National Cooperative Soil Survey Newsletter

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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.

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2015 National Cooperative Soil Survey Conference

The biennial National Cooperative Soil Survey (NCSS) Conference will be held June 7 through 11, 2015, in Duluth, Minnesota. The conference will be hosted by the University of Minnesota, Twin Cities, and supported by the Natural Resources Conservation Service, the U.S. Forest Service, the Minnesota Association of Professional Soil Scientists, the Soil Science Society of America, and the National Association of Consulting Soil Scientists.

NRCS personnel supporting the conference include the area resource soil scientists as well as the soil survey office staffs from throughout Minnesota.

The conference is an opportunity for U.S. and international representatives from cooperating universities, governmental agencies, and the private sector to meet and address issues of concern to soil science and to the National Cooperative Soil Survey. The theme of the 2015 conference is "Soils and a Changing Climate: Future Trends of the NCSS."

Two field tours are associated with this year's meeting—one on Sunday, June 7, and one on Wednesday, June 10. The Sunday trip will be to the multi-year cooperative (U.S. Department of Energy and U.S. Forest Service) research site at SPRUCE (Spruce and Peatland Responses Under Climatic and Environmental Change) north of Grand Rapids, Minnesota. This research site was designed to assess the response of northern peatland ecosystems to increases in temperature and exposure to elevated concentrations of atmospheric CO_2. The Wednesday field tour will be via bus along the northern shore of Lake Superior. It will consist of several stops at soil pits and road cuts, including views of the very fine till commonly encountered in the region. In addition, the Ecological Site Inventory will be discussed at a Sugar Maple site. This trip will also include a stop to observe deep organic deposits for a discussion regarding the Euic and Dysic interface of Histosols.

The conference program, online registration, accommodations, and committee and contact information are available at: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/partnership/?cid=stelprdb1267531.

The national conference convenes on odd-numbered years. The regional conferences are held on even-numbered years. The conference locations are selected by the conference steering teams, whose members are representatives of the NCSS. The location of the national conference is rotated through the four established regions of the NCSS as dictated by regional and national bylaws. The national conference is hosted by local or regional cooperators, and NRCS facilitates the agenda in consultation with local and national members. The regional conferences follow a similar convention between States. NRCS, as leader of the Federal part of the NCSS, also provides facilitation and coordination to the yearly partnership effort. Participants of the National Cooperative Soil Survey include representatives from the 1862 land-grant universities, experiment stations, NRCS, USFS, BLM, BIA, EPA, USFWS, SSSA, National Association of Consulting Soil Scientists, the 1890 land-grant universities, and western tribal colleges. Other interested foreign and domestic groups, such as lead scientists from Canada, Mexico, and other cooperating countries, are invited to participate. Students are welcome and will be offered discounted registration for full participation in the conference.

Important topics that will be discussed at the conference include:

- Enhancing, promoting, and supporting soil data,
- Advancing frontiers in digital soil mapping/information applications,
- Evolving the vision for ecological sites and soil health, and
- Updating and expanding soil survey operations. ■

World Map of Ecological Land Units

The U.S. Geological Survey and Esri have created an interactive map (http://blogs.esri.com/esri/esri-insider/2014/12/09/) that allows the user to explore ecological land units across the world down to an 820 foot (250 meter) resolution.

This GIS map breaks down the world's surface features into cells, or ecological facets, defined by four layers that drive ecological processes: bioclimate, landform, lithology (rock type), and land cover parameters. Esri's researchers chose the layers in terms of their accuracy, currency, and global coverage. In all, there are 47,650 combinations of the four layers, with each cell aggregated into one of 3,923 ecological land units (ELU). This map is considered the very first (and is certainly the most detailed) map showing the ELUs of the world.

For more information, go to:

- http://esriurl.com/elu for the Introductory Story Map to the ecological land units,
- http://esriurl.com/EcoTapestry to explore the online application,
- http://www.aag.org/global_ecosystems to learn more about ecological land units, and
- http://www.arcgis.com/home/group.html?owner=esri&title=Landscape%20Layers to get started using this content in ArcGIS. ■

Victorville MLRA Soil Survey Office Hosts 2-Day Tour of Desert Soils

On October 30–November 1, 2014, the Victorville MLRA Soil Survey Office, Dr. Bob Graham of the University of California–Riverside (UCR), and Brenda Buck of the University of Nevada—Las Vegas (UNLV) hosted the "Desert Pedology, Land Use and Wild Lands—Las Vegas to Long Beach" 2-day tour as part of SSSA meetings in California. The tour was planned and executed by Leon Lato and the rest of the Victorville MLRA Soil Survey, Region 8 team, including Carrie Ann Houdeshell, who initiated the effort before she transferred to the Region 2 team.

The tour group on the eastern edge of the Kelso Dune field in Mojave National Preserve. The group is in an area stabilized by big galleta grass.

From Las Vegas, Nevada, to the outskirts of the Los Angeles Basin in California, there is a wide range of desert landscape, remote wilderness, and unique vegetation and soil formation. This area represents isolation and preservation but also has possibilities for the future of renewable energy production, food and fiber production, watershed renovation, and alternative uses of new minerals for green infrastructure and modern technology.

The tour started in Las Vegas at the University of Nevada with a lecture and lab tour from NCSS Cooperator Dr. Brenda Buck. Her lecture "Naturally Occurring Asbestos: Potential for Human Exposure, Southern Nevada, USA" was an illuminating start to understanding the effects of dust in the Mojave Desert and the southwestern United States on humans and the difficulties of studying this issue in an urbanizing environment.

The group travelled on to California to the Mojave National Preserve (MNP). Dr. Mandy Williams of UNLV and Dustin Detweiler, NRCS ecological site specialist, started the field discussions with examples of ecological site descriptions, biocrusts, and the function of dust in these systems. Dr. Daniel Hirmas, Kansas University, explained his Ph.D. UCR thesis on eolian deposits on mountains, and Leon Lato, NRCS soil survey project leader, Mojave National Preserve, led the discussion of the playa soil of Soda Dry Lake. The group stayed at the Desert Studies Center in Zzyzx, California.

On the second day, the group visited the basalt flows in the Cima volcanic field with Dr. Yvonne Katzenstein. These flows illustrate the potential of 1 to 3 meters of dust (eolian fines) to inflate the landscape over measured geologic time.

A highlight of the tour was the taxonomic discussion and illustration of the new master V horizon by Dr. Robert Graham, UCR. The site shows how the V horizon developed from eolian deposits under a desert pavement surface. The vesicular pores and platy structure of the silt loam surface (V horizon) contrast strongly with the gravelly-sandy material below.

The final stop of the tour was at the eastern side of the Kelso Dunes, where Dr. Katherine Kendrick, USGS, explained desert dust and dune processes.

The tour brought together students, soil scientists, and soil taxonomists from China, Iraq, Syria, India, Europe, Canada, Australia, and Africa and throughout the United States. Those who attended came away with a clearer understanding of the importance of the V master horizon and dust in desert environments as well as an appreciation of NRCS's work in the region. They enjoyed spectacular weather, including some overnight rain and relatively light desert breezes. ■

Playa soil on Soda Dry Lake looking south from the Desert Studies Center, in Zzyzx, California. The soil is classified as coarse-loamy, mixed, superactive, hyperthermic Oxyaquic Udorthents.

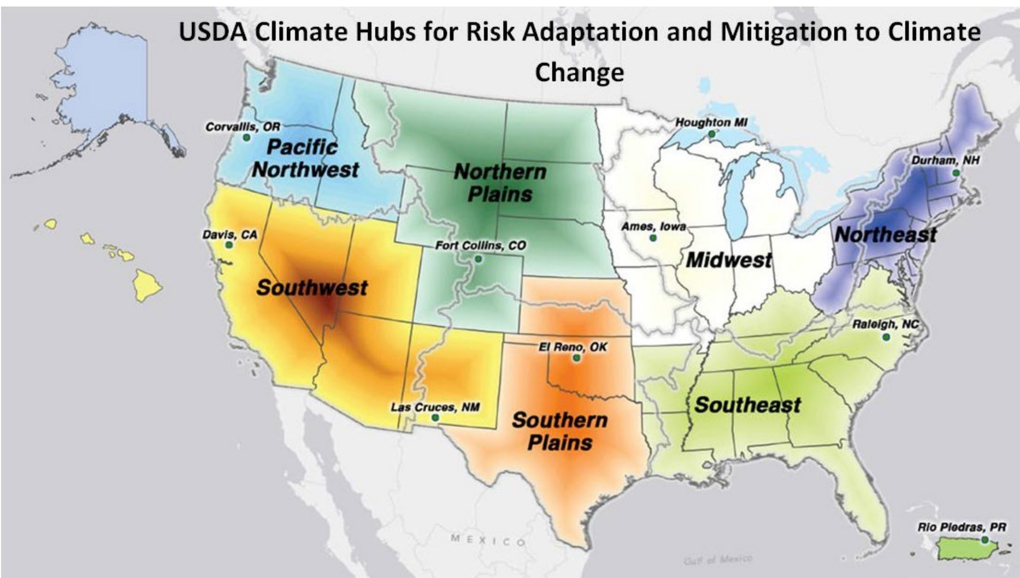
Desert pavement with a V horizon at Mojave National Preserve. The soil is classified as sandy-skeletal, mixed, thermic Typic Haplocalcids.

