National Cooperative Soil Survey Newsletter

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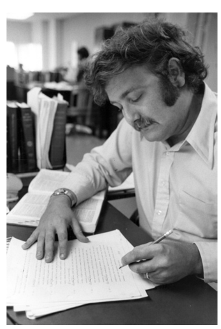
In This Issue—

Editor's Note



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You are invited to submit stories for this newsletter to Stanley Anderson, National Soil Survey Center, Lincoln, Nebraska. Phone—402-437-5357; FAX—402-437-5336; email—stan.anderson@lin.usda.gov.

Digital Soil Mapping: Quantifying the Soil-Landscape Paradigm

By Jay Skovlin, MLRA Soil Survey Leader, Natural Resources Conservation Service, Missoula, Montana.

Last fall I had the opportunity to attend the 2010 Soil Science Society of America meetings. Listening to the speakers in the Digital Soil Mapping (DSM) sessions got me thinking about where the state of the art of soil mapping is headed. In considering some of the methods presented, I found myself comparing them with traditional soil survey methods and trying to put them in the context of our agency culture and the development of the soil survey program. This article is my attempt to shed some light on how DSM methods fit into our existing processes.

Berman Hudson astutely categorized soil survey as a scientific program based on the application of the soil-landscape paradigm (Hudson, 1992). So what is the soil-landscape paradigm and how did Hudson define it?

Hudson's soil-landscape paradigm was his summary of a deterministic approach to mapping soils in which the interaction of soil-forming factors, on a given landscape, results in distinct and repeating "soil-landscape units." Underpinning the soil-landscape paradigm is an equally powerful paradigm, the theory of soil-forming factors, initially conceived by Dokuchaeiv (Glinka, 1927) and Hilgard (Jenny, 1961). The work of Hans Jenny (1941) further articulated and validated the soil-forming factors of climate, living organisms, relief, parent material, and time, expressed by the acronym CLORPT, which remains a seminal concept of pedology. Over the last century of soil survey, the soil-landscape paradigm arose as the dominant operative approach validated by decades of repeated observation of soils on the landscape. Hudson's soil-landscape paradigm has since been modified by additional process models and has evolved into the soil-geomorphic approach emphasized today within the Natural Resources Conservation Service (NRCS) and the National Cooperative Soil Survey (NCSS) (Wysocki and Schoeneberger, 2000).

Despite the benefits of operating under such a useful construct as the soil-landscape paradigm, we continue to be hampered by its weaknesses. This paradigm is overly dependent on tacit knowledge rather than clearly documented and described evidence and rationale supporting the landscape models learned through experience (Ditzler, 2003). The full knowledge and understanding of the soil scientist who produces the map cannot be easily articulated and commonly cannot be adequately captured in the actual product. Furthermore, the tacit knowledge accumulated in the process of producing a soil survey is difficult to transfer even among soil scientists. Confounding the difficulty of the transfer of tacit knowledge is the fact that in the past the documentation collected during the creation of a soil survey was considered less important than the finished product and thus important reference data were often lost or destroyed. As a result, important knowledge of the spatial relationships of the soil landscape that is gained in applying the soil-landscape paradigm is not explicitly distilled and remains embedded in categorical maps which do not convey the complexity of the information in an efficient and transparent manner (Bui, 2004). As noted by Hudson (1992), the cumulative result is that the tacit knowledge gained over time, through decades of soil survey efforts, has not been explained and summarized in language so that the insights from this vast trove of knowledge can be integrated into the soil science literature.

As a field soil scientist, I see DSM playing an important role in the capture and communication of tacit knowledge. Most DSM methods aim to quantify aspects of the soil-landscape paradigm. They can be used to apply the concepts we have developed from our tacit knowledge and help us capture that information in the more specific spatial representation of spatial models and raster maps. Although DSM methods attempt to quantify soil relationships and properties using the often unfamiliar vocabulary of statistics, these methods and models generally reflect a digital version of the thought process that occurs in the mind of any soil scientist engaged in the enterprise of mapping soils. Using multiple input layers derived from digital terrain models, categorical data (such as geologic or vegetation data), remote sensing data, and direct observations, the analyst looks for spatial relationships and assesses the strength of relationships between these environmental covariates and the variable of interest. Only in the last several years has the potential in computing power combined with advances in GIS and the availability of geostatistical methods made these more computationally intensive approaches possible (McBratney et al., 2003).

