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In This Issue—

Editor's Note

Issues of this newsletter are available on the World Wide Web (http://soils.usda.gov/). Under Quick Access, click on NCSS, then on Newsletters, and then on the desired issue number.

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.

An Approach to the Development of Inherent Soil Productivity Indices

By H. Raymond Sinclair, Jr., Robert R. Dobos, and Sharon W. Waltman, Soil Scientists, NRCS.

Introduction

This article describes a prototype model of Soil Rating for Plant Growth, version 4 (SRPG4), which generates inherent productivity indices for soils in the United States using soil survey data. The article demonstrates how this system assigns productivity indices to soils growing commodity crops. The soil data elements in NASIS and soil interpretations model (Soil Survey Staff, 2006a and 2006b) in the NASIS interpretation module will be used to generate the productivity indices. The article will outline how the model is being developed. It is the first in a series of publications that will explain the development and use of this model. Future publications will discuss all aspects of the SRPG4 model in detail. This article will not discuss some aspects that are still in developmental stages. These planned aspects are available in the NASIS interpretation module.

The Soil Survey Staff (2000) explained the use of rating classes or traditional "crisp" limits (table 1) to assign soil productivity indices for commodity crops. Users suggested that a continuous evaluation of soil properties (SRPG4) could possibly assign soil productivity indices that avoid boundary conditions where drastically different productivity indices occur with only a minor difference in the numerical values between the same data element. Figure 1 demonstrates the use of a continuous evaluation to assign numerical rating values for a soil property. The continuous evaluation typically assigns values ranging from 0.01 to 1.0. In table 1, rating classes are assigned numerical values. The rating classes are typically assigned values ranging from 5 to 100. The numerical values assigned to the rating classes are more ambiguous than the values in a continuous evaluation. In this example, both the class and continuum indicate a condition that is more favorable for plant growth as the assigned numerical values become larger.

Table 1.—Values assigned to crisp classes

Class definition	*Assigned value*
Most favorable	100, or else
↓	95, or else,
	85, or else
	75, or else
	60, or else
Least favorable	5.

K.W. Flach (1985) indicated the need for modeling in soil science, that is, the need for "a model of the relationship between kinds of soils and landscape." The mapper "maps ahead using this model." Verbalizing the model usually is difficult, as is "putting it into quantitative terms," but the mapper "could not function effectively without it."

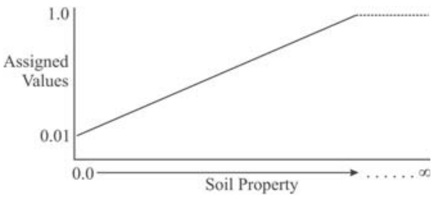


Figure 1.—Values assigned for a continuous evaluation.

Many crop indices with their published methodology have been developed for many geographical areas over the past years. Each model developed criteria and used data elements that enable it to work for a selected area. Everyone should study the methodology that results in the generation of indices that satisfy the customers using these models. After the models were examined, none seemed to generate indices that would array the soils of the United States for growing commodity crops. Huddleston (1984) details the development and use of soil productivity ratings in the U.S. The Storie Index is a method of soil rating that is based on soil characteristics that govern the land's potential utilization and productive capacity. It is independent of other physical and economic factors that might determine the desirability of growing certain plants in a given location. The publications by Huddleston and Storie are only two of the more than 90 citations available on the subject of crop indices.

Methodology and Development of SRPG4

Soil productivity is strongly influenced by the capacity of a soil to supply the nutrients and soil-stored water that a crop growing in a given climate needs (Olson and Lang, 2002). SRPG4 uses the soil interpretations module of the soil survey database system (Soil Survey Staff, 2006b) to assess the impact of numerous soil constraints or qualities on plant growth and thus compute a soil productivity or inherent soil quality index for components of soil map units (Soil Survey Staff, 2006a). The SRPG4 calculations followed the "Storie Index Rating" (Storie and Weir, 1958; Storie, 1978), which was based on soil characteristics that govern the land's potential utilization and productive capacity. The Storie index was originally adapted to semiarid and arid regions and included profile characteristics that influenced the effective rooting depth and the quality of the root zone; subsurface properties (permeability, available water capacity, drainage class, and soluble salts); and landscape properties, such as slope, microrelief, and the degree of erosion. SRPG4 also considers climate as an additional factor in calculating the index. Climate is a particularly significant parameter, given the range of climate across regions. SRPG4 provides a reasonable semi-quantitative index (from 0.01 to 1) of soil productivity applicable to map unit components of the soil survey database. A table near the end of this article (table 4) shows a productivity index generated by an early version of SRPG4.

