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From the Soil to the Stars: Partnership Between USDA-NRCS and NASA DEVELOP Program to Benefit Lake Champlain Basin

By Zachary Warning, NRCS soil scientist, Belmont, New York.

It is said that every human on Earth is connected by, at most, just six degrees of separation. What is fascinating about being a scientist is that, for us, that number is almost certainly less. The circles in the sciences are remarkably small, further emphasizing the value and necessity of continued collaboration and interconnectedness among agencies, universities, and private companies working toward similar goals. In my small circle of STEM colleagues, I have come to know Paxton LaJoie, a Fellow for the NASA DEVELOP Program, stationed out of the Marshall Space Flight Center in Huntsville, Alabama. We both attended the State University of New York College of Environmental Science and Forestry (SUNY-ESF) as undergrads. Paxton and I were keenly aware of each other's fields of expertise, and it was Paxton's idea to take our two passions and combine them.

As a Fellow, Paxton had the responsibility of picking a partner entity, as well as the projects her teams of participants would research. As a nod to our mutual love of soil, she decided her partner this term would be the USDA-NRCS Northeast Region. After she consulted with various staff around the region, a project of high-priority was chosen, titled "Using NASA Earth Observations to Identify Spatial and Seasonal Trends of Harmful Algal Events in Lake Champlain."

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; FAX—(402) 437-5336; email—jenny.sutherland@usda.gov. ■



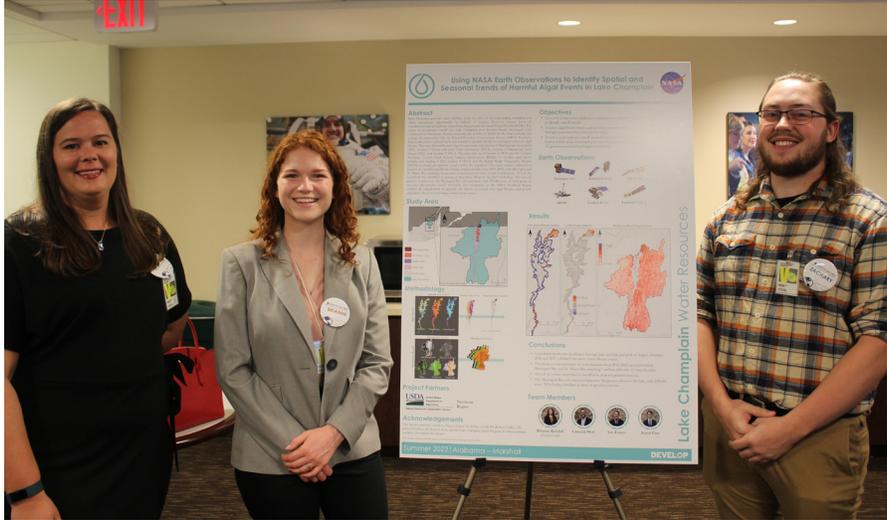


Figure 1.—Soil Scientist Rebecca Fox, DEVELOP Team Lead Brianne Kendall, and Soil Scientist Zachary Warning stand beside the poster created by the DEVELOP team, which showcases their research. (Credit: NASA)

The project was just completed in the last few weeks. The results will be used to plan future soil survey update activities in the watershed and help us to better serve our customers around Lake Champlain. To showcase the incredible work done by Paxton and her team, Soil Scientist Rebecca Fox and I were invited to attend the final presentation conference at NASA's Headquarters in Washington, D.C., on August 8 and 9, 2022.

At the conference, each DEVELOP team from around the country presented their results to a room of fellow DEVELOP members, NASA scientists, and partners such as Rebecca and myself. A handful of projects were selected for special "flash talks," one of which was the Lake Champlain Basin project. This project was presented by Team Lead Brianne Kendall. Brianne detailed the high-level complexities and intricacies of the team's research with the cadence and skill of a thespian, a prowess of speaking she unsurprisingly credited to years of theater. From beginning to end, we were

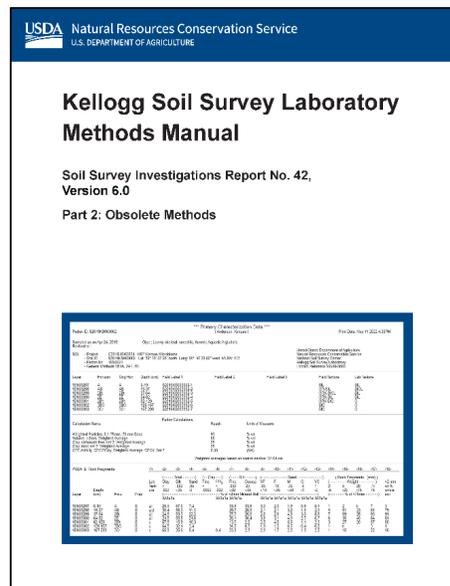
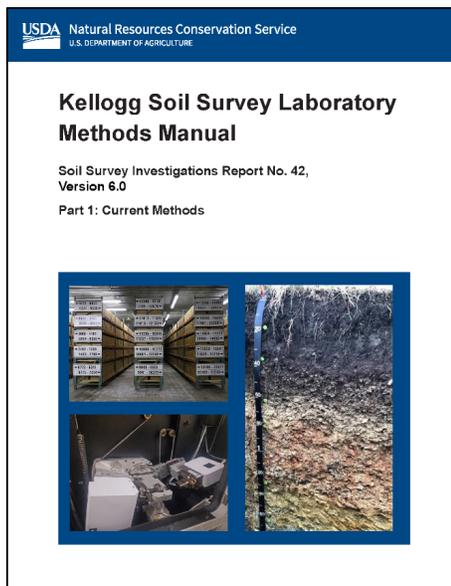


Figure 2.—Soil Scientist Rebecca Fox (center, seated) speaks on behalf of the USDA-NRCS Northeast Region on the Partner Discussion Panel. (Credit: NASA)

stunned by the competence and professionalism of the team with which we were so fortunate to be partnered.

I would be remiss not to directly acknowledge each member of the Marshall DEVELOP Team, who individually contributed so much of their knowledge, time, and effort into producing such a comprehensive, well-made, and visually stunning final product. On behalf of the entire USDA-NRCS Northeast Region, and especially the folks around Lake Champlain who rely on this watershed for their drinking water, business, recreation, and tourism, I extend our sincerest gratitude to Fellow Paxton LaJoie, Team Lead Brienne Kendall, and participants Laramie Plott, Aaron Carr, and Ian Turner. Repeatedly throughout this experience, this team has been a shining example of brilliance, competence, efficiency, and professionalism. The team overcame repeated challenges, routinely met with us, and took our questions and suggestions seriously, making us feel like true partners from start to finish.

I am not only eager, but feel obligated, to suggest to folks across the country in NRCS that if you have a project or resource concern you believe would be helped by remote sensing and NASA satellite imagery, do not hesitate to reach out to folks at DEVELOP to begin a collaboration. ■



KSSL Methods Manual Update

“Kellogg Soil Survey Laboratory Methods Manual, Soil Survey Investigations Report (SSIR) No. 42, Version 6.0” is now available. The files for both Part 1, Current Methods, and Part 2, Obsolete Methods, can be downloaded from <https://nracs.app.box.com/s/fgrv9vdiwrymtemw3ns8ocsdz7n5q3q>. The methods described in the manual are those used by the USDA Kellogg Soil Survey Laboratory (KSSL) at the National Soil Survey Center in Lincoln, Nebraska.

The purpose of the manual is to document methodology and to serve as a reference for the laboratory analyst. The development of laboratory methods for Soil Survey is the cumulative effort of decades of investigation. The manual has changed over time as new knowledge and technologies have led to the development of new methods and the modification or retirement of old methods.

Laboratory data are critical to the understanding of the properties and genesis of a single soil pedon, as well as to the understanding of fundamental soil relationships based on many observations of numerous soils. All of the methods in the manual are documented by codes that link them to analytical results stored in the National Cooperative Soil Survey (NCSS) Soil Characterization Database. These linkages between laboratory method codes and the respective analytical results are reported on the KSSL data sheets.

Some analytical results in the NCSS Soil Characterization Database were obtained using procedures that are no longer used at the KSSL. Descriptions for these procedures are in Part 2, Obsolete Methods, and provide a historical perspective.

The current methods used at the KSSL are described in the manual in enough detail for many laboratories to replicate. Information on each group of related methods includes a description of common characteristics. ■



Tropical Crop Productivity

By Robert Dobos (soil scientist, NRCS Soil and Plant Science Division) and Manuel Matos (NRCS State Soil Scientist of Puerto Rico).

Introduction

The capacity of soils and landscapes to produce food, fuel, forage, and fiber is a subject of great interest. Metrics and models of soil productivity have been established for many areas and crops. Using the Soil Survey Database, we can begin to derive more spatially explicit, yet geographically extensive, mapping of model results to enhance our capability of informing effective crop production and land use. NRCS staff and NCSS partners are embarking on a project to produce useful and scientifically sound models of the productivity of soils, landscapes, and climates for tropical crops using the Soil Survey Database. We will start by looking at the plantains productivity of Puerto Rico. In this article, the plural “plantains” refers to the tropical plant and the singular “plantain” refers to the temperate weed.