In recent years, the soil survey program has made great strides in converting analog processes of product delivery to digital processes, such as the development of the Soil Data Mart and Web Soil Survey. The release of NASIS 6.0 and migration to the Microsoft SQL server database platform puts the soil survey program on a solid footing for future advances. In spite of these gains, however, our product development process remains insular and focused on vector mapping products. Digitally produced soil maps appear to have a distinct advantage over traditionally produced soil survey maps with respect to the ability to apply a consistent methodology, assess the level of accuracy, and represent different kinds and amounts of detail (Hempel et al., 2008).

Another important idea comes from Hudson's use of the term "set" (Hanson, 1969), which involves the process of preparing a person to see new phenomena and to see it in a certain way. The idea is that what one can observe and learn depends largely on what one has been prepared to observe and learn. So how can we, as NCSS soil scientists, "set" ourselves to learn more about and be more receptive to applying DSM methods? I would argue that as field soil scientists, trained in seeing the world through the soil-landscape paradigm, we are already primed to understand the appropriate application of DSM methods to soil survey. We as soil scientists need to learn more about DSM methods to ensure that they are prudently applied to the soil landscape. I would challenge each one of us, whatever our experience, to see and understand our work from a new perspective. Many of the changes that have occurred in how we accomplish the work of soil survey in the last 10 years represent a positive shift in thinking and agency culture. NRCS support of such projects as the Global Soil Map Initiative (www.globalsoilmap.net) will drive the broad application of DSM methods and the development of raster products. As products from this and other initiatives become available, the global demand for raster soil survey products will increase (Cook et al., 2008). We should work to understand where we fit within the framework of these efforts and position ourselves to make more direct contributions to it. Ultimately, it will take the ability to collaborate more freely across disciplines, agencies, countries, and states and among soil survey offices to form working groups which will focus effort and provide leadership on methods and standards for raster products. Many decisions will need to be made as to how these raster products will be delivered within the context of the existing soil survey products.

Soil scientists are as different in their opinions as the soils they find on the landscape. Attitudes and opinions about DSM methods are wide ranging, but often there is a sense of negativity about modeling and computational approaches. These opinions seem to stem from our extreme reliance on our hard-earned tacit knowledge of local and regional soil landscapes and our reluctance to admit that useful knowledge of soils could be gained by investigating soils any other way. The gestalt shift (transformational shift) in thinking and observation which allows a new soil scientist to dissect the landscape, drape soil-forming factors on it, and “see” the spatial distribution of the resulting soil families is a deeply ingrained rite of passage within our profession. In reality, DSM methods do nothing to undermine or threaten these traditions. In contrast, DSM methods hold great potential as a set of additional tools which can help us further validate our tacit knowledge and capture the results in more spatially explicit products. Now more than ever, the community of NCSS soil scientists needs to take an active role in how DSM methods are applied to our soils data. We know our data and how it was developed—its strengths and limitations. If we continue to sit back, we will find ourselves in the unenviable position of reacting to methods and products that others will develop for us (Arnold and Wilding, 1991).