USDA Climate Hubs—Increasing Soil Resilience on Private Working Lands

By M.A. Wilson, NRCS National Leader for Climate Change, and D.W. Smith, Deputy Chief, Soil Science and Resource Assessment.

> *"The year 2014 was the warmest year across global land and ocean surfaces since records began in 1880. The annually-averaged temperature was 0.69 °C (1.24 °F) above the 20th century average of 13.9 °C (57.0 °F), easily breaking the previous records of 2005 and 2010 by 0.04 °C (0.07 °F). This also marks the 38th consecutive year (since 1977) that the yearly global temperature was above average. Including 2014, 9 of the 10 warmest years in the 135-year period of record have occurred in the 21st century. 1998 currently ranks as the fourth warmest year on record."*
>
> NOAA National Climatic Data Center

The network of USDA Climate Hubs was created in February 2014. It was aligned to represent major regions of the U.S. that have unique climatic conditions, cropping systems, and potential impacts from climate change. These hubs (http://climatehubs.oce.usda.gov/) were created to provide outreach, extension, and technical support to farmers, ranchers, forest landowners, and rural communities via tools, strategies, and science-based risk management options. The ultimate goals are to increase resiliency of the agricultural production system on private working lands and identify viable potential transformation strategies in light of climatic impacts.



The seven climate hub regions across the U.S., including the three subsidiary hubs located in Davis, California; Houghton, Michigan; and San Juan, Puerto Rico.

NRCS, ARS, and the Forest Service are the three primary partners leading the regional climate hubs, but all USDA agencies are involved in governance from a national level. Within each hub, creating partnerships has been a primary goal this initial year. Other cooperators invited by USDA agencies into the hub setup include land-grant universities, Cooperative Extension, NOAA, Department of the Interior, and NASA. NRCS conservationists, soil scientists, and ecologists are a vital part of the hub network for outreach and education to assist producers. A primary design concept in creating this network was to cooperate with, not compete with, other government agencies and public or private groups to assist producers in maximizing productivity and conserving natural resources in the most efficient and effective manner.

The involvement of NRCS within these USDA hubs will focus on our existing conservation programs and activities. Our agency has been working to build soil resiliency and protect natural resources since its inception in 1935. Our work in soil mapping, conservation planning, soil ecology, soil moisture monitoring, and soil health provides the framework for NRCS to assist farmers and ranchers through these hubs. The plan is to present existing conservation strategies to farmers and ranchers, but with a greater awareness of the impacts of climate. The concerns of climate scientists about the cause and future impacts of climate change and the need to focus on mitigation are not shared by all. Thus, the manner in which we present information has an important impact on the way the information is received. Therefore, hub discussions do not focus on climate change but rather on climate impacts (e.g., drought, weather extremes, and changing seasonal patterns) and how to assist farmers in maintaining a positive profit margin in these challenging economic times.

Soil health practices and carbon sequestration make up one emphasis area for the hubs. No-till, cover crops, crop rotations, green manures, and other carbon-building practices are central to increasing infiltration rates and the water-holding capacity of soils, decreasing erosivity, and improving the nutrient status and fertilizer efficiency of soils. These outcomes are key to building soil resiliency and protecting production systems from climatic impacts. In addition, the hub websites offer tools and information on such topics as seasonal weather trends, planting dates, soil property data (physical, chemical, hydrologic, and thermal), crop varieties, and carbon sequestration calculation. Not all tools and resources originate from USDA, but the hub websites function as clearinghouses for information and assistance.

Conservation programs funded through the 2014 Farm Bill cover a broad spectrum of farmland protection to assist producers, in part, in overcoming the impacts of climate change. Hub personnel can assist producers in understanding programs in their area and identifying specific needs. Environmental Quality Incentives, Conservation Stewardship, and Agricultural Management Assistance Programs all provide financial assistance for conservation activities. The Healthy Forest Reserve Program provides financial incentives for producers to protect forestland resources through easements, and the Agricultural Conservation Easement Program helps protect both working lands and wetlands.

The Conservation Innovation Grants Program is unique; it funds projects that develop and test innovative conservation approaches. Many of the grants awarded in 2014 focused on soil health and nutrient management. Some past award winners examined techniques to maximize nitrogen efficiency and reduce losses of gaseous N_2O (a potent greenhouse gas) as well as developed methods to track carbon sequestration on agricultural lands in the Prairie Pothole Region of North Dakota. Sequestration of carbon reverses gaseous CO_2 emissions into the atmosphere. The latter project has recently come to bear fruit: Chevrolet announced this past fall that it will buy carbon credits from producers. The agreement may signal a future trend in which farmers are paid to sequester carbon, a move that enhances soil resiliency and mitigates greenhouse gases.

In conclusion, the USDA Climate Hubs are celebrating their first anniversary. This first year has been spent organizing personnel, initiating programs, and building partnerships. NRCS employees play a key role in these hubs, doing what we do best—applying conservation practices on private working lands, building soil resilience, and enhancing the lives of farmers, ranchers, and forestland owners. ■

Effects of Climate Change on Surface Water Quality in the U.S. Great Plains

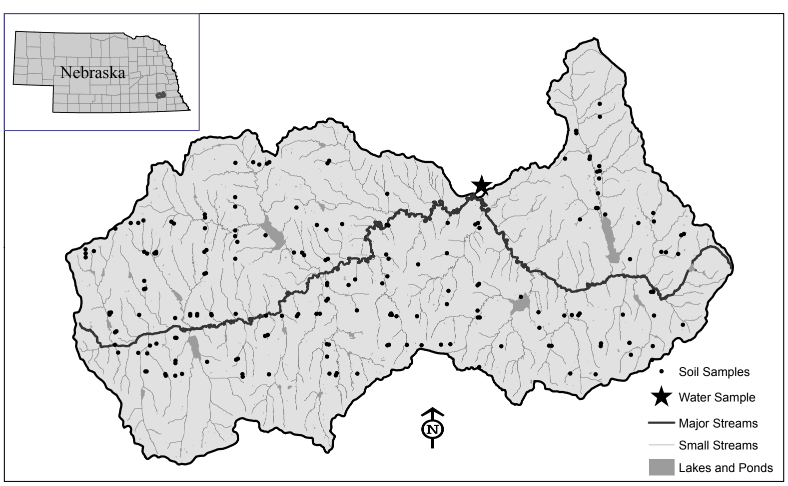
By Moustafa A. Elrashidi, Cathy A. Seybold, and Steve D. Peaslee, NSSC, Lincoln, Nebraska.

Declining surface water quality is of great concern across the Great Plains. Recent changes in the earth's climate can create abrupt changes in domestic weather that alter the impact of non-point sources on water quality. A 2-year study (1 dry year and 1 wet year) was conducted to assess the impact of annual precipitation and runoff on water quality. The study area was in the Roca watershed in southeastern Nebraska.

The content of both dissolved and sediment-bound forms of alkaline earth elements (AEEs) were determined weekly in runoff. The AEEs were calcium (Ca), magnesium (Mg), potassium (K), barium (Ba), and strontium (Sr). Dissolved forms accounted for most of the element contents in runoff. The average concentrations of dissolved Ca, Mg, K, Ba, and Sr in runoff during the dry year (104, 24, 7.6, 0.38, and 0.61 mg/L, respectively) were greater than during the wet year (65, 15.5, 7.2, 0.19, and 0.37 mg/L, respectively). In contrast, the annual element loadings in surface water were greater for the wet year. Calcium contributed to the greatest loadings (920 and 2,234 metric tons for the dry and wet years, respectively), while Ba had the least loadings (3.7 and 12.3 metric tons for the dry and wet years, respectively).

The vast majority of dissolved species of AEEs in runoff from soils in the Roca watershed were in these forms: Ca^{+2}, Mg^{+2}, K^{+}, Ba^{+2}, and Sr^{+2}. The concentration and species of dissolved AEEs measured in Salt Creek stream water are not expected to contribute to any problem related to human or animal health or aquatic life. However, the relatively high concentrations of Ca and Mg in water may be objectionable in drinking water because of unpleasant taste and greater costs associated with additional water treatment. Also, both Ca and Mg contribute to water hardness, which causes encrustation on utensils, pipes, and water heaters.