Background

By definition, the tropics are the area of the Earth delimited by the Tropic of Cancer in the northern hemisphere (23.46°N) and the Tropic of Capricorn in the southern hemisphere (23.46°S). As described in the Köppen-Geiger climate classification system, the tropics are typically characterized by having equatorial climates with a minimum annual temperature of 18°C; however, some high-elevation areas within the tropics can have lower temperatures. Climatic classification is further broken down by the amount and timing of rainfall, as shown in table 1 (Kottek et al., 2006).

Hernandez Ayala (2012) produced a Köppen-Geiger climate map for Puerto Rico, shown in figure 1. It is imperative to note that, despite the relatively small area of

Table 1: Köppen-Geiger equatorial climates, from Kottek et al. (2006)

Type	Description	Criterion
Af	Equatorial (tropical) rainforest, fully humid	At least 60 mm precipitation in the driest month
Am	Equatorial (tropical) monsoon	Annual precipitation is equal to or greater than 25 times 100 minus the precipitation of the driest month
As	Equatorial (tropical) savannah with dry summer	Less than 60 mm monthly rainfall in the summer
Aw	Equatorial (tropical) savannah with dry winter	Less than 60 mm monthly rainfall in the winter

the island, the climates are quite diverse. Alternatively, the United States Geological Survey (1982) developed a map of climatic subdivisions, shown in figure 2. However, the basic information, in regard to the descriptions of the varied climates within the confines of the island, is the same.

The current study will focus on the climatic and soil conditions for crop production in Puerto Rico and then further be refined to plantains production.

Rainfall and temperature are critical environmental components for crop production. As the growing season in Puerto Rico is year-round, it is not mapped. Rainfall on the island ranges from just over 600 mm per year along the southwestern coast to more than 4,000 mm per year in the high mountains in the east (see figure 3). The amount and timing of rainfall have a profound effect on which crops can be grown in which areas if irrigation water is not available. Precipitation is mainly bimodal: starting maximum in May, a noted decrease between June and August, and a second peak of

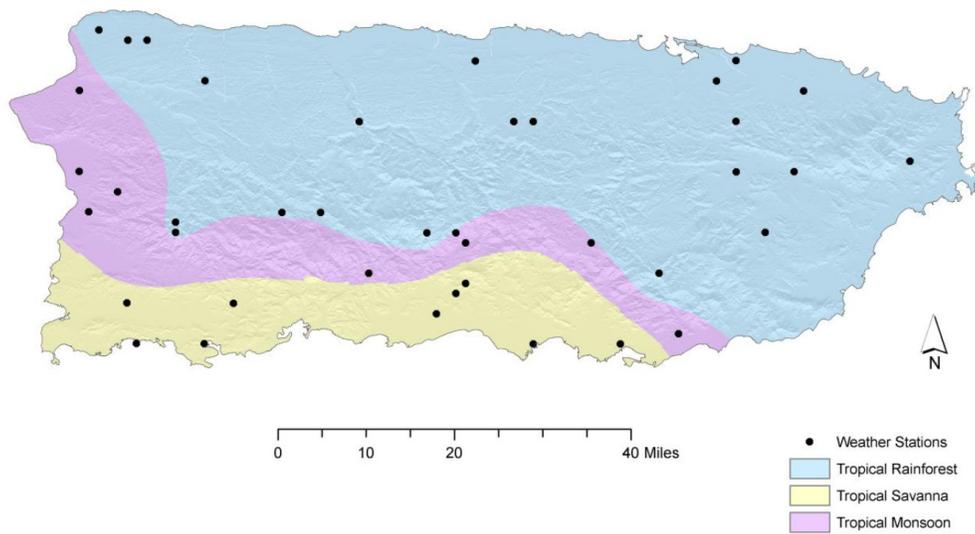


Figure 1.—Köppen-Geiger climate map of Puerto Rico (from Hernandez Ayala, 2012).



Figure 2.—USGS climatic subdivisions of Puerto Rico and outlying islands.

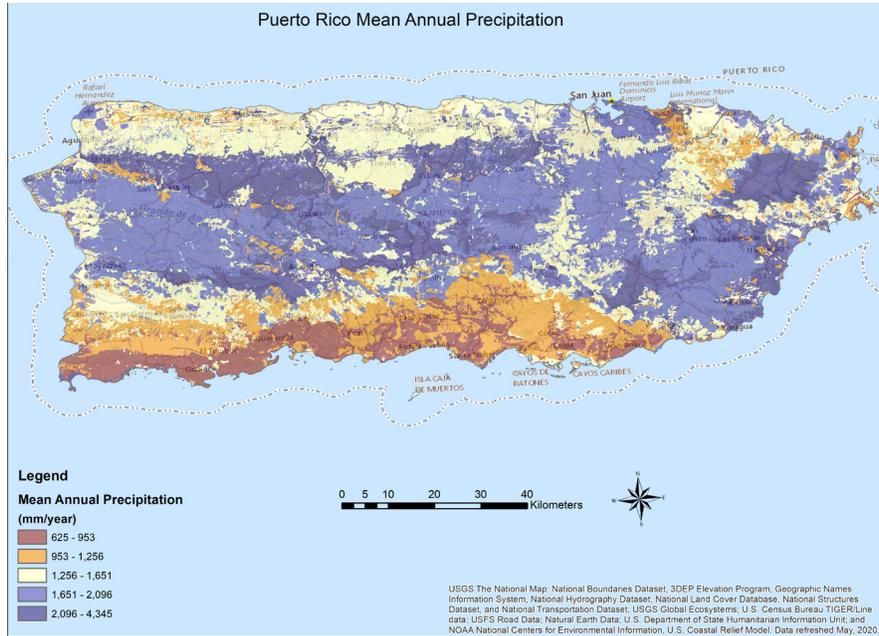


Figure 3.—Mean annual precipitation for Puerto Rico (data derived from the Soil Survey Database).

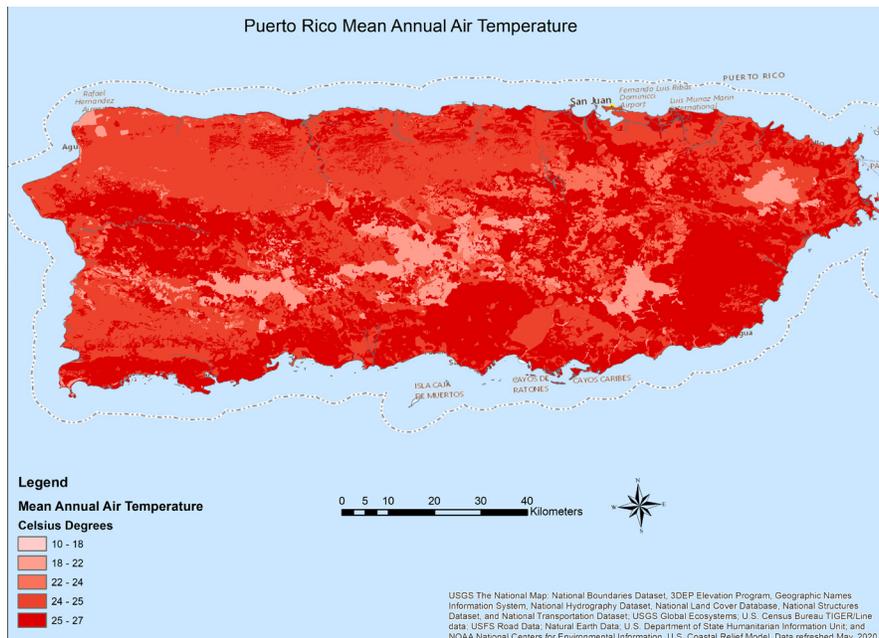


Figure 4.—Mean annual air temperature for Puerto Rico (data derived from the Soil Survey Database).

maximum around September to October (Chen and Taylor, 2002). The precipitation differences affect the production of plantains across the island, and in most cases farmers need to use water irrigation systems for commercial applications. The geography of crop production in Puerto Rico is further affected by mean annual air temperature (see figure 4). Mean annual air temperature ranges from just over 13 degrees C in the mountains in the central part of the island to just under 32 degrees C along the southwestern coast.