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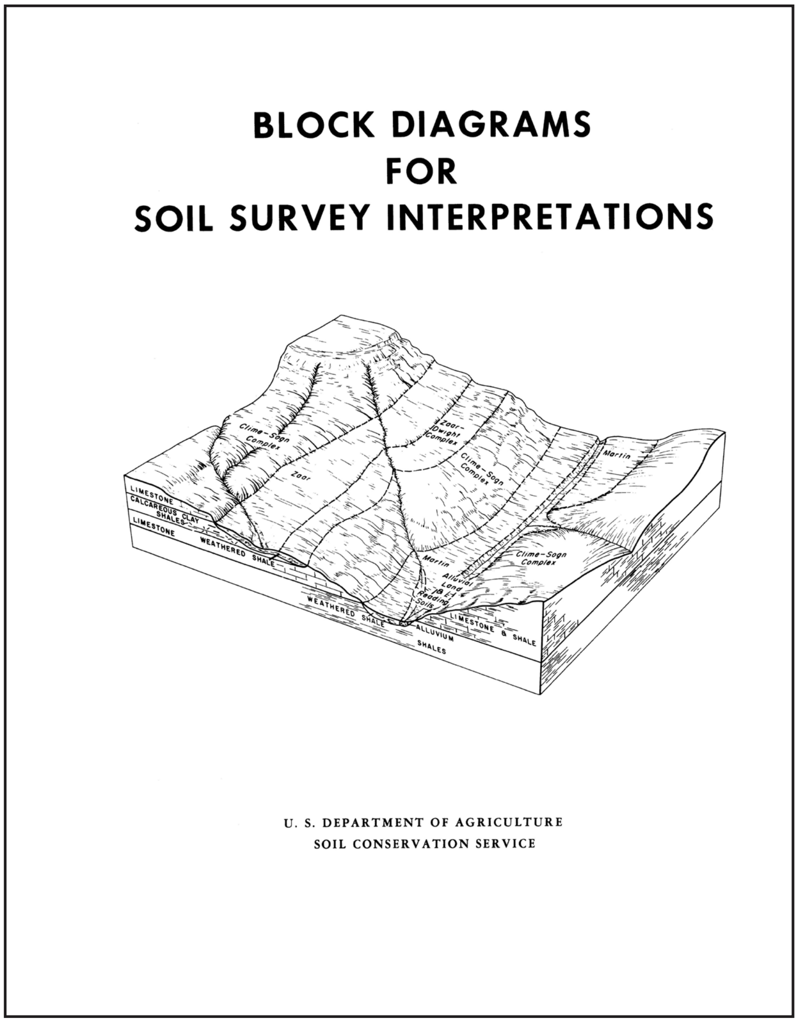

BLOCK DIAGRAMS
FOR
SOIL SURVEY INTERPRETATIONS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

An Old Book About Block Diagrams Available on the Web

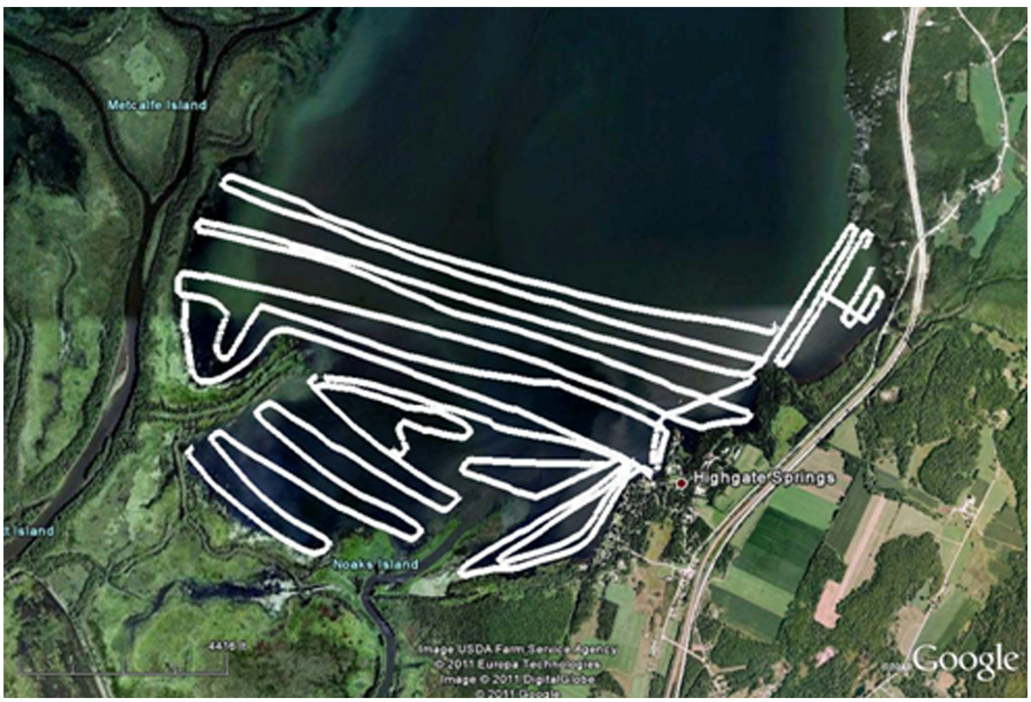
By Stanley P. Anderson, editor, NRCS, National Soil Survey Center, Lincoln, Nebraska.

