National Cooperative Soil Survey

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In This Issue—

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. ■

Soil Biology Working Group to Develop Protocols for Field Investigations Related to Soil Biology

By James Komar, NRCS Area Resource Soil Scientist, and Dave Hoover, National Leader for Soil Business Systems, National Soil Survey Center.

In recent years, a consensus has formed that soil biology—the dark matter of our soil universe—plays a substantial role in governing soil performance and function. Given the dynamic nature of most biological properties and indicators, the parallel universe in which use and management affects soil change must be taken into account as well.

An initial soil biology working group was convened October 28 and 29, 2015, at the National Soil Survey Center in Lincoln, Nebraska. The objective of the group is to develop an action plan for conducting the systematic collection of biological and dynamic properties and indicators along with the associated metadata on use and management, which provide the context for their interpretation. Discussions over the 2 days centered on the mechanics of collecting the data. A full range of field- and laboratory-based biological properties and indicators will be considered under this action plan.

To serve the broadest base of customers, the group ratified its vision to have the standardization, collection, and dissemination of the data be a responsibility of the NRCS Soil Survey Division and its NCSS partners, primarily through soil survey update activities. In a nod to the pioneering nature of this work, the group established its view that the whole soil needs to be examined. Subcommittees were established to address the multiple components of the action plan. They will focus on standards, indicator selection, program design, metadata collection, and business system development.

For over a century, National Cooperative Soil Survey (NCSS) program activities have focused on the mapping, classification, and interpretation of soils based on two classes of relatively static soil properties, namely the physical and chemical properties. A third class of properties—those encompassing the biological properties and their associated dynamic soil properties—was necessarily set aside in the conduct of initial soil survey.

The era of initial soil survey has served the soil science profession and the public well. Soil scientists, however, have long recognized that soil properties change with use and management of the soil. Not accounting for the dynamic nature of soils has confused the interpretation of soil data, and, in some cases, led users to incorrect or incomplete conclusions. Detaching soil properties from the influence of the overlying land use has perpetuated the application of unidimensional, dose-response relationships—an approach that conflicts with the growing desire for whole-system soil management. The time is right to make the technological leap and produce soil survey update products that consider all three classes of soil properties and the overlying management activities that directly affect soil performance.

The data collected will help establish benchmark ranges for each biological and dynamic property for a specified management state. These data will be the feedstock for evaluating science-based, soil health assessment tools and for determining which soil health management systems have the greatest potential to improve soil function on working lands. Ecological site descriptions will be supplemented with critical, use-dependent data, and National Resource Inventory interpretations will be augmented.

Future NCSS customers will be able to best integrate soil information into the management of the natural resources that sustain life if the soil information represents the whole soil body in its full ecological context. The leap to inclusion of dynamic soil properties will represent not simply a random evolution of the science of soils but rather a deliberate step in a broad and complex journey towards re-tooling soil survey program activities to meet 21st century demands for soil information. A new level of collaboration between operational soil survey, conservationists, academia, and cooperators will be needed to meet this challenge. ■

Infrared Spectroscopy Calibrations and Statistical Extrapolations of Dynamic Soil Properties in the Longleaf Wiregrass Landscape

By John Paul Schmidt, Research Scientist, Odum School of Ecology, University of Georgia, Athens, and Daniel F. Wallace, USDA-NRCS Georgia Resource Inventory Coordinator.

The soil organic carbon (SOC) pool represents a dynamic equilibrium of gains and losses that can be shifted dramatically by conversion of land use/land cover (LULC) and by management practices in agricultural, forested, or rangeland landscapes. LULC and management can similarly alter other measures of soil quality/health, including chemical (e.g., N content), physical (e.g., bulk density and infiltration rates), and biological (e.g., microbial biomass).

Quantifying changes in this suite of soil properties (chemical, physical, and biological) identified as Dynamic Soil Properties (DSPs) has become a stated priority of the National Cooperative Soil Survey (NCSS, 2013). Key impediments to developing DSPs by LULC are the high cost of collecting and analyzing soil data and the high levels of variability of similar soil types under the same management. Thus, quantifying the impacts of management and land use changes on soils will require rapid and inexpensive methods for expanding the collection of point soil data and for extrapolating the collected point data into existing SSURGO products.

One possible method for rapid and inexpensive data collection is the use of visible, near-infrared (400–2500 nm) and mid-infrared (2500–25000 nm) spectroscopy (VNIR-MIRS) (Rossel and Behrens, 2010). Once calibrated, VNIR-MIRS provides a cheap and rapid means for capturing new soil data. It has the potential to facilitate the assembly of DSPs by leveraging existing data from lab analyses of soil samples to characterize an increasing volume of soil data gathered rapidly by scanning for spectral reflectance. VNIR was used in the recent Rapid Carbon Assessment, the biggest DSP effort so far (USDA, 2013).

