National Cooperative Soil Survey

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# NCSS Newsletter

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**Editor's Note**

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## Soil Interpretations: Looking Forward Over Our Shoulder

By Karl W. Hipple, National Leader, Soil Survey Interpretations, National Soil Survey Center, Lincoln, Nebraska.

Soil interpretations are obviously not new. In reality they are probably as old as the first intelligent life on the planet. Most certainly, members of ancient societies knew some things about soil because it produced some of their food. At least in some cases it provided the raw materials for building their homes, and it was also the foundation for much of their existence. They ate plants that grew in soil, they used plants for fuel for fire, and they used wood for weapons and hunting tools. These early people knew that some soils made better bricks than other soils. The Egyptians did not build the pyramids in a swamp for obvious reasons, and they also knew that some areas were more fertile than others. They diverted water from the Nile River to supply water to drier areas in order to produce crops. These very early soil interpretations arose from the need of ancient cultures to manage land resources, produce food, and build and support structures.

Soil survey programs in countries other than the U.S. have flourished and then vanished because after the soil mapping was completed, soil interpretations and other useful products were not built to provide utility to the soil maps. They simply remained soil maps! The National Cooperative Soil Survey (NCSS) program over its history has demonstrated a usefulness and responsiveness for its soil maps to a

variety of customers. Therefore, it is still funded and thriving today. In the earliest days, the efforts of the soil survey program focussed primarily on agricultural uses and predictions. During the first few years of the soil survey program, each soil survey stood on its own. There was no soil correlation across survey boundaries. Each soil survey contained different amounts of soil interpretations. Most interpretations were related to the kinds of crops produced and relative yields by crop. Soil surveys often provided information on soil erosion by wind and water and the need for drainage.

In the 1950s, when the Bureau of Chemistry and Soils and the Soil Survey of the Soil Conservation Service were combined, the NCSS program began to produce interpretations for rangeland and forestland as well as a few other nonagronomic interpretations. In fact, in 1953, Dr. Charles Kellogg created a job titled “Soil Correlator for Interpretation” in each principal Correlator’s Office (NCSS Newsletter, Issue 7, 1999). During the 1960s and 1970s, the NCSS added urban interpretations to its suite of soil survey products. Also at that time, Dr. Kellogg promoted single soil property interpretation maps. He thought that these were the most useful and beneficial form for urban interpretations. Soil interpretations remained fairly static until the 1990s, when military interpretations were added to the products offered by the NCSS to nontraditional customers. Today, the NCSS still packages interpretations and soil maps together (soil survey manuscripts and Web Soil Survey) based on public demand. However, the hard copy, bound soil survey’s days are numbered. NRCS Field Offices already use electronic soil maps for resource planning. Web-delivered soil survey products will soon be the common products delivered to both internal and external customers.

Historically, several kinds of soil interpretations have been used by the NCSS. Interpretative groups, such as prime farmland, hydric soils, land capability classes, ecological sites, and highly erodible soils, have been developed for many different uses and agricultural programs. Soil potentials, suitabilities, and limitations are also different kinds of soil interpretations that have been made and used by the NCSS. In the 1990s, fuzzy logic was introduced into soil interpretations to make interpretative ratings more precise and useful to customers. A limited number of soil interpretations still use crisp class limits for rating soil components. It is imperative to point out that the major reason that NCSS interpretations are sought after and widely used is because they are based on quality scientific data collected during field mapping. This brings to mind a statement that Dr. Kellogg made at the West Regional Technical Soil Survey Work Planning Conference in Seattle, Washington, in 1964. It measures the NCSS success, and it still applies today. He said, “Without well prepared, timely, and quality data for interpretations, the soil survey report becomes merely a pooling of ignorance” (Report of Conference Proceedings, Western Regional Technical Soil Survey Work Planning Conference, Seattle, Washington, January 28-31, 1964). Quality data created by standard protocols are the basic components of NCSS soil interpretations.

Soil interpretations changed little over the past 30 or 40 years until the National Soil Information System (NASIS) was developed and deployed as the dominant soil survey database for the NCSS. Aside from the incorporation of fuzzy logic, the original standard interpretations remain much as they were when originally developed. Soil interpretive criteria remain very similar to the original criteria used for initial soil interpretation development. Data are more accessible by more customers and users now that they are stored electronically in NASIS. Data population efforts, however, still seem to be secondary to producing either initial or second-generation soil survey maps. More of the standard interpretations are now adjusted to fit regions or States, and some additional data are used as criteria within these interpretations.