A book entitled *Block Diagrams for Soil Survey Interpretations* is available on the Web (ftp://ftp-fc.sc.egov.usda.gov/NSSC/job_aids/graphics/diagrams/BlockDiagrams.pdf). This book was published by the Soil Conservation Service in Lincoln, Nebraska, in 1968. It was compiled by Robert W. Eikleberry. It is an old reference book illustrating how to draw block diagrams. ■

Use of a Mobile GPR Platform in Vermont

From Soil Survey Division, “Weekly Update,” March 2, 2011.

During the period of February 22 to 24, personnel from the National Soil Survey Center, the Vermont NRCS Soil Resource Staff, and staff with the U.S. Fish and Wildlife Service’s Missisquoi National Wildlife Refuge used a mobile GPR platform to complete more than 52 km (32 miles) of continuous, georeferenced GPR data recordings across an ice-covered portion of Missisquoi Bay (a northern bay of Lake Champlain) in northwestern Vermont. In conjunction with the GPR data collection, a soil scientist from the NRCS MLRA Regional Office assisted with the collection and description of soil cores, which were used to confirm radar interpretations. A goal of this investigation is to develop field methods for the rapid identification, classification, and delineation of subaqueous soils and landscapes. The collected radar data will be used to identify differences in substrates and distinguish different subaqueous landscape units based on bathymetry, slope, landscape shape, sediment type, and geographical location.



A Google Earth image showing the locations of GPR traverse lines that were completed over the southeast portion of Missisquoi Bay.

A team of research soil scientists at the NSSC will use the GPR data and terrain analysis techniques to identify subaqueous landscape units and partition the submersed areas into more homogenous subaqueous soil map units. The identification and mapping of subaqueous soils, a new frontier in soil survey, is motivated by management issues, such as the inventory and restoration of submersed aquatic vegetation, organisms, and habitats; the improvement of water quality; and the assessment of carbon sequestration potentials. In the greater Lake Champlain watershed, local, State, and Federal agencies are concerned with the rapid increase in sedimentation rates and nutrient inputs caused by changes in land use. ■

View from the summit of Mount Mitchell.

2011 National Cooperative Soil Survey National Conference

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

This conference will be held May 22–26, 2011, at the Crowne Plaza Resort in Asheville, North Carolina, and will be hosted by North Carolina State University. The national conference convenes every other year (in the odd-numbered year) to discuss and develop solutions to issues of concern to the National Cooperative Soil Survey. The theme of the 2011 conference is "Soil Survey—Interpreting the Inventory in a Digital World." The keynote address ("75 Years of Partnership for Soil Survey") will be delivered by Charles Rice, SSSA President, on Monday morning (May 23).

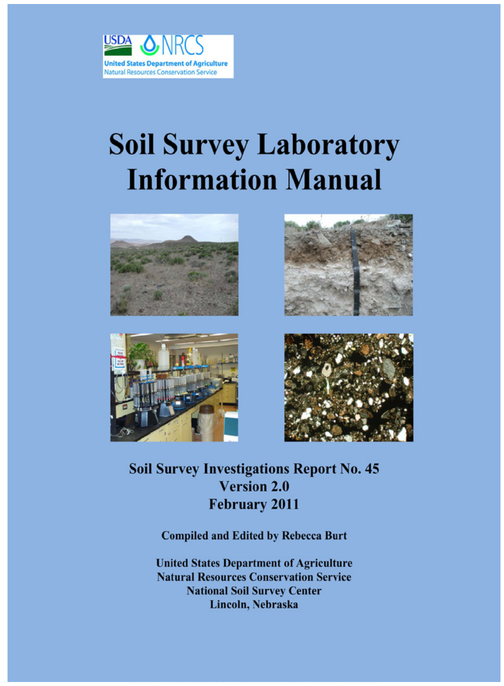
Field trips are scheduled for Sunday, May 22, 7:30 a.m. to 5:00 p.m., and Wednesday, May 25, 7:30 a.m. to 9:00 p.m. The trip on Wednesday, to Mount Mitchell (http://www.google.com/search?q=%22Mount+Mitchell%22&hl=en&num=10&lr=&ft=i&cr=&safe=images&tbs=) and the Biltmore Estate (http://www.google.com/search?q=%22Biltmore+Estate%22&hl=en&num=10&lr=&ft=i&cr=&safe=images&tbs=), will include lunch, dinner, wine tasting, and a social hour. The trips will focus on geomorphology and landscapes, ecological site descriptions, water table monitoring, and interpretations.