In a collaborative project between the National Soil Survey Center, the Georgia NRCS office, and researchers at the University of Georgia, we are currently working with Dr. Daniel Markewitz, soil ecologist in the Warnell School of Forest Resources, and graduate assistant Jenna Stockton to again use VNIR-MIRS. The project focuses geographically on ecological units historically associated with the longleaf pine biome. This region, which includes parts of South Carolina, Georgia, and Florida, has been designated a priority landscape by the USDA's Longleaf Pine Initiative. For this pilot research, the study area is the subregion of the longleaf pine biome falling within the purview of the MLRA soil survey offices at Richmond Hill (~15,000,000 acres) and Tifton (~12,250,000 acres) (fig. 1). This study area covers portions of the Atlantic Coast Flatwoods and Southern Coastal Plain MLRAs.

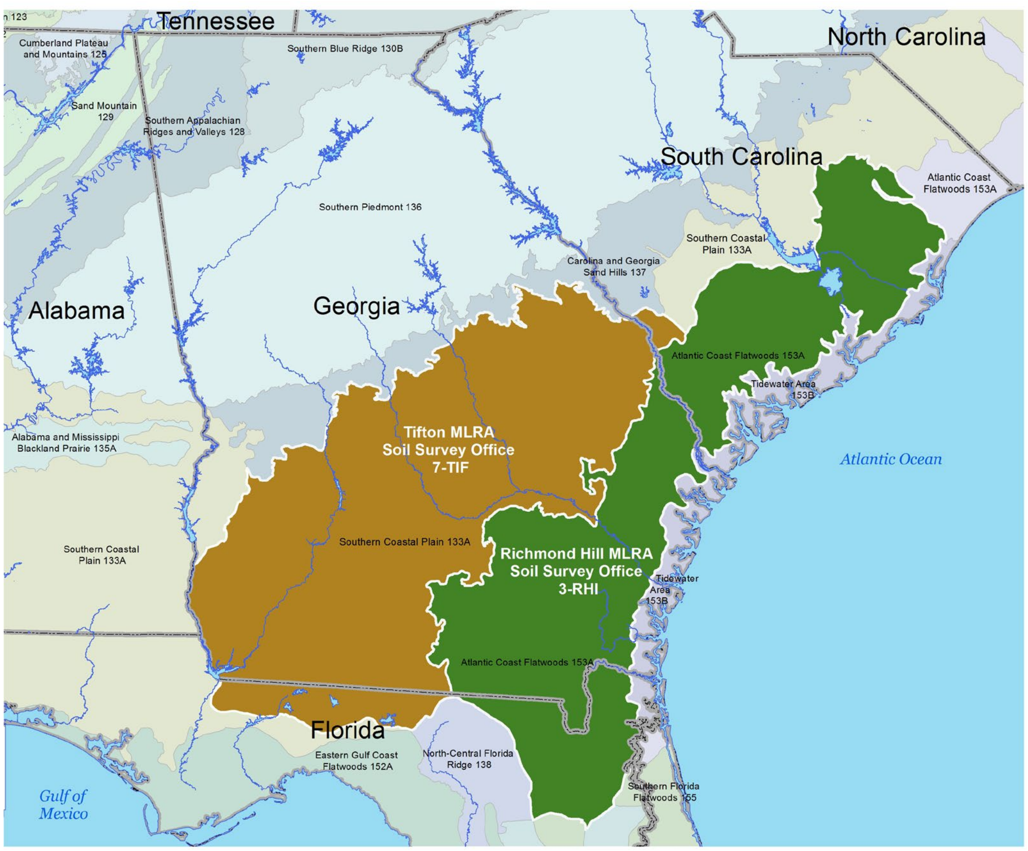

Figure 1.—Study area of the project.

To select a set of DSPs, we concentrated on soil attributes that are available for most or all of the soil samples to which we currently have access (e.g., pH, SOC, and

C:N ratio) and that are favorable for accurate calibrations (i.e., chemical rather than physical or biological attributes).

Within this geography and for this set of variables, we will address the need for accurate calibrations of spectra to soil properties and the best possible statistical modeling. For calibrations, we are relying mainly on existing soil samples, including Tifton and Dothan soils (84 profiles); Lakeland and Norfolk soils from sites within the 30,000-acre Jones Ecological Research Center in Baker County, Georgia (730 profiles); and profiles within this area from the archives of the Kellogg Soil Survey Laboratory (527 profiles). Table 1 shows the top 25 soil series in the dataset.