Markedly missing from current NCSS soil interpretations is a spatial component to accompany the map unit soil data. Point data are still aggregated and used for map unit interpretations, but spatial relationships between and among map units and other data are needed to make soil interpretations. The lack of inclusion of spatial attributes in interpretations is an immediate challenge for the NCSS to meet and solve. Customers now routinely use Geographic Information Systems (GIS) to display soil information, so the stage is set to add spatial utility to interpretations.

In my opinion, several other interpretation issues must be addressed in order to expand and improve soil interpretations, to satisfy existing customers, and to recruit new customers. Needed enhancements for soil interpretations include: a) consistent metadata to accompany soil interpretations that permits users to know who developed the interpretation, if the interpretation has been tested, validated, and certified, how widely the interpretation can be used, and what science was used to develop the interpretation; b) new methods, in addition to the standard flat tables, to display interpretations; c) spatially enhanced interpretations; and d) interpretations that use dynamic soil property data as criteria. The dynamic soil properties arena has widespread potential for designing and applying land management systems and for agricultural program development, cost estimates, and alternative selection.

New information requirements relate to long-term impacts of management on soil and land resources. Decision makers need information about how soils change. Interpretations are needed that compare land management alternatives so that managers can make decisions that balance long- and short-range productivity and environmental considerations. Soil function interpretations are needed to assist managers define potential soil capacity, determine what the capacity should be for desired uses, and decide if it can be maintained, improved, or restored. These interpretations can provide soil survey users information that can help present management to achieve future results. As management costs increase, investing wisely today may prevent the need for extremely large future investments to repair significant damage to the soil resource.

Soil interpretation is basically the translation of scientific and technical data for use by others (such as soil scientists, engineers, foresters, planners, and laymen). The purpose of soil interpretations is to make predictions about soil behavior that will allow decision makers to compare alternatives and make informed decisions. A considerable body of knowledge and high-quality data standards and new technologies are required to meet future demands for soil interpretations. Soil scientists cannot accomplish this task alone. Specialists/scientists from other disciplines must be integral players as we move forward. Cooperation will enure that we no longer focus on soil as a discrete entity, but rather as a part of biological, hydrological, and human systems. An opportunity to gather information for new interpretations exists in integrated benchmark soil studies. Knowledge of how soil functions in landscapes within an ecosystem can be can be obtained through these studies and can be used to develop and test new interpretations.

The soil survey program has come a long way, and it still has a long way to go. New areas are opening routinely that require standard and new soil interpretations. Subaqueous soil mapping will require a suite of soil interpretations to assist users in applying this information. New landscape analysis models require accompanying soil interpretations to make them useful and worthwhile. This is an exciting time for soil scientists within the NCSS. More and more, new nontraditional customers are asking for an ever-increasing array of nontraditional soil interpretations. The soil investigations and soil interpretations staffs at NSSC are joining ranks to move ahead and create the next generation of soil interpretations. The Soil Survey Division is expanding the role of marketing within the soil survey program. Field soil scientists and our research partners have a huge role to play in soil interpretations and a large stake in the marketing process as well. Let’s step up and get to work! ■

## Soil Survey Operations Using Satellite Imagery

By Robert Wilson, Resource Soil Scientist, Natural Resources Conservation Service, Chandler, Arizona.

The NRCS in Arizona has completed an Order 4 soil mapping project on 1,000,000 acres of withdrawn public land in southern Arizona. The project area is the Barry Goldwater Bombing Range (BGBR) managed by the 56th Fighter Range Management Office, Luke AFB, located near Phoenix. F16’s from Luke, A-10’s from Davis-Monthan, Tucson, Arizona, and Apache helicopters from Marana, Arizona, train on the site. Over 95 percent of the fighter pilots in the Gulf War and the Global War on Terrorism trained at BGBR. Pilots from Germany, Saudi Arabia, and many other nations rotate their fighter pilots through the training facilities.

The NRCS mapping project began in August 2001. After the attack on the WTC in September of that year, the Air Force redirected funding from the Order 3 project after about 35,000 acres was mapped.