Standing committees and ad hoc working groups will meet during the conference. The standing committees are Research Agenda, NCSS Standards, New Technology, and Interpretations. The ad hoc working groups are Subaqueous Soils and Soil Change. The Soil Change group is scheduled to be changed to a standing committee (Ecological Site Inventory). Reports by the standing committees and ad hoc working groups will be given on the last day of the conference (May 26).

The last day also will feature a lunch banquet with a presentation of "North Carolina Tall Soils Stories."

Information about online registration, accommodations, the agenda, contacts, and committees is available online (http://soils.usda.gov/partnerships/ncss/conferences/2011_national/index.html). ■

Publication of *Soil Survey Laboratory Information Manual*, Version 2.0



The *Soil Survey Laboratory Information Manual*, Soil Survey Investigations Report (SSIR) No. 45, Version 2.0, was recently posted on the Web (http://soils.usda.gov/technical). This work was compiled and edited by Rebecca Burt, Research Soil Scientist, Soil Survey Research and Laboratory, National Soil Survey Center. The manual describes and explains the operational and conceptual definitions of Soil Survey Laboratory (SSL) procedures. The manual is intended to serve as a standard reference in the use and application of SSL characterization data and to help maximize user understanding of these data. SSIR No. 45 was designed to document the historical background of the development of many SSL methods. Documenting soil characterization methods has been instrumental in improving our understanding of the nature and behavior of a wide range of soils. It is expected that this manual will continue to evolve over time as new methods are developed and applied based on new knowledge or technologies. It is for these reasons that the scope of SSIR No. 45, Version 2.0, was significantly revised and expanded compared to the previous version (published in 1995). The current document provides information for such diverse uses as soil survey, salinity, fertility, and soil quality. It is further anticipated that with the continued development of and modification to the database derived from these diverse data, more discipline-dedicated manuals will be developed and enhanced. ■

Dr. Arnold Features a Red Cap

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

NSSC editor Jennifer Sutherland and I are preparing Dr. Richard Arnold's extensive collection of papers for presentation on the Web. I searched for

suitable pictures in a gallery Gary Muckel assembled years ago (unfortunately without captions). I found a number of pictures of Dr. Arnold in his red cap, six of which are reproduced on pages 8 and 9. Gary Muckel is in the second picture on page 9, as is Horace Smith. Dr. Arnold wrote me the following about the top two pictures on page 8:

> An interesting sidelight about two of the pictures where I have a partly unbuttoned blue shirt. Hari Eswaran and I went to a soil meeting in Urumqi, a city in the far northwest of China. The meeting was about soils of arid lands. My suitcase did not arrive from Beijing and I had a pair of dress trousers, my red field cap, and one change of underwear. I was washing out clothes each night in a bathtub and the extremely low humidity meant

> that I had dry clothes the next day. Finally one of the younger guys from Nanjing Soil Institute took me shopping for clothes. Well, guess what—my body shape was not right for any work clothes but we found a box under a table with old men's pants (wool, not denim or other cotton - ugh) and they buttoned instead of a zipper. Then after a long search we found a blue cotton shirt that almost went around me. And as I was a monitor at one soil site there I was leading the discussion. The other pic with those nice clothes was in a large quarry where they excavated the soil to use in construction and we were discussing the layering of sediments at that site.
>
> When we finally got back to Beijing I asked about my luggage. It had been sent to Urumqi and actually was at that airport all the time of the meeting, so they phoned out and had it brought back to Beijing. I had clean clothes for my meetings there for several days before we returned home. Such are the "stories" of other times, other places.