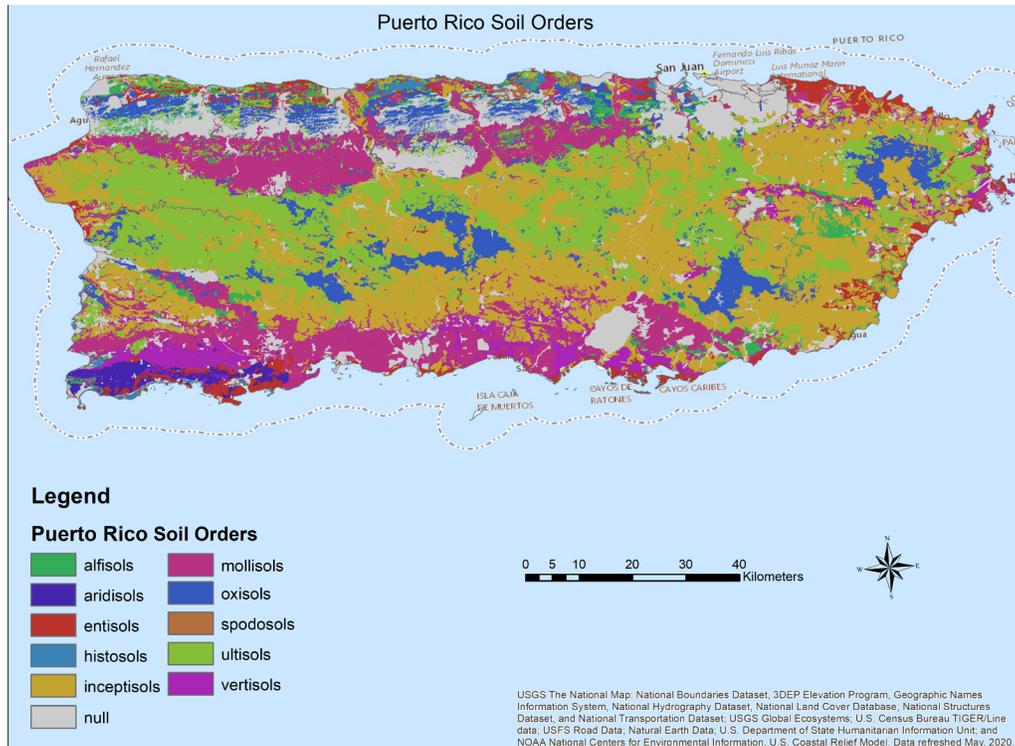


Figure 5.—Soil orders of Puerto Rico (data derived from the Soil Survey Database).

Puerto Rico is a region of humid and semi-arid mountains, valleys, and coastal plains (USDA Handbook 296, 2002). The geologic history of the island is a fascinating topic that can be discussed another time. As may be expected, the range in temperature and rainfall, along with the diverse geology, gives rise to a great variety of soils (see figure 5). Puerto Rico has 10 of the 12 soil orders of Soil Taxonomy. The diversity of soil classifications reflects a great diversity in soil properties. For example, the high shrink-swell of active clays can be a limitation for land use on one part of the island (areas of Vertisols) while the aluminum toxicity, associated with extreme weathering, can profoundly affect crop growth on another part of the island (areas of Ultisols and Oxisols).

Plantains

Plantains and bananas are the fourth most important global food commodity (UNCST, 2007). Plantains (*Musa* spp. AAB) are similar to the dessert banana but are generally cooked before being eaten. They are a critical staple crop in the tropics (Norgrove and Hauser, 2014) and are the largest herbaceous plant. The pseudostem can be as tall as a tree, between 2 and 8 meters in height, and consists of compacted leaf sheaths; the plant does not have a woody stem (Karamura and Karamura, 1995). Plantains require a mean monthly temperature of 27 degrees C and evenly distributed rainfall for optimum growth. They are adapted to a wide range of soils but do best on deep, well drained soils that have a high content of organic matter and a high water-holding capacity and that are not affected by salinity or aluminum toxicity (Purseglove, 1972). Ssali (1972) determined that most of the root uptake occurred in the upper 60 cm of soil, which has implications for rooting and depth to saturation requirements. Other soil and site properties, such as slope, available water storage, cation-exchange capacity, water and gas transmission, soil depth, and the depth and timing of saturation, also affect productivity.

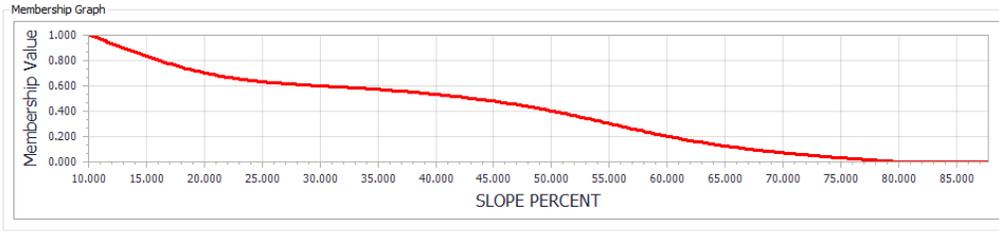


Figure 6.—Slope membership function for plantains.

Modelling Productivity

The Soil Survey Database uses a rule-based fuzzy logic system to predict the effect of soil and site properties on land use. These types of systems are described in Chapter 8 of the *Soil Survey Manual* (Soil Science Division Staff, 2017) and in Dobos et al. (2021), so only a brief overview is provided here. According to Zedah (1965), fuzzy logic is based on the concept of partial membership in a set. This is opposed to the Boolean logic of discrete true or false. Numbers from 0 to 1 are indicative of the degree of membership in a set (Zedah, 1965). For example, suppose that it is absolutely true that if a soil is on a slope of less than 10 percent it is suitable for plantains while it is absolutely false that if a soil is on a slope of more than 80 percent it is suitable for plantains. A soil on a slope of 30 percent would be a partial member of the set of suited soils. A membership function allows us to assign a degree of membership, in this case about 0.60, by mapping to the membership function (see figure 6). The membership functions are derived from a variety of sources. Scientific

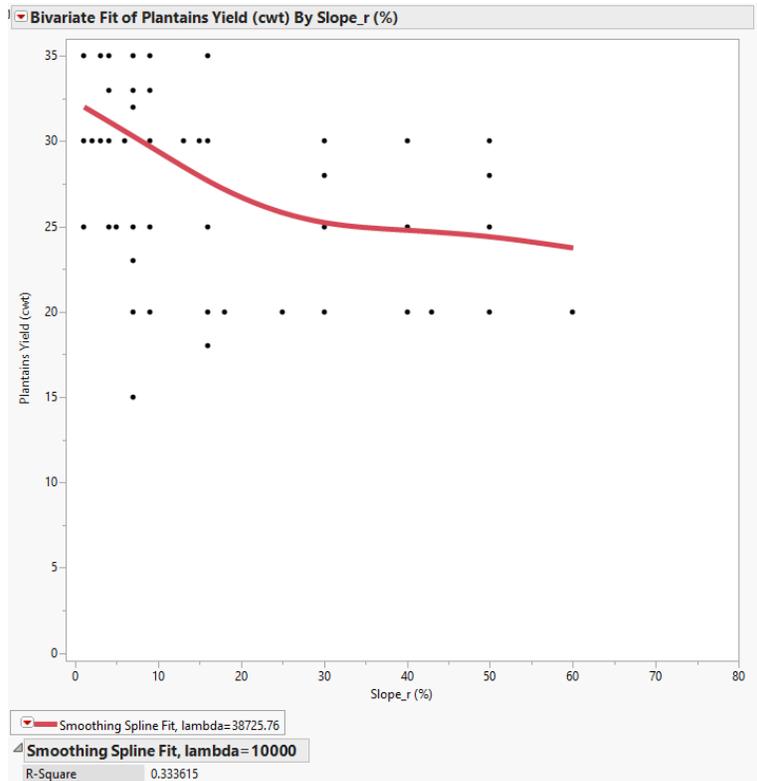


Figure 7.—Scattergram with fitted spline for plantains yield versus slope.

literature frequently provides thresholds, maxima, or minima for the response of crops to various soil and site properties.

The Soil Survey Database is often queried in searches for relationships. In the case of productivity models, if some yield data is populated, an approximation of the response of yield to a variable can be derived. For example, in the case of plantains production versus slope, the database can be mined, the data plotted, and figure 7 drawn. Note that the R square of the fitted spline is 0.37, which is relatively high for a single variable in a productivity index and has implications for weighting when the rules are assembled in the model. Even if the yield data is uncertain, some key points (such as maxima or minima) in the response can be approximated. This speaks to another attribute of fuzzy logic, which is dealing with ambiguity in the thresholds (Cox and O'Hagan, 1998). In referring to figure 7, one could argue that the threshold presented in figure 6 should be closer to 10 percent slope and be correct. Further refinement of the rule set is always possible. The soil and site characteristics considered in the model are presented in table 2.

Most of the time, variables are extracted directly from the database. Some variables, however, are synthesized from other variables in order to arrive at a condition that has a better relationship with productivity than a single variable. For example, the base ten logarithm of the product of horizon saturated conductivity multiplied by the linear extensibility is used to gain a variable that better describes gas and water flow under unsaturated conditions. Other examples are the response of yield to flooding or ponding. The duration (how long a flooding or ponding event is estimated to last) and frequency of the events and the number of months during the year the events are estimated to occur are combined as an index of ponding or flooding.

