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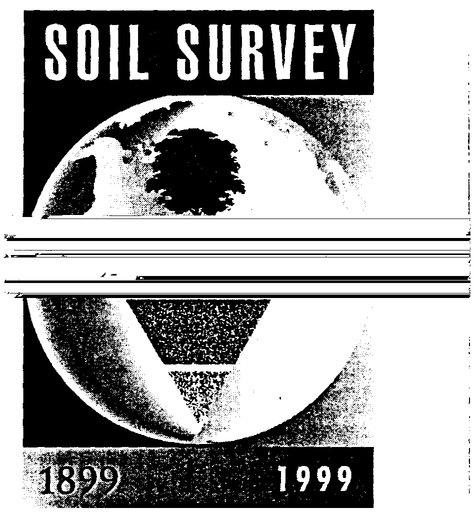
National Cooperative Soil Survey Conference

Back To The Future,
A Centennial Celebration Of
Service To The Nation

June 27-July 2,1999



CENTENNIAL

Holiday Inn Select
Downtown Convention Center
811 North Ninth Street
St. Louis, MO 63101

United States Department of Agriculture
Natural Resources Conservation Service

June 27 - Sunday

Registration	4:00 - 7:00 PM

June 28 - Monday

Facilitator: Dennis Potter

7:00 - 9:00 AM	*Registration*
8:00 - 8:15 AM	*Welcome by the Univ. of MO-Columbia* Dr. William C. Stringer, Assoc. Dean College of Ag., Food and Natural Resources
8:15 - 8:30 AM	*NRCS* in *Missouri* Roger A. Hansen
8:30 - 8:45 AM	*Soil Survey and Resource Assessment in NRCS* Maurice Mausbach, Deputy Chief
8:45 - 9:00 AM	*Tools of the Trade - 100 years of exploring soil resources - video* Gary Muckel
9:00 - 9:30 AM	*NCSS in NRCS* Horace Smith
9:30 - 10:00 AM	*BREAK*
10:00 - 11:30 AM	*Panel Presentation on Centennial Memories - Back to the Future J. Nichols, K. Flach, B. Hajek, H. Byrd, B. Shelton*
11:30 - 12:00 PM	*Highlights of USFS Soil Survey Activities* Jim Keys
12:00 - 1:00 PM	LUNCH

Facilitator: Jim Keys

1:00 - 1:30 PM	*NASIS - Status and Utility* Russ Kelsea
1:30 - 2:00 PM	*Highlights of Soil Survey Activities in the West Region* Curtis Monger
2:00 - 2:30PM	*Highlights of BLM Soil Survey Activities* Lee Barkow/Steve Borchard

2:30 - 3:00 PM	*Standing Committee Soil Taxonomy (and other standards)* Bob Ahrens
3:00 - 3:30 PM	*BREAK*
3:30 - 4:00 PM	*Standing committee on New Technology* Bob McLeese
4:00 - 4:30 PM	*Final Report from Eroded Soils Committee* Tom Fenton
5:30 - 7:00 PM	*Social Mixer - cash bar*

June29 - Tuesday

Facilitator: Berman Hudson

8:00 - 8:30 AM	*Highlights of Soil Survey Activities in the South Region* Tom Ammons
8:30 - 9:00 AM	*Marketing Strategy for Soil Survey in Missouri* Dennis Potter
9:00 - 9:30 AM	*National Society of Consulting Soil Scientist Activities* Barry Dutton
9:30 – 10:00 AM	*BREAK*
10:00 – 10:30 AM	*Highlights of Soil Survey Activities in the NE Region* Jim Baker
10:30 – 11:00 AM	*Highlights of Soil Survey Activities in the North Central Region* Del Mokma
11:00 – 11:30 AM	*1890 Universities Report Lincoln University* Freda Eivazi
12:00 – 1:00 PM	LUNCH

Facilitator: Curtis Monger

1:00 - 2:00 PM	Introduction of the Chief of NRCS by Maurice Mausbach *Comments from the Chief, NRCS and Open Forum (Presentation of NCSS Soil Scientist of the Year)* Chief - Pearlie Reed
2:00 - 2:30 PM	*Field Trip Orientation* David Hammer
2:30 - 3:00 PM	BREAK
3:00 - 5:00 PM	*Committee Breakout Sessions - 3 sessions running concurrently. Sessions run for one hour. At the end of each hour participants can rotate to another session of interest. This provides participants an opportunity to sit in on 2 sessions of their choice out of the three:* 1. Data Acquisition for Problem Solving 2. Training and Marketing Soil Scientists for the Future 3. Selling Soil Science to Society

June29 - Wednesday

7:30 AM – 5:00 PM Field Trip

The buses will leave the hotel at 7:30 a.m. and travel across the Mississippi River to a site near Collinsville, Illinois. This 30 minute ride will take us to Cahokia Mounds State Historic Site where we will view the remains of the most sophisticated prehistoric Indian civilization north of Mexico. Studies by Archeologists and Soil Scientists have revealed much about this ancient civilization and their attempts to alter the landscapes to suite their needs. We will tour the structures designated by these ancient people and discuss their accomplishments and failures.

The buses will depart Cahokia Mounds State Historic site at 10:30 a.m. and travel back across the Mississippi River to Missouri and arrive at Mastodon State Historic Site about 45 minutes later. This is the site of an extensive bone bed containing Mastodon and other Pleistocene animal remains. At this stop, we will tour the visitor's center and view areas of karst topography and slips initiated by extensive urbanization activities. We will also have lunch at this stop.

The buses will depart Mastodon State Historic Site at 12:30 p.m. for soil excavations where we will observe local soil profiles. At 1:30 p.m., the buses will depart for Wildwood, a newly incorporated community in western St. Louis County, Missouri. This bus trip will take the tour through the eastern Missouri Ozark landscapes where urban expansion is taking place. The tour will view and discuss situations considered as regulations were developed for this new community.

At 4:00 p.m. the buses will depart Wildwood for the hotel. We will arrive at the hotel at about 5:00 p.m. following this full day tour.

July 1 - Thursday

Facilitator: Steve Borchard

8:00 - 9:30 AM	*Panel Discussion 2: Soil Surveys for Environmental Problems* Berman Hudson
9:30 - 10:00 AM	BREAK
10:00 - 10:45 AM	*International Activities* Hari Eswaran/Paul Reich
10:30 - 11:00 AM	*Wetlands Technology* Delaney Johnson
11:00 - 11:30AM	*Highlights of NPS Soil Survey Activities* Pete Biggam
11:30 - 12:00 PM	*C.F. Marbut-MO Soil Scientist* Jim Williams
12:00 - 1:00 PM	LUNCH

Facilitator: Adrian Smith

1:00 - 1:30 PM	*Deep Soil Investigations Report* Phil Schoenberger
1:30 - 2:00 PM	*Site Specific Management* Mark McClain
2:00 - 2:30 PM	*Soil Mapping Using GIS, Expert Knowledge & Fuzzy Logic* A-Xing Zha
2:30 - 3:00 PM	BREAK
3:00 - 5:00 PM	*Agency/Society Breakout Time & Steering Committee Meeting*

July 2 - Friday

Facilitator: Pete Biggam

8:00 - 8:30 AM	*Committee 1. Data Acquisition for Problem Solving* Jay Bell
8:30 - 9:00 AM	*Committee 2. Training and Marketing Soil Scientists for the Future* Dean Martin
9:00 - 9:30 AM	*Committee 3. Selling Soil Science to Society* Barry Dutton
9:30 - 10:00 AM	BREAK
10:00 - 10:45 AM	*The Importance of Soil Survey Information to Land and Water Planning in the State of Oregon* Jim Johnson
10:45 - 11:30 AM	*Task Force Report on Soil Survey Products of the Future* Adrian Smith
11:30 - 12:00 PM	*Closing* Horace Smith

Steering Committee will meet from 3:00 - 5:00 PM on Thursday, July 1
Horace Smith Chairing

Committee members:

Al Amen	Bill Frederick
Tom Ammons	Jim Keys
Jim Baker	Cameron Loerch
Thomas E. Calhoun	Del Mokma
Jim Culver	Curtis Monger
Barry Dutton	Dean Rector
Freda Eivazi	Chris Smith

NPSS-99-603

NCSS Conference Steering Committee Minutes

SUBJECT: National Cooperative Soil Survey Conference Steering Committee Minutes — August 30, 1999

TO: Steering Committee Members (see attached list) — File Code:430-14

Please see the attached "Ballot" and return it as indicated.

The Steering Committee for the National Cooperative Soil Survey Conference met on Thursday July 1, 1999 in accordance with the by-laws. The meeting was called to order by Horace Smith at 3:00 PM, and a quorum was present. Steering Committee members present were the Committee Chair Horace Smith, Thomas Calhoun, Jim Culver, Curtis Monger, Al Amen, Barry Dutton, Del Mokma, Jim Baker, Bill Frederick. Steve Borchard, the new representative from BLM was also in attendance.

The meeting agenda was presented and it included:

I. A review of Article VI of the by-laws
II. Disposition of recommendations from the Conference Committees
III. Assigning new co-chairs for the Standing Committee on Research Needs
IV. Assigning new representatives from NRCSs to the 4 regional Ag. Experiment Station Committees.
V. The location of the next National Conference

Horace Smith opened the meeting by asking if there were any additions to the meeting agenda. Del Mokma suggested that the issue of a Clearing House for Soil Information be added for discussion.

I. Thomas Calhoun reviewed Article <u>VI. Steering Committee</u> of the by-laws and pointed out that section 1. 1.5 requires the Director of Soil Survey to select members of NRCS Regional Soil staffs as members of the Steering Committee. Due to the continued reorganization of NRCS, some Regional Offices do not have soil staffs. It was proposed that this section be amended to read "Section 1. 1.5 -- Six NRCS soil survey staff leaders, to include representatives of the National Headquarters, National Soil Survey Center, and Soil Survey Staff representing each of the four NCSS Regions, as determined by the Director of Soil Survey, NRCS." (this also affects Article III., Section 2.1.2 - Membership)

In addition, section 1.1.6 states that the President-elect of the National Society of Consulting Soil Scientists, Inc. will be the Steering Committee member. This is awkward for the Society since its officers change annually and the NCSS Conference has a two year cycle. The Society wished to designate a member to serve on the Steering Committee. It is proposed that this section be amended to read "Section 1. 1.6 -- A designated representative of the National Society of Consulting Soil Scientists, Inc. as determined by the Society representing the private sector.

These two suggested amendments are attached as a Ballot to these minutes.

II. COMMITTEE RECOMMENDATIONS

A. <u>Eroded Soils Committee Repoort</u>

Committee recommendations include:

1. Recognize accelerated erosion as a diagnostic soil characteristic and add exception statements at the appropriate places in Soil Taxonomy.
2. Incorporate the recognition of erosion into the official soil series description where appropriate.
3. The series classification should be based on the uneroded or slightly eroded series for those series for which erosion phases are recognized.

4. The classification of eroded phases according to Soil Taxonomy should be given as a part of the official series description.
5. A list (included in the report) of those properties considered to be clues to be used in the identification of eroded conditions should be listed under "Other Diagnostic Soil Characteristics (Mineral Soils)" in Soil Taxonomy. An eroded soil will have two or more of these properties. This section should include a discussion of accelerated erosion and reference the appropriate sections of the Soil Survey Manual and the National Soils Handbook.

Steering Committee, recommendations:

1. The report and the associated recommendations included is referred to the Soil Taxonomy Committee for action.
2. Final decisions on the recommendations will be made after the Soil Taxonomy committee recommends a course of action by an NCSS group assembled by the Director of the Soil Survey Division to include Dr. Fenton, representatives from BLM, USFS, and other Universities.

B. <u>Standing Committee on New Technology</u>

Committee recommendations include:

1. Via the soil survey fund allocation process "encourage" each State Conservationist to establish a MLRA soil survey project office that is staffed with a GIS/Remote Sensing Specialist and is equipped with the GIS hardware and software necessary to utilize DOQ's, DRG's, and DEM's.
2. Ensure that each State and Regional staff has the GIS expertise to provide the hardware, software and application support to soil survey project offices.
3. Charge each State Conservationist/State Soil Scientist to implement at least one soil survey project utilizing DOQ's, DRG's, DEM's, Landscape Classification models, on-screen digitizing, etc.
4. Establish cooperative agreements/partnerships at the highest level possible to co-research, co-test, and co-release hardware, software, protocol and procedures for digital data collection and dissemination.
5. Establish a national "soil survey technology clearinghouse" to review, test, and disseminate technology to soil survey project offices.
6. Cooperate with BLM to revise and update the original Technical Note 379 to include ILA approach and "Tool Box" concept.
7. Publish Illinois' Landscape Classification protocol.
8. Provide PEN technology to at least I soil survey project office in each state.
9. Develop a national "soil survey technology training" program cadre to develop manuals, courses, etc. to ensure soil survey staff is adequately trained in GIS and related technology.
10. Develop a national "soil survey technology information and education" program to promote digital technology and deliver web based applications.

Steering Committee recommendations:

1. The Director of the Soil Survey Division accepts recommendations 1, 2, 3, 4, 5, 8, 9 and 10 as information.
2. Recommendations 6 and 7 - A draft of Technical Note 379 will be developed and circulated among the Steering-Committee along with the Illinois Landscape Classification Protocol.
3. The Committee recommends Pete Biggam, NPS and Berman Hudson, NRCS National Leader for Soil Survey Interpretations as Co-Chairs of this Committee.
4. The Committee thanks Bob McLeese for assuming full responsibility for this committee and developing the report for this conference.

C. Committee 1 - Data Acquisition for Problem Solving

Committee recommendations include:

1. Develop a charge for consideration by the Regional NCSS Conferences in the year 2000 addressing a plan to collect measured soil chemical and physical properties and hydraulic conductivity measurements in the field and laboratory to populate the NCSS database under the stewardship of NRCS.
2. Establish a charge for the NCSS conference in the year 2001 addressing the plans developed by the regional NCSS conferences to collect measured soil chemical and physical properties and hydraulic conductivity measurements in the field and laboratory to populate the NCSS database under the stewardship of NRCS.
3. Encourage the Director of the Soil Survey Division to
   --Allocate additional resources to accelerate field data collection including considering additional sample site selection and further evaluation of data gaps
   --Work with subcontractors to collect data
   --Continue efforts to incorporate data from University Experiment Station soil characterization databases into a national database
   --Do a national evaluation and revision of the methodologies used to sample data map units
   --Increase efforts towards development of user interfaces to access both spatial and attribute soil survey data
   --Continue efforts to place soil survey databases on line with emphasis on the previous recommendation
   --Encourage more communication with our clients with regard to their data needs and potential data that they could contribute to the database.