Dr. Arnold also commented about his red cap(s):

> Believe it or not, I still have a few red caps and I often wear one when out working in our yard. Over the years I gave away quite a few and so had to keep looking for more, but I loved them as a means of recognition. It all started when Al Southard and I were grad students at Cornell and we bought our first red hats at a street sale in Gloversville, NY, while working on soil survey there. That was probably 1958. Here in Indiana red is the color of the University of Indiana and so Purdue fans do not look favorably at me when I wear the cap in town.

Dr. Arnold's comment about the last picture:

> ... the last one is in the Swiss mountains. We were on a post Soil Congress tour after being in Hamburg, Germany, and several stops were in Switzerland. At this height they were studying the weathering of cloth samples. They were put in special containers and they dug them up from time to time to see what damage the microbial populations were doing. This is a beautiful glaciated landscape with a small town and lake in the valley below.

Another comment by Dr. Arnold sheds light on the extent and nature of the papers we are collecting:

> I have just finished typing up notes I transcribed from tapes I made at the Soil Congress in Madison, WI, in August 1960. That was the one where Guy Smith and others presented the 7th Approximation of Soil Taxonomy to the world. I have them ready to send to Jenny. It was my first contact with Russian soil scientists and in 2010 I was once again in Russia giving several lectures about sustainable ecosystems and the role of soils. The soil survey has truly been an exciting, challenging, and satisfying career for me. ■

Response to Japan Earthquake

From Soil Survey Division, "Weekly Update," March 23, 2011.

Scenario: Fallout over the States of Hawaii, Alaska, Washington, Oregon, and California from a nuclear reactor accident.

Staff of SSRA (Soil Survey and Resource Assessment in NRCS) responded to a data call for the Secretary by providing 43 maps relating to Potential for Radioactive Bioaccumulation in Soils, Potential for Sequestration in Soils, and Limitations for

Large Animal Disposal. Also, NASS (National Agricultural Statistics Service) data on land use/cover, land capability class, and numbers of livestock by county have been provided.

The map **Potential for Radioactive Bioaccumulation in Soils** is based on chemical and physical soil properties that affect the potential for retaining cesium and strontium available for plant uptake. Croplands and grazed grasslands where the bioaccumulation potential is higher may be priority areas for the removal of animals and destruction of crops.

The map **Potential for Sequestration in Soils** is based on soil texture, pH, and cation-exchange capacity. Soils with a high potential for sequestration of strontium and cesium may be ameliorated by excavating and removing the contaminated material.

Note: Strontium is not released from a nuclear reactor incident. Iodine_{131} is released. It is a molecule with no charge (not an ion). The above ratings do not address the fate of Iodine_{131}.

The map **Limitations for Large Animal Disposal** indicates soil features that limit the suitability for pit and trench types of mass carcass burial. Other factors must be considered before site selection is made, such as ownership, infrastructure, and kind and amount of vegetation. ■

Suitability of Soils for Gopher Tortoise Habitat

From Soil Survey Division, “Weekly Update,” March 23, 2011.

Soil Survey Interpretations and Soil Ecology staff members at the National Soil Survey Center have been collaborating with U.S. Fish and Wildlife biologists and NRCS soil scientists in Alabama and Mississippi to model soils for gopher tortoise (*Gopherus polyphemus*) habitat suitability (fig. 1). The gopher tortoise is seen as a keystone species because the burrows that it digs for itself provide shelter for many other animals. These burrows are home to about 360 species of animals at one time or another. Some species share the burrows with the tortoises, and others use abandoned burrows.

The range of the gopher tortoise extends from southern South Carolina to southeast Louisiana. The U.S. Fish and Wildlife Service considers the species threatened when found west of the Mobile and Tombigbee Rivers in Alabama. As a part of the

Figure 1.—Gopher tortoise.