Once the soil and site properties and yield relationships are quantified using membership functions (as in figure 6), rules are made to estimate the effect of each parameter. These rules are then combined into a parent rule. Figure 8 shows the parent rule for plantains productivity. The related soil and site properties are grouped together into the Climate Properties, Soil Chemical Properties, Landscape Properties, and Soil Physical Properties sub-rules. The subaqueous sub-rule

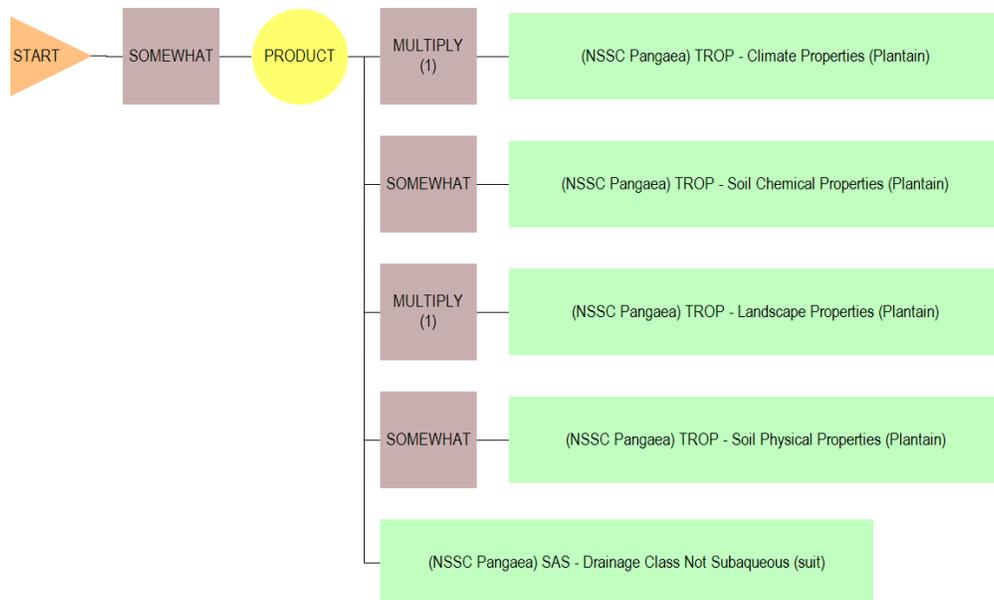


Figure 8.—Parent rule of the plantains productivity model.

Table 2: Criteria considered for plantains productivity

Feature	Well Suited	Somewhat Suited	Not Suited	Reason
pH	5.6 to 6.5	5.5 to 4.3 OR 5.5 to 9.0	<4.3 OR >9.0	Aluminum toxicity Nutrient deficiency
MEQ of exchange	2 to 12	0 to 2 OR 12 to 30	0 OR >30	Nutrient storage Interaction with LEP?
Organic matter (%)	3 to 18 (excluding organic soils and their intergrades)	0.1 to 3	<0.1	Soil physical properties Interaction with saturation?
Electrical conductivity (dS/m)	0.75 to 1.1	0.1 to 0.75 OR 1.1 to 8.0	<0.1 OR >8.0	Poor ionic environment Excess salts
Mean annual precipitation (mm/yr)	1350 to 1600	600 to 1350 OR 1600 to 3000	< 600 OR >3000	Insufficient water Too much water
Mean annual air temperature (C)	22 to 25	14 to 22 OR 25 to 33	<14 OR >33	Too cold Too hot
Surface stone coverage (%)	<3	3 to 15	>15	Traffic impediment
Average water table depth for consecutive months (cm)	>150	5 to 150	<5	Anaerobic root zone, fungal infection
Slope (%)	<10	10 to 80	>80	Erosion; trafficability; managing soils with more than 12 percent slopes should include conservation practices (contour farming, conservation covers, minimum tillage, no till, infiltration ditches)
Ponding frequency x duration x months index	<1	1 to 5	>5	Anaerobic environment, fungal infection
Flooding frequency x duration x months index	<16	16 to 420	>420	Physical damage, excess wetness
((Ksat)(LEP))log10	0.6 to 1.6	-4.0 to 0.6 OR 1.6 to 3	<-4.0 OR >3.0	Insufficient gas and water transmission Water too transient
Rock fragment content (volume %)	<2.0	2.0 to 70.0	>70.0	Soil diluted, root resistance
Depth to restriction (cm)	>150	5 to 150	<5	Volume of soil for rooting
Root zone AWS (cm)	>25	1 to 25	<1	Plant available water storage insufficient
Linear extensibility (%)	4.5 to 6.0	0 to 4.5 OR 6 to 15	>15	Root damage

prevents subaqueous soils from receiving subaerial ratings. The pink squares represent hedges that allow sub-rules to be weighted according to their correlation with yield. The “somewhat” hedge indicates that the square root of the membership function will be found. This is a convenient way to keep the membership values from becoming too close to zero when the “product” operator is used. The effect is to not change the values close to 1 very much but to increase the values closer to zero substantially without affecting the array or order of the soil ratings. In this suitability style interpretation, the “somewhat” hedge tends to decrease the effect of a variable or group of variables.

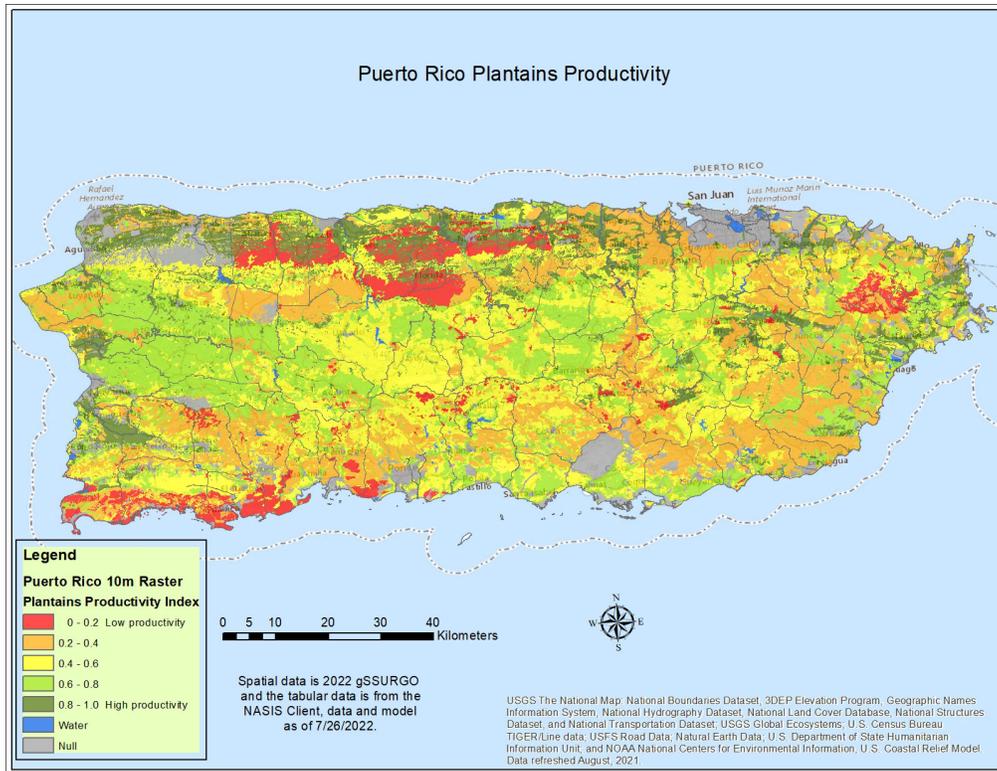


Figure 9.—Plantains productivity for Puerto Rico.

The indices generated by the model can be mapped using GIS. Figure 9 shows the resultant map for Puerto Rico. Soil and site conditions along the northern part of the island are predicted to be the most favorable for plantains production. Conditions in the southwest corner, where rainfall is deficient, are predicted to not be favorable. This model is ready for testing and will be made available on the Soil and Plant Science Division Interpretations Testing Site:

https://nasis.sc.egov.usda.gov/NasisReportsWebSite/lmsreport.aspx?reportname=Interpretations_testing.

This model will have little applicability in places other than the tropics.

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Field Team Receives Recognition for Tackling Training for Tough Topic

Allison Hammer's work as an area resource soil scientist in Chesapeake, Virginia, often requires working solo in remote locations. She didn't think too much about it until one day a local farmer said some things that made her wonder about her personal safety.

That night, she reached out to a colleague in a nearby field office to compare notes and found that her experience was not unique. Jenny Templeton admitted she had had similar encounters in her local service area and was willing to talk about them.

Surely, the two women thought, NRCS had a resource or training aid to assist employees in dealing with these awkward (but not always rare) situations. When they



Allison Hammer (left) and Jenny Templeton (right). Photo courtesy of John Markon, Virginia NRCS.

could not find one, Hammer and Templeton developed a presentation titled “Handling Uncomfortable Situations,” which was first delivered in their home area and later shared with NRCS employees in two other regions of the State.

“That was in 2015 and 2016,” Hammer recalled. “We provided the training, felt it was well received, and also thought it might have been over. We never really envisioned adapting the presentation for a virtual audience or delivering it outside of Virginia.”