Table 1.—Twenty-five Most Numerous Profiles in the Dataset

Rank	Soil Series	No. of profiles	Rank	Soil Series	No. of profiles
1	Wagram	311	14	Lucy	48
2	Troup	229	15	Carnegie	45
3	Grady	142	16	Lakeland	38
4	Norfolk	136	17	Kershaw	31
5	Orangeburg	112	18	Leon	30
6	Tifton	111	19	Rains	28
7	Hornsville	99	20	Suffolk	24
8	Bonneau	80	21	Duplin	21
9	Wahee	72	22	Alapaha	17
10	Pelham	55	23	Johnston	11
11	Bigbee	53	24	Esto-Norfolk	10
12	Pungo	50	25	Goldsboro	10
13	Albany	49			

We hypothesize that soil properties within the longleaf landscape will differentiate in general patterns; i.e., SOC under cropland < pasture < savanna. Of interest will be testing to determine whether differences resulting from management regimes within LULC categories can be detected given the dataset available. Examples include cropping systems that incorporate cover crops or no-till and silvicultural practices that incorporate burning. Figure 2 shows the LULCs on Tifton and Pelham soils in the dataset.

Furthermore, we expect these general patterns of differentiation to exhibit distinct ranges by soil type within a given LULC; i.e., cropland SOC in excessively drained soils < well drained < poorly drained. We will assess how many combinations of soil type x LULC have sufficient data to define statistically meaningful ranges. We will also assess why there is insufficient data; e.g., the soil type x LULC combination does not occur (longleaf pine on very poorly drained soil) or the combination has not been sampled (cropland on somewhat poorly drained soil).

We are currently analyzing the data, both spectral and chemical/physical, we have compiled. Our goal is twofold. First, we want to establish DSP ranges statistically across LULC and soil groups, thus evaluating the hypotheses above. Second, we want to determine the accuracy with which soil quality/health can be estimated by spectra and thereby determine the feasibility of capturing a larger volume of soil data via spectra reflectance and producing a set of methods that can best enable rapid and increased DSP data collection. Results are expected in 2016. This work could be important in providing whole-soil DSP characterizations to support and augment soil

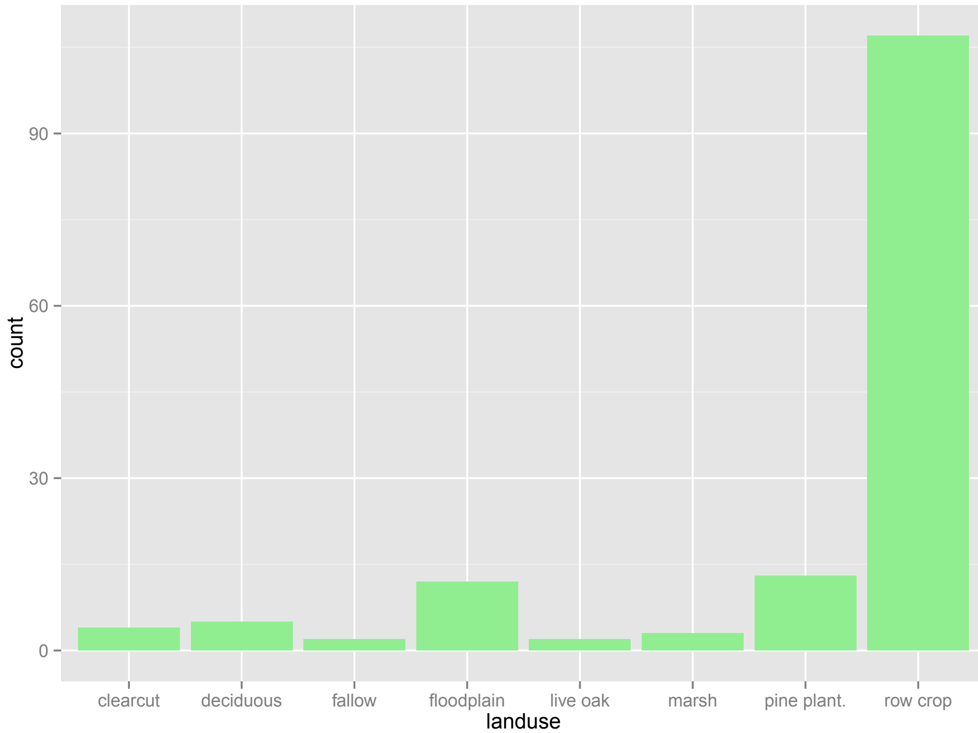

Figure 2.—Histogram of LULCs for Tifton and Pelham soil series in the dataset.

health conservation planning, conservation practice effects assessment, soil function research, and, ultimately, land management.