Steering Committee recommendations:

1. Recommendations 1 and 2 are referred to the Regional Research Committees to report,out at the year 2000 meetings.
2. The Director accepts recommendation 3.

D. Committee 2 - Training and Marketing Soil Scientists for the Future

Committee recommendations include:

1. Emphasize science - university programs should be based on physics, chemistry, biology, ecology, and the application of soil science through the development and testing of hypotheses.
2. Hire more entry-level soil scientists in NRCS and cooperating agencies.
3. Promote field experience through lab and field classes and through internships.
4. Provide for on-going education, training, and professional meeting opportunities for soil scientists.
5. Maintain a high level of quality control.
6. Maintain and update the existing soil science databases as well as developing new surveys.
7. Provide competitive wages and promotional opportunities for soil scientists.
8. Provide a reliable funding source for soil science needs.
9. Integrate soil science into other environmental disciplines and work on interdisciplinary teams.
10. Establish rigorous certification and licensing programs for soil scientists.

Steering Committee recommendations:

The Steering Committee accepts the report for inclusion in the Proceedings.

E. Committee 3 - Selling Soil Science to Society

Committee recommendations include:

To continue the committee under Barry Dutton as chair.

Steering Committee recommendations:

Recommendation accepted and suggested that Gary Muckel, NRCS, NSSC be asked toCo-Chair the committee.

III. The Steering committee recommended Curtis Monger, NMSU and Rebecca Burt, NRCS-NSSC as Co-Chairs of the Standing Committee on Research Needs. The Committee thanks Dr. Larry Wilding and Dr. John Kimble for their leadership of this committee over the past 4 years.

IV. Added discussion on the need for a Clearing House for Soil Survey Information.

- There is a lot of information and data in individuals files and elsewhere that should be made available to all for answering questions.
- There should be a National Clearing House.
- NRCS should be charged with keeping the information, but not necessarily for collecting it.
- The Agricultural Experiment Stations should collect it.
- The information should be referenced by Topic, by State, and by individual.
- Perhaps the National Agricultural Library at Beltsville, MD should be contacted to see if they would be interested in housing the information.
- A committee should be established to address this need.
- Ed Ciolkosz is recommended to chair the committee.
- Each of the four Ag. Experiment Station Regions will be asked to designate an Agency member and an Ag. Experiment Station Member.
- The committee should figure out what information should be collected and archived;
  How the information should be configured or referenced;
  Who will catalogue the information;
  Contact the Ag. Library;
  Seek grants (NFS perhaps) to do this;
- Start the processes of collecting and archiving the information;

V. The Steering Committee recommends the next conference in the year 2001 be held in Ft. Collins, Colorado.

Meeting was adjourned

THOMAS E. CALHOUN
Program Manager,
Soil Survey Division

Enclosure

cc:
Horace Smith, Director Soil Survey Division, NRCS, Washington, D

SUBJECT: National Cooperative Soil Survey Conference By-Laws Changes — July 19, 1999

TO: Conference Members (see attached listing) — File Code:430-14

The National Cooperative Soil Survey Conference meets every other year to update the membership on the progress of the Soil Survey and to deal with technical issues germane to the National Cooperative Soil Survey effort. At our recent National Conference in St. Louis, Missouri 3 changes to our National by-laws were proposed. Changing our by-laws requires a majority vote of the permanent membership. Our permanent membership includes representatives of all agencies having a Memorandum of Understanding on the National Cooperative Soil Survey with the Natural Resources Conservation Service. Attached to this memo is a copy of the conference by-laws and a ballot with the proposed by-laws changes.

Please take the time to vote and return this ballot by September 3, 1999 to:

THOMAS E. CALHOUN
USDA/NRCS Soil Survey Division
P.O. Box 2890
Rm. 4242-S
Washington, D.C. 20013

THOMAS E. CALHOUN
Program Manager,
Soil Survey Division

Enclosure

cc: Horace Smith, Director Soil Survey Division, NRCS, Washington, D.C.

OFFICIAL NCSS BALLOT

This ballot reflects committee actions form the National Cooperative Soil Survey Conference held in St. Louis, Missouri, June 28-July 2, 1999 that require amendments to the Conference by-laws.

In accordance with **Article IX. Amendments**:

The by-laws may be amended by ballot with a majority vote of the permanent members. An amendment shall, unles0.00erwishe rovinded00peAin,(tpeafilecntdvesbalt)8(ma)8(e)2di

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VOTE: yvse **no**______________

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"Section 1. 1.6 -- A designated representative of the National Society of Consulting Soil Scientists, Inc. as determined by the Society representing the private sector"

VOTE: **yes ______________** **no_____________**

3. Article III Section 2.1.2

Explanation

This section names the Conference members from Ag. Experiment Stations and from NRCS. It currently states that "two State members appointed by each of the four regional conferences and six NRCS lead soil scientists as members representing each of the six NRCS Regions" will be members. This is the same issue discussed under item number 1 and should be in alignment with that recommendation.

This section should be amended as follows

Section 2.1.2 -- Two State members appointed by each of the four regional conferences and six NRCS soil survey staff leaders, to include representatives of the National Headquarters, National Soil Survey Center, and Soil Survey Staff representing each of four NCSS Regions, as determined by the Director of Soil Survey, NRCS."

VOTE: **yes ______________** **no_____________**

(Exhibit 602-1)

Article 1. Name

Section 1.0 - The name of the Conference. shall be the National Cooperative Soil Survey (NCSS) Conference.

Article II. Objectives

Section 1. 0 - The objective of the Conference is to contribute to the general human welfare by promoting the use of soil resource information and by developing recommendations for courses of action, including national policies and procedures, related to soil surveys and soil resource information.

Article II. Membership and Participants

Section 1.0 -- Permanent chair of the Conference is Director of Soil Survey, NRCS.

Section 2.0 -- Permanent membership of the Conference shall consist of

Section 2.1.1 -- Members of the steering committee,

Section 2.1.2 -- Two State members appointed by each of the four regional conferences and six NRCS lead soil scientists as members representing each of the six NRCS Regions,

Section 2.1.3 -- Individuals designated by the Federal agencies listed in Appendix A.

Section 3.0 -- Participants of the Conference shall consist of:

Section 3.1.1--Permanent members,

Section 3.1.2 -- Individuals invited by the Steering Committee.

Article IV. Regional Conferences

Section 1.0-- Regional Conferences are organized in the northeast, north-central, southern, and western regions of the United States.

Section 2.0 -- Regional Conferences determine their own membership requirements, officers, and number and kind of meetings.

Section 3.0 -- Each Regional Conference adopts its own purpose, policies, and procedures, provided these are consistent with the bylaws and objectives of the NCSS Conference.

Section 4. 0 -- Each Regional Conference shall publish proceedings of regional meetings.

Article V. Executive Services

Section 1.0 -- The National Headquarters Soils staff of the Natural Resources Conservation Service (NRCS) shall provide the Conference. with executive services.

Section 1.1 -- The Soils staff, NRCS, shall:

Section 1.1.1 -- Carry out administrative duties assigned by the Steering Committee.

Section 1.1.2 -- Distribute draft committee reports to participants.

Section 1.1.3 -- Issue announcements and invitations.

Section 1.1.4 -- Prepare and distribute the program.

Section 1.1.5 -- Make arrangements for lodging, food, meeting rooms, and, local transportation for official functions.

Section 1.1.6 -- Provide a recorder.

Section 1.1.7 -- Assemble and distribute the proceedings.

Section 1.1.8 -- Provide publicity.

Section 1.1.9 -- Maintain the Conference mailing list.

Section 1.1.10 -- Maintain a record of all Conference proceedings; proceedings of Regional Conference meetings; and a copy of each Regional Conference's purpose, policies, and procedures.

Article VI. Steering Committee

*Section 1.*0 -- The Conference shall have a Steering Committee.

Section 1.1 -- The steering committee shall consist of.

Section 1 1.1 -- The Director of Soil Survey, NRCS, is permanent chair and is responsible for all work of the Steering Committee.

Section 1.1.2 -- The U.S. Forest Service Soil Survey Leader.

Section 1.1.3 -- The Bureau of Land Management Senior Soil Scientist.

Section 1.1.4 -- Four Agriculture Experiment Station Soil Survey Leaders, one from each respective Regional Conference. This normally is the State representative that was chair or vice chair of the previous Regional Conference.

Section 1.1.5 -- Six NRCS soil survey staff leaders, to include representatives of the National Headquarters, National Soil Survey Center, and Regional soil staffs as determined by the Director of Soil Survey, NRCS.

*Section 1.1.*6 -- The President-elect of the National Society of Consulting Soil Scientists, Inc., representing the private sector.

Section 2.0 -- The Steering Committee shall select a vice chair for a 2-year term. The vice chair acts for the chair in the chair's absence or disability or as assigned.

Section 3.0 -- The Steering Committee shall formulate policy and procedure for the Conference.

Section 4.0 -- The Steering Committee shall plan, organize, and manage the Conference.

Section 4.1 -- The Steering Committee shall:

Section 4.1.1 -- Determine subjects to be discussed.

Section 4.1.2 -- Determine committees to be formed.

Section 4.1.3 -- Select committee chair and obtain their approval and that of their agency for participation.

Section 4.1.4 -- Assign charges to the committee chairs.

Section 4.1.5 -- Recommend committee members to committee chairs.

Section 4.1.6 -- Determine individuals from the United States or other countries with soil science or related professional interest to be invited to participate.

Section 4.1.7 -- Determine the place and date of the Conference.

Section 4.1.8 -- Organize the program and select the presiding chairs for the sessions.

Section 4.1.9 -- *Assemble*

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Section 1.0 -- The committees of the Conference shall be determined by the Steering Committee. Permanent or standing committees, ad hoc committees, and task force groups are considered to be committees of the Conference. The Steering Committee shall select committee chairs.

Section 2.0 -- Committee members shall be selected by the committee chairs. Committee members shall be selected after considering Steering Committee recommendations, Regional Conference recommendations, individual interests, technical proficiency, and continuity of the work. They are not limited to members of the National Cooperative Soil Survey.

Section 3.0 -- Each committee commonly conducts its work by correspondence among committee members. Committee chairs shall provide their committee members with the charges as assigned by the Steering Committee and procedure for committee operation.

Section 4.0 -- Each committee chair shall send copies of a draft committee report to the Steering Committee prior to the Conference.

Section 5.0 -- Each committee shall report at the Conference.

Article IX. Amendments.

Section 1.0 -- The bylaws may be amended by ballot with a majority vote of the permanent members. An amendment shall, unless otherwise provided therein, be effective immediately upon adoption and shall remain in effect until changed.

Appendix A

Memorandum of Understandings with the Natural Resources Conservation Service in the National Cooperative Soil Survey Conference:

- Agricultural Stabilization and Conservation Service, U.S
- Bureau of Indian Affairs, U.S. Department of the Interior
- Department of Agriculture
- Bureau of Land Management, U.S. Department of the Interior
- Bureau of Reclamation, U.S. Department of the Interior
- Defense Mapping Agency, U.S. Department of Defense
- Economics and Statistics Service, U.S. Department of Agriculture
- Environmental Protection Agency
- Federal Crop Insurance Corporation, U.S. Department of Agriculture
- Forest Service, U.S. Department of Agriculture
- National Bureau of Standards, U.S. Department of Commerce
- National Oceanic and Atmospheric Administration, U.S. Department of Commerce
- National Park Service, U.S. Department of the Interior
- National Society of Consulting Soil Scientists, Inc.
- Office of Territorial Affairs, U.S. Department of the Interior
- Science and Education Administration, U.S. Department of Agriculture, Extension, CRIS
- Tennessee Valley Authority (quasi Federal)
- U.S. Army Corps of Engineers, U.S. Department of Defense
- U.S. Fish and Wildlife Service, U.S. Department of the Interior
- U.S. Food and Drug Administration, U.S. Department of Health and Human Services
- U.S. Geological Survey, U.S. Department of the Interior
- State Agricultural Experiment Stations

WELCOME REMARKS FOR
NCSS CONFERENCE
ST. LOUIS, MISSOURI
JUNE 27-30,1999

MAURICE J. MAUSBACH
Deputy Chief for Soil Survey and Resource Assessment

INTRODUCTION

On behalf of the Natural Resources Conservation Service and the Soil Survey and Resource Assessment Deputy area, I welcome you to the Centennial NCSS conference. We have much to be proud of in our first 100 years of soil survey and much to look forward to in our next 100 years of soil survey. It will take all of us working together to maintain a strong, viable soil survey program that is responsive to the needs of our clients.

In my remarks today I will briefly touch on some of the more recent accomplishment in the first century of soil survey, current and emerging issues, and finish with some challenges for the next century.

ACCOMPLISHMENTS

This is where we get to gloat a bit by remembering a few

CURRENT AND EMERGING ISSUES

- Global Climate Change - Carbon Sequestration
  - Current climate change studies have placed soil survey in a pivotal position. As many of you know, soil survey has had a global climate change initiative for many years. One of the projects has been wet soil monitoring. With the renewed interest in carbon sequestration we may need to reprioritize our global change activities to address these emerging issues of estimating the potential for carbon storage in the soil.
  - NASIS and SSURGO play critical roles in estimating potential for carbon sequestration. It is critical that we get the information readily available to the users.
  - We are currently working with ARS and Colorado State University researchers to perfect models for estimate soil carbon. The CENTURY model will be critical to meeting Kyoto protocol objectives. We are also working with ARS scientists to, develop a model to estimate the impact of conservation systems on soil carbon.
- Animal Feeding Operations (AFO). We are working within the scientific community to develop Phosphorus index/loading thresholds for soils for use by our field technical specialists in developing nutrient management plans. We anticipate a full scale effort next year.
- Land health
  - We need to move from erosion to a more comprehensive estimate of the health of our land. Our staff in the Resource Assessment Division is working on measures and indicators for land health to be used in a State of the Land publication.

CHALLENGES FOR THE NEXT CENTURY

- In the first century we have concentrated on the so-called Static Properties of soils. In the next century we must collect information on the dynamic properties as related to land use and management. This includes the impact of land use and management on the properties of soil surface horizons. We observe the impact of land use on the soils daily in the mapping activities, but just need to develop procedures for recording the information in our databases.
- Geospatial techniques for analyzing and using soil survey information. We are just scratching the surface in the potential use of digital soil survey information. We must have a cadre of research scientists investigating new ways of utilizing this valuable information including the use of geostatistical clustering techniques and virtual simulations of water movement through the landscape.
- Interpretations have been and will remain the bread and butter of soil survey. We need to investigate landscape interpretive models using our soil survey data and who better to do this that the scientists who developed the soil mapping models.