It was concluded that greater precipitation during the wet year increased the amount of runoff-AEEs discharged into Salt Creek, which may increase the negative impact on surface water quality. The study revealed the importance of AEEs for both environmental and agronomical issues. The environmental impact of AEEs on natural water resources is not fully understood. More work is needed to better understand the effects of abrupt changes in precipitation on removal of nutrients and other chemical components from soils by runoff and leaching. This information would help in determining which management practices could minimize the impact on water quality and improve soil health. ■



Location of sites for sampling water and soil in the study area.

A Short History of Wind Erosion in North Dakota

By D.W. Franzen, Professor of Soil Science, Extension Soil Specialist, North Dakota State University, Fargo.

The landscape of North Dakota before farming was dominated by prairie, with trees established only next to rivers and streams. The prairies thrived for thousands of years and consisted of grasses and forbs (broadleaf native plants). These plants gradually helped to deconstruct sediment minerals, releasing nutrients, including phosphorus, potassium, and zinc, and tending to conserve and recycle these nutrients close to the soil surface. The farmer-settlers who came to North Dakota found that the prairie was a very fertile land. These settlers came from many places in Europe and the eastern U.S. where a strong wind may have been only about 10 miles per hour. To farm in the late 1800s and early 1900s, one needed the new John Deere steel plow, sturdy draft animals, and a constitution for hard work. There was no one in North Dakota to counsel new farmers about the extreme weather conditions that one would face in the region. The indigenous peoples only farmed on the Missouri River flood plains, and there is little evidence that a plow was ever used to prepare the soil for crops. The nomadic peoples of the region considered the prairie sacred and abhorred the idea of scarring the land by turning it over with a plow.

North Dakota was plowed over from about 1885 to the mid-1920s (fig. 1). The only trees to break the wind were located right next to the few rivers and streams that crossed the State. Early yields of wheat from many fields were similar to wheat yields today. These high yields were supported by high native soil fertility.

Figure 1.—Red River Valley field ready for planting circa 1910–1915. There is not a tree anywhere. (State of North Dakota archived image.)

Starting in the late 1920s, the climate turned dry and the topsoil began to blow. Dust storms lasted for days. Dust was always in the air. People breathed it, animals breathed it. People became sick and came down with “dust pneumonia.” Uncounted numbers of people, particularly small children, died from the effects of breathing dust. The movement of soil across the plains was astounding (figs. 2 and 3).

USDA discovered that soils in the Great Plains were extremely erodible. A 1936 report from USDA estimated that nearly 10 million acres of land had been destroyed in terms of crop production due to wind erosion. Many growers today think that the result

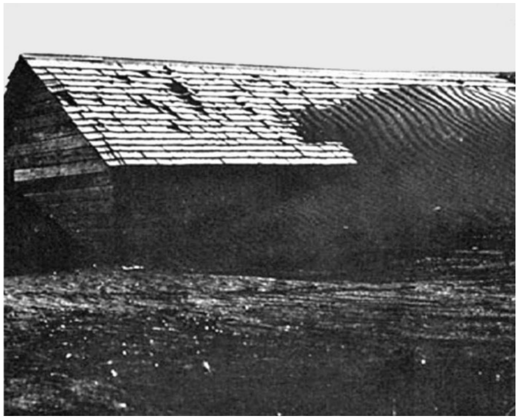


Figure 2.—Topsoil dunes over a barn in Kidder County, 1939. (State of North Dakota archives.)

of wind erosion is soil filling the field border ditches. However, reports from aviators mentioned significant dust at an elevation of 14,000 feet in a 1934 storm in North Dakota.

Today we can see the height of dust storms from space. During the Dust Bowl, scientists in eastern cities could scoop up dust blown in from the Great Plains. They found that the dust contained 19 times more phosphorus (P_2O_5), 10 times more organic matter, 9 times more nitrogen, and 45 times more potassium (K_2O) than the remaining topsoil from whence it came. A conservative estimate of soil lost from North Dakota during the 1930s is about 16 billion tons. This loss included about 8 million tons of phosphate (P), which is equivalent to 40 years of P application at present rates. Although dust storms are not as common now, periodic losses of soil continue to occur. According to NRCS soil-loss estimates since the 1940s (and supported by recent, paired-soil characterization studies that investigated soil pedon changes since the 1960s in North Dakota), the equivalent of another 30 years of P application has been lost since the Dust Bowl. Many growers are not aware of the slow devastation of soils due to continued tillage, which mixes some remaining black soil with the subsoil. The soil still looks “black.” Much greater effort is needed to stop this serious soil loss. Tree rows need to be replanted, and no-till and modified no-till need to be adopted. ■

Figure 3.—Fence built on top of a fence covered with soil, Emmons County, late 1930s. Note the man’s tie. (State of North Dakota archives.)

Dr. Arnold’s “The Soil Survey: Past, Present, and Future”

Dr. Richard Arnold was the Director of the Soil Survey Division from 1980 to 1996 and then served as a special advisor to the Deputy Chief until 2000. In 1999, he produced an over-arching document entitled “The Soil Survey: Past, Present, and Future.”

Although written over 15 years ago, the information in this document remains an excellent overview of the principles and history of soil science, pedology, and soil survey. It provides a unique understanding of the foundations of soil survey from one of the most insightful minds to ever work in soil science.

The document is especially noteworthy in celebration of the International Year of Soils. Everyone should take the opportunity to read and enjoy this astute and perceptive manuscript.

The full document is online at: Soil Survey: Past, Present, and Future. ■

The 6th Global Workshop on Digital Soil Mapping

The 6th Global Workshop on Digital Soil Mapping (DSM) was organized by The International Working Group on Digital Soil Mapping and State Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences. The workshop took place in Nanjing, China, from November 11–14, 2014. The major objectives of the workshop were to review and discuss the state-of-the-art in DSM and to explore strategies for bridging research, production, and environmental applications.

The major theme of the workshop was "Digital Soil Mapping Across Paradigms, Scales and Boundaries." Topics included (i) new paradigms and techniques for DSM, (ii) multiscale and spatiotemporal DSM models, (iii) DSM in 3D, (iv) remote sensing/proximal sensing for DSM, (v) digital soil assessment and applications, (vi) evaluation and integration of legacy soil data in DSM, and (vii) web-based digital soil mapping.

Participants from more than 20 countries shared their work on the latest DSM developments and approaches (fig. 1). The presentations were followed by questions and discussions on the merits and limitations of DSM and ways to overcome the challenges.

Figure 1.—Group photo of the DSM workshop participants.

Zamir Libohova, research soil scientist from the Soil Survey Research and Laboratory Branch at the National Soil Survey Center, participated in the workshop and presented his work on quantifying uncertainty in soil-property predictions for the GlobalSoilMap using legacy data. The presentation was co-authored by Nathan Odgers from the University of Sydney, Australia; Jenette Ashtekar and Phillip Owens from Purdue University; Jim Thomson from West Virginia University; and Jon Hempel from the National Soil Survey Center. The presentation focused on two case studies that highlighted challenges related to quantifying the uncertainty due to the inherent nature of legacy data coming from different sources and vintages (varying scales, formats, degree of completeness, differences in methods of observations, measurements, and classifications). The case studies, one from the U.S. and one from Llanos Orientales, South America, each presented unique challenges. For both studies, limited data and insufficient point observations prevent a meaningful statistical approach for the estimation of uncertainty.

For the U.S. study case, the available point measurements are not adequate for uncertainty quantification at soil map unit level and furthermore have been purposively collected to support the assignment of estimated mean, upper, and lower property values to soil map units. Comparisons of selected soil properties indicate no significant differences between estimated upper and lower limits from soil map units and measured values from pedons at ± 2σ (standard deviations).

Comparisons between estimated lower and upper limits (LL and UL) from SSURGO versus measured means ± 2σ (standard deviations) from pedons for selected soil properties.

Mean LL SSURGO vs. Pedon - 2σ

Soil Property	Adjusted R^2	RMSE
pH 1:1 H_2O	0.82	0.27
Sand (%)	0.99	0.60
Silt (%)	0.99	1.98
Clay (%)	0.82	5.20
CEC (cmolc/kg)	0.37	6.32
D_b (g cm^{-3})	0.04	0.08

Mean UL $_{SSURGO}$ vs. Pedon + 2σ

Soil Property	Adjusted R^2	RMSE
pH 1:1 H_2O	0.67	0.21
Sand (%)	0.95	7.80
Silt (%)	0.98	2.97
Clay (%)	0.96	2.20
CEC (cmolc/kg)	0.77	6.62
D_b (g cm^{-3})	0.58	0.06

The results suggest that the estimated upper and lower values from soil map units can be used for estimating the uncertainty, at least initially, until other independent, measured point data becomes available.