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Soil Treasure Unearthed

By Susan Y. Demas, NRCS Soil Scientist, New Jersey. Eileen Miller, NRCS Resource Conservationist, contributed information and photos.

Recently, my colleague Eileen Miller sent me an email concerning an unusual collection that had been given to her by a local science teacher. This unique and very special collection just so happened to be soil collected 100 years ago.

The person responsible for conveying this treasure to Eileen is Jill Guenther, a teacher for the past 28 years, currently with the Cumberland County New Jersey School District. Ms. Guenther was given the collection by another teacher and has been using it ever since to teach students about weathering and erosion. She noted

The 1916 U.S. soil collection and publication "Important Soils of the United States" (United States Department of Agriculture, Bureau of Soils).

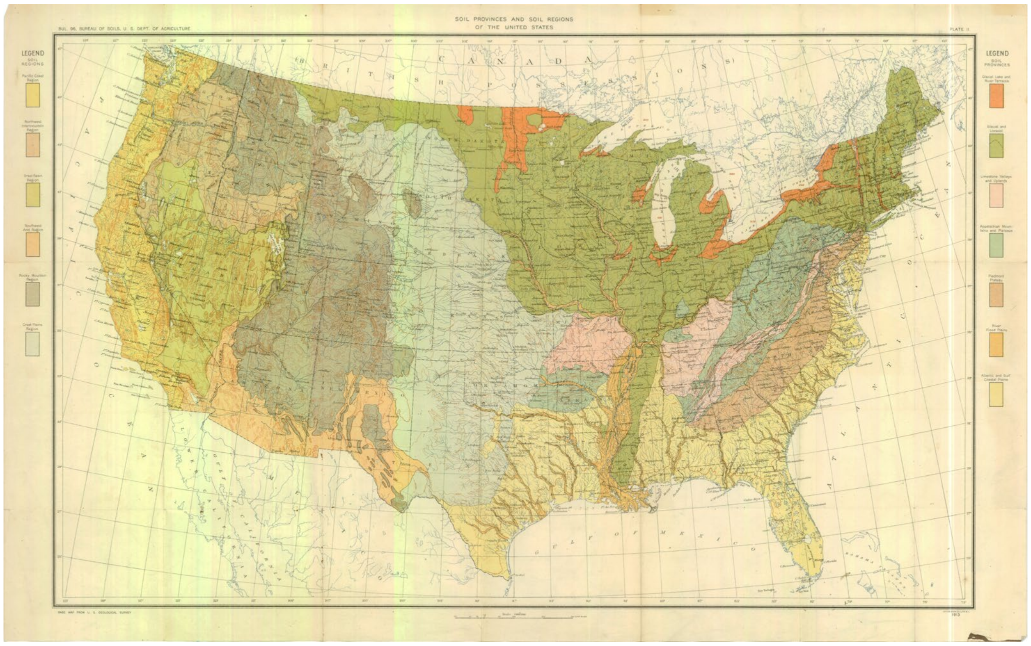
that the bulletin accompanying the collection indicates that the kits were made for schools. Because she was concerned that the soil samples could be lost or broken, Ms. Guenther decided that the collection should have a suitable home and reached out to Eileen, who shares her love of soils.

Immediately upon receiving Eileen's email about the collection, I contacted Dr. Del Fanning, emeritus professor of the University of Maryland, for assistance in trying to find a permanent home for the collection. Del contacted several institutions and individuals, including Dr. Edward Landa of the Environmental Science and Technology Department at the University of Maryland and Dr. Dennis Merkel, professor in the School of Biological Sciences at Lake Superior State University. Dr. Merkel was of the opinion that the publication was abstracted from "Soils of the United States" (1913 edition), United States Department of Agriculture, U.S. Bureau of Soils, Bulletin 96, by Curtis F. Marbut, Hugh H. Bennett, Jessie Erwin (J.E.) Lapham, and Macy (M. H.) Lapham. Dr. Landa stated, "I think the term 'physical geography' in the subtitle of the bulletin is reflective of Curtis Marbut's influence. He had long standing, strong ties to the physical geography community from his days at University of Missouri and extending to his career at the Bureau of Soils."