SUMMARY

I believe we have a bright future for soil survey, but it will take diligent, hard work from all of us to maintain and enhance the program and science in a society of rapid change. I am excited about being able to work with the soil science community to bring a viable soil survey into the 21st century. Thank you for your attention.

The NCSS: Past Accomplishments, Current Status, and a look to the next Millennium[1]

by

Horace Smith
Director, Soil Survey Division
USDA Natural Resources Conservation Service
Washington, D.C.

As chairman of the National Cooperative Soil Survey (NCSS) Conference's Steering Committee and leader of the federal part of the NCSS, I want to join with the others in welcoming each of you to this conference. This conference is unique in that it provides a forum for NCSS soil scientists and others to get together every two years and reflect on where the soil survey is now and where we hope to take it in the future. It also allows us to discuss and prioritize those important key activities that will lead us into the future. I especially want to welcome those who are participating for the first-time, and those from outside the United States. With shrinking budgets and full schedules, I am sure many of you made great sacrifices to be here. I also want to thank the retired NCSS soil scientists who are with us and will be on the program later. It is always good to see those individuals doing so well and enjoying the fruits of retirement. Many of us worked with them in past years.

map the soils in four widely separated areas of the United States. These original test projects are of great historic interest. They mark the beginning of a very ambitious effort: to classify and map the soils of an entire country. This was a first in the history of the world. These four surveys have led us down a long, rocky, yet fascinating road. The soil survey program in America expanded rapidly during the first year. By 1910, detailed soil surveys had been completed on nearly 137 million acres. Our soil survey program began with some very ambitious goals. Let me attempt to summarize them:

1. Investigate the biological, physical, and chemical nature of America's soils.
2. Determine the potential uses and limitations of the nation's soils.
3. Classify the soils of America and prepare detailed soil maps for the entire country.
4. Make soil maps and information readily available to the American public in the form they can use effectively to make sound land use decisions.

With the remaining time allotted to me, I would like to talk briefly about the progress we have made during the past 100 years in meeting each of these broad goals. I would also like to bring you up-to-date on the current status of the soil survey and discuss some future directions and challenges, as I see them, as we prepare to lead the NCSS into the 21st Century.

Let us talk briefly about the progress we have made in meeting each of these broad goals:

Goal number 1: Investigate the biological, physical, and chemical nature of America's soils.

We have made good progress at achieving this goal as indicated by the following:

- At the National Soil Survey Laboratory in Lincoln, Nebraska, we now have analytical soil data for over 25,000 locations from the United States and abroad. This information is augmented by the large amount of soil data that has been gathered and catalogued by cooperating state universities over a period of many years.
- A good indicator of the zeal with which we have tried to meet this goal is the long list of excellent scientific papers in the field of applied soil science. Most of the classic papers were written by the early pioneers of the soil survey and the NCSS during the first three-quarters of this century. I am happy to say that our friends and colleagues at cooperating universities wrote a large number of these papers dealing with important soil survey issues.
- We have not been aggressive in investigating the biological nature of soils, especially the surface and near-surface parts of the profile. Data for this part of the soil will be routinely needed in the future. We have placed special emphasis on this with a change in our priorities and the creation of the Soil Quality Institute.

Goal number 2: Determine the potential and limitations of the nation's soils.

We have made great strides in accomplishing this goal, but much is yet needed. The general area of soil interpretations needs constant research and development, as well as constant testing of existing methods and concepts. A few of these accomplishments include:

- We have developed soil interpretations for a large number of various land uses.
- We have now developed computerized criteria capable of rating any soil in the country and providing information on its inherent potential as well as its limitations for a wide range of uses.
- We have established a staff at the National Soil Survey Center (NSSC), led by a National Leader, to provide leadership for the development of new and innovative soil interpretations and the refinement of existing ones.

Goal number 3: Classify the soils of America and prepare detailed maps for the entire country.

Years of soil survey and associated research have taught us much about the soils of this continent and of the world. We realized some years ago that, just as in most other natural sciences, we needed a classification system to help organize and transfer the large amount of knowledge we have accumulated. During the past century, we have developed an impressive soil classification system and have completed soil surveys on a large portion of the country. A brief summary of these achievements includes:

- One of the earliest classification systems, developed largely by Dr. Curtis Marbut, was presented early after the turn of the century. Another scheme was published in *The Yearbook of Agriculture, 1938*.
- In the early 1950s, we began work on a quantitative system that could be used to classify not only all of soils in the United States, but all of the soils in the world. Soil Taxonomy was published in 1975 and the first comprehensive revision will be published this year. This is the most comprehensive soil classification system ever developed and is used throughout most of the world.
- During the past 100 years, we have completed medium intensity soil surveys on more than 90% of the total land area of the country. However, more than 40% of these surveys are outdated and in need of updating.

Goal number 4: Make soil maps and information readily available to the American public in a form they can use effectively to make sound land use decisions.

We have been making soil survey information available in print form for almost as long as we have been making soil surveys. Currently, we have begun to provide soil survey information in other forms and as we approach the next century, new and innovative formats will be commonplace:

- Many people in my generation are amazed at how computers and information technology have impacted about everything we do, including soil survey. We now have soil survey information available via the Worldwide Web and CD ROMS.
- Some years ago, we concluded that we had to move as rapidly as possible to start producing soil surveys in digital format. We formulated a long-term goal of making soil maps and interpretive information for the whole country available directly on computer. I would say, we are making slow but steady progress.
- We have instituted a program to acquire digital orthophotography for every soil survey area in the country. Our current plans are to have complete orthophotography on all private lands by the year 2000 and on all public lands by 2002. Digital orthophotography is used to accurately compile soil maps on a rectified, stable base as a first step in digitizing them.
- Our ultimate goal is to digitize the soil maps for every survey area in the country. At the present time, we have a little over 600 surveys digitized and certified to SSURGO Standards.
- This effort at nationwide digitizing of soils is both ambitious and exciting. Our ability to analyze resource data, conduct environmental assessments, and evaluate the performance of environmental programs--all will be enhanced by the availability of digital soils data.

As we prepare to move the NCSS into a new millennium, a few things will remain status quo. But by necessity, the NCSS will look quite different and its focus will change drastically in many important areas. Needless to say, the NCSS must and will remain committed to a science-based approach in all of its activities. I would now like to briefly highlight a few areas, some are new, that I believe will characterize the NCSS in the 21st Century:
The NCSS will be the developers and repository for soil survey standards, while the National Society of Consulting Soil Scientists and the private sector will become more actively involved in data collection;

- The NCSS will become more politically active in securing support and resource for the soil survey;
- The NCSS will need to strengthen current partnerships and develop new ones, especially with geoscience groups;
- The NCSS will continue to support international exchanges and collaboration, and involve the international community in the testing and refinement of soil survey standards;
- We will examine soils to whatever depth information is needed and not be limited to the arbitrary depth of 2 meters;

- We will employ GIS, expert knowledge systems, fuzzy logic, Global Positioning Systems, Ground Penetrating Radar, Digital Elevations Models, remote sensing, and other advanced technologies in the soil survey;
- Soil surveys will be conducted and maintained along MLRA or natural landscape boundaries, with fewer, but larger and better equipped and staffed project offices;
- Getting an initial once-over soil survey completed on all private and public lands of the United States will continue to be a priority;
- We will need to recruit and maintain a diverse cadre of highly competent soil scientists;
- We will seek better knowledge of urban soils and work to develop a classification scheme for anthropogenic soils;
- We will deliver soil survey products in several media--traditional hardback, CD ROMS, World Wide Web, etc.;
- We will continue to solicit support for the ongoing development and maintenance of the National Soil Information System (NASIS);
- We will continue to accelerate the digitizing effort that was started a few years ago; and
- We will take a hard look at our soil survey investigations efforts, continue those projects that are needed and can be justified and phase out those that have served their purpose.

In conclusion, I believe we all can agree that the NCSS has had a very interesting and productive 100 years, but there is much yet to be done. The soil science discipline is still very young. During this centennial year, we are looking back over a century and reflecting on our many achievements and proud history. We have held a series of Town Hall Meetings around the country to get feedback from our cooperators, customers, and users of soil survey products on what they would like the Soil Survey to be in the next millennium and what kinds of products should it generate. Feedback from these meetings will help us as we develop policy and long-range strategies for the next century. I believe the Soil Survey of the 21st Century will be science based, professional, productive, and respected. The potential constraints are few and opportunities for achievement and advancement are unlimited.

1999 National Cooperative Soil Survey Conference
BACK TO THE FUTURE PANEL DISCUSSION

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Soil Classification, Correlation and Interpretation From 1956 to 1993.

Field Training

I entered training in February 1965, in Oklahoma, on the Standard Soil Survey. We used phases of soil series from the 1938 Soil Classification System as amended in 1949, in single named units as well as soil complexes and undifferentiated units. The soil series had a soil description but was based on a modal concept centered around the typical description and had only a few lines of Range of Characteristics. Much of the series definition was in the Differentiae From Other Series, in statements on how the series differed from closely related series. We understood the concept of inclusions and these were in the mapping unit description. The definition of the series was the realm of the Senior Soil Correlators with considerable help from the field party and State Soils Staff.

This was a period of rapid change from a limited number of soil scientist during World War Two and few soil surveys were published. Only three years earlier the two soil surveys, the "Bureau" and the Soil Conservation Survey were combined by the Secretary of Agriculture. The Bureau surveys had been largely at I inch per mile(although they were changing to a larger scale) and by soil series. The SCS surveys were on a simplified code based on soil texture, depth and permeability although Oklahoma had several county surveys by phase of series. The code surveys were made for farm and ranch planning and were not intended to be published and were not subject to Bureau correlation. The new standard surveys were by series and were to be published. The state and field staffs were mainly former SCS'ers and the Washington and regional staffs and laboratory staffs were mainly former Bureau employees. We new hires could see a some fiction in the marriage although I think about all worked to make the new system work. The SCS Regional Offices had been eliminated and the technical staffs scattered about the time the two soil surveys were combined but the PSC Offices were left alone. My idea is that the resulting confusion among conservation types let the soils people develop a workable system.

Interpretations were made by mapping units and were made for each survey. The conservation part was coordinated by Major Land Resource areas and was a system of alternative treatments. Field inspections were mainly by state staffs. Correlations were by Senior Soil Correlators, usually located at colleges and covering more than one state. They were on the PSC's staff and were called Washington field staff. Their name went on the cover page of the survey after the names of the field party. Intermediate correlations were made by the Principal Correlators Office and final correlations were made by the Washington office. Soil series and their classification were the responsibility of the Washington office. Our guidelines were the Soil Survey Manual and NHQ Soil Memoranda and Advisories, sometimes supplemented by the state.

By the time the second survey I had worked on was finished in 1959 there were some changes. The correlators name no longer went on the survey and about this time they lost the senior from their title and were under the supervision of the state soil scientist. Dr. Charles E. Kellogg had put a correlator for interpretations on the PSC's staff and later a soil scientist manuscript position. His speeches reflected the need for better interpretation and better manuscript writing.

When I was Party Chief of the Osage County, Oklahoma survey in 1960 another party chief and I went to Lincoln to the Correlation School. Dr. Roy Simonson gave us information on the new 7th Approximation and what it would do. Carl Fisher and I went to Stillwater a few months later to assist Louis Derr and Henry Otsuki in putting the soils of Oklahoma in the system. Later I would help make changes each time revisions came out. In about 1961 Regional Range Conservationist Arnold Herrwagen came to Osage County with a large contingent of state staffers. He had a new idea that I attributed to he and Dr. Andrew Aandahl. Soil complexes would also be range site complexes. Previously they had been one range site averaging conditions between the two soils. We would coordinate range sites by soil series or by soil types. Range interpretations were by taxonomic and not by mapping units. The crops people would come along in a few years.

I was a soil survey specialist for Southwest Oklahoma when Washington Advisory W223 was issued that soil interpretations would be coordinated interstate. We met with other states and coordinated interpretations by MLRA's We used those large spread sheets for several years until the next development.

The Early Soil Taxonomy

We received the June 1964 Supplement to Soil Taxonomy in the summer of 1964 with the order to use it in soil surveys. A technical staff was being established at Fort Worth as a part of four Nation Technical Centers to serve the Country and the five PSC offices were reduced to four as part of that setup. Series had to be classified in the new system and written in the new format before correlation in a county. One of the big changes was that climate was a part of classification. No more running Yahola, an alluvial soil, from the Oklahoma Panhandle to Central Louisiana. Another big change was departure from the modal concept of series to boundaries in characteristics between series. The concept of B was also expanded and it was given more than one meaning. Dr. Kellogg had put Dr. Guy Smith in charge of the new Taxonomy and it sort of took on a life of its own. I am sure some of the changes worried the old timers but most were enthusiastically accepted by state staffs.

I became the soil correlator for Oklahoma in 1965 and got Ed Templin's old desk. Ed worked with Henry Otsuki, Fenton Gray and I on the first correlation I took to the new NTC at Ft. Worth. Ed was one old timer that was supportive of the new system. He retired soon after. In the fall and for several years after we would meet at Ft. Worth with our brief cases full of soils data and work on Soil Taxonomy. One of our first problems was that slightly developed soils on terraces were in the same family as very thick soils on old surfaces on the coastal plains. We added the Pale Great Group. There would be Pale in the Mollisols and Alfisols also, all the way to the Aridisol break.

Another of the old Bureau titles was abolished in 1966 when party chief was changed to party leader by Washington edict. The personnel person said that the SCS did not have Indians. I noticed a few years later the head of the SCS became the Chief of SCS. Probably no connection.

The classification boundaries seemed too wide to fit our series and MLRA concept on the drier side of Oklahoma. We needed an aridic subgroup to be on the drier side of typic for both Mollisols; and for Alfisols. I found that the ARS and the Oklahoma Agriculture Experiment Station had soil moisture data by neutron probe for several sites for several years. I used that data to write a definition to separate aridic from typic subgroups by days dry. The days dry was later changed to a proportion of the time the soil moisture control section was above 5 degrees. This 'may present a problem at the northern boundary were the days involved could be less than we could map precisely. At the time the drier subgroups of Alfisols and Mollisols had a dual differentiate of depth to lime and soil moisture. The lesson was that even in this case it was difficult to keep two soil characteristics parallel. Depth to lime, was dropped.

We had a problem on soil map detail where we needed more detail for crop land than for rangeland. Louis Derr had addressed this, when he instructed in the Osage County, Oklahoma Initial Review, to not delineate areas smaller than one animal grazing unit. Dr. Bartelli said to call these units soil associations and to document them with soil transects. There were guidelines for transects as several papers ha been written on this Subject. Later a committee would be set up to make a study since we were not alone with the problem. Eventually the study would culminate with Orders of Soil Surveys and definitions.

