiwassee College in 1976. He had a great ability to put botany, soils, geology, and agriculture together. Yes, geology and agriculture. Max Springer and Frank Bell also had this ability. It was they who, a couple of years later at the University of Tennessee, made it so clear why the successful dairy farms were on the rolling non-cherty soils weathered from Ordovician limestone.

My first job after graduating was with the Soil Conservation Service. I was a county soil scientist in west Tennessee (1981–1982), where I worked with Craig Ditzler, David Thomas, and Rick Cody. The "Agricultural Geology" in that region was loess stratigraphy on broad terraces, wetland soils on bottomlands, and dissected Coastal Plain.

After working for SCS I returned to University of Tennessee, but this time in the geology department to work on an M.S. degree. I studied the clay mineralogy of a proposed low-level nuclear waste site at the Oak Ridge National Lab. I worked with Otto Kopp and Rick Arnseth (geology professors) and David Lietzke (soils professor), who arranged for me to make a soil map of the proposed repository. In some places, the area had residual soils that were 150 feet thick over cherty limestone. Agricultural Geology didn't exist at that site.

In 1985 (not 1885), I became a westerner. I enrolled in a Ph.D. program at New Mexico State University, where I worked under LeRoy Daughery. My project focused on clay mineralogy in petrocalcic horizons and explored how microorganisms cause calcium carbonate to form in desert soils. After graduation and a postdoc position working with archaeologists at Fort Bliss, I was hired as faculty. This allowed me to work with SCS's Leland Gile, John Hawley, and Bob Grossman—talk about high standards—who were still going strong on the Desert Soil-Geomorphology Project started by Guy Smith and Robert Ruhe in 1957. Agricultural Geology, or more specifically the Torrifluvents and irrigation water of the Rio Grande flood plain, was the reason New Mexico put its land grant university in Las Cruces.

So, that's my past. What about the future? As National Leader for Soil Survey Standards I can say two things. First, "what a scientific network!" No other agency in the U.S. has the widespread distribution of scientists that know the landscape and soils like those in NRCS. To work with these scientists on developing and maintaining standards that ensure high quality and uniformity across the nation is great.

Second, I predict "having your cake and eating it too" will be very positive for our agency. What does this mean? Both rural and urban societies have benefited significantly from soil survey because it has generated a scientific understanding of soil's capabilities and limitations. Food production is the best example. However, are we now at Step 2? That is, can we expand that scientific understanding to explore how soil map units function together as a system across many scales, both spatial and temporal? If so, many environmental issues can be addressed. Hence, having your cake and eating it too is exemplified by maintaining yields and profits without causing a dead zone in the Gulf of Mexico.

My wish is that soil survey will continue to give young people the opportunity to understand soils and landscapes in the traditional sense, but also to use this knowledge to increase environmental quality. As National Leader for Soil Survey Standards, I'd like to be part of that endeavor. ■

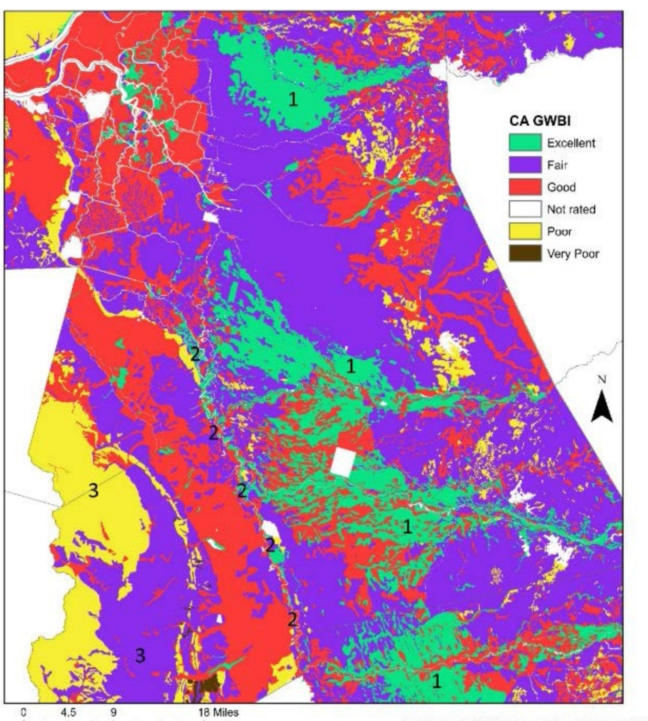
Groundwater Banking Index

The National Soil Survey Center has developed a NASIS-derived interpretation named the California Groundwater Banking Index (GWBI). The interpretation is in review by the NRCS State soils staff in California and by the University of California Agriculture and Natural Resources Cooperative Extension (UCCE). The interpretation is modeled using criteria for the SSURGO-based Soil Agricultural Groundwater Banking Index (SAGBI), which was developed by UCCE. These indexes identify areas with potential for groundwater banking to restore aquifers deleted by drought on agricultural lands.

The interpretation has geographic applicability to the Central Valley of California, the California Delta, and California coastal plains and valleys. These areas are neither snow-covered nor frozen, and most have existing water management infrastructure.

The GWBI interpretation is based on five major soil factors that are critical to successful agricultural groundwater banking: deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition. These five factors are weighted by a multiplier as originally modeled by UCCE. The factors are then summed to calculate an overall component-based rating. The major difference between the NASIS-based rule and the UCCE model is that the UCCE model uses assigned component soil drainage class while the NRCS model uses soil aquic conditions which correlates to higher residence time of water in the soil and consequently a lower index rating.

Groundwater banking is a water management strategy that stores surface water in aquifers for future withdrawal. The hope is to achieve water banking through application of surface water during winter when



Thematic map of the California Groundwater Banking Index in the California Central Valley. The map is based on 2015 gSSURGO and the 2015 interpretation export from NASIS. The map shows drainages (in green from north to south) of the Mokelumne, Stanislaus, Tuolumne, and Merced Rivers. (Note: Legend object rating class alphabetic sort is based on use of raster data.)

crop trees (almond, walnut, and pistachio), alfalfa, and vines (wine grapes and raisin grapes) are dormant or when the fields are not planted with row crops.

Research is currently being conducted by the University of California at Davis to determine whether permanent crops will survive this water management scenario and to see if yields are limited or if disease risks are increased and whether nitrates and other pollutants will enter the groundwater.

One potential source of water for recharge is river floodwaters. Using these floodwaters has the dual benefit of withdrawing large amounts of water from a river that is at or near flood stage and reducing downstream flood risks and levee breaches.

The image above is a partial (MLRA 17) view of a GWBI interpretation in the California Central Valley floor. It shows that granitic alluvial deposits from the Sierra Nevada Mountains are the best sites for banking groundwater (green). Each low gradient fan is associated with a major river that drains the mountains to the east (1). These areas have slopes of 0 to 3 percent, favorable permeability, low or no salt content, and irrigation infrastructure. The San Joaquin River flows northward in the valley. Its course is evident along the edge of the green delineations (2). On the western side of the valley, soils are derived from uplifted marine sediments that are less sandy (3) and rate fair to poor as sites for banking groundwater. In addition, the western side of the valley has no rivers flowing from the adjacent Coast Range that lies to the west. ■

Nondiscrimination Statement