The collection represents a crucial link to the past by representing soil science knowledge and theory at the time it was made. It also demonstrates how soil information was conveyed during early efforts of the national U.S. Soil Survey, which was started by the USDA Bureau of Soils in 1899. The map of 13 soil regions was the second U.S. national soil map (Brevik and Hartemink, 2013). The 13 subdivisions were based on physiography and are no longer used, but many of the soil series names that appeared in the 1913 classification are still in use today.

I also contacted Dr. Douglas Helms, retired historian, NRCS, who thought that the collection should be part of the National Agricultural Library (NAL) and provided a contact for the "Special Collections" section. After all options were evaluated, NAL appeared to be the best fit for the collection.

On August 19, 2015, approximately 50 people, including staff from the University of Maryland, Rutgers University, NRCS, USDA Agricultural Research Service (ARS), NAL, and members of the Mid-Atlantic Association of Professional Soil Scientists



Map of the United States showing 13 soil provinces and regions, taken from "Soils of the United States" (1913 edition), United States Department of Agriculture, Bureau of Soils, Bulletin 96. Photo courtesy of Dr. Dennis Merkel.

(MAPSS) gathered at the NAL for a ceremony to convey the historic 1916 U.S. soils collection to the NAL. Acting NAL Director Stan Kosecki welcomed everyone, and ARS National Program Leader Sally M. Schneider provided opening remarks. NRCS Assistant Chief Kirk Hanlin and NRCS Deputy Chief for Soil Science and Resource Assessment David Smith each shared their insights on the importance of soil education in the past, present, and future and their enthusiasm for this donation. Jill Guenther also spoke and was presented with a certificate commemorating her donation.

NAL Supervisory Librarian Susan Fugate, ARS National Program Leader Sally Schneider, Acting NAL Director Stan Kosecki, Vineland teacher Jill Guenther, NRCS Assistant Chief Kirk Hanlin, and NRCS SSRA Deputy Chief David Smith.

The inclusion of the collection in the NAL special collections on the centennial of its creation is fitting for this “soil treasure.” This may help spur our current efforts in continuing soil science education. The soil science community is grateful for the insight and generosity of Jill Guenther in preserving this unique piece of soil science history. It is also fitting that this event occurred during the International Year of Soils, helping us to celebrate the contributions of early pioneers in our profession.

Note: An earlier version of this article appeared in the 2015 summer issue of “Pedologue,” the Newsletter of the Mid-Atlantic Association of Professional Soil Scientists. Link to the MAPSS website and “Pedologue:” http://www.midatlanticsoilscientists.org/pedologue/.

Reference

Brevik, Eric C., and Alfred E. Hartemink. 2013. Soil maps of the United States of America. Soil Sci. Soc. Am. J. 77:1117–1132. ■

Application of Soils Information

By Jon Hempel, Environmental Quality Programs Specialist, Nebraska Department of Environmental Quality, and former Director of the NRCS National Soil Survey Center.

In the brief time since I retired from NRCS and began working for the Nebraska Department of Environmental Quality (NDEQ), I have been directly applying information produced by the National Cooperative Soil Survey. In this short time, I have become acutely aware of a couple of items of importance to the NCSS:

1. The depth, flexibility, and applicability of the NCSS soil survey information and data are quite remarkable.
2. The use and application of the information by less sophisticated users are greatly hindered by the form of the data.

I am working in the Wastewater Section of the NDEQ Water Quality Division, specifically in the onsite wastewater unit. Nebraska has over 800 certified onsite wastewater treatment system professionals as well as many professional engineers, registered environmental health specialists, and local planning and zoning specialists who work on the design and installation of onsite wastewater systems. Additionally, an untold number of homeowners, realtors, and lending institutions have a direct interest in wastewater treatment.