The available points in the Llanos Orientales case study were collected for soil fertility evaluations and were independent of soil polygon map units. Also, they were surficial samples, clustered, and biased toward cultivated fields. As a result, the range of the upper and lower 90% confidence interval was as wide as the range of the mean predicted soil properties.

The examples from both case studies highlight the need for more measured point data and flexible approaches when addressing uncertainty quantification. A versioning approach that would allow for the incorporation of more measured data as they become available needs to be implemented.

A field excursion took place on November 13 in Jiangdu District and Yangzhou City. The participants visited an experimental farm and were introduced to a climate change experiment that monitors the rice yield and organic matter response to elevated concentrations of atmospheric CO_2 (fig. 2).

Figure 2.—An experimental rice field where elevated concentrations of atmospheric CO_2 are applied and the rice yield and organic matter response are monitored.

One of the interesting observations at the experimental farm was the post-harvest treatment of rice, which needed to be dried before storage. Because of the relatively dry fall season, a common practice was to lay harvested, unshelled rice on residential streets (fig. 3). The rice was regularly driven over by small farming equipment and walked on by pedestrians without damage to the quality of the harvest.

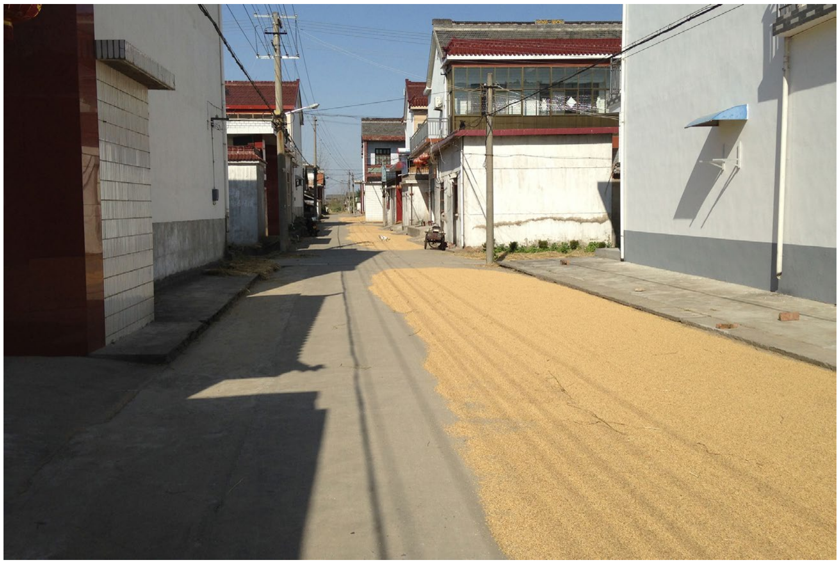


Figure 3.—Harvested, unshelled rice spread out on residential streets in the village at the experimental station.

During the field trip, the group also visited soil profiles that had been used for rice production in the Yangtze River Valley for thousands of years. The group discussed soil development and hydrology under heavily anthropogenic influences (fig. 4).

Figure 4.—Profile of a soil that has been used for rice production for thousands of years.

The DSM workshop participants visited the Soil Museum, where they were introduced to the major soils of China. The soil monoliths were displayed along with their landscapes, which allowed for an easy understanding of soil-landscapes models (fig. 5). ■

Figure 5.—Soil monoliths of the major soils in China.

Loess Where There "Isn't Any"—A Study of the Kalamazoo and Related Soils in Southwestern Michigan

By Randall J. Schaetzl (soils@msu.edu), Michael D. Luehmann, and Christopher B. Connallon, Department of Geography, Michigan State University, MI 48824-1117.

Summary

Ascertaining the parent material for a soil series is often problematic. For example, Kalamazoo and similar soils on the outwash plains of southwestern Michigan commonly have loamy upper profiles, despite being underlain by coarse, sandy outwash. As part of a graduate seminar at Michigan State University, we studied such soils to ascertain the origin of this upper, loamy material. The textural curves of this material are commonly bimodal, with distinct silt and sand peaks. The sand peaks in the upper, loamy material align with those in the outwash below. We concluded that the upper material was originally silty and the loamy textures formed by mixing with sand from below. Field data showed that the upper, loamy material is thickest just east of a large, broad, north-south-trending valley (the Niles-Thornapple Spillway) that

carried glacial meltwater between circa 17,300 and 16,800 calibrated years ago. The loamy sediment becomes thinner, better sorted, and finer in texture towards the east, away the channel. We concluded that the loamy material is a thin mantle of loess derived from the Spillway. Sand from the underlying outwash has been bioturbated up and into the loess, forming the loamy textures. Our study illustrates that a thin parent material in a two-storied soil can be identified using both textural and spatial data.

Background

Two major complications routinely arise when trying to identify soil parent materials: (1) identification of the genetic or sedimentologic origin of the material is not always straightforward, and (2) in two-storied soil, i.e., those composed of stacked parent materials with an intervening lithologic discontinuity, the uppermost parent material is commonly so thin that is has been variously mixed with the sediment below (Schaetzl and Luehmann, 2013). Both factors combine to render interpretation of the soil's genetic history difficult. Thus, the parent materials of many soil series are described with generic names, such as "sandy materials," "loamy materials," or "drift."

We present data on Kalamazoo (fine-loamy, mixed, semiactive, mesic Typic Hapludalfs) and similar soils, which are found extensively across southwestern Michigan, on outwash plains. Although the soils on some of these outwash surfaces are sandy throughout, most are increasingly loamy in the upper profile. Some even have silt loam textures in the upper profile. We analyzed the spatio-textural characteristics and distribution of these types of loamy-textured sediments and hypothesized that these soils have had past additions of loess.

Study Area

The terrain of southwestern Michigan is a mix of Late Wisconsin-aged moraines, till plains, meltwater channels, and outwash plains (Kehew et al., 2005; Schaetzl et al., 2013). Most of the study area was covered by the Saginaw lobe, which retreated from the region to the northeast, and the Lake Michigan lobe, which retreated to the west. Moraines associated with the Saginaw lobe are, from oldest to youngest: the Sturgis, Tekonsha, Kalamazoo, and Valparaiso-Charlotte (fig. 1). While ice stood at the Tekonsha margin, meltwater flowed southwesterly, forming the large outwash surface known as the Three Rivers Lowlands (Schaetzl et al., 2013) (fig. 2). These outwash plains form the core of the study area. They represent broad outwash surfaces covered mainly with Kalamazoo and related soils.

Later, ice retreated and stabilized at the Kalamazoo moraine (fig. 1). While the ice of the Lake Michigan and Saginaw lobes sat at the Kalamazoo moraine, meltwater continued to flow across the Three Rivers Lowlands. Subsequently, the ice withdrew from the Kalamazoo margin, perhaps stabilizing at the Valparaiso (Lake Michigan lobe)–Charlotte (Saginaw lobe) position (fig. 1). A new meltwater channel then formed between the retreating ice margin and the west-facing slope of the Kalamazoo moraine—the Niles-Thornapple Spillway (fig. 1). The Spillway is a north-south-trending channel, roughly 4 km wide, with local relief between 25 and 45 m, that drained southwardly into present-day Indiana (Schaetzl et al., 2013).

In the north, in Saginaw lobe terrain, meltwater was not confined by the large Kalamazoo moraine but instead flowed chaotically to the west and south. It flowed through a system of tunnel channels and into what would become the Kalamazoo and Thornapple River valleys, both of which then merged into the spillway (fig. 1). Saginaw-lobe tunnel channels are etched into the loamy, till plain sediments (fig. 1). The Niles-Thornapple Spillway eventually became the dominant drainageway for meltwater from both the Saginaw and Lake Michigan lobes.