The conceptual model of the soil interpretations module, or prototype as outlined in this article, consists of four basic parts. These are "main rules" (also called "interpretations"), "subrules" (composed of "base rules"), "evaluations," and "properties." A "property" is a Structured Query Language (SQL) script that retrieves the desired soil attribute data, such as the pH of the surface horizon. This piece of data is placed into an evaluation, which is a graph that indicates the degree of membership of that attribute in the set of soils that are productive. In this example, a soil component having a pH of 6.5 would receive a score of 1, whereas a soil component having a pH of 5.0 would receive a score of less than 1. The shape of the curve depends on the soil attribute being modeled (see figures 2 through 5).

The rating from the evaluation is fed into a base rule indicating the impact of the soil attribute in question on the land use. The base rule is a logical diagram depicting the relationship between the soil attributes and the land use being modeled. Base rules can be put together to make various levels of subrules, depending on the complexity of the land use situation being considered (Soil Survey Staff, 2001).

Table 2 lists the four subrules (chemical and physical properties and climate and landscape factors) used to calculate SRPG4. As is indicated in table 2, base rule level 2 has 22 elements, which mathematically calculate the values for the four elements in subrule level 1.

Soil attribute data can be manipulated in a variety of ways to arrive at a value that is meaningful in terms of soil productivity. For example, roots are sensitive to the bulk density of a soil layer, since penetration resistance is partially a function of bulk density. At some point, a soil layer becomes too dense for root ramification. The values for nonlimiting, critical, and root-limiting bulk densities for each family particle-size class are shown in table 3 (Pierce et al., 1983).

The information in table 3 is manipulated in a property script to arrive at a way of comparing the populated bulk density to a bulk density that is conducive to root growth for any particular combination of sand, silt, and clay. The resulting number is

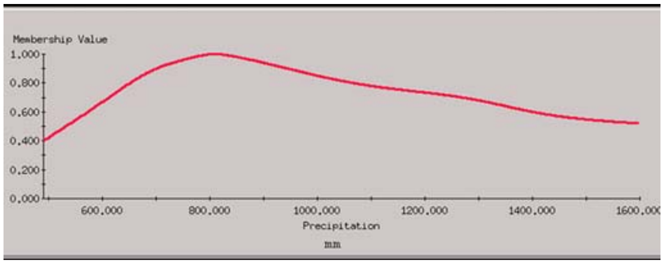


Figure 2.—Precipitation.

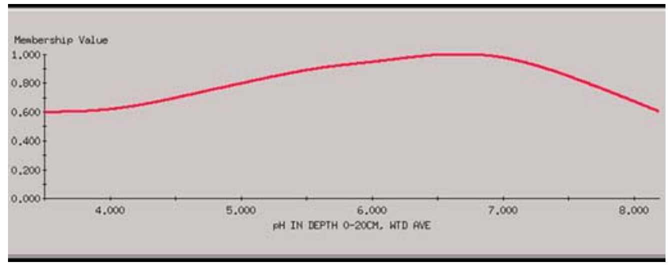


Figure 3.—pH, 0-20 cm, weighted average.

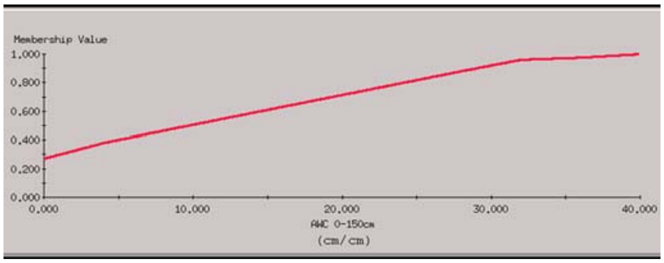


Figure 4.—Available water capacity (AWC), 0-150 cm.