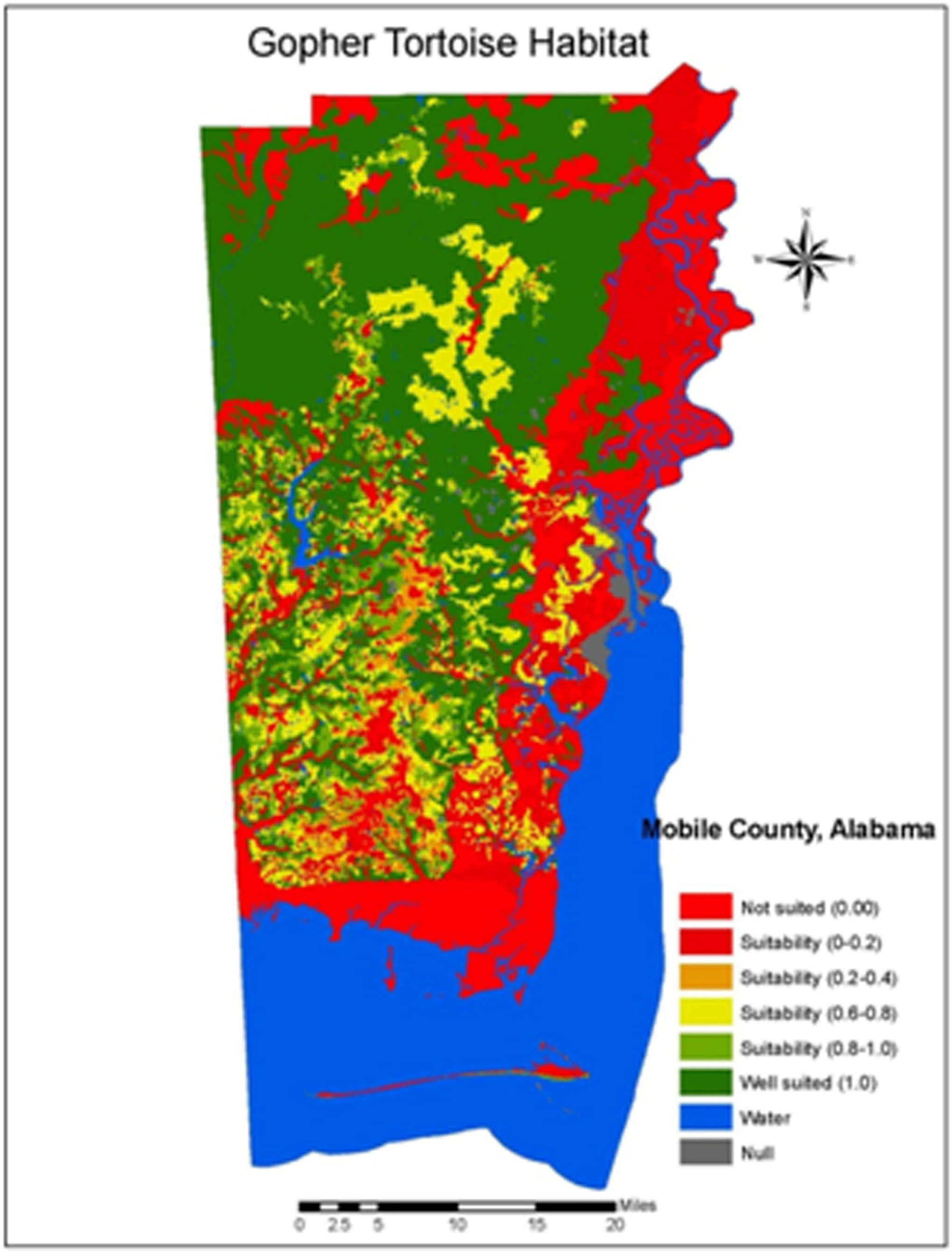


Figure 2.—Suitability of soils in Mobile County, Alabama, as habitat for gopher tortoises.

conservation effort, NSSC was contacted to assist in locating the most suitable sites for gopher tortoise habitat. Soil information is valuable when various efforts are made, including population surveys and status assessments, protection and management of populations on Federal and State land, encouragement of habitat protection on private land, and promotion of tortoise conservation banks on lands with suitable habitat. The most suitable areas are readily identified. Figure 2 is a preliminary map of habitat suitability for Mobile County, Alabama. The tortoise needs dry, deep, sandy soils in which to burrow. ■

Cleiton Sequeira Joins National Soil Survey Center

From Soil Survey Division, "Weekly Update," March 2, 2011.

Cleiton Sequeira has joined the NSSC staff as a Post Doctoral Associate through a contract with the University of Nebraska. Cleiton recently completed his Ph.D. at Virginia Tech University. His primary duties at the NSSC will be to summarize and analyze data associated with the Rapid Assessment of Soil Carbon project. ■