The Soil Survey Laboratories responded with assistance for the data we needed to properly classify soils. We spent considerable time sampling for specific problems as well as to answer questions for correlations. The Oklahoma Experiment Station set up a lab to assist the SCS labs in this work. The Soil Investigation Units in New Mexico and North Carolina gave their expertise on numerous occasions. One such trip was to Southwest Oklahoma and the adjoining area of the Rolling Plains in Texas to look at and sample Paleosols. I thought those trips were extremely important to get ideas together and to train soil scientist. On this trip we also looked at the Indiahoma series, a Vertisol with linear gilgai and a cyclic pattern. The red soil on the ridge top was one classification and the dark brown soil in the swale was a different classification with a different plant community. I had proposed the series and Henry Otsuki distributed it for comment with two typifying pedons. At first Dr. Bartelli liked the idea but then he thought Simonson would think we were off the deep end in the South. The soil now has one typifying pedon with a strange range of characteristics. I have a copy of the file at home and if I ever think of a better solution I will let you know. The farmers called the soil candy striped land. The party chief Wondered if we were making an improvement to the science of understanding.

Several states had their own interpretation sheet to record and hopefully coordinate interpretations. Dr. Bartelli convinced the state soil scientist and soil survey leaders that the south could do a better job with this system. Several meetings and a Southern Work Planning Conference later we had a pencil form with guidelines. The West N'TC area was also working out guidelines. With experience and much work this system became the Soils 5 Form and the interpretations part of the National Soil Handbook. I think this system made the Soil Taxonomy work because as long as some states could make their own interpretations they tried to hang on to their favorite series. These were difficult times as many series were narrowed in area. Some states lost favorite series that had been used in general soil maps and on experiment stations. One soil survey leader said we could not change that soil because it was the only one the Dean of Agriculture knew.

After moving Colorado as state soil scientist a reoccurring problem with Kansas came up. If they started with Class I soil on the East side of the state in the Udic regime and dropped one class for each moisture regime and each MLRA they joined Colorado with Land Capability Class IV which did not leave Colorado conservationist much leeway. This was an area where much of the farming was cultivated every other year with moisture stored in the off year (fallow). This was an essentially unsolvable problem where there were no mistakes but groupings with uneven numbers fit together roughly. Bob Ikleberry, correlator for interpretation at Lincoln, told me never to use one interpretation to make another but to go back to the soil characteristics. This is still sound advice.

Toward the Modem Soil Survey

I moved to the South NTC in 1971. 1 took an idea from the west to make computer generated soil interpretation maps. Dr. Bartelli gave the go ahead and I worked with my old boss Henry Otsuki in Oklahoma and a cartographer and a data base manager programmer to adopt the U. S. Forest Map Information and Display System (MIADS) to make cell maps on 20 to 40 acre cells. The system worked and eventually the system covered nearly 400 counties, mostly in the South but some in all four NTC areas. The system could have been improved further but NHQ insisted on putting 01 of the computer map resources into a fine program that was not to work until several years later because of computer size and map joining problems. The MLADS program was used mainly for education and not the planning system I had envisioned. I hope you are faring better with the STATSGO system.

Bartelli and Keith Young had worked on storing the soil interpretation form and printing out tables for manuscripts. With word processors being invented Bartelli put Westal Fuchs and I on the project with two secretaries while he worked with IBM on the data problem. We made it work and gave the NHQ Soil Staff and ADP staff a demonstration. They approved the idea for national use and got Iowa State to do the storage and retrieval and got us word processors to use in the project. There was a national committee on how to do soil survey manuscripts and soil maps because there was a large backlog of unpublished surveys and more coming into the pipeline. I believe the 133 soil surveys published in 1979 was a record.

When we had a problem on correlation such as naming phases, we would go to Bartelli and he would get out a book of letters and comments from Dr. Simonson and find a solution. When James Coover took over as PSC, James DeMent asked if all of the assistants could have a copy of that "book". Dr. DeMent was working in the correlation room with Oklahoma correlator Jimmie Frie when he looked up a solution in the book. Jimmie said, "$$$, if I had a copy of that book I could have got it right the first time". The states were then sent a copy. Later this would become a part of the National Soil Handbook. There is a lesson here that probably is not realized at this stage of the survey. The Senior Soil Correlators and PSC's always had some information that the field people. or even the state staffs did not have. In addition NHQ usually had some ideas that were unknown to the field. When the Soil Taxonomy was being distributed to the field James Coover remarked that now soil scientist could be their own correlators. Meaning that all levels of soil scientist had access to the material for soil classification. It was a few years before map unit naming procedures were well spelled out in the National Soil Handbook although Soils Memo 66 was a masterpiece as far as it went. I recommend reading it today for an example of clear, concise writing.

The first International trip for soil classification was to Brazil in 1977. Dr. John McClelland and I went on some sort of deal with University of Puerto funds. There are several people here who were on that first trip. Guy Smith and Roy Simonson were there as was Rene Tavenier from Belgium. Soil scientist representing many countries and much expertise were there to look primarily at low activity clay soils. After the first field trip day Dr. McClelland asked how the trip differed from trips in the U. S. I had noticed that a fairly large number of soil scientist accepted the soil description furnished with the data and did not get in the hole. U. S. soil scientist tended to get in the hole, dig and often make their own descriptions. Rather than carry the heavy "green book" I had my secretary photocopy the main definitions and keys and divide the columns so that I had a four by ten inch by one-half inch thick pocket book. Many on the tour liked the book and I gave it to the leader at the end of the tour. I assume Jack McClelland turned that idea into the series of Keys to Soil Taxonomy.

A correlation in Florida, had both Order 2 and Order 3 mapping units and what James DeMent thought was an Order 4 because of the detail, the way it was mapped and the substantiating evidence. The unit was nearly level, flooded daily by tides and were largely organic soils. Robert Johnson wanted to place the unit with the other Order 3 units. When I called Bob to ask why he gave me the straight story as was his custom. If he let it go Order 4 it was to be described and interpreted in the map units and in Order 3, the interpretations could go in the table. We went with Bob but I hated to see one set of policies affecting another.

In one of the Washington reorganizations the NHQ Head Correlator job was eliminated. The PSC's talked it over and asked Dr. Flach for an NHQ correlator and he set up the position. Victor Link and then Richard Guthrie held the position. The value I think was that the states felt they had some sort of supreme court although they rarely used it. I believed, as I think the others did, that it helps to have arbitrators if we become too regionalized.

At a soil conference of the Washington and NTC staff in 1982 I proposed that we separate Order 2 and Order 3 mapping units in separate interpretation tables. I believed they were different and we said they were made for specific purposes, indicating that we should not be making all kinds of interpretations for them. I was voted down because of the complications of producing the manuscripts. I was assigned chairmanship of a National Work Planning Conference Committee in 1983 on Interpretations for different Orders of Survey. I had a good committee and we raised a lot of questions. The consensus was that the simplicity of our interpretations did not require a separate effort. When the single weight characteristics f6r non-agriculture interpretations are superseded by better interpretations and when we get into more planning with STATSGO and other generalized maps I believe you need to revisit the kinds of interpretations for different kinds of surveys.

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Aspects of the evolution of the soil survey:
The move to quantification.

by

Klaus W. Flach

The charge to this panel is to discuss aspects of the evolution of the survey. I have chosen to discuss the introduction of quantitative criteria into soil classification and interpretation which took part between 1952 and 1972 which happens to encompass the first 20 years of my association with the Survey. During this time, computers became generally available and I will briefly mention our first experiences. I am pleased that I am sharing this podium with old friends Joe Nichols, Ben Hajek, Hubert Byrd, and Bill Shelton. More than 40 years ago, Bill and I mapped together in Clinton County. New York.

1952 to 72 were my formative years in soil science, as a graduate student under Marlin Cline at Cornell University, who was also a part time senior correlator in the soil survey, as a research soil scientist at the Soil Survey Laboratory in Beltsville, and as head of the Soil Survey Laboratory in Riverside, Ca. I worked closely with Marlin Cline, Guy Smith L.T. Alexander, and John G. Cady, but I also had extensive contacts with Dr. Charles E. Kellogg (nobody called him Charley to his face, except for Roy Simonson who occasionally ventured a respectful "Charles") , Roy Simonson, and Cliff Orvedal of whose death I just learned a few weeks ago. I also had opportunity to associate with Sterling Hendricks, essentially the founder of modern clay mineralogy, and L. A. Richards, who had developed the concepts of soil moisture characteristics that we still use today, and the methods for their determination. All these men were not only outstanding scientists but also excellent and willing teachers as well as helpful friends. Hendricks, by the time I knew him, had shifted to a very successful second career in plant-physiology but he still had his office down the hall" . He had retained his interest in soil science and joined us regularly for lunch; Richards was not directly associated with the soil survey but had his office next door with ARS in Riverside.)

This period includes, of course, the time when the first seven approximations were developed; beginning with the first approximation in 1952 and the presentation of the 7' Approximation at the International Congress of Soil Science in Madison, WI in 1960 which included a memorable discussion between Guy Smith and Victor Kovda, at that time the leading Russian soil scientist. It took quite a few amendments to arrive at the final publication in 1975 (although no major work was done on the system after Guy's retirement in 1972.

The development of Soil Taxonomy as a soil classification system was, of course, important. But I prefer to see its importance more in having caused fundamental changes in the way we looked at all aspects of soil science related to soil survey. In those years soil classification changed from using ill-defined qualitative to using measurable quantitative criteria. This not only revolutionized soil classification but also constituted an indispensable step in making modern soil survey interpretations possible and providing the standards for computer based data bases. In other words, to use Newton's dictum that a science has to deal with measurable entities to deserve the name science, soil classification changed from an art into a science. In my mind, this quantification was more important and had a more profound influence on soil science than the creation of those neat little boxes that are the units of Soil Taxonomy.

To appreciate the magnitude of this change we need to go back to the 1920's. Marbut was head of the soil survey. In 1927 he gave the American soil survey international recognition by organizing the first international Soil Congress, conducting a brilliant field trip (in a Pullman train) of the soils of the United States, and presenting a soil classification system that with several modifications lasted until it was replaced by Soil Taxonomy in 1975. But in 1927 other events which were ignored and are largely forgotten now, may have had a much more profound influence on the future of the soil survey. My birth in the same year is not necessarily one of these events.

Marbut's objectives for the soil survey were extremely narrow. In a paper on *The Soil Survey - Present & Future* at the 1922 meeting of the American Soil Survey Association the author, for example, stated that "one point of view regards soil surveys [is] to do for soils what Gray, for instance, did for our native plants. From this standpoint the chief function of the soil surveyor is to discover, describe, map, but not be concerned with the utilities, or possible utilities, or potential utilities of the soil types which he maps. In the discussion of the paper, Marbut backed the speaker rather emphatically and said that this was not one view but that "we who are doing the soil survey work know that to be the point of view." Marbut also seemed to believe that everything worth knowing about a soil could be deduced from field studies of the soil profile by what he called the "soil profile method." Discussing a paper on soil acidity, he asked the author whether a difference in acidity between two soils was reflected in differences in the soil profile. The author, a chemist, replied that he "didn't know anything about the profile," upon which Marbut concluded that, "then it is not proved that the profile method is not satisfactory." In other words, Marbut was not interested in documenting soil characteristics that were not needed to distinguish one soil from the other, whatever their practical importance.

It seems that many soil scientists, primarily those at the agricultural experiment stations, did not agree with Marbut's views. When the American Soil Survey Association was founded in 1920 it established at its first meeting a "Committee on correlative laboratory work". The committee didn't accomplish much, but it may have provided the incentives for two professors (Krusekopf, a soil surveyor and R. Bradfield, a physical chemist) at the University of Missouri to present papers on *"What information is necessary for* after Bradfield had left. So Bradfield's ideas must have been around. Jenny was a pioneer of quantitative pedology in his own rights, although he thought in terms of pedologic functions rather than quantitatively defined taxonomic criteria.

You probably do not realize just how few reasonably comprehensive data that could be considered representative of taxa were available to Guy in 1952. But then great efforts were made both by the new Soil Survey Laboratories and quite a number of the agricultural experiment stations to rectify this situation and I was very much involved in this work.

The 1950s was also the time when computers and electronic data storage became commercially available but few people realized in 1952 the potential of this new tool. I have often wondered, just what form soil classification might have taken if the decision to take a new approach to soil classification had come a little later or the computer revolution a little sooner. I remember very vividly that in 1970 or 71 some of us who had shown interest in electronic data management were called to Washington to discuss the potential use of computers in soil survey. The meeting started with a lecture by Kellogg. I didn't think he knew much about computers, and he didn't, but he made a fine presentation on how information management had developed starting with knotted ropes, pictographs, poetry, and finally writing, printing and classification systems.

The computer revolution in soil survey started when the Lincoln Laboratory in the mid 60's contracted with a private outfit to do the laborious calculations for mechanical analyses. I remember how amazed we were to find out that computers could do the little cheating we did to make mechanical analyses come out with a total of 100.0 percent by adjusting the single largest size fraction. At that time IBM leased computers to universities at very favorable rates. Well, Benny Brasher and I took a evening class in Fortran programming and then we tried to talk the University of California at Riverside to let us use their IBM 360. According to the terms of the IBM contract, the access to that computer was restricted to members of the university but someone in Washington found a very old copy of the cooperative agreement between the Soil Survey and the University. And this agreement specified that the University and the Soil Survey would share equally the cost of livery that is the cost of the hay and oats for the horses used by soil survey parties. And an unusually flexible bean counter at the university agreed with us that this justified our use of their computer. It was still a cumbersome process, punching data on IBM cards and running them in batch mode. But it worked and a year later we had a disk with the first pedon data base. Since then, computers and data bases made it possible to translate the new ideas on quantitative pedology into practical reality.

1999 NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE

BACK TO THE FUTURE

A CENTENNIAL CELEBRATION OF SERVICE

TO THE NATION

Panel Presentation on Centennial Memories - Back to the Future
Role of State Agencies in Soil Survey: 100 Years of Cooperation
Ben F. Hajek, Professor Emeritus[2]

Almost from the onset, soil survey in the US was a cooperative effort between federal and state agencies. States were participating in field mapping and correlation before 1905. In Alabama, soil surveys published in 1902 - 1905 did not indicate any participation by the state. The State Department of Agriculture and Industries was listed as a cooperator on a survey published in 1907. This Alabama agency continued to employ soil scientists as late as 1960.

Any contributions of state agency personnel are overshadowed by federal agency personnel, especially during the early development days of the NCSS. Workers at state universities were concerned primarily with the soils as they related to production of crops. This was evident to WWI and somewhat beyond.