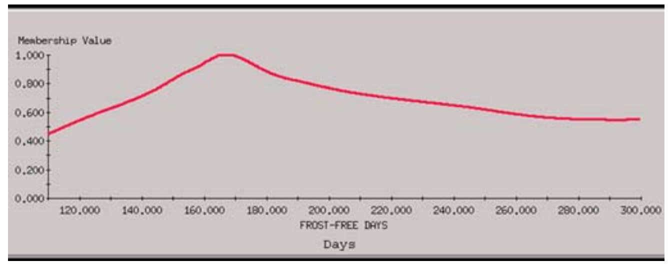


Figure 5.—Frost-free days.

then scored on the basis of its estimated impact on soil productivity using the appropriate evaluation.

The soil interpretations module allows the logical relationships, such as interactions and weighting, among soil, landscape, and site features to be modeled. In SRPG4, the weight of a particular variable can be assigned in the subrule diagram. Figure 6 is an example of how physical soil factors might be related in a subrule. The "divide" boxes are used to adjust the weight of the individual factors or groups of factors. The results are multiplied together, as in the Storie index.

Some products that can be generated using the SRPG4 model are indicated in figure 7 and table 4. Figure 7 shows the available water capacity of the root zone for the soils in Tazewell County, Illinois (Soil Survey Staff, 2005). There is a very good relationship between crop yields and the available water capacity of the root zone. Table 4 illustrates the numerical values generated by the rule, subrules, and base rules in the SRPG4 model. The table also indicates the taxonomic classification of the soil.

The ratings for the subrule level 1 factors are weighted and used in the calculation of the final SRPG productivity index for commodity crops.

The SRPG4 model should be tested in many different geographical areas. Constructive suggestions would be appreciated. Ideas and suggestions are continually being tested and incorporated into the

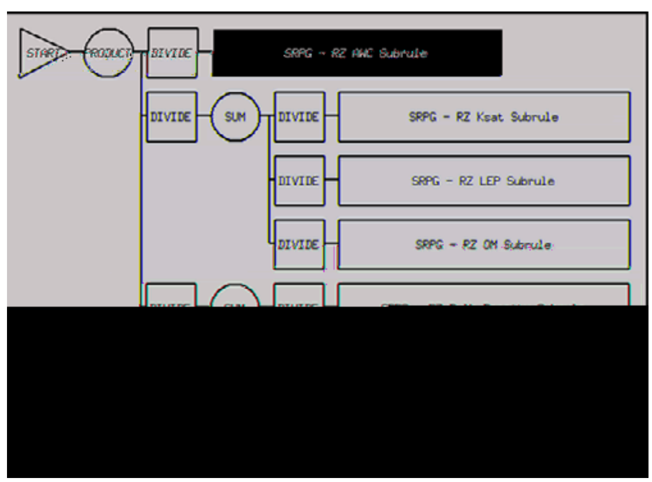


Figure 6.—A subrule diagram of physical soil properties.

Table 2. —Schema for rule, subrules, and base rules to determine indices of inherent soil productivity

Main rule	*Subrule level 1*	*Base rule level 2*
SRPG4:		
	Climate factors:	mean air annual temperature frost-free days mean annual precipitation
	Chemical properties:	cation-exchange capacity soil reaction sodium adsorption ratio gypsum electrical conductivity calcium carbonate
	Landscape factors:	slope water table surface rock fragments flooding ponding accelerated erosion
	Physical properties:	content of organic matter saturated hydraulic conductivity bulk density linear extensibility percent available water capacity rock fragment content root zone depth

Table 3.—Nonlimiting, critical, and root-limiting bulk densities for each family texture class (Pierce et al., 1983)

Family texture class	Nonlimiting bulk density	Critical bulk density	Root-limiting bulk density
	g cm^{-3}	*g cm^{-3}*	*g cm^{-3}*
Sandy	1.60	1.69	1.85
Coarse-loamy	1.50	1.63	1.80
Fine-loamy	1.46	1.67	1.78
Coarse-silty	1.43	1.67	1.79
Fine-silty	1.34	1.54	1.65
Clayey (35-45%)	1.40	1.49	1.58
Clayey (45-100%)	1.30	1.39	1.47

model. Thus, the SRPG model is continually being improved. Using the model keeps us current with its dynamic capabilities.