In January 2022, however, Hammer and Templeton accepted an invitation by the Women in NRCS (WiN) to present at their Southeast Regional Meeting. They followed up by an encore at WiN’s national meeting in April. The predominantly female organization of 326 members was, not surprisingly, very interested in their message.

“I think that was the big door-opener for them,” said Tina Jerome, a WiN officer and director of NRCS’s East National Technology Support Center in Greensboro, North Carolina. “The WiN audiences were virtual but included several higher-ups and decision-makers in NRCS. It wasn’t long before some of them started thinking ‘I’d like to bring that to my State.’”

Hammer and Templeton have now shared their message with NRCS audiences in Wisconsin and Oregon, and presentations in other States will likely to be scheduled before the end of summer. Jerome also nominated the pair for WiN’s 2022 Group Award of Excellence, which they received on August 2 in a virtual presentation during the Soil and Water Conservation Society Conference in Denver.

“Tina was my first boss when I started in Accomac,” recalled Templeton. “She’s always encouraged us and has been a believer in the project. Our area supervisor, Keith Boyd, is another supporter who ought to be mentioned. He’s been totally behind us.”

The half-day, two-part presentation developed by Hammer and Templeton includes an opening exploration of potential workplace safety issues, followed by some role-playing and discussion of difficult situations NRCS employees might face when engaging with customers in the field:

1. Unwanted advances that persist even after the individual is asked to stop.
2. Unwelcome physical contact.

3. Use of racist language.
4. Derogatory remarks.
5. A confrontational attitude about an NRCS employee's presence on the property, even if the employee has permission to be there.
6. A generally hostile attitude toward the Federal government.

While women may most frequently encounter the first two situations listed, based on actual field experiences, any employee could encounter the other four situations. The presentation is never recorded, allowing participants to speak as freely as they choose during and after the exercises.

"Women were obviously a key audience," Hammer said, "but we wanted to make the program universal and applicable to all. We reached out to our colleagues in Virginia to see what situations they encountered and incorporated some of those into the training. Every scenario we offer in the presentation is something an actual NRCS employee has experienced. In person, we use about 2 hours for each half of the program. When we present online, like we did for WiN, we only do the sample scenarios and group discussions."

"Our feedback tells us that people think the small groups are the most valuable part," Templeton said. "There really aren't any 'right' and 'wrong' answers to how to handle the scenarios. The value comes from talking about possible actions and the impacts of each one. Some of the stories that tend to emerge in the small groups are shocking, but they also build awareness of the problems."

While Templeton and Hammer had no previous experience crafting employee development presentations, they brought more to their project than amateur enthusiasm. Templeton is certified as a trainer by the USDA's National Employee Development Center. Not long after completing the first phase of "Uncomfortable Situations," Hammer was hired as an adjunct professor by Virginia Wesleyan University in Virginia Beach, where she teaches courses in geology and soil science.

"At this point," Hammer said, "Jenny and I will probably keep on offering the presentation and trying to improve it as long as people want to see it. We'd both be really happy to see a diminished need for this type of awareness training moving forward."

Anyone interested in providing this training to their staff is asked to contact Allison Hammer (allison.hammer@usda.gov) or Jenny Templeton (Jennifer.templeton@usda.gov) for more information. ■



Soil Tours for California Area 1 Communities

By Jacqueline Vega, resource soil scientist, Area 1 field office, NRCS California.

Jacqueline Vega collaborated with soil survey offices (SSOs) in Arcata CA, Chico CA, and Klamath Falls OR Major Land Resource Areas (MLRAs) to provide Area 1 field office staff with relevant soil information for conservation planners. Vega and SSO staff created a series of soil tours for the three communities that comprise Area 1: the Modoc Plateau, North Coast, and Sacramento Valley Communities.

The team hosted the soil tours for the Sacramento Valley and Modoc Plateau Communities in May. With the support of the Arcata MLRA SSO, they plan to complete the tour series with the North Coast Community Soil Tour in October.

These soil tours are intended for field office staff who are involved in conservation planning or who will be assigned responsibilities as part of the conservation planning process. The tours provide an opportunity to introduce or expand field knowledge and skills of relevant soil properties and interpretations (e.g., infiltration), the basics of map unit composition, and Web Soil Survey (the official source of soils data). They also

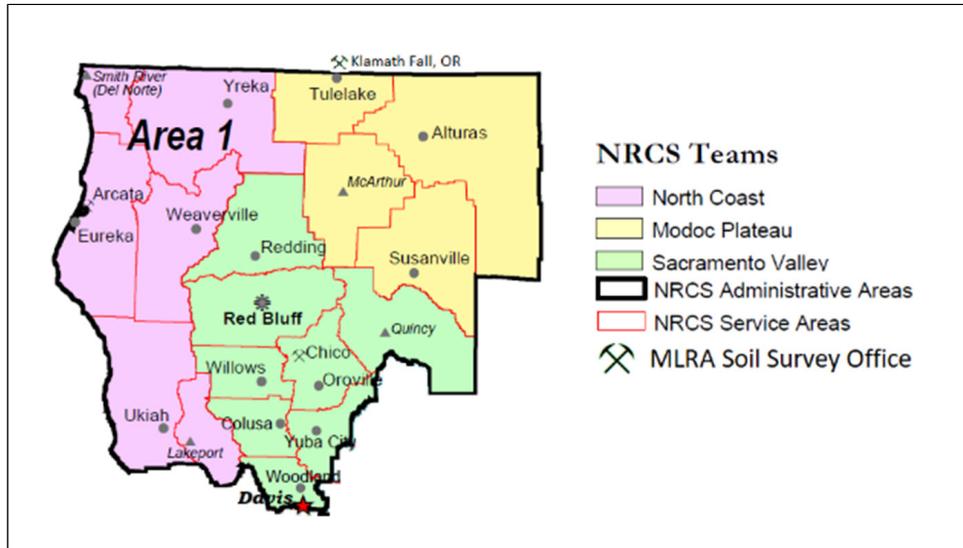


Figure 1.—Locations of California NRCS Area 1 service areas and offices.

provide field office staff the opportunity to use their soils knowledge within the context of the conservation planning process.

The tours are excellent opportunities for the field office staff to evaluate different types of landforms, soil types, and management practices under various land uses (e.g., cropland, rangeland, and pastureland) while they interact and learn from the soil scientists who mapped, collected, and developed soils data in their respective areas.

Sacramento Valley Community – Chico CA MLRA SSO

The Sacramento Valley Community Soil Tour was led by Soil Scientist Andrew Conlin with the assistance of Ecologist Darren Pinnegar. The tour consisted of two



Figure 2.—(Left) Tour participants observe and discuss soil properties representing soil development over time. (Right) Darren Pinnegar (Chico CA MLRA) explains the ecosystem dynamics of a clayey site.

parts in [Bidwell Park](#), Chico. The first part of the tour was a walk of about 0.75 mile from the flood plain to the bedrock foothill ridgetop. It included seven soils (stops) in a complete sequence. This complete soil sequence represented a variety of soil characteristics and plant communities in the region. The second part was a one-way walk of about 1.5 miles up the canyon. The attendees had the opportunity to practice applying the soils knowledge learned in the first part of the tour within the context of the conservation planning process.

Sacramento Valley (left four)

Cascade foothills (right three)



Figure 3.—A close-up of the seven surface samples from the complete sequence observed on the first part of the Sacramento Valley Community Soil Tour. Differences in inherent characteristics can influence soil health observations and assessments.



Figure 4.—Participants in the Sacramento Valley Community Soil Tour, Chico, California, May 11, 2022. The Hanford, Sonora, and Templeton MLRA SSOs were involved in this event. Photo by David Immecker, USDA Forest Service hydrologist, Lassen National Forest, California.

Modoc Plateau Community – Klamath Falls OR MLRA SSO

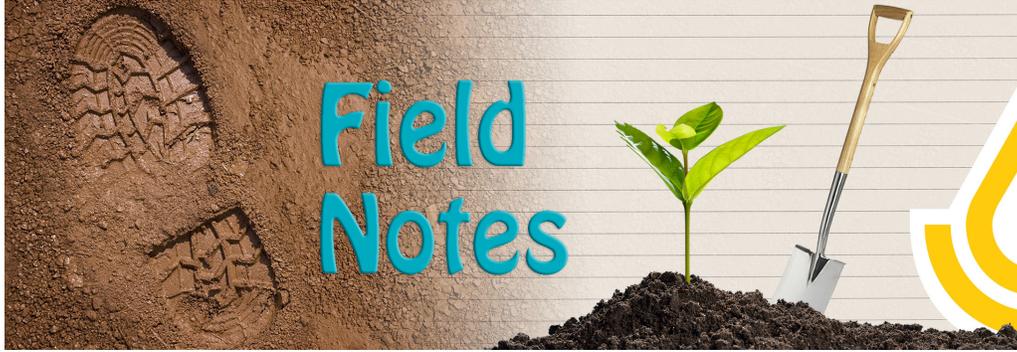
The Modoc Plateau Community Soil Tour was led by Soil Scientist Chris Gebauer, from the Klamath Falls OR MLRA SSO. The attendees visited two different alfalfa farms that had similar management histories and resource concerns but different soil map units. They had the opportunity to evaluate the farms together, review soil survey data for the area, dig a pit, determine soil texture, learn how to measure infiltration rate, and evaluate the relationships between local soil properties and management practices. ■



Figure 5.—(Left) MLRA Soil Survey Leader Chris Gebauer explains the soil survey data and the relationship between local soil properties and management practices. (Center) Jacqueline Vega demonstrates how to measure infiltration rate. (Right) NRCS staff discuss soil properties in an alfalfa field which had significantly reduced irrigation water both last year and this year.