M.L. Cline (1977) indicated that communication between university faculty and federal scientists in the Bureau of Soils was seriously lacking prior to WWI. There was no forum common to the two groups. Following WWI, in 1920, a soil scientist group was formed. The organization which was made up of both federal and state scientists, held their first meeting in Chicago in 1923 and were fully functional by 1925. Proceedings of the American Association of Soil Survey Workers were published annually. This organization was the nucleus from which in 1935 was formed the Soil Science Society Of America. Currently Division S5 is a direct continuation of this 1920 group of soil scientists. Volume 1 (1936) of the Soil Science Society Proceedings, Division V, listed L.C. Wheeting of Washington State College as chairman and Past Chair was G.D. Scarseth of the Alabama Agricultural Experiment Station. The society had $890.14 on deposit.

In 1952 the Bureau of Soils and the Soil Conservation Service soil survey, merged and under the leadership of Dr. Charles Kellogg, the National Cooperative Soil Survey, as we know it today developed, with full participation by many state and federal agencies in state, regional and national work planning conferences and all various cooperative projects such as making regional and state soil association maps, and regional research projects and work groups.

I did not attempt to catalog and review all specific contributions made by scientists while employed by state experiment stations or other agencies. I have confined this to a few areas and will list some individuals as examples of the many who contributed and who gave a professional lifetime to the NCSS while employed by state agencies and working in close cooperation soil survey field parties, state, regional, national and in many cases international soil staffs. The topics are loosely grouped into the following sections:

[2] Ben F. Hajek, Agronomy and Soils Dept., Auburn Univ., Auburn Alabama 36849

Development of Basic Understanding and Theories
Education, Publication and Training
Soil Mapping
Characterization and Support
Financial Support
Leadership

DEVELOPMENT OF BASIC UNDERSTANDING AND THEORIES

Eugene W Hilgard is the most noteworthy state employed scientist that significantly added to our knowledge of soils. He began his work in Mississippi from 1855 to 1873 before the US soil survey began. He worked a brief time in Michigan, 1973 to 1975 and spent the rest of his career in California, 1875 to 1906. He enumerated most of the theories of soil that the Russians used as the foundation of their concepts.

Hilgard at the same time or earlier than the Russians recognized the correspondence among soil regions, biological regions, and climatic belts. His book, "Soils, Their Formation, Properties, Composition, and Relations to Climate and Plant Growth in the Humid and Arid Regions", is a classic, published in 1911 after a long career of research in the eastern and western United States, is relevant today (may need to update nomenclature). His work did not receive adequate recognition. Marbut must have been aware of his work but chose to take tools developed in Russia to develop a system of soil classification for the United States (Cline, 1977). 1 cannot understand why Marbut gave absolutely no credit to Hilgard in his Introduction in Joffe's book, "Pedology", which is also a significant contribution from Rutgers.

In Joffe's book Marbut makes a point to define Pedology as the only true and unique branch of "Soil Science". Pedology is not a fundamental science as are math, chemistry and physics, it is an independent science dealing with a natural body "soil' the same as botany deals with the natural body "plants", and zoology with " animals". Pedology has a unique nomenclature and starting with Hilgard and Duchieviev, pedology provides the basis for all other disciplines now collectively called soil science.

EDUCATION, PUBLICATION AND TRAINING

Dr. Hans Jenny's, book "Factors of Soil Formation: A System of Quantitative Pedology" has provided a fine work for teaching pedology. He inspired us to think mathematically and logically about soil formation and about integrating soil forming factors to help explain the morphological nature of soils. Later his book "The Soil Resource: Origin and Behavior" published in 1980, provided quantitative examples of soil formation and is and excellent reference for any serious student of pedology.

For years many of us teaching soil morphology and classification did not have a classroom text. When I first started, as a student and an instructor I had The Soil Survey Manual, which was an excellent reference but not a teaching text. Stan Buol (NC State), Frances Hole (Wisconsin) and Ralph McCracken (NC State and Washington, D.C.) contributed significantly to soil survey by authoring the book, "Soil Genesis and Classification", now in its 4' edition. Later Del Fanning, Maryland, published "Soil Morphology, Genesis and Classification7 also and excellent text. However, changes in Taxonomy necessitated editing as soon as it was published.. Dr. Fanning made his typed manuscript available before his book was published. The manuscript provided many complete lesson plans for instructors.

I am confident that anyone that has taken a course in soil classification learned, either directly by reading his publications or indirectly from literature citations, from Dr. M.. Cline (Cornell, New York). His paper in Soil Science (vol. 67: 81-9 1) "Basic Principles of Soil Classification" provides a basis for understanding not only the basics of soil classification but also the logic in classifying things.

Starting in the 1950's Land Judging and Collegiate Soil Judging offered a new approach to teaching soil morphology, classification and interpretation. Teaching soil judging was a college and university function. Setting up contests was usually a joint state - federal activity. Today it is not uncommon for employers recruiting agronomy students to ask if they had participated in soil judging. Participating in soil judging attracted many women and men into careers in soil survey.

Graduate programs, M.S. and Ph.D. have provided the opportunity for Experiment Station faculty, students and federal soil scientists to participate in research from the identification of a problem or need, to sampling, analysis, and interpretation. Numerous students became soil scientists after completing graduate studies. Many full-time soil scientists earned graduate degrees while working and adjusted schedule or while on leave-without-pay.

USDA-NRCS entered into agreements with several universities that conducted soil classification workshops, short courses, and formal courses that qualified for graduate credit.

It is in this realm, education, publication of research results, and participating in training soil scientists that experiment stations have made their greatest contributions to the National Cooperative Soil Survey. They also provided early career employment opportunities to many scientists who moved on to federal agencies. The list includes:

Whitney
Marbut
Guy Smith
Charles Kellogg
Richard Arnold
Ralph McCracken

SOIL MAPPING

State agencies have participated by providing field soil scientists that mapped in state mapping parties or were attached to NRCS soil survey parties. Correlation and quality control were provided by NRCS, however Experiment Station faculty that had state responsibility for soil survey assisted in reviews and correlations. I use my state as an example, because Alabama became involved early in the survey. The first published soil survey that listed Alabama Department of Agriculture and Industries as a cooperator was published in 1907. Consequently cooperation must have started earlier. Alabama (Department of Agriculture and Industries) employed soil scientists into the early 1960's. I am aware that some states are still employing soil scientists to accelerate the soil survey. This opportunity for early careers training also provided soil scientists that joined NRCS for a career in soil survey.

CHARACTERIZATION SUPPORT

Experiment station laboratories throughout the US provided and are providing soil characterization data. When Soil Taxonomy was adopted all regions of the US needed laboratory data to classify in the new system. The NRCS regional laboratories at that time were providing support both with field sampling and characterization however, state labs assumed, in some cases the entire characterization needs for surveys in their respective states. A survey by the laboratory subcommittee of Div. S5 (Soil Science Society of America) conducted in the mid 1970's received responses from all regions of the United States. The results indicated that state laboratory data consisted from only particle-size to all data needed to classify soils. Particle size was the most frequently requested data probably because of family particle-size class limits needed to classify soils.

APPROPRIATED FINANCIAL AND FACILITY SUPPORT

State support for soil survey includes more than actual field mapping and correlation. Funds are appropriated directly to be used by NRCS for soil survey activities. State and local agencies provide office space and office support staff. A major source of support are state appropriations to the state and local soil and water conservation committees.

LEADERSHIP

From the onset soil survey was a cooperative federal-state effort, and despite some breakdown in communications the cooperative has been successful. The success is primarily a tribute to individual state and federal soil scientists recognizing the need and benefits of cooperation and not administrative directives and policies. In contrast, Joe Nichols and I had the opportunity to evaluate the soil survey program in another country. We found three agencies involved in soil survey with essentially no effective cooperation. I often wonder what happened to that program.

During the approximation phase of Soil Taxonomy, and following publication, Dr. Smith and his successors in the soil survey relied heavily on input and leadership for initial definition of classes and later for leadership in making major revisions in Soil Taxonomy. Marlin Cline stands out for his major contributions to soil classification during this period and later he headed the effort to revise the Soil Survey Manual. Major revisions to taxonomy were made under the leadership of the chairmen of ICOM-International Committees, for Oxisols, Stan Buol, North Carolina State University, Spodosols, Bob Rourke, University of Maine, Gelisols, James Bockheim, Wisconsin, Families, Ben Hajek, Auburn University, and currently, Antrophic soils, Ray Bryant, Cornell University. These were major efforts with experiment station leaders time being supported by their respective state teaching and research budgets. In today's committee, goal, strategic plan, and competitive grant society, I wonder if many of us retired experiment station pedologists would have made tenure in today's academic world. I never had a project or budget for soil survey during my entire career. I was hired as a soil mineralogist, soon saw the research needs and opportunities in soil survey. Neither Carter Steers (USDANRCS) or I had any budget nor were we directed to develop a statistical method to use line transects as individuals to evaluate map unit composition. This is an example of recognizing needs and addressing them.

Throughout my teaching and research career in Alabama, I was considered as an unpaid employee of NRCS and I considered that I had a staff to assist me in both teaching and research in every county in the state.

Some Reflections On Soil Survey Interpretations
by William L. Shelton

When I was asked to speak about some of my memories of my career in the National Cooperative Soil Survey I tried to recall some of my early experiences with soils and their interpretations. Naturally, I remembered school and some of those who taught me, but I had to go back even further to those earlier times that had a great influence on what and who I am. My thoughts therefore drifted back to my maternal grandparents who were both part Native American. They instilled within me certain principles and ideals that have lasted over the years and made me have a greater appreciation of the good earth and the forces of nature.

I remember a speech I read that was given by Chief Seattle in 1844. The Chief said that every part of the earth is sacred, every pine needle, every sandy shore, and even every insect is holy in the memory and experience of the Chief and his people. He said that the very air we breathe is precious and the air shares its spirit with all life that it supports. The earth does not belong to humans but humans belong to the earth and whatever happens to the earth happens to us. This is the type of legacy that was passed on to me, a skinny black boy growing up on a subsistence farm in the state of Virginia. I share this with you because, although I did not have any idea then about soil surveys and soil interpretation, I developed a respect and concern for the earth and our relationship to all phases of our environment.

I received a Bachelor of Science degree in Agronomy from Virginia State College and a Master of Science degree from Michigan State. I began my career as a soil scientist with the Soil Conservation Service in upstate New York in 1955. My early soil surveying was strictly on-farm mapping for soil conservationists to develop individual farm plans. Those were the times of trying to map fast enough to stay ahead of the conservationists and farm planners so they could complete the farm plans.

I worked in three New York counties that joined the Canadian border. A number of farmers had moved down from Canada and some did not speak English and I did not speak French. This problem was frequently overcome by one of the farmer's children serving as an interpreter. I later was a soil survey party leader in central New York. In those days I spent long hours writing descriptions of soil series, map units, land use capability and soil associations.

The experiences and responsibilities as soil survey party leader were good background for a 2 year tour of duty in Nigeria in West Africa. This was a chance to experience a different concept of the conservation of natural resources. Our objective was to teach the local people about good conservation practices such as terraces, diversions, grassed waterways and the other conservation practices needed in Nigeria. This was an opportunity to teach people who were eager to learn and the young men we taught had an insatiable thirst for knowledge. Not only information on conservation but all types of information. We did not have lap top computers then, but they were eager to read books, magazines, and any periodicals we had with us. Although we were teaching good conservation of the soil I learned much from the people in Nigeria. They were very strong on recycling and avoiding waste of resources. I still have souvenirs that were made from scrap metal that had been melted and converted into useful items. I know that international activities are scheduled to be discussed later this week and I strongly encourage participation in international soils work. We have much to offer and there is much to be gained and a wealth of information can be had by working in other countries.

Much of my time prior to retiring 12 years ago involved working with soil survey manuscripts being prepared for publication. This involved serving as a liaison between the editors and the authors of soil survey manuscripts. Believe me this could get a little tricky. We soil scientists know that we can write and do not need an editor rewriting our masterpieces. Most editors have never mapped soils but do know how to make a manuscript read smoothly. We looked at soil survey interpretations with the objective of using the same criteria for all regions of the country. Sometimes in order to achieve this objective we had to work with State Soil Scientists and the Principal Soil Correlators. This type of coordination and exchange resulted in making soil interpretations and other information in published soil surveys readily accessible to all of the many users. This great variety of users include homebuyers, farmers, engineers, foresters, builders, developers, and educators.

During my reflection -- my trip down memory lane -- it occurred to me that regardless of which part of this country I have lived in or even areas outside of this country I have had the opportunity to work with a major resource, the people. I have tried to be an active participant of each community in which I have lived. Recently I talked with a mother whose son was in the Boy Scout Troop I worked with many years ago. She said her son told her about how I encouraged him to finish some of the long hikes we were making. He is now an avid mountain climber but remembers lessons learned during those days in scouting. The work of soil scientists requires us to move frequently and to live in different communities but this is a wonderful opportunity to work with our most precious resource - our fellow human beings, especially children and youth. I think that this is not only an opportunity it is an obligation.

Finally I thought about how at the beginning how difficult it was for me to start my career as a soil scientist with the National Cooperative Soil Survey. Although I had a M.S. degree in soils from one of the top agricultural colleges I was given the runaround. This is an unpleasant memory but one we as a nation must not forget. We must utilize all of our people regardless of race, culture or anything else. Our most important resource is our people. My thanks to all for this opportunity to share some of my thoughts. I wish you good luck and continued success.

Comments of a Southern Soil Scientist

By Hubert Byrd

In this centennial year of the soil survey, it's fitting to invite a few old-timers to your conference. I'm pleased to be among them. Thank you.

In my remarks about events of the past, I'll put some spin on those events, but my hope is that nobody will take umbrage at things said.

A number of articles and news items reappearing about this history. Those I've seen have been good and put some focus on events through the years. One I especially liked was in Conservation Voices. By decades it listed the more notable events and I've chosen to cluster my remarks that way.

My work as a soil surveyor (we weren't soil scientists then) began in December 1950 at Americus, Georgia. Our product was soil & capability maps of farms. I was provided a screw auger, a map board & soil legend, photographs and a truck. In Berman Hudson's first article I learned the origins of the land capability system extensively used at that time to emphasize the conservation needs of the land.

Producing a soil map of a farm seemed a neat idea, but the legend information didn't seem to spark a lot of interest on the owner's part. It was to be nearly a decade later that new and innovative ideas, such as predicting function and suitability for other uses, would come about. I had copies of soil survey reports of counties, published in earlier years, and studied them, but they were the only evidence of the cooperative soil survey in those years.