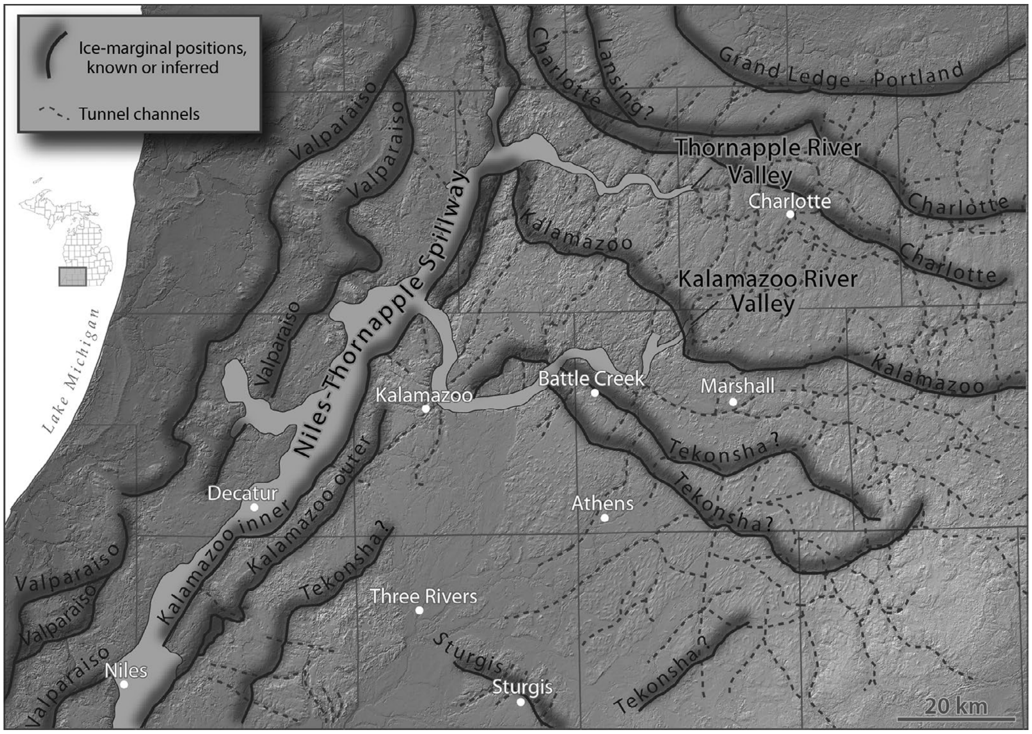


Figure 1.—The study area, showing general locations and names of the major ice margins as thick gray lines and the various tunnel channels formed during deglaciation as dashed lines.

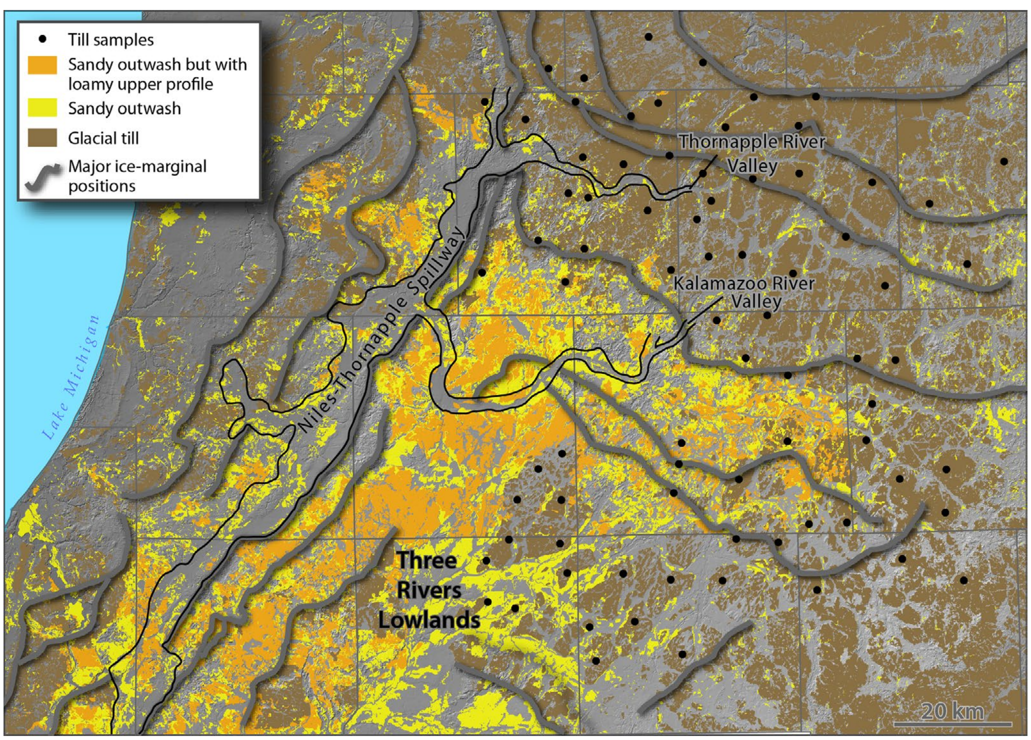


Figure 2.—Ice margins, landforms, and surficial sediments of the study area, interpreted from NRCS Soil Survey (SSURGO) data. Till sample sites are shown as black dots.

Our study focused on soils on broad, flat uplands formed in sandy outwash deposits. In addition to soils of the Kalamazoo series, such soils include the Schoolcraft (fine-loamy, mixed, superactive, mesic Typic Argiudolls), Dowagiac (fine-loamy, mixed, semiactive, mesic Mollic Hapludalfs), Ockley (fine-loamy, mixed, active, mesic Typic Hapludalfs), and Oshtemo (coarse-loamy, mixed, active, mesic Typic Hapludalfs) series (fig. 3). These soils are loamy in the upper part of the profile and sandy at depth. Even Oshtemo soils, the sandiest of the group, commonly are loamier near the surface than at depth. These types of textural

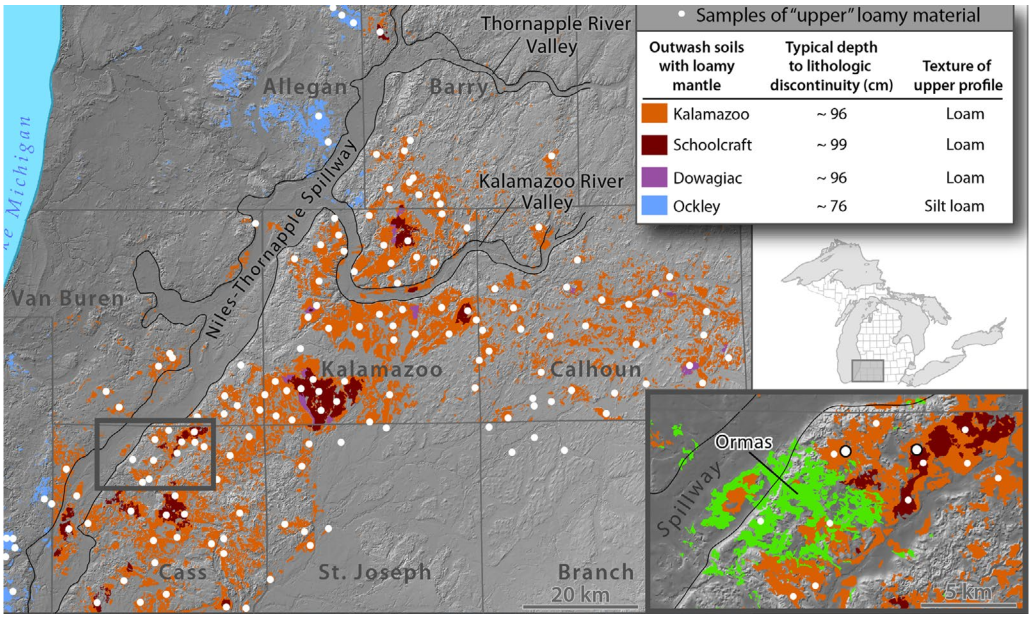


Figure 3.—The major soil series of outwash plains in the study area. Inset map shows the extent of Ormas soils.

depth trends suggest a secondary addition of fine sediment that originated at a distance from its present position and was deposited after the outwash surfaces stabilized.

Methods

Using a bucket auger, we sampled these types of soils at 164 sites (fig. 3). At 50 of those sites, a deep sample of the underlying outwash was also taken to allow for textural comparisons between the upper loamy material and the outwash. In addition, pits were excavated by backhoe in map units representative of Kalamazoo soil. We also sampled the calcareous till within the study area at 78 sites, using a bucket auger (fig. 2). All samples (upper loamy sediment, outwash, and till) were analyzed for texture by laser diffraction. A method developed by Luehmann et al. (2013) was used to "adjust," or filter, the data for the upper loamy samples. These data had a primary silt mode and a secondary sand-dominated mode. The filtering process removed the sand data, thereby recovering the textural data for the original sediment from the previously mixed sediment (fig. 4). We used simple Kriging to visualize and interpret our data.