Concluding Remarks

Soil scientists in NRCS want to be recognized as members of a dynamic discipline that is able to provide the integrated soil survey interpretations that rapidly changing societies in the United States and other parts of the world need. One of the challenges is to develop a soil productivity rating system for use in federal programs, such as programs that relate to crop production. To meet our nation's needs, a computer modeling approach is being developed to assign productivity indices to soils used for commodity crops. The SRPG4 module is operational and produces test results. It appears to correctly array test sets of soils. The next phase of testing will be to generate the productivity indices for soils with other taxonomic classifications. The model quantifies soils without regard to their political boundaries. It is testing past and current concepts and verifying their validity. The statistics used to develop the SRPG4 model will be documented in future publications. The development of SRPG version 2, for irrigated commodity crops, forestry SRPG version 1, and rangeland SRPG version 2 can be accomplished with minor changes in the base rules and evaluations of SRPG4 for commodity crops. The soil scientists in the National Cooperative Soil Survey should evaluate SRPG4 to ensure that it arrays the soils of the United States realistically.

References

Flach, K.W. 1985. Modeling and soil survey. Soil Survey Horizons 26(2): 15-20.

Table 4.—Numerical values generated for subrule level 1, base rule level 2, and rule by SRPG model

Chemical 0.971	Cation-exchange capacity 1	pH 0.971	Sodium adsorption ratio 1	Gypsum 1	Electrical conductivity 1	Calcium carbonate 1	
Landscape 0.947	Slope 0.947	Water table 1	Surface rock fragments 1	Flooding 1	Ponding 1	Accelerated erosion 1	
	Content of organic		Bulk	Linear e	Available	Rock	Root

Figure 7.—Available water capacity of the root zone in the soils of Tazewell County, Illinois. ■

Wade G. Hurt Receives SSSA Award

During the Soil Science Society of America Awards Program at the 2006 ASA-CSSA-SSSA International Annual Meetings in Indianapolis, Indiana, November 12-16, Wade Hurt, Soil Scientist, NRCS, received the “Soil Science Professional Service Award” for his important work on the indicators of hydric soils. The award is described as follows:

> This award is given for outstanding service in promoting programs, practices, technology, or products that enhance soil science. The aim is to recognize outstanding service and leadership by industrial, private, and governmental soil scientists. The award consists of a certificate and $1,000 honorarium.

Wade edited all versions of *Field Indicators of Hydric Soils in the United States: A Guide for Identifying and Delineating Hydric Soils,* including Version 6.0 (2006). Following is a picture from the cover of the 2006 version of this publication. This picture shows a hydric soil that has the hydric soil indicators S6 (Stripped Matrix) and S7 (Dark Surface).

A picture from the cover of the latest version of *Field Indicators of Hydric Soils in the United States.* ■

From left to right, Ken Harward, Project Manager, ITC, Ft. Collins, Colorado; Jim Fortner, Soil Scientist, NSSC, Lincoln, Nebraska; Jack Dangermond, ESRI president; and Dennis Williamson, State GIS Manager, Temple, Texas.

NRCS Receives ESRI Award

The Natural Resources Conservation Service was recognized for excellence in the geographic information system (GIS) field with a 2006 Special Achievement in GIS (SAG) award at the Twenty-Sixth Annual ESRI International User Conference in San Diego, California, August 7-11. ESRI presents the award to organizations and agencies that display dedication and commitment through their use of GIS technology. This year 178 awardees were chosen from more than 3,000 nominations for the award.

"The SAG awards celebrate the achievement and vision of innovators in the GIS field," says Jack Dangermond, ESRI president. "Each winner brings benefits to their communities and influences others to do the same."

NRCS received the award for the development of the Web Soil Survey (WSS). Web Soil Survey provides browser-based soil survey information and maps to the general public. WSS replaces current paper-based soil survey publications. It shortens the time from completion of field mapping to publication of soil survey information.

Ken Harward, Jim Fortner, and Dennis Williamson accepted the award on behalf of NRCS.■

Retirement of Frederick M. Kaisaki

Fred Kaisaki, supervisory soil scientist on the Soil Survey Investigations/Soil Survey Laboratory staff, National Soil Survey Center, will retire on January 3, 2007, with more than 30 years of Federal service. Fred was born in Lewiston, Idaho. He obtained his B.S. degree in Agricultural Biochemistry from the University of Idaho, Moscow. After serving in the U.S. Army, Fred returned to college and obtained his M.S. degree in Soil Science at the University of Wisconsin, Madison.