The project resumed in February 2004, and fieldwork was completed in early November of the same year. Time in the field was controlled by range maintenance schedules, which closed certain ranges to flight operations for up to 3 weeks at a time so ground crews could repair and replace targets and Air Force Explosive Ordinance Demolition (EOD) teams could locate and destroy unexploded ordinance. BGBR is divided into three large tactical areas—north, east, and south. Within each tactical area there are several different independent ranges that offer target acquisition scenarios,

**Don Breckenfeld discusses a landscape concept with Phil Camp, State Soil Scientist, and Eric Wolfbrandt, GIS Specialist.**

including tanks and truck convoys, airfields, ground-to-air missile sites, and radar instillations complete with weapons jamming capabilities.

Don Breckenfeld, NRCS MLRA Soil Survey Leader, Eric Wolfbrandt, NRCS GIS Specialist, and Rob Wilson, NRCS Resource Soil Scientist, developed and implemented pre-mapping techniques using rectified Landsat 7 multispectral imagery at 30 meter resolution. We evaluated several different color band combinations of the visible, infrared, and near infrared part of the spectrum using Leica Geosystem's ERDAS software. By selecting different ratios within this spectrum, we were able to accentuate soil and landscape properties. We then compared different scenes, made some basic interpretations, and selected typical areas for ground truthing. The color band combinations of (5, 4, 2) (5, 4, 1) and band ratios of (5/7) (5/4) and (3/1) provided the most accurate and functional data sets for the project. Field mapping was done on a single sheet 36 inches long by 24 inches wide at a scale of 1:125,000. USGS Topographic sheets at 3 meter contour interval, Digital Elevation Models (DEMs) at 10 meter resolution, and a limited number of black and white aerials at 1:7,920 were used in conjunction with the Landsat imagery.

The vast majority of the BGBR range is in the hyperthermic soil temperature regime, with just a few hundred acres of thermic joining along the Tohono O'odahm Nation to the southeast. BGBR is in a typic-aridic soil moisture regime but has three different precipitation zones. The basin floor has zones receiving 2-4 inches and 4-6 inches, and the higher elevations receive 10-12 inches.

As field investigation progressed, we were able to recognize the geomorphic units of the large basin and range and apply them to the pattern of the Landsat imagery. We identified three ages of the slightly stepped basin floor.

The most interesting feature of the upper member is the saline, somewhat excessively drained Growler series. This series is coarse-loamy, and 95 percent of its surface is covered with varnished desert pavement that fits together so tightly that it resembles a blacktop parking lot. The illusion is reinforced by the fact that very little vegetation grows in areas of this series, leaving most people with the initial impression that the surface is a manmade feature.

The middle member is dominated by soils that are sandy throughout their depth or are sandy over sandy clay loam. These areas support a wide variety of annual forbs and grasses and cacti.

The lower member of the system consists of a playa unit. This landscape is the most variable and diverse in the basin. The very lowest portion of the landscape consists of clayey and silty alluvial soils. The wind has reworked the clayey and silty surfaces into a belt of low parna dunes adjacent to the lowest part of the unit.

We also identified and were able to accurately predict the four basic rock types that make up the mountains surrounding and within the basin. These are basalt, andesite, gneiss, and schist.

Initial fieldwork was very time and labor intensive. Several transects were completed for each map unit. Each transect had a minimum of 10 points; most had 15 or more. Each component of the map unit was carefully identified, and correct proportions of each component in the map unit noted. As notes were compared and transect data sheets reviewed, the map unit concept began to evolve. Once this base data set was developed, mapping

Desert pavement

proceeded at a much faster rate. Don pointed out that the design of the map unit was critical to meeting time and acre goals. Just like on any soil survey, slow, meticulous work in the beginning pays huge dividends later.

The team identified a large playa system that may have one of two possible origins. The system may have been the course of the Gila River during the Pleistocene. The dimensions of the channel adjusted during different times partly because of reduced waterflow after the Pleistocene. As the river began to drop more of its sediment load in the channel, trees and other vegetation began to further restrict flow. During ice-off, the water volume increased and this portion of the river restricted flow to the point that the river began to adjust its course about 2 miles north to its present location. Photo analysis reveals a chain of smaller playas that appear to define the old course of the river.

Another observation is that the Gila River appears to have emptied into the paleo Gulf of California. This sea caused a small delta to form where the playa is now. That marshy delta area evolved into the playa system. An extensive area of sand dunes west of the Mohawk Mountains adjacent to BGBR and the saline-sodic soils near the playa are lines of evidence supporting this point of view.