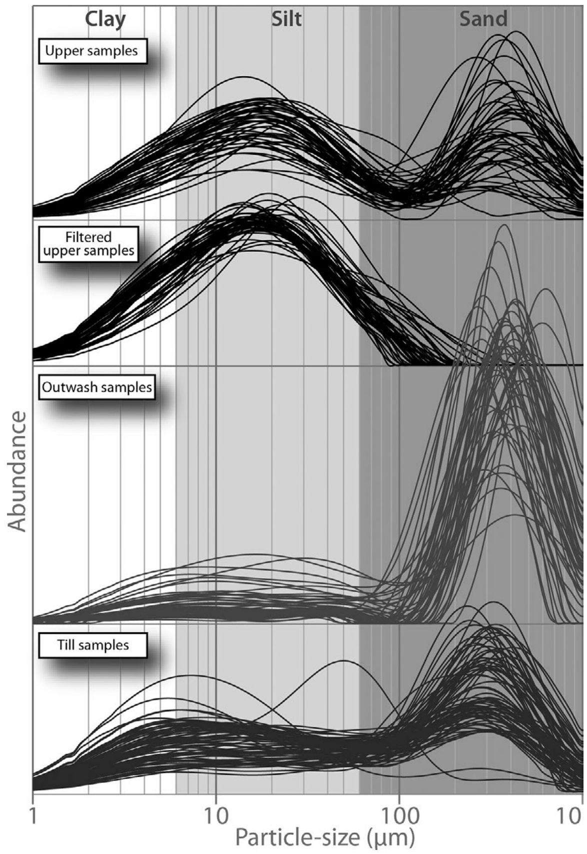


Figure 4.—Particle-size curves for the samples taken in this study. Data for the 164 upper, loamy samples are shown before and after the filtering process.

Results and Discussion

Origin of the Upper, Loamy Material

Textural and morphologic data from the soil pits were used to evaluate our hypothesis of additions of loess to the sandy outwash soils of southwestern Michigan. The two representative pits shown in figure 5 illustrate the loamy textures in near-surface horizons and the sandy textures below. Note how, in both pits, the sand peaks in the outwash continue up and into the loamy material. The peaks remain relatively unchanged in modal value as they progress upward, although their intensity declines toward the surface. In pit A, the sand peak declines so rapidly that it is barely visible in the upper 20 cm, where the horizons have silt loam textures. In the upper profile of pit B, the sand peak in the upper loamy material remains strong up to the surface, where soil texture is loam. These data indicate that mixing, probably via bioturbation, has been a prominent process in these soils, blurring the lithologic discontinuity between two parent materials and, as a result, clouding the historical interpretation of the upper, loamy material.

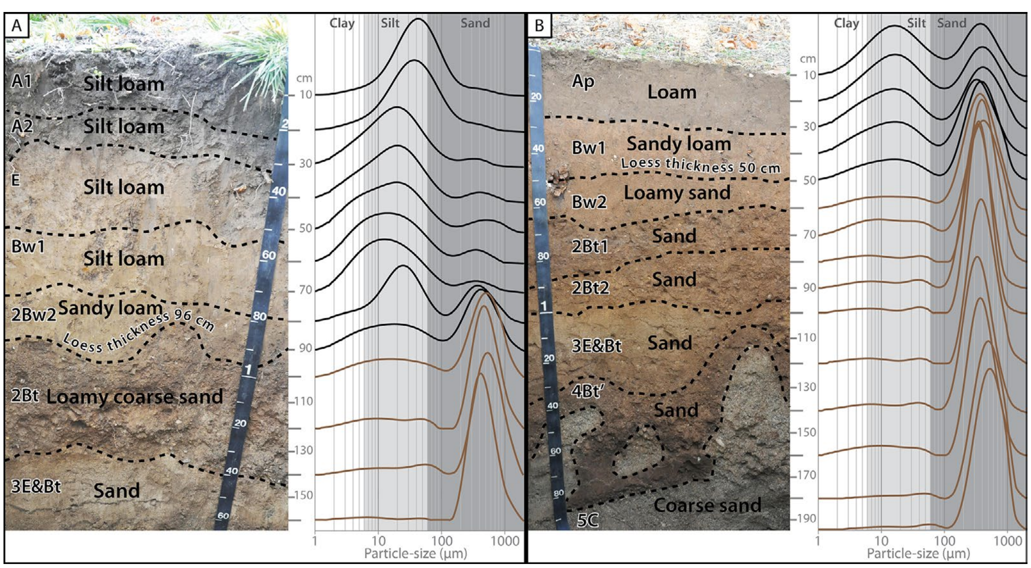


Figure 5.—Photos, textural curves, and horizonation for two representative Kalamazoo soils.

Most of the outwash samples had coarse sand or loamy coarse sand textures, whereas most of the upper, loamy material samples had silt loam or loam textures. The textural curves show that the latter samples have bimodal particle-size distributions, similar to those in the soil pits (figs. 4 and 5). These textural data strongly suggest that sandy sediment has been mixed up and into a silt-rich sediment of a different sedimentological origin. Bioturbation, especially by soil infauna such as worms and ants, is the most likely form of pedoturbation that could account for this type of mixing. In the deep, rich, loamy soils of these outwash plain landscapes, soil faunal populations would have been high and the well drained soils would have allowed deep burrowing. Based on our particle-size data, along with the spatial characteristics of those data (discussed below), we interpret the upper loamy material as loess. Depending on specific site characteristics, various amounts of outwash sediment from lower in the profile have been mixed into the originally silty loess.

Spatial Characteristics of Loess within the Study Area

The map of data for thickness of the loamy material (loess) illustrates that the material is thickest east of the center of the Niles-Thornapple Spillway and thins toward the eastern margins of the study area (fig. 6). Very few of the outwash soils west of the Spillway have such a loamy mantle. Together, these data suggest that the spillway was a loess source and that loess transport was from predominantly westerly winds.

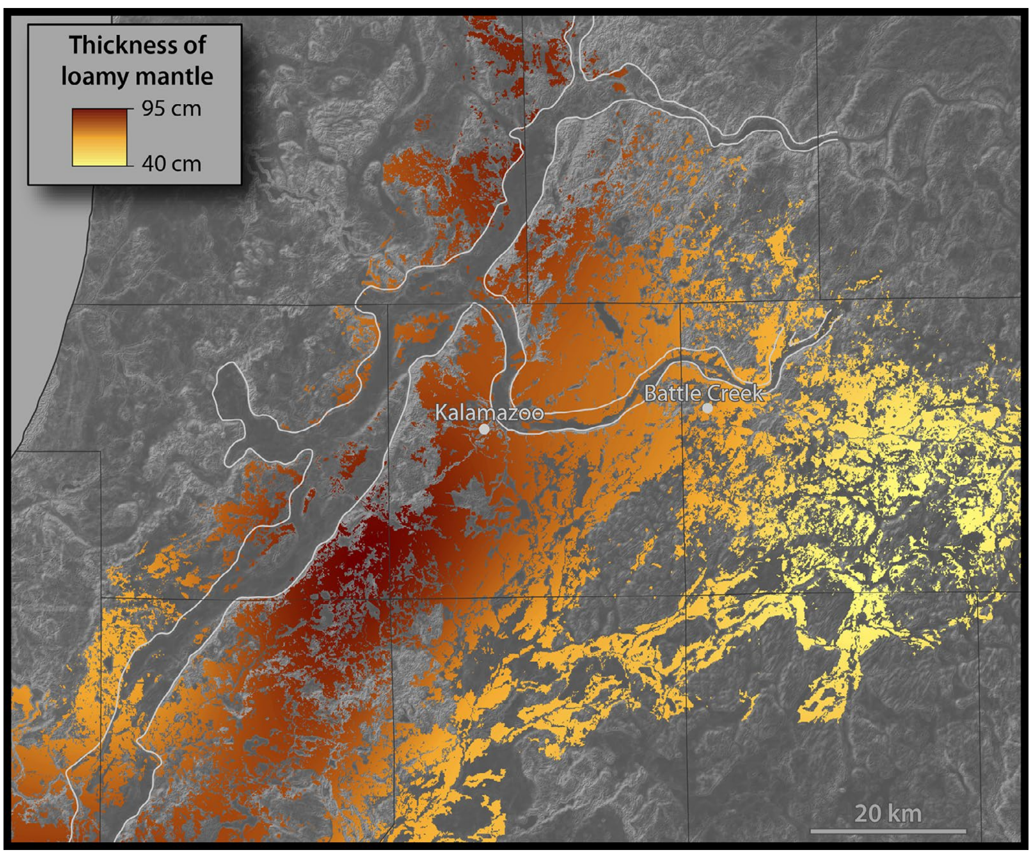


Figure 6.—Interpolated, Kriged map of the thickness of the upper sediment, which was interpreted as loess, across southwestern Michigan. Interpolated data are shown mainly in areas where one of the four target soils is mapped.

Spatial patterns of textural data (not shown) add additional support for the position that the Niles-Thornapple Spillway was the source for this loess. Near the Spillway, the loess is sandier and has lower silt/sand ratios. Mean weighted particle-size data also exhibit local highs near the Spillway and become progressively lower to the east. Lastly, we note that the loess closest to the Spillway is more poorly sorted.

On local uplands near and just east of the Spillway, Ormas soils (loamy, mixed, active, mesic Arenic Hapludalfs) are mapped (fig. 3). Ormas soils have loamy sand textures throughout their upper profile and are underlain by gravelly-sandy sediment. We interpret Ormas soils as a thick, coarse, poorly sorted end-member to the loess deposit that starts at the Spillway and extends more than 60 km to the east. Ormas map units near the Spillway merge into Kalamazoo map units farther east as the loamy sand sediment grades into siltier sediment and becomes better sorted.