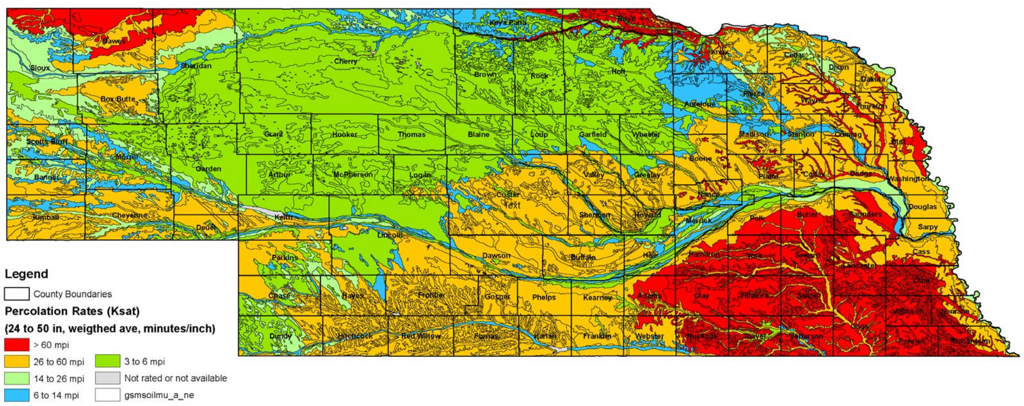
We know that about 25 percent of all homes across Nebraska use in-ground wastewater systems. If that number is extrapolated to a national basis, the scope of the onsite wastewater treatment industry is obviously significant. The industry is also, as we all know, completely reliant on the soil for appropriate functioning of these systems and on knowledge of the soil for proper citing criteria.

At NDEQ, we are involved with University of Nebraska extension and NRCS to expand on the educational opportunities and other resources available to assist with the proper application of onsite wastewater systems. These resources are mainly related to promoting a better understanding of soil properties that are relevant to these systems.

The NCSS has been inclined to provide information in a form that is most usable for the scientific community. Most of the information is presented in the metric system. Unfortunately, the vast majority of our potential users do not relate well to this. An example is the Official Series Description database. This data has an incredible potential for promoting understanding of soil properties among less-technical users, but the presentation of values in metric is a limitation and possibly even a deterrent to many of these users.

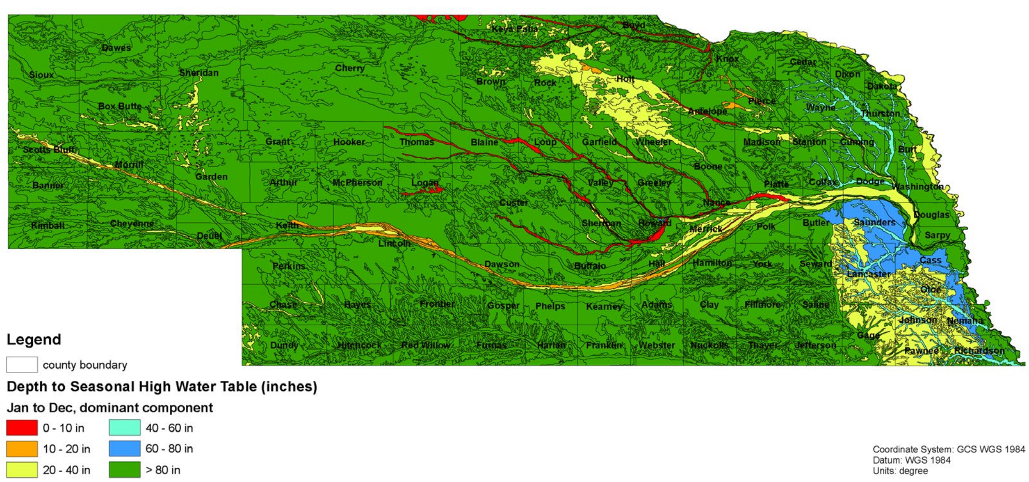
Needless to say, the Web Soil Survey (WSS) has proven to be an incredible resource for providing soils information. It has an ever widening audience interested in soils data, including the onsite wastewater disposal community. Permeability and percolation rates are valuable data for this user group. In WSS, this data is presented as K_{sat} in units of µm/sec. I think we can be assured that many users interested in soils information will be unable to reasonably convert from µm/sec to more familiar units.

In Nebraska, the standards for citing septic tank absorption fields are percolation rates in minutes/inch. In an effort to provide usable soil survey data on K_{sat}, I converted µm/sec to minutes per inch. This may not be the best conversion to make, but it does provide the existing soil survey data in units that can be readily understood by the user community.



Percolation rates in min/in as converted from K_{sat} values for Nebraska Soil Regions.

Depth to seasonal high water table is another important interpretation for the proper citing of onsite wastewater systems. In WSS, this data is presented in centimeters. Again, many users interested in this important soil property will be unable to make a reasonable conversion from metric units to English units.



Depth to seasonal high water table in inches as converted from centimeters for Nebraska Soil Regions (based on the U.S. General Soil Map).

Over the years, there has been discussion at many levels within the NCSS about producing information that is usable and understandable for a variety of users, from the average homeowner to members of the modeling community. As I transitioned into a position that is focused on a distinct user community, I found it apparent that the NCSS soil survey data is not always in a format that is readily usable to a broad user community.