Soils in the lower portion of the playa consist of fine-silty, calcareous Typic Torrifluvents. These soils occur on slopes of 0 to 0.5 percent. Associated with these soils are coarse-loamy Typic Haplocambids on slopes of 0 to 2 percent. The team did not observe any integrated drainages. The basin essentially traps all the water that enters the watershed. There was evidence of prehistoric human activity adjacent to the playa when it offered good water, hunting, and fishing. It was a strange feeling to see, interspersed within these areas, .50 caliber bullets and brass casings with WWII dates stamped on them and 20-mm cannon shells from modern aircraft.

Near the western side of the range there is a large area of saline-sodic soils. Several large areas are crusted with salts and support a very sparse vegetative cover of wolfberry, desert saltbush, and seepweed. These soils had Ece of >40 dS/m, SAR >100, and a pH of 9.0. Even in the heat of the summer, the soils are moist and spongy. Adjacent to and northeast of this site is

An area of saline-sodic soils.

**Don Breckenfeld makes adjustment to the soil map as Rob Wilson observes.**

an extensive belt of sand dunes. The town of Dateland is built on this dune system. The active dunes were mapped as the Rositas series (mixed Typic Torripsamments with dS/m of >10). The stabilized dunes were mapped as the Superstition series (sandy Typic Haplocalcids).

Only a fraction of the bombing range is actively used by the Air Force. The vast majority is used as air space for dogfighting and practicing evasive action and as stand-off areas behind the active target ranges. Most of these tactical ranges have been closed to the public since 1942, and the mapping project provided the opportunity to go back into some of these very remote areas and observe soil, water, landscape, and plant relationships in a virtually undisturbed condition. Dan Robinett, Rangeland Management Specialist, accompanied the team to the field several times in order to ensure that the ecological site descriptions matched the map unit design. While in the field, he was able to make some seed collections of native grasses, which were very robust because of the lack of domestic grazing on the bombing range.

After the field mapping was completed, Eric performed the digitation. He utilized a “heads-up” digitizing process using ESRI’s ArcView GIS software with stream mode digitizing extension. The control base was 1-meter resolution digital orthorectified imagery (original USGS DOQs processed by the NRCS into Mr. SID digital mosaics). After the line work was placed, ESRI’s ArcGIS software was used to run error checks on the spatial data and to create the accompanying metadata.

Phil Camp, State Soil Scientist for Arizona, is enthusiastic about the procedures developed during this project, which resulted in a very high quality and usable product. He is confident that this project showcases a cost-effective approach to completing the initial soil survey of low rainfall areas where military training or ephemeral grazing is the dominant land use. ■

## Special Topics in SSSAJ

By Joyce Scheyer, Soil Scientist, National Soil Survey Center, Lincoln, Nebraska.

According to the May 2005 issue of “CSANews,” the Soil Science Society of America Journal (SSSAJ) will begin publishing papers that relate to two Special Topics: (1) Urban Soils; and (2) Landscape Management. Acceptance of manuscript submissions on these topics will begin in July. Instructions to authors may be found at http://www.soils.org/publications.html.

The traditional topics of the SSSAJ corresponded to the following divisions within SSSA:

1. Soil Physics
2. Soil Chemistry
3. Soil Biology & Biochemistry
4. Soil Fertility & Plant Nutrition
5. Pedology
6. Soil & Water Management & Conservation
7. Forest, Range & Wildland Soils
8. Nutrient Management & Soil & Plant Analysis
9. Soil Mineralogy
10. Wetland Soils

According to “CSANews,” the SSSAJ will maintain its traditional structure but will begin to accept “manuscripts under Special Topics that address issues of contemporary interest, so as to promote interdisciplinary publication and increase journal visibility. Such topics will be offered for a one-year period of open submission.” ■

## William E. Puckett Named Deputy Chief

From "NRCS Technology News," April 2005.

Dr. William E. Puckett was named the Deputy Chief for Soil Survey and Resource Assessment in January 2005, replacing Maurice Mausbach. He has overall responsibility for the National Cooperative Soil Survey Program, the National Resources Inventory Program, geospatial activities, resource assessment and policy analysis, climate change activities, the agency's international programs, and homeland security.

Prior to this position, Dr. Puckett served as Director of NRCS's East National Technology Support Center in Greensboro, North Carolina.