Figure 6.—Participants in the Modoc Plateau Community Soil Tour, Tulalake, California, May 19, 2022.



Monthly Webinar Series Puts Fieldwork in the Spotlight!

By Kristie Wiley and Paul Reich, USDA Natural Resources Conservation Service.

The Natural Resources Conservation Service’s Soil and Plant Science Division (SPSD) launched a webinar series to spotlight soil and plant science fieldwork. The series, titled Field Notes, is a monthly live event featuring two or three 15-minute presentations.

“The webinar is an opportunity for the field staff to share results, present methods, pose questions, or serve as subject matter experts for regional issues,” said David Hoover, Director of the National Soil Survey Center and moderator for Field Notes.

Since its premiere on March 9, 2021, Field Notes has featured 36 presentations. The webinar is recorded, and you can view past presentations on the National Soil Survey Center YouTube channel, [Field Notes Webinar Playlist](#).

Field Notes — Past Presentations		
	Presentation Title	Presenter
Webinar #1	• Initial Ecological Concepts for a Highly Altered Region	Darren Pinnegar
	• A Digital Soil Survey Mapping Approach to a Coastal Zone Soil Survey of West Galveston Bay	Kenneth Hall
	• Using RStudio for Enhanced Digital Soil Mapping	Sara Russell
	• Virtual Education and Outreach Strategies from NRCS Connecticut	Jacob Isleib
Webinar #2	• TSS During a Pandemic: One MLRA Office’s Experiences with Digital Media	Matt Havens and Zach Warning
	• Measuring Soil Carbon within San Antonio City Limits	Travis Waiser
	• Soil Survey of Olympic National Park – Progress and Field Season Highlights	Max Ross
Webinar #3	• Connecting the Dots: Dynamic Soil Properties and Ecological Sites	Erin Hourihan
	• Using DSM Method for Initial Soil Survey – Altus Air Force Base	Tyson Morley
	• Dynamic Soil Survey in Oklahoma – Little Washita River Experimental Watershed	Alan Deubler

NCSS Newsletter

Webinar #4	• Soils 2026 Implementation Planning	Tiffany Allen
	• Nevada Playa Characterization Study	Chris Savastio
Webinar #5	• Sensitivity Analysis for Standard Profile Descriptions	Andrew Brown
	• Dig it: A Tale of Soils in the High Desert of Eastern Oregon	Meghan Krueger
Webinar #6	• Upper Missouri River Basin Soil Rankings to Site Soil Climate Stations	Alex Stum
	• Video Killed the Cubicle Star – Creating Quick Training Videos to Share with Coworkers when we are all remote working during a pandemic	Meredith Albers
Webinar #7	• MLRA 53B Closed Depression Digital Mapping Project	Brianna Wegner
	• A New Chapter for a Globally Imperiled Species: Harbison’s Hawthorn	Barry Hart
Webinar #8	• Evidence of an Extinct Lake and Rapid Drainage Features	Andrew Conlin
	• Sierra Nevada to the Alaska Range - An ecological site specialist resource exchange between two regions	Nathan Roe
Webinar #9	• Challenges and successes mapping Olympic National Park Part 2	Lizzie Carp and Erin Kreutz
	• Urban Soils of New York	Milton Vega
Webinar #10	• Three Creeks Grazing Consolidation DSP Project Details	Kristi Mingus
	• Emery County Initial Soil Survey Work	Miles Coker
Webinar #11	• Willow National Petroleum Reserve Soil Survey Work	Mike Sousa and Phil Barber
	• Status of NRCS Proximal Sensing Tools Inventory	Kristine Ryan
Webinar #12	• Resource Evaluation in Determining ESDs and Habitat Types on Forest Service Initial Mapping in Utah	M. Dean Stacy
	• Ashley National Forest Initial/DSM Soil Survey Work	Lucille Rollins
Webinar #13	• Collecting data on urban soils to provide insight on how to improve soil health and water quality within the urban setting	Gary Harris
	• Using a Soil Survey Approach to Quantify Dynamic Changes in Blue Carbon	A. Reuben Wilson
Webinar #14	• Soil Survey of Sequoia and Kings Canyon National Parks	Juliet Baker
	• Assessing Surface Stoniness: Transect vs Area Methods	Zach Warning
Webinar #15	• Carbon Sequestration: The Science Behind the Free Market	Sara Russell
	• Discussion on Soil Temperature Monitoring in MLRA 77E	Brandon Vaverka

Webinar #16	• Soil Sampling for Soil Carbon Inventories: Where, How Deep, and When to Dig	Beyhan Amichev
	• Lake Mattamuskeet, NC: Reclamation, Restoration, and Coastal Zone Soil Survey	Austin Price

Would you like to be a presenter?

The SPSPD is always looking for topics for the monthly webinar series. National Cooperative Soil Survey partners are encouraged to present. If you are interested in presenting a topic for Field Notes, email your request to Field-Notes-Webinar@usda.gov and include the following:

- “Field Notes—Request to Present” in the subject line
- Topic title
- A brief description of your topic (100 words maximum)

When is the next webinar?

The next webinar is on September 13, 2022, at 2:00 PM (EDT). On the day of the webinar, click on the following link to join the live event:

[Attendee link to field notes webinar #17](#)

For a sneak peek of September’s webinar, click [here](#). ■



Coastal Zone Soil Surveys and the Preservation of Coastal Cultural Resources

By Debbie Surabian (NRCS State Soil Scientist for Connecticut and Rhode Island) and Krista Dotzel (NRCS archaeologist).

The NRCS Survey and Plant Science Division (SPSPD) staff and National Cooperative Soil Survey (NCSS) partners continue to collect soil cores for the coastal zone soil survey (CZSS) of Long Island Sound. Traveling from east to west along the Connecticut coastline, the NRCS coring boats have moved into the Thames River (figs. 1 and 2).

The Thames River is located in eastern Connecticut. It flows south for 15 miles, from Norwich, Connecticut, to New London and Groton. It has provided important harbors since the mid 17th century. It was originally known as the Pequot River after the Indigenous Pequot who dominated the area. In 1685, the town was officially named New London and the estuary river was renamed the Thames after the River Thames in London, England (ref. 1).

A collection of national and historical sites is along the shores of the Thames River. Included are two historic forts (now State parks) that overlook the mouth of the river: Fort Griswold on the eastern Groton Heights and Fort Trumbull on the New London side.

Since the Colonial era, Fort Trumbull has been the location for military forts, schools, and research facilities for the United States Army, Coast Guard, and Navy. The fort was originally built to protect the New London Harbor from British attack and later served as part of the country’s coastal defense system. The masonry fort, which still stands today, was constructed between 1839 and 1852. Fort Trumbull has been the site of many events that have shaped our Nation, including an attack by the British under the command of Benedict Arnold (September 6, 1781), the U-boat menace of World War II, and the anti-submarine efforts during the Cold War (ref. 2).



Figure 1. —The Gold Start Memorial Bridge (middle ground) and the Thames River Bridge (background) over the Thames River. The Gold Start Memorial Bridge carries Interstate 95 and U.S. Route 1. It is the largest structure in the State and longest bridge in the State. It was originally built in 1919 and one of eight moveable bridges. The Thames River Bridge carries Amtrak.

In tandem with Fort Trumbull on the opposite side of the harbor, Fort Griswold (in Fort Griswold Battlefield State Park) served to defend the port of New London, a supply center for the new Continental Army and a friendly port for Connecticut-sanctioned privateers who preyed on British ships (ref. 2).

Fort Griswold Battlefield State Park is the site of the 1781 Battle of Groton Heights. British troops, under the command of the infamous traitor Brigadier General Benedict Arnold, attacked the fort, resulting in a massacre of American soldiers. The park includes the Groton Monument, which lists the names of those who died defending the fort. It was built between 1826 and 1830 and is the oldest monument of its type in the country. The monument is built of granite that was quarried locally, stands 135 feet tall, and has 166 steps (ref. 2).

Located along the river today are the United States Coast Guard Academy, Connecticut College, a U.S. Navy submarine base, the Electric Boat submarine shipyard, and the USS Nautilus. The USS Nautilus is the world's first nuclear-powered submarine. It was launched into the Thames River on January 21, 1954. First Lady Mamie Eisenhower broke the traditional bottle of champagne across its bow. It was also the first ship to go to the North Pole and the first submarine to journey "20,000 leagues under the sea" (ref. 1).