Paleoenvironments of Loess Deposition

The Spillway was likely actively carrying meltwater from circa 17,300 calibrated years ago, when the ice first began to retreat from the Inner Kalamazoo margin, to circa 16,800 calibrated years ago, when the ice margin was at the Inner Valparaiso margin, i.e., for about 500 years. Retreat from the Inner Valparaiso margin would have allowed meltwater to follow other routes, leaving the Spillway dry. The two main meltwater tributaries at the upper end of the Spillway—the Kalamazoo and Thornapple Rivers—both have overwidened valleys and flow through them today as underfit streams. These valleys in turn connect upstream to an impressive network of tunnel channel valleys (fig. 1). These tunnel channels were eroding into Saginaw lobe till that was, according to our data (fig. 4), rich in silt. This implies that the meltwater would have also been silt-rich, enabling the Spillway to be a prodigious source of silt.

Conclusions

The loamy mantle on Kalamazoo and related soils has long been an enigma to local soil scientists. Was it till? Could it be a debris-flow deposit, or perhaps a fine facies member associated with the outwash system? Our work has shown that this mantle is simply loess that has been mixed with the outwash sands below. In fairness to those who came before us, loess in this region has been difficult to recognize because it is thin and therefore mixed with sediment from below. Our detailed textural analysis and spatial approach allowed us to confirm that the loamy sediment on these outwash plains is loess and that it has the clear spatial properties typical of silty eolian sediment. Thus, we provide the first documentation of loess in southwestern Michigan. Our work highlights the point that loess-enriched soils may not always be obvious and may be far more common than assumed.

References

Kehew, A.E., S.P. Beukema, B.C. Bird, and A.L. Kozlowski. 2005. Fast flow of the Lake Michigan lobe: Evidence from sediment-landform assemblages in southwestern Michigan, USA. Quat. Sci. Revs. 24:2335–2353.

Luehmann, M.D., R.J. Schaetzl, B.A. Miller, and M. Bigsby. 2013. Thin, pedoturbated and locally sourced loess in the western Upper Peninsula of Michigan. Aeolian Res. 8:85–100.

Schaetzl, R.J., and M.D. Luehmann. 2013. Coarse-textured basal zones in thin loess deposits: Products of sediment mixing and/or paleoenvironmental change? Geoderma 192:277–285.

Schaetzl, R.J., H. Enander, M.D. Luehmann, D.P. Lusch, C. Fish, M. Bigsby, M. Steigmeyer, J. Guasco, C. Forgacs, and A. Pollyea. 2013. Mapping the physiography of Michigan using GIS. Phys. Geog. 34:1–38. ■

Workshop on Ecological Sites for Conservation Planning and Land Management in Missouri

NRCS retirees Doug Wallace and Fred Young, along with colleagues from the Missouri Department of Conservation (MDC) and the Missouri Department of Natural Resources (DNR), conducted a workshop titled “Ecological Sites for Conservation Planning and Land Management in Missouri.” The workshop was part of this year’s Missouri Natural Resources Conference, which is held every winter in Osage Beach, Missouri. Wallace and Young, working as ACES contractors, along with cooperators in MDC and DNR, have developed draft provisional Ecological Site Descriptions (ESDs) for all of Missouri. The workshop was designed to acquaint Missouri natural resource professionals and students with the practical applications of ESDs in Missouri.

Moderated by Fred Young (soil scientist), the workshop opened with a series of five presentations:

- “Missouri Ecological Classification System” by Alicia Struckhoff (MDC), Ecological Classification System Program Coordinator;
- “The Missouri ESD Project: An Overview of Five Ecological Sites” by Tim Nigh (MDC, retired), terrestrial ecologist;
- “Ecological Site Descriptions: A New Tool for Conservation Planning and Program Support” by Doug Wallace, forester;
- “Managing Conservation Areas Using Ecological Sites” by Jason Villwock (MDC), resource forester; and
- “Natural Areas and Ecological Sites” by Mike Leahy (MDC), Natural Areas Coordinator.

The second part of the workshop was a field trip to nearby Lake of the Ozarks State Park, where Tim Nigh and Dennis Meinert (DNR soil scientist) led participants through a sequence of ecological sites, namely:

- Shallow Dolomite Upland Glade/Woodland,
- Chert Dolomite Exposed Backslope Woodland,
- Chert Protected Backslope Forest, and
- Low-base Chert Upland Woodland.

At each site, participants examined the state-and-transition model and discussed management options appropriate for the site. Over 85 people attended the presentations, and 30 people went on the field trip. ■

Dennis Meinert and Tim Nigh discuss the Shallow Dolomite Upland Glade/Woodland ecological site.

A New Way to Access and View Soil Survey Lab Data

By Jason Nemecek, Wisconsin State Soil Scientist, Madison, and Dylan Beaudette, Digital Soil Mapping Specialist, NRCS, Davis, California.

There is now a website where users can readily access and view soil characterization data from the National Cooperative Soil Survey Soil Characterization Database. Several applications are available. All are based on snapshots of the KSSL database, and some include "live" links to NASIS. The following site provides a spatial interface to KSSL pedons using an application built with Java Script and Leaflet:

http://soilmap2-1.lawr.ucdavis.edu/dylan/leaflet/LEAFLET_KSSL_02092014/

Users can zoom to their area of interest using the +\- tool, double-clicking with the left mouse button, or using the scroll wheel. Each increasing zoom reveals more pedon locations (fig. 1).

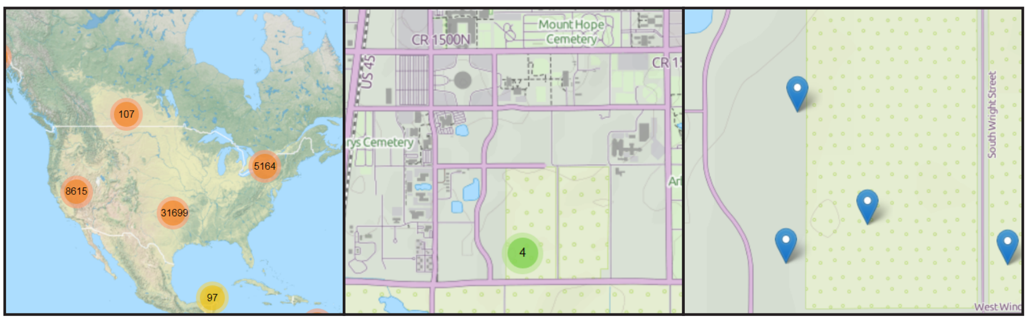


Figure 1.—Screenshots of the GIS interface for "NCSS Soil Characterization Point Data Cluster Map with Generated Profile." From left to right, the three images display the effects of increasing zoom to reveal specific pedons.

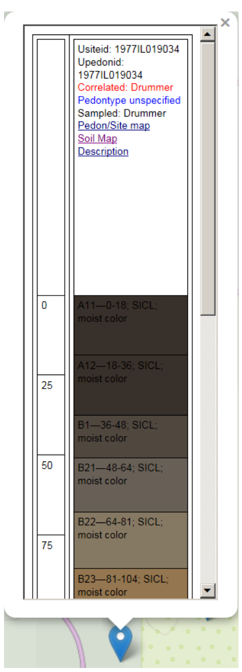


Figure 2.—The results of clicking on a pedon marker.

Clicking on a site location opens a pop-up window showing site and pedon IDs, taxon names, and a visual summary of horizon depths, colors, and textures (fig. 2).

A more detailed, graphic summary of 21 physical and chemical soil properties that are correlated to any given soil series within the KSSL database can be accessed by adding the series name to the end of the following URL:

http://casoilresource.lawr.ucdavis.edu/soil_web/R/lab_summary.php?series=

For example, the URL for the properties of the Coolville series is the following:

http://casoilresource.lawr.ucdavis.edu/soil_web/R/lab_summary.php?series=coolville

In figure 3, the median is represented by the solid line and the shaded portion represents the 5th and 95th percentiles. These summaries are generated by computing percentiles across the collection of pedons (correlated to "Coolville") along a series of 1-cm-thick slices. The numbers along the right side of each panel represent the percentage of pedons within the collection that contributed to the summary. The summaries are typically in sync with the most recent release of KSSL snapshots (http://ncsslabdatamart.sc.egov.usda.gov/).