If our intention is to continue to expand, increase, and develop wider user communities, the NCSS should consider focusing on making data available in a wider variety of formats. Databases that are geared towards the less-technical community have a great potential for use and application. There is a distinct market for this very wide user group. ■

Detail to Salem, Oregon

NRCS Region 12 Soil Scientists Carla Ahlschwede (Flint, MI) and Marissa Theve (Tolland, CT) were delighted to be able to participate in a 2-week detail to Salem, Oregon (in Region 1) this September. Although both scientists have experience with mapping in order 2 urban areas, this opportunity allowed them to experience traditional, natural settings and order 3 mapping. Their duties included pre-mapping assignments, more than 10 full pedon descriptions each, ecological site and plant ID discussions, landscape identification, site selection, and assistance with an ESD field tour with Forest Service staff. Each detailee was paired with a local soil scientist. They worked almost entirely on U.S. Forest Service land in the Western Cascade mountain range in the Willamette National Forest. As they began to get to know the landscape, Carla and Marissa were able to distinguish cirques, earth slides,

debris flows, moraines, and ridges both on the topographic maps and on the ground. Eventually, plant types—such as Oregon grape, rhododendron, vine maple, and, of course, Douglas and silver fir—also became easily recognizable. The identification of these differentiae is key to mapping soils, climate regimes, and ecological sites accurately and efficiently in these rugged, volcanic landscapes. Luckily, the detail was scheduled at the end of fire season and just before the winter rains, so the weather was agreeable.

Marissa's comments

"As someone from an area that is in 100 percent update mode, I found this opportunity to be invaluable. The skills and techniques I brought back to my office are refreshing, and I was able to gain a more holistic perspective of the Soil Science Division. I feel lucky to have been able to get to know the beauty of the Western Cascades so well in 2 short weeks. Other than a run-in with some unhappy yellow jackets, it was a near perfect experience!"

Carla's comments

"I have been lucky enough to work on an initial urban soil survey in Detroit, but it was a treat to work with the very different soils of Willamette National Forest. I was able to learn new approaches to solving problems and took away some new ideas to tackle challenges in my own region. The Salem staff was kind enough to include us in a field meeting with U.S. Forest Service staff and provided a great opportunity to collaborate with our customers. Touching base with the customers while a survey is in progress allowed us to discuss potential changes moving forward to ensure the end product is as useful as possible."

Acknowledgements

Marissa and Carla offer their special thanks to everyone who helped to make the detail happen, especially Region 1 staff for hosting and Region 12 staff for facilitating participation. ■

Virginia Tech Wins Regional Soil Judging Championship

The Virginia Tech Soil Judging Team won first place at the 2015 Southeast Region Collegiate Soil Judging Contest, which was held near Murray, Kentucky, on October 11–15. The overall team standings were: 1) Virginia Tech, 2) Tennessee-Knoxville, 3) Tennessee Tech, 4) Georgia, 5) West Virginia, 6) Western Kentucky, 7) Clemson, 8) Auburn, and 9) Tennessee-Martin. The top 5 teams advance to the National Championship, to be held in Manhattan, Kansas, on April 3, 2016. In the individual contest, the following students placed in the top 5 out of 67 contestants: 1) Patty Lawson (Georgia); 2) Mandy Millard (Tennessee Tech); 3) Kristen Moretz (Tennessee-Knoxville); 4) Rob Goodwin (Virginia Tech); and 5) Steffany Yamada (Virginia Tech). Congratulations to these students and all of the 67 participants.

At the start of the contest week, the participants described 12 practice pits in pasture and forests. The soils and site properties had previously been described by professional soil scientists from the Natural Resources Conservation Service. On contest day, the teams described four more pits and matched their answers with those of the official judges. The soils in the nearly level areas formed from ancient windblown silt deposits (loess), and the soils in the gently rolling areas formed from

Front row, left to right: Jake McGaughey, Steffany Yamada, Coach John Galbraith, Naina Sharma, and Caitlyn Herron. Back row, left to right: Robert Goodwin, Hunter Wyatt, Janelle Salapich, Jessica Cox, Scott Bauman, Coach Dan Johnson, and Olivia Simpson.

ancient loamy and sandy Coastal Plain deposits. Many of the soils had a restrictive subsoil feature and color patterns that confirmed past saturation and reduction. “The students were asked to record their estimates of the soil properties and evaluate the soils and sites for uses such as buildings with basements or septic tank absorption fields. The students also evaluated the hydraulic conductivity, depth to high water table, runoff, and erosion potential of the site. These skills are in top demand by employers,” according to Dr. John Galbraith. ■