The banks of the Thames River are also home to Native American cultural resources, such as the Fort Shantok National Historic Landmark in Montville, Connecticut. This archaeological site is one of the largest and best preserved sites documenting 17th century Native American life. The site was occupied by Mohegans under the leadership of Uncas. It has yielded extensive evidence of trade relationships between the Mohegans and European colonists as well as evidence of Mohegan diplomatic and military activity. The site is of great spiritual importance to the modern Mohegan people (ref. 3).



Figure 2.—The Ledge Lighthouse. This three-story lighthouse was built at the mouth of the Thames River in 1909.

Just as the coastal communities in Groton and New London face significant threats due to climate change, sites with meaningful and valuable cultural resources are also at risk. According to a scientific study done in 2017, close to 20,000 recorded archaeological sites along the coastline from Maryland to Louisiana are in danger of being destroyed by a sea-level rise of only 3 feet (ref. 4). There are 22 recorded Native American archaeological sites on the banks of the Thames River alone, all of which may be impacted by sea-level rise (ref. 5).

Many sites of cultural resources face an abundance of climate impacts, including the loss of sensitive archaeological evidence due to changing soil conditions, damage to historic buildings from groundwater and saltwater intrusion, destruction of organic building materials from soil temperature swings and pest migration, and structural damage or loss due to storm inundation and flooding.

With the unprecedented rates of coastal environmental changes, coastal zone soil surveys (CZSS) could be the key to understanding the changes to environmental processes that induce, accelerate, or amplify loss of cultural resources. CZSS may help us to understand the environmental drivers or changes in the coastal environment, including those related to water and soil temperatures, soil moisture patterns, saltwater inundation or intrusion, biodiversity, and ecosystems.

CZSS will greatly improve the science-based management of nearshore areas by collecting, analyzing, and distributing information on the properties and spatial distribution of subaqueous and tidal marsh soils as well as more detailed soil data on adjacent terrestrial areas. It will provide the appropriate soils data to assess how frequent major storms indicative of changing climatic patterns are impacting ecosystems, habitats, biodiversity, urban infrastructure, and cultural resources.

The impacts of climate change on history and culture are often underrepresented in climate planning, research, and policy but may be understood and addressed through CZSS. The sites of coastal cultural resources need to be protected to ensure the preservation of heritage and culture. If irreplaceable human and environmental records of the past are lost, future generations will not have opportunities to learn from them.

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4th Edition of WRB Issued and Peter Schad Awarded the Guy Smith Medal

The latest edition of the World Resource Base (WRB) soil classification system was released in conjunction with the 22nd World Congress of Soil Science in Glasgow, Scotland (July 31 to April 8). In this edition of WRB many criteria of the diagnostics, the key, and definitions of the qualifiers were refined. It also incorporated the FAO horizon nomenclature as an appendix. The 4th edition is an electronic publication (ISBN 979-8-9862451-1-9) by the International Union of Soil Science (IUSS). It is available at <https://www3.ls.tum.de/boku/?id=1419>.



Figure 1.—Peter Schad is the recipient of the 6th Guy Smith Medal.



Figure 2.—Award presented by Curtis Monger (left), Chair of IUSS Commission 1.4 Soil Classification. The Selection Committee consisted of Jozef (Seppe) Deckers (Belgium), Prof. Lúcia Helena C. Anjos (Brazil), and Prof. Maria Gerasimova (Russia).

Dr. Peter Schad, chair or vice-chair of the IUSS-WRB Working Group from 2002 to 2022, was awarded the Guy Smith Medal for his outstanding contributions to international soil classification. Professor Schad and his WRB colleagues have made the WRB a widely (probably the most widely) used classification system of international soils. WRB excursions outside of Europe in the last 20 years have included Argentina, Australia, Bolivia, Brazil, Burkina Faso, Chile, China, Colombia, Côte d'Ivoire, Ecuador, Georgia, Indonesia, Kenya, Korea, Malaysia, Mexico, Mongolia, Namibia, Peru, Russia, Singapore, South Africa, Tanzania, Thailand, USA, and Vietnam.

Those of us who use USDA's Soil Taxonomy salute Professor Schad

and his colleagues, realizing that the number of countries now using Soil Taxonomy has declined. Like WRB, Soil Taxonomy was designed as an international system and, consequently, provided much material currently used in WRB. Soil Taxonomy remains an elegant classification system and is an increasingly useful tool for addressing global environmental issues, such as identifying soils that are likely to release carbon dioxide with global warming, soils that have high potential (or low potential) for carbon sequestration, and soils that are vulnerable to physical and chemical degradation, issues important for sustainable agriculture and food security. ■

Subtleties of the Land Surface and Importance of Soil Geomorphology

By Jay Skovlin, NRCS MLRA soil survey leader, Missoula, Montana.

It was my first week of mapping soils in Northeast Oregon, and I was excited to get out there. My boss had selected a quadrangle area in the Malheur National Forest that he thought had some variety and would be a good place to start. He turned me loose and said, “The first thing I want you to do is drive as many roads as you can and tour the area.” He stressed the importance of getting the “big picture” of the landscape. I took his experience and wisdom to heart and found a landscape that had some fascinating features, including volcanic ash from the Mount Mazama eruption, gooey fine-family clayey soils that formed on the volcanic tuffs of the Clarno Formation, and massive slumps where this gooey material had failed under the weight of overlying basalt flows.

An introductory soil course and a pedology class had taught me how to imagine soil variability through the lens of the soil-forming factors. A field course had helped me to further understand these factors, but they were still mostly abstract concepts. This was my chance to put that vision into practice and use my observation skills to build a map of soils on the landscape. At first, I dug and described soils in areas that seemed disparate and unconnected. I quickly realized that despite touring the area for the “big picture,” I wasn’t getting it. I hadn’t been looking at and thinking about the landscape at the appropriate scale. As a new mapper, I was too focused on the next soil pit and looking at roadcuts trying to figure out what the soils were doing. My observations were at the wrong scale to see the larger relationships.

This introduction to seeing the landscape remains an important turning point in my experience of learning to map soils. We’ve all seen those photo mosaics of many small images which compose a much larger picture; similarly, landscapes are composed of many repeating and nested landform features. The larger patterns of geomorphic features and processes repeat themselves across all landscapes. Learning to recognize the subtle differences in soil parent materials and their origin, changes in composition, boundaries on the landscape where they change, their behavior or relative stability under various conditions, their relative age, superposition, and cross-cutting relationships are all observations that give us a contextual foundation on which we can arrange our observations of soil properties. The hard work of building foundational mental models and developing working hypotheses of parent material and soil geomorphology relationships allows us to deconstruct what happened on landscapes and to identify and delineate the distribution of soils.

Reading a landscape and incorporating the dimension of time through an understanding of landform feature construction, and erosional and depositional processes, is no small task. As soil scientists, how good are we at doing this? One of the best things about soil science is that as a discipline it connects with many other

fields related to natural resources. As a group, I think we have been wildly successful at mapping soil through the soil-landscape paradigm (Hudson, 1992). We have an advantage based on our many above- and below-ground observations. We see landscapes not only from the top side, noting vegetation patterns, surface shape, and erosional and depositional morphology, but also from the bottom side, studying soils and reading the soil profile, information which can either support or reject a working hypothesis of parent material and depositional process.

Current and developing approaches to mapping soils are more and more reliant on computer vision and digital representations of the soil-forming factors within a covariate feature space. These approaches are useful and promising for future developments and comprise a natural progression of our science into digital methodologies. Although the aim of new methods should not be to recreate previous methods in a digital form, it is important to critically assess what works and what doesn't work to inform and guide development of new methods.

If landform and geomorphic context are so important to understanding soil variation and distribution, how do we incorporate the nuances of a geomorphic framework and associated landscape relationships into our models?

Attempts have been made to develop and apply algorithms and classifications of surface shape and morphometry, such as geomorphons (Jasiewicz and Stepinski, 2013), to soil mapping. Although these methods are helpful as a uniform means of parsing a landscape surface based on surface shape, they largely break down outside of the most local scales due to a lack of enforced hierarchical nesting in their construction. The computer lacks the ability to assess anything but what it is given as inputs. Covariates capturing relationships of relative age, chronology, and even simple fluvial cross-cutting of geomorphic surfaces are largely absent in current elevation and spectral-derived covariate data sources. For example, the difference between a ridge on a mountaintop and a ridge on a hogback or hillslope cannot be discerned even though the geomorphic processes that lead to the creation of those features could be very different. Overlooking these covariates can generate greater confusion, less coherency, and less confidence in digital soil mapping (DSM) products.