Dr. Puckett has held numerous positions with NRCS. He began his career in 1983 as a field soil scientist in Florida. He became State Soil Scientist in Oklahoma in 1991, and 2 years later he was named Assistant State Conservationist for Operations in Oklahoma. In 1995, he moved into an Operations Management position in the South Central Region office in Ft. Worth, Texas. In 1997, he joined the Oversight and Evaluations staff in Atlanta, Georgia, and from 1999 to 2001, he served as a Major Land Resource Area Leader for soil survey in Auburn, Alabama. From 2001 to 2004, he served as Director of the Soil Quality Institute.

He holds a Bachelor of Science degree in agronomy and a Master of Science degree in soil physics and mineralogy from Auburn University. He received a doctorate in soil genesis and classification from the University of Florida.

Dr. Puckett has received many awards throughout his career. They include the Berg Fellowship from the Soil and Water Conservation Society as well as accolades from Phi Kappa Phi, Sigma Xi, and Gamma Sigma Delta Honor Societies. ■

## U.S. Department of Agriculture and People's Republic of China, Ministry of Agriculture Technology Exchange

From "NRCS Technology News," March 2005.

A technical exchange sponsored by the USDA-NRCS International Programs Division, USDA-Foreign Agricultural Service (USDA-FAS) and with the People's Republic of China, Ministry of Agriculture (PRC-MOA), was recently completed. The U.S. participants included: Michael Wilson (USDA-NRCS, Lincoln, Nebraska), John Kelley (USDA-NRCS, Raleigh, North Carolina) Catherine Jackson (USDA-FAS, Washington, DC), and Ming Chen (University of Florida, Belle Grade, Florida). The U.S. delegation traveled to China in December 2002. The China delegation, in return, visited the U.S. in August 2004.

### China Exchange

The exchange in China consisted of two phases, the first in Beijing and the second in Guangzhou. The Beijing portion of the exchange consisted of a series of informational meetings with government and university personnel. Scientists from the Ministry of China and the Chinese Academy of Agricultural Sciences conduct nationwide soil surveys that examine chemical usage and other environmental concerns. The U.S. delegates were able to examine soils in southern China that are important to the production of crops, such as rice, vegetables, bananas, and oranges. The project was locally coordinated by the South China Agriculture University (SCAU), Guangzhou.

The purpose of sharing ideas and concepts was to provide a better

**Group visiting the China Academy of Sciences, Institute of Geographic Sciences and Natural Resources Research. From left to right, Ming Cheng, Mike Wilson, Catherine Jackson, John Kelley, and Lingfend Hue, Ministry of Agriculture, People's Republic of China.**

**After sampling soils, John Kelley and Mike Wilson visiting the home of a farmer and family in the village of Aotou, Guangdong Province.**

understanding of the importance of land management techniques (fertilizer and compost additions) for maintaining soil productivity and ensuring long-term land use. Information gained by the Chinese agricultural community was helpful to the U.S. agriculturalists because of the similarities of many of the soils found in China to those in southern U.S. and Hawaii.

The initial exchange process was a great opportunity for project members from both the U.S. and China to gain a better understanding of the problems and opportunities that exist for agriculture in both countries.

## U.S. Exchange

The U.S. portion of the jointly funded technical exchange program took place in Iredell County, NC, and Washington, DC, during the first two weeks of August 2004. The Chinese delegation sent three representatives.

An orientation meeting was held in Iredell County to introduce the Chinese scientists to various U.S. county, state, and Federal agencies' roles and responsibilities for agriculture development and environmental support. The rest of the field time was dedicated to examining soils and landscapes and collecting soil samples similar to those examined in Guangdong Province. The delegates' goal was to foster increased cooperation, interaction and transfer of technologies in the future.

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## Language Matters

By Stanley P. Anderson, Editor, NRCS, National Soil Survey Center, Lincoln, Nebraska.

I was saddened to learn that Phil Chavez, formerly an editor for NRCS (SCS in his time), died of cancer on April 24. Phil was working as a supervisory editor on the Soil Survey Editorial Staff in Hyattsville, Maryland, when I joined the staff in June 1974. He was a talented editor with a great sense of humor.

Another supervisor on the editorial staff in 1974 was Thelma Finlay. Thelma was my boss. She died of cancer on December 14, 1981, the day Joseph, my youngest son, was born. Phil visited her at the hospice where she was staying in her final days. After a time, she told him that he would have to leave. She was getting tired, and she had to use the bedpan. As he was walking out the door, she asked, "Bedpan—is that one word or two?" ■