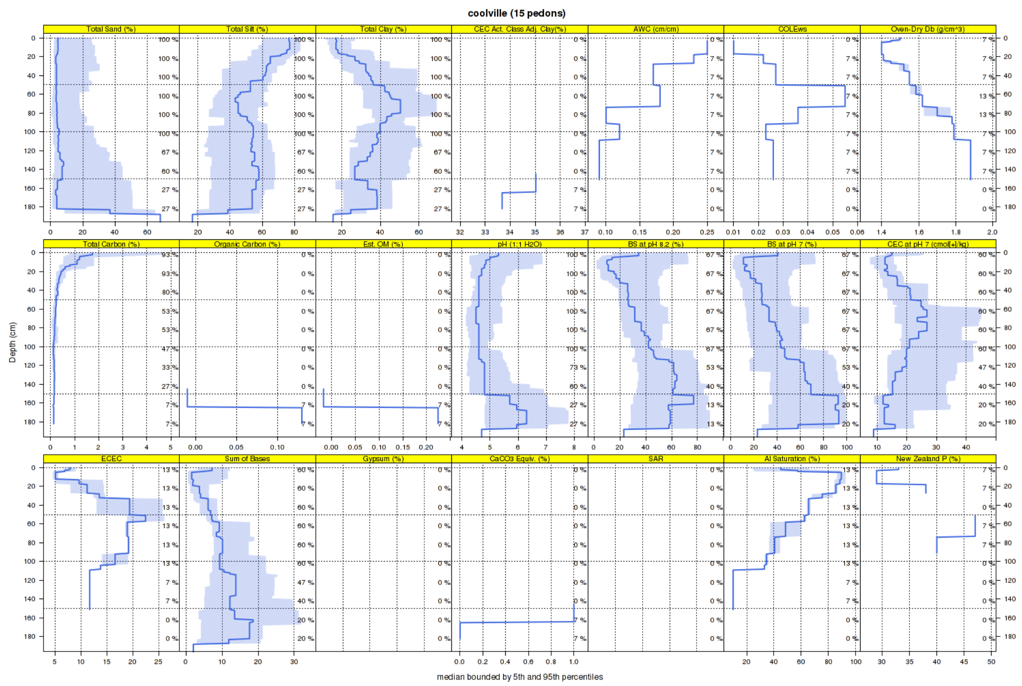


Figure 3.—Screenshot displaying a graphic summary of 21 physical and chemical soil properties for the Coolville series.

Aggregated lab data, graphic summaries of related soil series, links to block diagrams, and a summary of map units that include a given soil series can be accessed by adding the series name to the end of the following URL:

http://casoilresource.lawr.ucdavis.edu/soil_web/R/series_summary.php?series=

For example, the URL for information related to the Coolville series is:

http://casoilresource.lawr.ucdavis.edu/soil_web/R/series_summary.php?series=coolville

Note that the data on this page are hosted by SoilWeb. These data are synchronized every fiscal year with the official SSURGO data. It is recommended that you check the data against the official data from WSS.

Component association diagrams (figs. 4 and 5) are based on those components that occur within map units containing the Coolville series as a major component. Component association is a function of how frequently components co-occur, weighted by component percentage. This summary should generate structures that are related to soil-landscape concepts that were used to construct map units containing the Coolville series. Both views (network and dendrogram) are approximations of the multi-dimensional relationship between components. Note that these diagrams give only partial information on the

Figure 4.—Network representation of component association for the Coolville series.

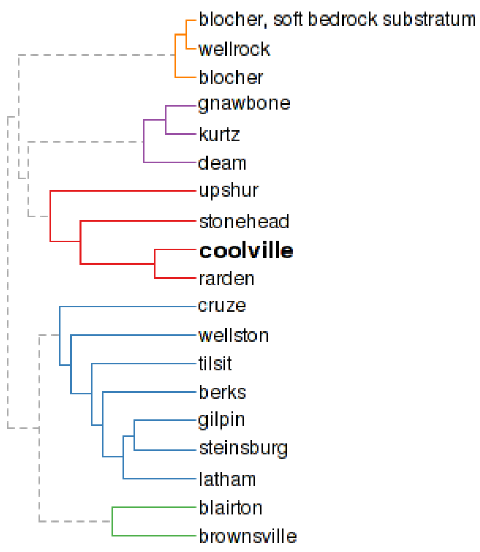


Figure 5.—Dendrogram representation of component association for the Coolville series.

relationships between components other than Coolville.

In figure 4, each circle (vertex) is a component, lines (edges) connect components that have been mapped together, colors define groups of components that frequently co-occur, and vertex proximity is proportional to co-occurrence as weighted by component percentage. Dark lines connect vertices to the queried soil series, and gray lines connect other vertices.

In figure 5, branch height (relative to the left side of the figure) is proportional to co-occurrence as weighted by component percentage. Clusters of components are highlighted.

In figure 6, profile sketches of soils that occur in map units containing the Coolville series are arranged according to their subgroup-level taxonomic structure. The information used to generate the sketches is from parsed Official Series Descriptions and a snapshot of the Soil Series Classification Database.

A complete list of related applications provided by SoilWeb can be found at: http://casoilresource.lawr.ucdavis.edu/soilweb-apps. ■

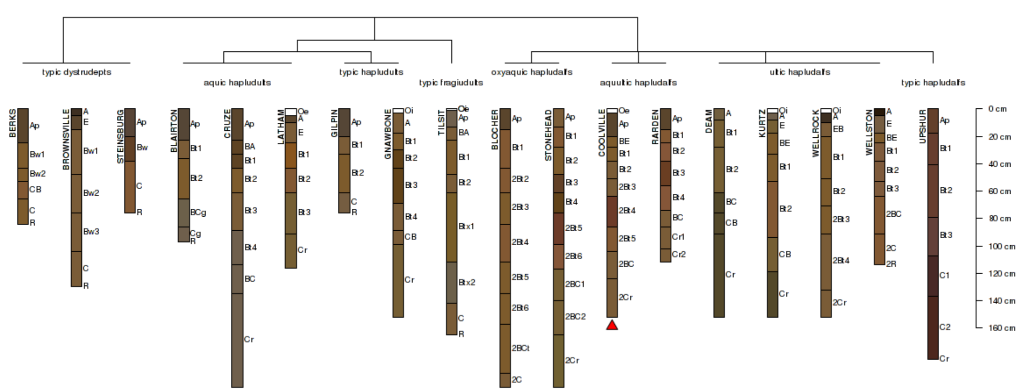


Figure 6.—Profile sketches of soils that occur in map units containing the Coolville series.

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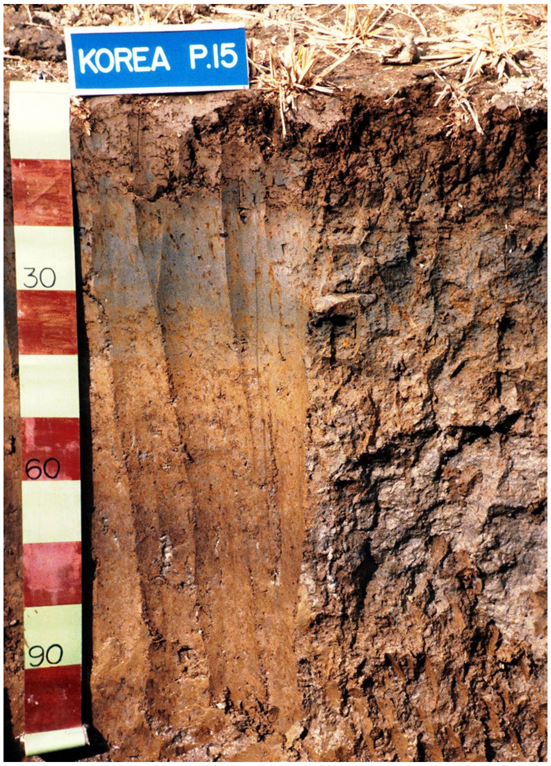
Soil Survey on the NRCS Photo Gallery

The Soil Science Division has been actively adding to the NRCS Photo Gallery. Among the recently added photos are many soil survey profiles from historical archives at the National Soil Survey Center. These photos have been collected by scientists traveling both nationally and around the world over many decades. This collection will be continually expanded as more archived photos and information about them becomes available. The photo gallery is an excellent resource for developing presentations about the diversity of soils from around the world. It may be particularly helpful for those who are developing talks related to the International Year of Soils celebration.

The advanced search function of the gallery allows for searches of both captions and keywords. Many terms related to Soil Taxonomy, such as ochric, redoximorphic, and Vertisol, are available as keywords.

The soil survey gallery is at http://photogallery.nrcs.usda.gov/ ■



A soil used for paddy rice production in Korea. The surface is manipulated and puddled with irrigation water so that it remains flooded while the crop matures. The gray colors above 30 cm are caused by the human-induced wet soil conditions resulting in the chemical reduction of iron in the upper part of the soil. The left side of the profile has been smoothed. The right side retains the natural soil structure. Scale is in cm. (Classification: Epiaquepts)