Fred started his career with the Soil Conservation Service in Burley, Idaho, in 1978 after working for the Idaho Department of Lands as a soil scientist. He transferred into the National Soil Survey Laboratory in November 1982. He was in charge of the Chemical Analyses Staff before the reorganization in 1994. He spent considerable time on the LIMS design team. His knowledge of laboratory chemical analyses procedures was essential for team success. Fred resumed his position on the Chemical Analyses Staff in 2005. His recent contributions to the National Cooperative Soil Survey include several promising soil field kits and leadership in technician cross-training, which has increased laboratory efficiency and production. Fred's combination of field and laboratory experiences and his passion for soil science gave him a unique appreciation of the value and role of the Soil Survey Laboratory as an important service facility for field soil scientists

Fred and his wife, Wan, will be moving to Spokane, Washington, where Fred plans to join a study of macro invertebrates in west slope streams as a volunteer for the University of Idaho. ■

Retirement of Robert J. Engel

Robert (Bob) J. Engel of the National Soil Survey Center (NSSC), Lincoln, Nebraska, will retire on January 3, 2007, after about 40 years of government service. Bob was born on a dairy farm in Cochrane, Wisconsin, and spent his early years growing up on the farm, where he developed a love of nature and the outdoors. He obtained his B.S. degree in plant and earth science in 1968 from the University of Wisconsin, River Falls.

Bob began his USDA career in 1965 with the Agricultural Stabilization & Conservation Service (ASCS) as an intermittent crop reporter in Alma, Wisconsin. He began his career with the Soil Conservation Service in June 1967 with a summer detail in Buffalo County, Wisconsin. In December 1968, he started his career as a soil scientist in Rock County (Janesville), Wisconsin. His career took him to Sheboygan County (Sheboygan), Wisconsin, as a soil survey party leader in 1970; to Washtenaw County (Ann Arbor), Michigan, in 1973; and Jackson County (Jackson), Michigan, in 1975. In 1977, Bob became the SCS state soil correlator for the State of Washington. He lived in Spokane until 1988, when he joined the staff of the National Soil Survey Center (NSSC) in Lincoln, Nebraska.

Since 1988, Bob has been working mainly on updating *Soil Taxonomy* and the *Keys to Soil Taxonomy* at the National Soil Survey Center. Bob also has provided training to the majority of the NCSS soil scientists around the country through his instruction in courses, such as "Basic Soil Survey—Lab and Field" and "Soil Correlation." Bob has been instrumental in working internationally with soil scientists developing the "World Reference Base" (WRB) soil classification system. His efforts have made a significant contribution to aligning WRB with Soil Taxonomy. ■

Nonretirement of Stanley P. Anderson: A Reprise

Stan Anderson, Editor, NRCS, National Soil Survey Center, has once again decided not to retire. The last time that Stan's nonretirement was announced was February 2005, in issue 30 of the NCSS Newsletter.

"If they want to get rid of me, they'll have to throw me out," Stan said in an exclusive interview in which he muttered to himself.

The list of people who are disappointed by Stan's decision is too long to reproduce in the NCSS Newsletter, even if an entire issue is devoted to the list of these people's names (and only their names).

Dr. Robert Ahrens, Director of the National Soil Survey Center, is considering taking up a collection from the people referred to in the previous paragraph, hoping to raise enough money for an attractive buy-out offer.

In the meantime, Stan plans to stay around for as many years as the number of times he is reiterated in the following illustration:

Web-Based Soil Extent Mapping Tool

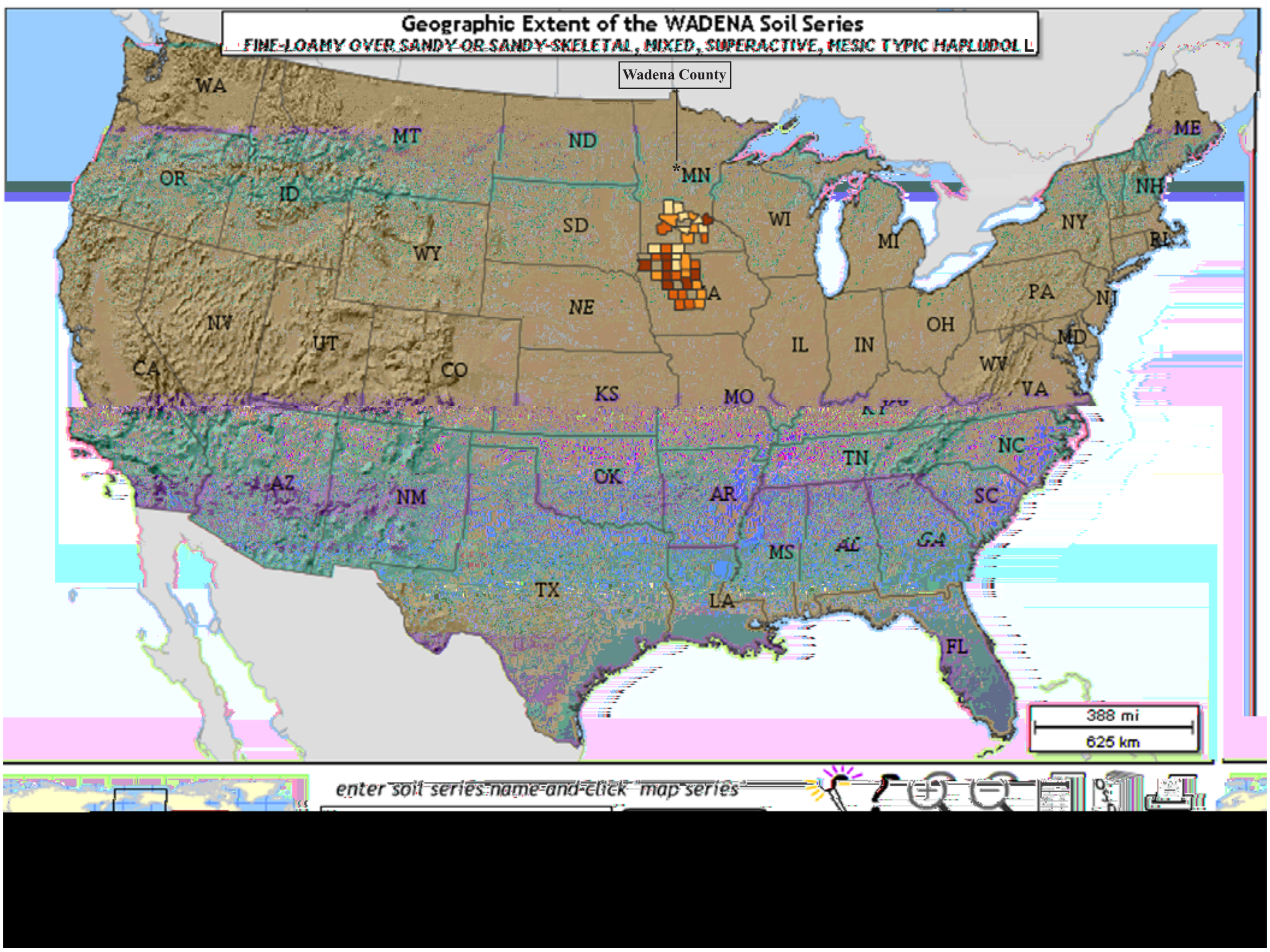
By Sharon Waltman, Soil Scientist-National Soil Geospatial Database Team Leader, National Geospatial Development Center, NRCS, Morgantown, West Virginia.

Background

The national extent (acreage) of soil series in the United States was last mapped a decade ago. Public domain GIS software and main frame computer output were used. They required installation on local computers across the nation. Today, a Cooperative Ecological Studies Unit (CESU) partnership has improved the ability to map soil extent through use of the Web-Based Soil Extent Mapping (SEM) Tool (http://soils.usda.gov). The partnership includes Penn State University, Center for Environmental Informatics; West Virginia University; and NRCS, National Geospatial Development Center and National Soil Survey Center.

Explanation

The SEM Tool is an exciting new Web application that for the first time provides the user with interactive national maps of the extent of soil series based on the land area of mapped soils. This tool enhances the understanding of soil series concepts and soil taxonomy in relation to the natural divisions of physical land resources, enabling closer scrutiny of these concepts by NRCS soil scientists, university educators, and the general public. The more than 20,000 interactive maps are based on the land area of soil series mapped in detailed soil surveys throughout the United States. The tool also provides tabular acreage summaries for individual soil series by soil survey area and access to the Official Soil Series Descriptions.