The soil survey manual came out; we learned of the bucket auger and the screw auger became obsolete. Thank God! In the article in Conservation Voices, it's noted that a decision was reached to give morphology emphasis over genesis. Word came down in the mid-fifties for us to describe the soils in each of the series being mapped. One reaction I recall from that time was to wait and see if it'll go away. An explosion in the use of soil surveys for non-farm purposes began with the sixties. The Soil Survey of McIntosh County, Georgia, sent to press in 1960, was among those that fueled this interest. It may have been the first with a full section predicting forest products production based on site index of tree species.

I don't claim any credit for that. I was doing what was instructed. But, it's clear to me now that innovations in predicting function and performance stemmed from learning to record soil morphology using standard terminology from the manual and gaining insight from what could be done with that systematic knowledge. It also fueled soil consulting which now is in fall flower.

The sixties was a coming to terms with a new classification system. The brown book arrived as I entered on the tasks of a soil specialist for Georgia. Clay skinning became an outdoor sport. Few or no clay films could be observed in the textural horizon s of our soils and we were puzzled to be left out of that film. The issue got settled during a characterization study of soils in Peach and Houston counties, Georgia. Pete Pederson and a sampling crew came down in 1963, when we described and sampled a large group of productive soils. Out of that experience, bridging of sand by clay was accepted as evidence of an argillic horizon and the depth at which base saturation was measured was moved downward. Long term fertilizing of those soils had increased base saturation more than two feet below the soil surface.

My first close encounter with the new system came when we were asked to place the series as we used them into soil families. Had you asked, we'd have assured you that we knew the properties of soils being mapped. We did know those being used to identify and fit a soil into a series. That's not the same thing. The old lithosols group was said to be AC soils. That is they lacked a B horizon, but they didn't. It was a cambic horizon. Were they lithic or paralithic? Nobody knew, but those questions needed answers. The soils said to contain ftagipans didn't turn out that way; instead, they were plinthic layers. The larger problem lay in the large number of well drained series that fell into typical families within a great group with one or two in other subgroups. Criteria that separated extremely thick soils of marine sediments from residual soils in the piedmont were not in the system. Old series like Lakeland, a psamment, with all its phases must have spawned several dozen series which landed in other orders.

All the while, mapping of counties for publication was underway using map units coined from automatic slope and erosion classes. When I left Georgia, in 1967, the pipelines for correlation, map preparation, and manuscript editing were jammed to overflowing. The quantity of soil surveys and the work required to clean them up had been badly underestimated.

Upon arrival in North Carolina as state soil scientist, in early 1969, a letter from New Hanover county waited with an offer to cost share in order to secure a soil survey of the county. That letter and others to follow were symptoms of interest among counties to gain soil maps and the non-farm predictions of soil function. What came later and in 1970 were the field sheets and manuscripts of five counties completed and sent off for publication. That had to have been a common experience for most state programs.

With the strong interest in our work, we began to enlarge the program from 24 soil scientists. Atlantic Farms embarked on large land clearing and development in the blacklands, organic soils and close associates, and they wanted soil maps, but we didn't even have series for most of those soils.

Then the almost insurmountable hurdle -- personnel ceilings -- hit us. No matter how much interest existed, we could not accept money and hire people to do the work. State government saw the light and chose to match money from counties and set up a section to employ soil scientists.

Also at the time, Cartographic was pushing for high altitude photography for publication, a cooperative program in North Carolina to give coverage of the state with orthophotos helped solve that question.

So, in the seventies, making change and managing that change so the program didn't get off track was our challenge. It kept us busy. On the occasion of the first conference of state soil scientists, in Chicago, my priority was training new soil scientists. We had 24 with less than a year's 'experience. Training was not the central issue of other states.

Highlights of USFS Soil Survey Activities
by Jim Keys

1999 NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE
Holiday Inn Select Downtown Convention Center, St. Louis, Missouri
June 28, 1999

HISTORY OF SOIL INVENTORY
(Condensed from: D. Roth "Soil Science and the U.S. Forest Service" 1997, pp. 1-13)

In 1905, Congress established a new land management agency in the Department of Agriculture transferring millions of acres of public forest land and personnel from the General Land Office in the Department of Interior to Gifford Pinchot's USDA Bureau of Forestry, which was renamed the forest Service. National Forests in the eastern United States were added with the purchase from private ownership. The Forest Service has been charged with managing national forest lands for multiple uses since its beginning. However, relative priorities have changed from timber and range management to recreation, wildlife, and watershed management.

During the first decade of existence the Forest Service was directed by Congress to open lands within National Forests which could be homesteaded. The agency called on the Bureau of Soils to help identify potential crop land for this purpose. The Bureau of Soils scientists conducted large-scale reconnaissance surveys of many of the National forests during the summers from 1913 to 1917. As they located agricultural land, they also mapped forest soils for many of the forests. The maps were not accompanied by interpretations, but were used to show the potential location of agricultural lands.

For the next thirty years of custodial management, when little or no commercial and recreational use was being made of National forests, foresters felt no need to call upon other disciplines or agencies to assist them. The lack of demand for knowledge of soils was counterbalanced by soil scientists indifference to the study of forest soils. Preoccupation with the classification of agricultural lands was the norm for the period. However, the construction boon during World War II brought an end to the custodial era of managing National forests.

The War caused a tremendous demand for commercial timber supplying part of that need from national forest lands. Proper engineering of logging roads, particularly in California, Oregon, and Washington depended on the knowledge of soils. The agencies forest soil scientists used landscape and soils information to predict areas susceptible to landslides.

Also following the War, research scientists became interested in the association of soils with vegetation and wanted more useful information than was currently provided. The California Soil and Vegetation Survey combined the efforts of the agencies Pacific Northwest Station, Berkeley, and the Soil Conservation Service (now Natural Resources Conservation Service). Surveys occurred mostly on private forests, but included some National forest lands. Around 1949 researchers began providing training in forest soils and vegetation for foresters.

It was not until 1955 that a national soils program was established within the Forest Service. Between the years of 1955 and 1959, regional soil scientists were hired. Ironically, most were formerly from the Soil Conservation Service. National concerns included complying with standards of the National Cooperative Soil Survey and using soils information in forest management.

Early regional soil surveys were known as "pilot surveys". It was not until the first formal agreement was signed with the Soil Conservation Service in 1961 and soil scientists were made a part of the agencies Division of watershed Management that the term pilot survey was dropped. The Forest Service agreed to follow procedures of the National cooperative Soil Survey.

The decentralization of the forest Service allowed regional soil scientists to take somewhat different approaches to soil survey in meeting program management needs. There were varying degrees of cooperation and agreement with the Soil Conservation Service on soil survey procedures and standards. Surveys included the previously mentioned pilot surveys, large-scale reconnaissance surveys, soil resource inventories, standard soil surveys, terrestrial ecosystem surveys, land systems inventories, and ecological unit inventories. Each varied in their purpose and interpretation needs, intensity, methods and standards, and quality control. Today, soil inventory is completed as a part of ecological unit inventory where land, soils, and vegetation are studied and mapped in an integrated manner. The soils portion of ecological unit inventory is required to meet National cooperative Soil Survey standards as established in 1978 by the Soil Conservation Service. Efforts are being made to update inventories not meeting minimum standards.

CURRENT ACTIVITIES

Agreement to Cooperate on Corporate Information Systems - The forest Service has prepared a strategy for linkage of the Natural resource Information system (NRIS) with the NRCS National Soil Information system (NASIS) and an agreement is being finalized. The agreement will provide for sharing of information between data bases, and in the long term conduct a comprehensive analysis of business objectives to evaluate possibilities for a shared data base for natural resource information. The agreement may also include co-development of a field data entry application for soils.

National Soils Strategy for sustainabilily - Soils Program Managers within the Forest Service have prepared a draft strategy for soil sustainability which is being reviewed by the Chief s office. Soil management and inventory are key components. The Strategy has the following vision, mission, goals, and objectives:

VISION: Knowledge of soils, their properties, distribution, and behavior are recognized as essential to understanding ecosystem composition, structure and function.

MISSION: Integrate scientifically based soil information into management decisions and practices to sustain healthy, diverse, and productive ecosystems to meet the needs of present and future generations.

GOAL I -- Ensure sustainable Ecosystems Tbrough Quality Soils Management
Objective 1.1 - Ensure that soil quality objectives are included as a component of Ecosystem Health and Sustainability Assessments.
Objective 1.2 - Establish and institutionalize into management the multi-scale levels of the National terrestrial and aquatic hierarchies of ecological units, and provide for the spatial delineation and the collaborative sharing of data at multiple scales by various agencies.
Objective 1.3 - Establish an Awareness of the Role of Soils in Water resource Management.
Objective 1.4 - Move the agency toward an ecologically based Riparian/Wetland classification and management scheme.

GOAL II -- Ensure that Budgets, Skills, and Performance Lead to Quality Land Stewardship
Objective 2.1 - Budgets should be structured to be responsive to changing management needs, reflect the integrated role of soils in relation to other resources, and result in quality land management.
Objective 2.2 - ensure that soils staffing and skills are tied to program emphasis areas and legal mandates to achieve quality land stewardship and be responsive to changing agency needs.
following executive review, the strategy will be transmitted to Forest Service Units.

Personnel - The agency is minus about 112 soil scientists since 1980, and approximately 40 to 45 percent of the present work force will retire within 7 years. We are in the process of completing successional planning for personnel looking at opportunities to replace our aging work force. Different skills are needed for future scientists with interpretation and application of soils and related information becoming a major responsibility.

NASIS Status and Utility
summary of remarks made at the
National Cooperative Soil Survey Conference
St. Louis, Missouri – June 28, 1999

Presenter: Russ Kelsea
National Soil Survey Center
Lincoln, Nebraska

Charge: The conference steering committee requested a report on the status of NASIS, it's utility, and other related activities over the last two years.

Background

Two years ago, we had NASIS 3.0 implemented at offices around the county without a means of communicating or sharing data between systems. We had converted soil survey data from the old SSSD environment, but were still dependent on SSSD for soil survey schedule functions. We could produce reports from NASIS, and we could create new interpretations using the interpretation generator, but the interpretive criteria and interpretation report layouts were limited.

Status Report

In June 1997, the Soil Survey Division released NASIS Version 3.1 which provided the following features:

- Installation of HP9000 computer systems to accommodate consolidation of data at 17 MLRA Soil Survey Offices.
- The ability to download NASIS data in the existing Field Office Computing System (FOCS) and Soil Survey Geographic database (SSURGO) format.
- The ability to change ownership from one group of users in NASIS to another group of users in NASIS at the same site.
- The introduction of ready-to-use and certification flags for identifying the editing status of data in NASIS.
- The ability to provide pop-up descriptions of each choice in a NASIS choice list.
- Several lessons and tutorial exercises in developing and using the new NASIS interpretations.
- A new Report Writing Workbook and Technical Reference for NASIS users who write report scripts.
- Enhancements to the NASIS interpretations generator.

In August 1998, the Soil Survey Division released NASIS Version 4.0 which provided the following features:

- An Edit Setup utility which allows users to define which columns will appear in their NASIS session, the order of those columns, the sort order of rows in each table, and the ability to "freeze" one or more columns necessary for reference when scrolling wide tables.
- The ability to generate interpretive results from within reports, which provides users with the ability to define a wide variety of interpretation output formats and page layouts.
- A replicate database at Iowa State University which provided a nationally complete collection of soil survey map unit data.
- New pedon and site tables for recording soil profile descriptions.
- New soil survey schedule data elements for recording mapping progress and major milestones in the development of SSURGO as well as the text, tables, and maps used in published soil surveys.

- The ability to specify multiple target tables when selecting data which makes loading data into NASIS faster and more convenient for users.
- Improved cancel and record locking which makes operating NASIS faster and more convenient for users.
- Certification as y2k compliant.

In January 1999, the Soil Survey Division introduced a Web Page for accessing NASIS data. This web page, located at http://ssschedule.nrcs.usda.gov, provides authorized users with:

- easy access to soil survey schedule data and reports
- limited, but easy to use editing of SSURGO tracking attributes National Cooperative Soil Survey partners who want access to soil survey schedule on the web may obtain a login and password from the NASIS hotline at the National Soil Survey Center by contacting Steve Speidel at 4024375378.

NASIS Objectives and Development Philosophy

NASIS is envisioned as an integrated, comprehensive information system for collecting, managing, and distributing National Cooperative Soil Survey data. It is intended to provide all NCSS partners with immediate access to all of the complete and up-to-date data at any time from any location and guarantee the integrity and security of those data. The NASIS design provides powerful tools for analysis and interpretation of NCSS data at virtually any scale, from local to continental.

In building NASIS, we have tried to consider the needs of all partners in the National Cooperative Soil Survey. In addition to traditional soil survey activities conducted by several agencies, the system is designed to handle consultants' needs for standard data, customized legends, and specialized legends. NASIS is also designed to accommodate undergraduate and graduate projects in soil classification and mapping, and follow-up projects in soil interpretation land use planning. Notable among the new features is the NASIS interpretations generator, which produces interpretive results each time they are needed by comparing the actual soil characteristics stored in the database with the interpretive criteria. We recognize that to produce accurate interpretation of soil behavior, soil characteristics must be accurately recorded and interpretive criteria must be complete and correct for the interpretive use. NASIS accommodates, and the Soil Survey Division encourages, both accurate representation of soils as observed in the field and complete and correct interpretive criteria. To facilitate accurate interpretations, national interpretive criteria have been developed for many uses. NASIS users are encouraged to modify these national criteria to meet local needs or create new interpretive criteria to meet unique interpretive needs.

NASIS is not yet complete. We recognized early in the system development process that soil survey is a complex business and it was not practical to build the entire soil information system all at once. Building NASIS required that we divide soil survey into major areas and create the information system in phases. We identified five major areas in soil survey:

- map unit attributes
- point and site attributes
- concepts, standards, and aggregation criteria
- spatial attributes
- operations and management

Initial development work focused on map unit attributes, familiar to most of us as the physical and chemical properties for soils in each map unit as published in the tables of soil survey manuscripts. Most of the National Soil Information System we see today deals with map unit attributes. Parts of the point, concept, and operations major areas have been included in NASIS during the past two years, but we still have a long way to go before the system is complete.

Current Development Activity

NASIS 4.1 is scheduled for release in September, 1999. The 4.1 release will have a capability to download soil data from NASIS to the Customer Service Toolkit being developed under the Business Process Reengineering initiative. This download will be a collapsed, decoded, and trimmed NASIS data structure in ASCII format suitable for importing into other database software such as Microsoft Access. Work is underway to coordinate this new data structure with SSURGO products and a Natural Resource Data Gateway through which the public will have access to soil data. Also under development is a central server for soil data which will give us the ability to link data across geographic areas to produce "seamless" joins of soil data and share interpretive criteria. Finally, NRCS is working with the US Forest Service to share data and coordinate development of NASIS with the USFS Natural Resource Information System called TERRA.