Although widely acknowledged as being very useful in mapping soil, surficial geology and landform maps are generally lacking as inputs to DSM products. Categorical data sources like these are often overlooked in favor of continuous data and are commonly derided as imparting too much rigidity to the DSM process and the model outputs. Terrain covariates of elevation and associated derivative layers are not equivalent sources for this kind of information because they are not a product that builds on the hierarchical arrangement of landform and associated parent material elements within a chronologic framework of construction process, material composition, and time. Several studies have pointed out this weakness in the DSM process and have attempted to bring attention to it within various landscape and landform catenas (Rossiter, 2016; Atkinson et al., 2020). Wide usage of modeling inputs such as geomorphons (granted a significant advance in surface shape classification) demonstrate the DSM community reaching out for any available inputs for systematically subsetting the landscape into geomorphically relevant units.

A common rebuttal to the lack of this kind of information in models is that within the DSM process those critical associations will materialize out of the relationships among the covariates used as inputs. This may be partially true, and I'm not saying it can't happen; however, the strength of an enduring soil map is that the soil relationships are nested and constrained within a chronologic framework of geomorphic surfaces and parent materials. There is order to the construction of any landscape, and it is important to convey the most current and accurate interpretation of landscape

construction, both known and unknown, that may exist there. Geomorphology acts genetically as a guiding framework by touching on three important soil-forming factors—topography, the nature of the parent material, and time (Zinck, 2016). We should not leave it to chance that those relationships will be “discovered” by the modeling process; conversely, they should be intentionally included within it. These inputs should be given equal weighting in their importance to the process and to generating more useful and intelligent model outputs.

Since those first heady days of field mapping, I have grown as a mapper and have worked to sharpen and target my observations to maximize efficiency. Even so, there have been times that I could not recognize a landform feature in front of me until I had the chance to see it replicated somewhere else and then was able to conceptualize the initial observations properly and put them in a related context. I need to get back to the “big picture” and allow my mind to run its own form of pattern and object recognition over the landscapes I’ve worked in. Soil science and pedology are fundamentally field sciences. As a discipline, we need to balance a more time- and resource-intensive “dig-it-all” approach with a modern tendency that, in the absence of fieldwork, sometimes results in a rush towards a “dig-at-all?” soil mapping product. Careful field observations of parent materials and landforms and a soil geomorphic understanding of the landscapes we work in will lead to improved and interpretable DSM outputs and products.

I offer these thoughts to you fellow soil scientists to consider the next time you are out field mapping, assessing an existing soil map, or sitting in front of a computer screen. Solutions to tackling these issues will be both challenging and exciting to develop and will ultimately improve our ability to relate our science and findings to others.

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Suggested further reading on topics related to soil geomorphology

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2023 Soils Planner is Now Available!

The USDA Natural Resources Conservation Service is pleased to announce that the 2023 Soils Planner is now available. This highly educational, calendar-style planner is free to the public while supplies last. Individual copies can be ordered from the NRCS Distribution Center at <https://nrcspad.sc.egov.usda.gov/DistributionCenter/>. Enter the keyword “Planner” and click “Search.”

The theme for the 2023 planner is “Twelve Tough Digs.” This planner recognizes unique and challenging locations that have been investigated by soil scientists. Many of the locations are spectacular but require scientists to endure extreme conditions.

“Soil science requires more than just data collection, rigorous research, and effective model development. It requires field crews who invest blood, sweat, and tears into soil mapping,” said Luis Tupas, NRCS Deputy Chief for Soil Science and Resource Assessment.

This planner acknowledges the exceptional effort of the people who dedicate themselves to sustainable land use. The stories and photographs featured in this planner are from the scientists who endured the necessary hardships to help us better understand the soil. ■



2022-23 Wisconsin Cooperative Soil Survey Planning Meeting Held at Schmeckle Reserve

By Andrew Paolucci, assistant state soil scientist/soil health specialist/WSPSS President, NRCS, Madison, Wisconsin; and Richard Reid, NRCS regional resource soil scientist, Central National Technology Support Center, Ft. Worth, Texas.

On Monday, August 22, 2022, soil scientists and other professionals who use or develop soil survey products met at Schmeckle Reserve in Stevens Point, Wisconsin. The group included about 50 participants, including NRCS soil scientists, university partners, private agronomists, environmental consultants, and Wisconsin State employees. Over 2 days, the group observed presentations about previous and ongoing projects related to soil survey.

The meeting was organized by Jeremy Ziegler, Jennifer Smith, and Andrew Paolucci (NRCS Wisconsin) and hosted by Dr. Bryant Scharenbroch and Dr. Jacob Prater (professors at the University of Wisconsin, Stevens Point (UWSP)). Bryant and Jacob assisted with the logistics of the conference and presented information about two collaborative projects between the university and NRCS. The event was planned as a joint meeting with the Wisconsin Society of Professional Soil Scientists (WSPSS), who hosted their meeting the second morning and sponsored lunch.



Figure 1.—Dr. Scharenbroch kicks off the meeting with a presentation about proximal soil sensors.

Dr. Scharenbroch, along with both his current and former students, presented about work being done with proximal sensors, including soil color sensors, portable x-ray fluorescence (pXRF), and portable mid-infrared (MIR) spectroscopy. The UWSP crew have evaluated the use of these tools to predict soil properties such as soil organic matter, clay content, and heavy metal content. The presentation outlined the science behind these tools, their practicality for predicting certain properties, and their potential for use in soil survey inventory.

Tools like pXRF are especially relevant for Wisconsin soil survey due to ongoing projects, such as the Milwaukee urban soil survey where pXRF could be used to detect heavy metals in soils that may be hazardous or indicative of certain soil processes (in human-transported and human-altered materials).

Another project that was presented by both Dr. Prater (UWSP) and Chris Tecklenburg (acting director of North Central Soil Survey Region) was the provisional ecological site description (ESD) agreement that UWSP and NRCS Wisconsin have been collaborating on for several years. Dr. Prater explained the process his lab used to develop ESDs for most of Wisconsin. Chris provided an update on activities and changes



Figure 2.—One of the soil pits used for the field tour at the Schmeckle Preserve.



Figure 3.—Mark Cook, Stevens Point alum, showcases the use of proximal sensors in one of the soil pits.

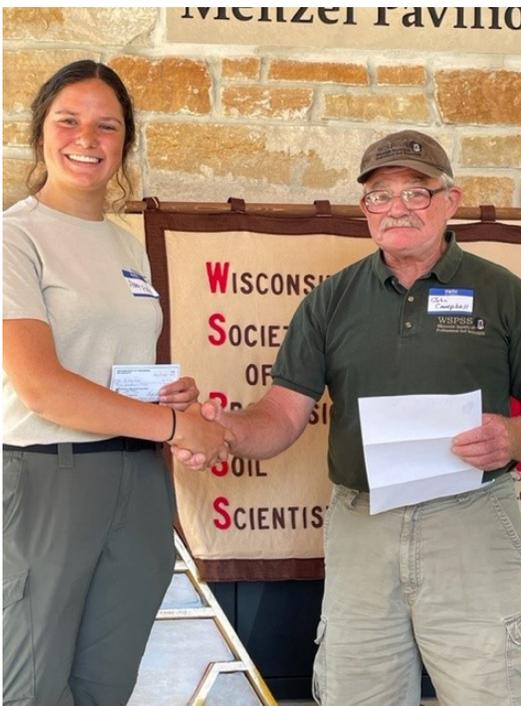


Figure 4.—Abigail Field, NRCS Wisconsin Pathways intern, receives scholarship from Professional Soil Scientist John Campbell.

in personnel within the region and touched on ESD progress in Wisconsin.

Richard Reid presented about Conservation Practice Standard 336 - Soil Carbon Amendment and the use of soil interpretations to supplement conservation practice implementation. A soil interpretation called “Dynamic Soil Property Response to Biochar” was developed to identify suitable locations for soil carbon amendments such as biochar. Most of the audience either develop soil survey data or use soil interpretations in their work. Richard’s presentation focused on how conservation practice standards are structured, how this soil interpretation was developed, and how soil survey data can be used for conservation practice implementation and practice standard development.

Adolfo Diaz, GIS specialist with the National Soil Survey Center, presented about an ArcPro tool for extracting pedons from NASIS. This tool is helpful for partners who may want to use pedon data but do not have access to the USDA-NRCS soil database, NASIS. It can also be used by MLRA staff to view pedon data in GIS interfaces. NRCS Soil and Plant Science Division staff from St. Paul, Minnesota, and Juneau, Wisconsin, provided updates on soil survey projects such as digital soil mapping in northeast Minnesota and urban soil mapping in Milwaukee.

The remaining presentations were academic program updates from Dr. Chris Baxter (University of Wisconsin, Platteville) and Dr. Holly Dolliver (University of Wisconsin, River Falls) regarding their soil programs, research, and other soil-related activities.

Day two included the WSPSS meeting in the morning, followed by a field tour. Tour participants were able to observe soil pits as well as developing technologies and hot topics related to soil survey, including proximal sensing tools, provisional ecological site descriptions, and soil health assessments.

NRCS Wisconsin and WSPSS are grateful to the University of Wisconsin, Stevens Point, for helping host the event as well as the participants who attended and contributed to the great discussions related to previous, ongoing, and future soil survey projects. ■



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