Later this fall, the SEM Tool will be expanded to enable querying and extent mapping of such soil taxa as order, suborder, and great group. The SEM Tool is launched when a user queries Official Soil Series Descriptions (http://soils.usda.gov/technical/classification/osd/). Also, it can be accessed from http://soils.usda.gov. A microphone icon is available for people who wish to contribute comments through the SEM user survey.

Contacts

Jon Hempel, Director, National Geospatial Development Center
jon.hempel@wv.usda.gov

Sharon W. Waltman, Soil Scientist-National Soil Geospatial Database Team Leader
sharon.waltman@wv.usda.gov

Editor's Note:

I tried the Wadena series. (See the map on the previous page.) I graduated from Wadena High School (in Minnesota). Although the series was established in Wadena County (in 1926), Wadena soils are not mapped in the county, which is about 75 miles north of the northern extent of the series. ■

Phil Derr Passes Away

Written on September 29, 2006, by Steven J. Jelden, Soil Scientist, NRCS, Casper, Wyoming.

Phil Derr, former Wyoming Soil Correlator (1977-1989) and Wyoming State Soil Scientist (1989-1994), passed away last week at his home in Casper, Wyoming. Phil was 66 years old at the time of his death.

Phil was one of the most colorful characters I have ever met. I learned a lot from him when the subject turned to soil science. Although his life was short in years, I think those who knew him would agree his life was lived with a special GUSTO.

If you have a favorite story about Phil or a story that you remember him telling, please send me an email and tell me about it. Phil always said he was going to write a book titled "The Book of Doubt," but I don't think he ever got around to recording his stories on paper. It's our loss. Most of his stories were "colorful," if you get my drift, but that was just Phil. All I can say is that after he retired, we all just sat around at break time and looked at each other. We had been listening to stories from Phil for so many years; it was difficult to compete with that.

Following is a story by Dr. Larry Munn from the University of Wyoming.

The Alaskan Moose

The moose story dates to about 1990. We were all in Fairbanks for a Western Regional Soil Survey Committee meeting and ended up one night at a riverfront restaurant/bar for some social time. The restaurant was plagued by a horrible stench from a dead cow moose that had floated down the Chetana River and lodged on a snag in the middle of the river. After some banter and bartering with the manager, he made an offer of 10 pitchers of free beer to anyone who would rid him of the stench.

So, the Wyoming contingent provided leadership (?) for an expedition to free the moose from the snag. Joe Moore refused us the use of his canoe (one can only consider this a wise decision on his part) and so we went to the far shore and waded out to the snag/bloated moose. I can remember Jack Rodgers from Montana standing on the bank muttering that we were all going to drown but the Wyoming group and a couple of the Alaskans ended up freeing the moose and letting her float away past the restaurant.

We did get some free beer from this but I am not sure if we really got 10 free pitchers; I don't believe anyone could count that high at that point—even Phil, who had a pretty good capacity, was pretty well in his cups as I recall.

I do remember Phil as having a memory for every soil pit he had ever seen (or at least he could argue about it!). I learned a lot from him and consider myself fortunate to have spent some time looking at soils with him.

Larry

I'm sure there are many more stories out there, so please share them. Maybe if I get enough stories, I'll try to finish "The Book of Doubt." Send stories to:

Steven J. Jelden
USDA, NRCS
P.O. Box 33124
Casper, Wyoming 82602
307-233-6773 ■

Rooftops to Rivers Publication Available

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

Rooftops to Rivers: Green Strategies for Controlling Stormwater and Combined Sewer Overflows from the Natural Resources Defense Council (NRDC) is a policy guide for decision makers looking to implement green strategies in their own area. It includes nine case studies of cities that have successfully used green techniques to create a healthier urban environment.

The urban landscape of roadways, sidewalks, and buildings has changed the way water moves through our environment. Rain or snow that falls on paved surfacesRi assists9(dscape20.00070.0ncas8 Tfn or spicks up(coe ade)3(NRlu(putss has changed)]TJ 0.0007 Tc 0.25(i snNRlt. Raises py

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