Highlights of Soil Survey Activities of the West Region

H. Curtis Monger

June 28, 1999

Highlights of soil survey activities by pedologists with the Land Grant University Agricultural Experiment Stations (AES) in the western United States was given based on reports from Montana, Idaho, Washington, Oregon, California, Utah, Colorado, New Mexico, Arizona, Hawaii, and Alaska. From these reports, teaching and research comprise the main activities related to soil survey investigations. Courses taught by university pedologists in the West include the following: Introductory Soils, Environmental Soil Science, Soil Mineralogy, Soil Genesis, Soil Morphology & Classification, Soil Physics, Soil Chemistry, Pedology, Soil Landscape Analysis, Chemical Analysis of Soil & Water, Soil & Water Conservation, Forest Soils, Pedology Field Courses, Soil and Site Evaluation, Global Environmental Interactions, World Agricultural Systems, Remote Sensing and Airphoto Interpretations, and Soil Judging.

Funding for research related to soil survey activities has progressively come from non-traditional AES sources, which mainly consisted of USDA-Hatch Funding. These non-traditional sources include the Kearney Foundation, Andrew Mellon Foundation, Verle Kaiser Foundation, International Arid Lands Consortium, USAID, individual state environmental departments, US Geological Survey, National Science Foundation, EPA, US Forest Service, USDA-ARS, USDA-National Research Initiative Program, and the USDA-NRCS.

Research activities reported by AES pedologists in the West fall into the categories of global change and how soils interact with the hydrosphere, lithosphere, atmosphere, and biosphere. Soil-hydrologic research includes alkaline playas, hydric soil indicators, Eh-pH-Fe^{2+} relations, perched water tables, saline-irrigation wetlands, nitrate movement in Oxisols, and Quaternary geology relationships to groundwater recharge and aquifer types. Soil-mineralogic research includes studies on zeolites, saponite, volcanic ash, Spodosols, bedrock weathering, and mineral transformations. Soil-ecologic research includes quantifying the relationships between vegetation and soils and, more recently, quantifying the relationships between animals and soils, especially endangered species. Soil-geomorphic research is being conducted in several western states and includes projects based on both field mapping and remote sensing. Global change research primarily focuses on measuring natural cycles of bioclimatic changes that occurred in the past in order to understand human impacts on global change.

Soil-atmospheric research focuses on the exchange of dust and gases between the soil and atmosphere. Dust exchange includes the role of dust deposition in soil genesis and the role of soil as a source of dust. Dust emissions from soils greatly affect air quality by reducing visibility and by increasing the amount of respirable particles, especially those particles having adsorbed pesticides. With respect to the exchange of gases between the atmosphere and soil, most research has focused on carbon dioxide. This is because of the global carbon pools, only the oceanic pool contains more carbon than the soil pool, which in turn contain more carbon than either the atmospheric or vegetative pools. For example, the estimated oceanic pool is 38,000 Pg, the soil organic pool is 1550 Pg, the soil carbonate-C pool is 750-950 Pg, the atmospheric pool is 750 Pg, and the vegetative pool is 560 Pg (Schlesinger, W.H., 1997. *Global Biogeochemical Cycles: An.Analysis of Global Change).* In many and regions of the United States, the amount of carbonate-C is ten times the amount of organic-C. In a recent study of aridic, ustic, and xeric soils by the author, carbonate-C was estimated to be 10.6 Pg in woodlands, 18.4 Pg in shrublands, and 22.9 Pg in grasslands (totaling 51.9 Pg). In this study, the annual sequestration rate of atmospheric$C0_2$as carbonate-C in the western U.S. was estimated to range from 3.2×10^{-5} to 3.4×10^{-3} Pg, which is 0.002 % to 0.2 % of the annual U.S. carbon emissions rate resulting from burning fossil fuels. Major uncertainties in these estimates include potential errors in estimating $CaC0_3$ formation rates, especially carbonate precipitated by soil microbes and plant roots. Another major uncertainty results from the inability to quantify the amount of Ca derived from limestone (in which case $CaC0_3$ would not sequester C) versus the amount of Ca derived from igneous parent materials (in which case $CaC0_3$ would sequester Q. However, in addition to carbonate being a potential sink for atmospheric $C0_2$, carbonate may be more important as a potential source for $C0_2$, which in theory could occur when calcic and petrocalcic horizons are exposed to acidic conditions as the result of erosion.

In general, pedologists with the western agricultural experiment stations expressed a feeling that the present research situation is favorable for pedologic research because of the increased environmental importance placed on soils by society and other scientific disciplines. The NRCS was also commended for putting their huge and extremely valuable database on the web, which has attracted many users. With respect to recommendations, some modelers have conveyed the suggestion that the NRCS database could be further enhanced if (1) hydraulic conductivity was added and if (2) pedon locations were linked to the USGS databases.

An announcement was presented for a tour of the Desert Soil-Geomorphology Project, which will occur May 22-25, 2000. The tour headquarters will be on the campus of New Mexico State University. The tour is held in honor of Leland H. Gile, Project co-founder, who will be completing 45+ years of soil-geomorphic research. Estimated fees, including box lunches, drinks, transportation, the guidebook and its supplements will be $350. Dormitory rooms will be available at $16/night (single). Those wishing to register for this tour should contact H. Curtis Monger (Dept. of Agronomy & Horticulture, MSC 3Q, NMSU, Las Cruces, NM 88003, cmonger@nmsu.edu).

HIGHLIGHTS OF BLM SOIL SURVEY ACTIVITIES
NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE
JUNE 28 - JULY 29 1999

Introduction and Background

We appreciate the opportunity to participate in this conference and to share with you highlights of the soil resource activities that the BLM is currently conducting.

Before I share with you, some of the BLM's Soil Resource Activities highlights, I would like to take a few moments to give a brief background on BLM and the multi-resource management demands being made on these public lands.

The BLM administers 264 million acres of public lands located primarily in the 12 Western States, including Alaska. The agency also manages an additional 300 million acres of subsurface mineral estate located throughout the country.

The public lands include a wide, diverse range of lands ranging from alpine tundra, rock canyons, to sagebrush hillside and sparsely vegetated desert areas.

Originally, these lands were valued principally for the commodities extracted from them. Today, the public also prizes them for their recreational opportunities and the natural, historical, and cultural resources they contain.

As the nation's population has grown, so have the demands on its public lands to provide multiple resources for a diverse clientele. Management of public lands has become increasingly complex, requiring sophisticated technologies and accurate information to serve a wide range of environmental, economic, and recreation needs.

Soils information and accompanying ecological site information are essential in managing public lands. One of the key references to help land use determinations and land health assessments is quality soil survey information that can be conveniently and effectively displayed and communicated.

Status of Soil Surveys

Of the 264 million acres of public lands administered by BLM, 176 million acres have been identified for Order 3 soil survey. About 135 million of the 176 million acres (about 80%) have been completed. The 87 million acres in Alaska have not been targeted for soil survey. The original goal (a very ambitious one set up in 1978) was to complete soil surveys on all public lands by 1989.

Current major soil survey efforts are being conducted in (1) the Grand Staircase - Escalante National monument area in Utah, (2) the Emery County Soil Survey in Utah and, (3) the Lake County Soil Survey area in Eastern Oregon. Soil surveys conducted in these areas total approximately 762,000 acres during the past mapping season and are being conducted cooperatively with NRCS.

The 1.7 million acres Grand Staircase - Escalante National Monument is located in South Central Utah. The BLM is building on its experience in collaborative stewardship as it develops a plan for managing the National Monument. To accomplish the goals of conserving the area's unique resources, while acknowledging the importance of grazing, hunting, and recreation within the monument boundaries - a soil survey is being conducted to provide a key resource database.

Emery Co., Utah, Soil Survey - The Soil Survey is being conducted using an integrated landscape approach using Geodata including - digital elevation models (DEM) data, landsat thematic mapper (TM) data, and digital orthophotos to conduct soil surveys in a rough terrain area.

The Lake County Oregon Soil Survey is being conducted by soil scientists and range specialists working jointly to produce a Soil Survey and accompanying ecological site inventory. This effort is currently being conducted in conjunction with NRCS. As the survey is conducted, soil and ecological site information is gathered and stored (automated) for use by all disciplines for land management decisions.

Clark County, Nevada Survey - Efforts are underway to complete the remaining 400,000 acres of BLM lands in the Clark, Nevada Soil Survey. This soil survey encompasses the Las Vegas, Nevada area.

Soil Staffing

The BLM currently has 38 soil scientists, of which 17 are located in Oregon, and two soil conservationists. Thus, soil expertise is spread very thin in many of the states. However, there are also many employees with other titles at the state and field office level who help provide soil related interpretations for management. Future efforts to provide needed soil expertise may include an interagency approach to soil staffing, zoning of soil scientists, or other innovative approaches.

Soil Survey Information Use in BLM

Soil survey information is vital to wise natural resource decision making. An ever expanding list of resource management issues need to be addressed by the Bureau of Land Management on a multitude of scales. Rangeland health assessment on 164 million acres of public land needs to be accomplished in the next 5 years. Forest health concerns are growing as risk of disease and insect infestations reach epidemic proportions and concerns about catastrophic fires escalate.

Clean water action plan implementation is increasingly focusing on non-point source pollution cleanup. Livestock permitting NEPA reviews are being more stringently enforced. Prescribed fire is being emphasized as a management tool to help re-establish natural fire regimes. Weed management continues to grow in emphasis. Restoration of impaired lands is a major workload that is continually growing. New and *innovative interpretations of soil information need to be developed to address these and other resource issues. An interdisciplinary approach is being used by Bureau soil scientists to accomplish this daunting task in an efficient, effective manner.

NCSS Centennial and BLM Soil Survey History

BLM is participating in the NCSS' 100 years Anniversary. Distribution of NCSS centennial information is being made to all of our soil scientists, field offices and visitor centers. Jim Muhn, BLM Historian has prepared a history of the soil survey within the Bureau that will be included in the NCSS History on Soil Survey. A quick glance at the History of Soil Surveys on Public Lands reveals: In 1961 - 1962 BLM entered into cooperative soil survey projects in New Mexico, Nevada, and Montana. One of the first soil surveys conducted and completed by the cooperative effort was the Cabeson Area, New Mexico, soil survey. This soil survey covers portions of the Rio Puerco Watershed. Major field work for this soil survey was done in the period of 1961 - 1962. The first BLM field soil scientist was hired in 1961 in New Mexico. In 1978 BLM entered into a memorandum of understanding (MOU) with the SCS to conduct soil surveys in accordance with NCSS standards.

The NCSS Centennial celebrates the accomplishments of soil survey but, more importantly will provide a time to focus attention on the continued importance of the soil survey and the value of soil information in BLM's Restoring and Maintaining the Health of the Land Initiative.

We appreciate the assistance from the NRCS and especially from Gary Muckel, Soil Scientist, located at the National Soil Survey Center in Lincoln, Nebraska, on this activity.

Rangeland Health Activities

As principal steward of the nation's public rangelands, the BLM has inherent and legal responsibilities to always "know" those rangelands. The BLM has had this responsibility throughout it's 50 year history. Today, the citizens of this Nation, along with its leaders, expect the public rangelands to be permanently maintained in good condition ecologically, while being managed for economic and ecological benefits. More sophistic understanding of environmental values, combined with expanded information, has resulted in the expectation that federal land managers will protect and preserve public rangelands even as they are subjected to various uses. No longer is it acceptable for BLM to rely solely on its professional judgement. Now, reliable and sound scientifically-base information and data are required to support management decisions.

Rangeland managed by the BLM encompasses about 177 million acres of the total ownership. Through a permitting system, approximately 17,800 grazing permitees, primarily in the 11 Western States, use BLM range "allotments" or designated areas of use for livestock grazing.

The purpose of the BLM's Healthy Rangeland Initiative is to carry out a rangeland management program to improve ecological site condition, while providing for sustainable development. The Initiative will enable the BLM to better manage public rangeland by ensuring proper function of rangeland ecosystems. This will maintain and improve biodiversity, while supporting other important uses. Improving the condition of riparian areas is of particular concern.

The Rangeland Health Initiative, which provides for the establishment of rangeland standards and guidelines, is strongly dependent upon Soil Survey Quality/Health information. We are continuing the development of rangeland health assessment guidelines and procedures for the upland component. These guidelines and procedures involve soil, vegetation, and topographic indicators, which are being-used to interpret rangeland condition and trend. A large share of the BLM rangelands occur in and semi-arid ecosystems where vegetation cover is more sparse with higher percentages of bare soil surfaces. Effects of surface litter, surface roughness, vegetation type, and soil surface condition (with emphasis on soil aggregate stability) strongly influence rangeland health in these and areas.

Soil Survey and accompanying soil quality and health information plays an important role in developing Ecological Site Inventories (ESIs) and in Rangeland Health evaluations.

Grazing Permit Renewal Activities

The BLM is currently involved in grazing allotment permit/renewal activities. Soil information is one of the ' resource data components used to assess rangeland health and risk assessment as related to permit renewal activities. The BLM is focusing on accelerating soil survey- digitizing. GIS provides the opportunity to more effectively display and analyze soil information as it relates to rangeland health evaluations. Soil Survey Geographic Data (SSURGO), where available is providing key information for the permit renewal process. The State of Nevada has made many of their soil surveys SSURGO available which has benefited the BLM, since a large part of the state is public land.

Rangeland Health Qualitative Assessment

This is an ocular, on-the-ground assessment of rangeland health. Its usefulness is primarily as an educational tool rather than as a monitoring system. The product of this qualitative assessment is a rating of three components of Rangeland Health (soil/site stability, hydrologic function and integrity of the biotic community) as to stability and function. Seventeen indicators are use to gauge the health of selected landscape units.

This assessment approach has been field tested in many locations with broad involvement. This approach provides the user with a good understanding of the components that compromise rangeland ecosystems and the basic processes that drive them. **Soil information** relating to physical, chemical, and biological properties of the soil as a plant growth medium are an important part of the Soil/Site stability and hydro logic function evaluation.

Rangeland Soil Quality Health Notebook

This notebook, Defining and Assessing Soil Quality/Health on Rangelands is being developed to provide an assemblage of synthesized information and key references on Soil Quality/Health for BLM staff. The purpose is to integrate the concepts of Soil Quality into land health activities within the BLM, with the goal of improving and maintaining the health of our public lands.