Rhode Island NRCS Soil Scientists Assist with “Beach Blast” Investigation

On July 11th, a woman was injured at Salty Brine State Beach in Rhode Island by a mysterious explosion in the intertidal area of the beach. Investigators ruled out manmade causes for the explosion. The investigation then turned to looking for a natural cause, such as a buildup of methane or hydrogen sulfide gasses. The Rhode Island Department of Environmental Management (RI DEM) was the lead State agency for the investigation because they manage the beach where the explosion occurred. RI DEM contacted experts at the University of Rhode Island and the Graduate School of Oceanography (GSO) to assist with the investigation. GSO recommended that soil cores be taken in the vicinity of the blast to determine the composition of the soils and identify any possible sources for gas production, such as buried organics (seaweed, etc.). The RI NRCS staff were then contacted because they had a portable vibracore rig and the equipment needed for collecting cores. RI NRCS soil scientists have been conducting a Coastal Zone Soil Survey of the State and have an arsenal of tools and technology for sampling coastal and submerged soils. RI DEM also requested that the soil scientists profile the beach with groundpenetrating radar (GPR) to look for buried objects or anything else that might trap gasses.

The GPR survey identified a linear anomaly just above the water table on the beach. The scientists dug a small test pit and discovered a buried copper electrical cable. The cable had been installed by the U.S. Coast Guard to power the breakwater near the area of the blast. It was no longer active because the Coast Guard changed to solar-powered lights in 2007. A trench was dug across the beach to remove the cable for inspection.

The NRCS scientists working with URI-GSO obtained three aluminum vibracore soil samples and three plastic hammer-core samples from the vicinity of the blast. The samples were taken to the GSO laboratory for analysis. A few days later, an additional 10 vibracore samples were obtained. The soil samples helped determine that the explosion was caused by hydrogen gas produced from the electrolysis of seawater by the copper cable. The story made the local nightly news for several weeks and even made national news lineups.

News Coverage

WPRI Channel 12

http://wpri.com/?s=Salty+Brine
http://wpri.com/2015/07/21/scientists-return-to-salty-brine-beach-in-hopes-of-solving-mysterious-blast/.
http://wpri.com/2015/07/16/scientists-investigate-salty-brine-beach-blast/.

NBC Channel 10

http://www.fb.com/SoilSNE

Providence Journal

http://www.providencejournal.com/article/20150716/NEWS/150719477/14425/NEWS
http://www.providencejournal.com/article/20150724/NEWS/150729588/14025/ENTERTAINMENT

RI Assistant State Soil Scientist Jim Turenne, who has worked in technical soil services for 26 years, states that this incident was by far the most unusual phenomenon he had ever encountered. Turenne said that initially nothing seemed to make sense about the explosion: why it occurred where it did, why no crater formed, why the woman suffered no burns, and why her chair stayed in place. Because the explosion was linked to a buried cable, some major questions have been raised concerning the safety of beaches in other areas. The Coast Guard has thousands of such cables powering lights in navigation areas throughout the United States. ■

Working on a plastic hammer-core sample.

ESDs Updated to Provisional Status

A multi-disciplinary team of local and regional NRCS experts and partners recently collaborated to upgrade the Ecological Site Descriptions (ESDs) in MLRA 65 to the provisional status. This effort included updates to the 14 existing ESDs currently identified in the MLRA and the creation of 2 new ESDs: Sandy Lowland and Deep Wetland. These new additions were in response to requests by the resource managers and conservation planners who rely on these documents during their daily course of work.

MLRA 65 is in Soil Survey Region 5. It encompasses the unique grasslands ecosystem of the Nebraska and southern South Dakota Sandhills. Livestock grazing is the primary industry in this largely unbroken native prairie, which also serves as home to a wide variety of wildlife species.

The team was assembled by Ecological Site Specialist Doug Whisenhunt, with soils input provided by Nebraska Resource Soil Scientist Chuck Markley, then-MLRA Leader Mary Jo Kimble, Nebraska Assistant State Soil Scientist Dan Shurtliff, and Soil Scientist Howard Main. Local NRCS Range Conservation Experts Jeff Nichols, Nadine Bishop, Dave Cook, and Marla Shelbourn provided insights into the interactions of herbivory and the associated ecological dynamics. We thank the Nebraska Game and Parks Commission and the University of Nebraska for their contributions to both the range and wildlife aspects of the documents. Nadine Bishop performed the Quality Control Review on each ESD. ■

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