Information on Soil Quality/Health has expanded and increased rapidly in the past 5 years and now includes an ever growing base of knowledge. Much of the information exists in scientific papers, unpublished reports, or has never been recorded and is not easily accessible by technical staff and managers. Also, much of the information is rarely synthesized and tailored to provide for effective application.

This Rangeland Soils Notebook is an assemblage of Soil Quality/Health information in a loose-leaf notebook format with tabbed sections to provide easy access to key information by subject and most importantly, to provide for periodic insertions of new material and revision of existing content. The information in the various sections represents pertinent literature for developing a conceptual framework on Soil Quality/Health for technical staff and managers. Sections are brief by design, with illustrations and graphics to facilitate a rapid assessment of information on specific topics. Efforts are also directed toward the development of software packages to assist Soil Quality/Health Evaluations. Development of an accompanying video or CD is proposed to incorporate slides to illustrate soil surface and other soil attribute behavioral characteristic and to convey reading soil health experiences.

The BLM, Natural Resource Conservation Service (NRCS), and Agriculture Research Service (ARS) have worked in partnership during the past 5 years in developing Soil Quality/Health information and its application relevant to land health activities.

This Soil Quality/Health information source provides a "From the ground-up approach to rangeland health" and strongly supports and complements the "BLM Land Health Initiatives." It provides background information and assistance for implementation of the Standards and Guidelines for Rangeland Health.

One of the important components of the Rangeland Soil Quality notebook are the Soil Quality Information sheets. In a cooperative effort with NRCS and ARS, Rangeland Soil Quality information sheets specifically tailored for western rangelands are currently being prepared. The BLM appreciates this effort as it provides key Soil Quality information relating to observing, identifying, and interpreting Rangeland Health.

National Resource Inventory

The Bureau completed field work on a pilot National Resource Inventory (NRI) Project in Colorado in 1997. About 450 sampling points were intensively inventoried and sampled to test and measure resource status and treads over broad regions of the state. The ultimate goal was to determine if this method could be used to efficiently and cost effectively provide answers to Congress and the public regarding whether land management activities are improving or degrading the productivity of public lands. The BLM is finalizing a report evaluating the operational aspects, ability of NRI to portray ecological processes and land health, identify the appropriate number of points for statistical accuracy for interpretation of data, and analyses of utility and cost effectiveness of NRI to BLM.

Soil information was collected at all sites to (1) verify the soil series and ecological sites and (2) to provide near surface morphology to describe soil physical and chemical indicators as related to water infiltration, root penetration, soil surface stability and overall rangeland health. Experiences gained from the NRI effort proved very valuable in identify the importance of Soil Quality/Health as a key component of rangeland health.

Soil Biological Communities Web Site

A team led by Bill Ypsilantes, Soil Scientist, put together an educational web site on Soil Biological Communities. The role and function of each group of soil biological communities, including biological soil crusts, mycarrhizal fungi, bacteria and actinomycetes, protozoa, nematodes, arthropod, burrowing mammals, and the soil food web are briefly explained. Text and illustrations are provided in an easy to understand, reader-friendly format for soil scientists, resource specialists, managers, and the general public. The sites URL is www.id.blm.gov/iso/931/SOIL/SOIL.htm

An effort needs to be undertaken to ensure that soil survey and range site data collection and interpretations incorporate more information about the biological soil component. These systems are a key constituent of soils and are excellent indicators of soil and ecosystem health.

Soil Data Automation

The Bureau is working diligently to digitize soil survey spatial data according to NCSS standards. This work is being done both in-house and in cooperation with the NRCS. We are also interested in efforts to incorporate soil survey attribute databases into NASIS and other formats which can be readily correlated to the digitized spatial data using ARCVIEW and similar software. We need to be able to make standard and specialized interpretations. Many of our offices are dependent upon a UNIX System, which complicates this effort. The ultimate goal is the capability for any resource specialist or manager to easily query the soil data to assist in the resource management decision making process.

Technology

New technologies are also being tested, such as the use of Geodata and GIS technology to make and enhance soil surveys and to provide for ecological site inventories and correlation. One approach being pioneered by the BLM, called Integrated Landscape Analysis (ILA), is intended to enhance BLM's management and monitoring of range and wildlands. ILA incorporates recent advances in GIS and digital technologies to better integrate landscape, soil, vegetative, and other resource data.

The ILA approach to making an enhancing soil survey and ecological site correlation process uses GIS technology to integrate digital elevation data (DEMs), orthophotos, Landstat Thematic Mapper (TM), and other supporting data (climate, geology, vegetation cover, and adjoining soil data) for improved definition of taxonomic soil components within soil mapping units for Order three soil surveys. This methodology emphasizes a landscape and geologic analysis approach using a computerized overlay process (ARC/INFO Imagine) and other software analysis and display systems. The use of GIS landform/hydro logic characterization methods and additional geologic interpretations provide more detailed information on the spatial variability of soil properties within soil map units.

Experience gained from pilot projects and activities conducted in Arizona, Nevada, Utah, and Wyoming indicate this approach to be very effective in wildlands and rangeland with rough terrain and areas that have large areas of shallow and medium depth soils and accompanying exposures of geologic formations. Currently, this technology is being used in the Emery County, Utah, soil survey in cooperation with the National Resource Conservation Service (NRCS) to produce quality soil surveys more economically.

The soil survey enhancement and ecological site correlation process provides additional interpretations and analysis capabilities for land management, for example, watershed analysis, riparian area and grazing management, monitoring site selection, land health assessment, and for more effectively displaying and communicating soil information.

Conclusion

Today, with increased demands on public land resources, having reliable and timely soil information is essential if sound land use decisions are to be made. Information on soil quality and behavior and management systems must be organized and presented to land managers so they can effectively work out optimum combinations of land management practices.

The BLM has been an important cooperator in the national soil survey program, with the BLMNCSS partnership playing an important role in the inventory and interpretation of soils in the Western United States. Through this partnership, BLM has shared its experience and expertise concerning the arid and semi-arid soils of the Western rangelands, providing an additional dimension to the program.

BLM's commitment to initiatives like the ILA and to the NCSS partnership underscores the agency's recognition of the role soil surveys and science play in making sound and use decisions. Without good soil information and interpretation, BLM cannot effectively manage the lands under its jurisdiction. When important things are accomplished, it is most often the results of cooperative efforts. Our partnership with the NCSS has provided the foundation of the BLM soil program.

Report prepared and presented by Lee Barkow, Steve Borchard, and Alan Amen.

Committee on Standards and Soil Taxonomy

Robert J. Ahrens

The standards of the National Cooperative Soil survey are contained in the *National Soil Survey Handbook, Soil Survey Manual, Soil Survey Laboratory Methods Manual,* and Soil Taxonomy. This report provides an update on three of these documents and information on future endeavors.

National Soil Survey Handbook (NSSH)
Amendment 4 to the NSSH was officially approved in September of 1998. Highlights from this amendment include changes and additions to Section 618-Soil Properties and Qualities and Section 627-5 Conventional and Special Symbols Legend. Section 655 dealing with technical soil services and standards for Order 1 soil surveys was recently sent out for review. Section 624-Soil Quality, Section 606-Soil Survey Schedule, and Section 620-Soil Interpretations are in various stages of draft. Proposed changes to the Handbook are available on the National Soil Survey Center Homepage.

Soil Taxonomy
The second edition of Soil Taxonomy was issued during the summer of 1999. Proposals to amend Soil Taxonomy keep coming into the National Soil Survey Center. These proposals will be circulated for review in the future, and if approved incorporated into an amendment. These are no plans to issue a new edition of the "Keys to Soil Taxonomy" in the next few years. Efforts have begun on writing the rationale for recent changes to Soil Taxonomy. Drafts of chapter have been written for the Andisols and Spodosols.

Soil Survey Manual
The Soil Survey Manual is now available on the World Wide Web. It has been 6 six years since its publication, and parts of it are in need of revision. A revised draft of Chapter 3 Examination and Description of Soils will be sent for review soon.

Hydric Soils
A technical standard for hydric soils is in draft status and will be discussed at the National Technical Committee for Hydric Soils in August. This standard recommends that hydric indicators be adapted, modified, or eliminated based on data collected for specific regions.

Other Items
Studies continue on anthropogenic soils. The International Committee on Anthropogenic Soils (ICOMANTH) hosted an international correlation workshop last September. The excursion began in Las Vegas and ended in the San Francisco Bay area. Special emphasis was given to classifying, mapping, and interpreting soils for mine reclamation, soils ripped for agriculture, and soils with contamination. Proceedings from this conference will soon be available.

The standards of the NCSS are recognized worldwide. The State of Kuwait recently requested assistance to determine if the data collected, maps, and map units met the standards of the NCSS. Marc Crouch and Robert Ahrens conducted comprehensive and final field reviews to assess the quality of the soil survey.

Future Direction and Emphasis
The NSSH will continue to evolve and be updated to meet the needs of the National Cooperative Soil Survey. Soil Taxonomy is expected to be more stable over the next few years. Attention needs to be given to updating the Soil *Survey Manual* over the next several years. In the immediate future special emphasis will be given to writing the rationale for recent changes to Soil Taxonomy, providing guidelines for the use of statistics in soil surveys, and updating Ag Handbook 296. The standards of the National Cooperative Soil Survey belong to all of us. Your input is important.

NATIONAL COOPERATIVE SOIL SURVEY
Standing Committee on New Technology
Report to the
National Cooperative Soil Survey Conference
St. Louis, Missouri
June 28, 1999

BACKGROUND

In 1997, the NCSS Steering Committee approved a recommendation from the NCSS Research Agenda Standing Committee to establish a new standing committee on Soil Survey Mapping Techniques to evaluate new technologies for soil survey operations.

In October 1997, Dennis Lytle, NRCS, Lincoln, Nebraska and Bob McLeese, NRCS, Champaign, Illinois agreed to serve as co-chairs for this new committee.

In September 1997, Dennis Lytle was in the process of organizing a group of individuals to address the integration of applicable new technologies and procedures into the mainstream of the soil survey. That group of 27 individuals became the membership of the committee that evolved to the New Technology Committee.

A teleconference was held on January 23, 1998 to which Lytle followed-up in February with an e-mail message. At that point, Lytle was assigned to other duties and committee action ceased.

McLeese reactivated the committee in March 1999 via email. Only 5 of the original 27 members responded to the "call for duty". Input was also solicited from the 50 NRCS State Soil Scientists. Only 8 State Soil Scientists responded and provided input.

COMMITTEE CHARGE

The committee charge as communicated by Lytle in January 1998 and re-stated by McLeese in March 1999 was--"To develop and document the procedures, processes, and standards that will be used to integrate GIS, remote sensing, landscape modeling, and other similar technologies into the mainstream of the soil and landscape inventory program".

COMMITTEE MEMBERSHIP

Individuals who responded to March 1999 email and agreed to serve:

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RESULTS

The committee members were asked to provide a list of tools, techniques, and technologies that they thought should and could be incorporated into soil survey protocol and to provide specific examples of where these technologies had been successfully used.

*Soil Landscue Analysis Proiect (SLAP) Methods
Incorporates computer-generated slope, aspect, and spectral maps for making Order 3 soil surveys and supplementing and updating existing soil surveys. Pilot test by BLM, NRCS, USGS, EROS Data Center in Nevada in 1983-85. Documented in Soil Landscape Analysis Project (SLAP) Methods in Soil Survys, August 1987, and in A Guide for the Use of Digital Elevation Model Data for Making Soil Surveys, Open File Report No. 88-102, 1988.

*Integrated Landscape Analysis (ILA) Approach

Uses GIS technology to integrate digital elevation data (DEM's) orthophotos, Landsat Thematic Mapper (TM), and other supporting data in making and enhancing Order 3 soil surveys and ecological site correlation. Pilot projects and activities conducted in Arizona, Nevada, Utah, New Mexico, and Wyoming by BLM.

*BLM's "Tool Box" Concept
Includes DEM's for the preparation of slope class, elevation, and aspect data layers and for landscape modeling, Digital orthophoto's (DOQ's) for use as base map, and Landsat TM satellite data used to identify soil surface, geologic, and vegetative types.

*Landscape Classification
Uses DEM's (30m DEM re-interpolated to 10 m resolution) to model landscape components to assist in soil mapping and recompilation. Tested by Illinois NRCS on Cypress, Illinois Quadrangle.

*Landsat 7 ETM+ Data
Proposal by NASA Goddard Space Flight Center to incorporate remote sensing data and derived information into soil survey protocol. Landsat 7 program will substantially reduce the cost of data. This technology is very accessible. Digital image analysis can be effectively and efficiently performed on desktop computers using commercial off-the-shelf software. Numerous papers have been published in the last 25 years documenting the potential use of remote sensing data in soil survey.

A pilot project in Utah is using new generation satellite imagery to aid in soil mapping.

*Applied Soil Survey for Site Specific Crop Management Project
This University of Minnesota project is using past soil survey information along with detailed landform information in conjunction with high resolution soil mapping to characterize soil patterns in a GIS environment. Digital color aerial photography, DGPS point files, DEM surface, isoline curvature layers, and slope layers are being utilized.

*Soil Survey Recompilation by "on-screen" edits
Utilizes original soil survey scanned into digital format and "rubber-sheeted" to a digital orthophoto (DOQ) base in the soil survey update process. Process being used for 6 soil survey update projects in Illinois and 1 in Kansas.

*PEN Technology
Field data recorders, Palm Pilots, and other PEN hand held units are capable of storing and displaying spatial and tabular databases and utilizing GPS technology. Data capture in the field will improve accuracy and efficiency.

Palm pilots are being used in Illinois. Another PEN prototype is being tested in Texas.

*AML's
Some AML's (Arc Macro Language) being used in Soil Survey Project Offices in Illinois are:
plotdrg.aml - pilots maps from DRG's at 1: 12,000
plotsoil.aml - plots soil maps at 1:12,000
Grass2arc,aml – converts GRASS coverage into Arc/INFO
proj_conv.aml – reprojects coverages from NAD27 to NAD83
edit.aml – sets edit environment and starts an edit menu

*GIS Specialist positions
Illinois, California, and Utah have soil survey GIS positions dedicated to introducing and incorporating GIS and related technologies into soil survey operations and other nautral resource data collection and implementation work.

*Soil Resources: Their Inventory Analysis, and Interpretation for Use in the 21st Century
This conference held June 10- 12, 1999 in Minneapolis, Minnesota provided a forum for the presentation and discussion of technology in soil survey. Oral presentations and poster presentations were given on use of Geographic Information Systems, Global Positioning Systems, Ground Penetrating Radar, Electromagnetic Induction, Digital Elevation Models, Digital Raster Graphics, Expert Systems, Soil-Landscape modeling, PEN technology and other technologies in soil survey.

DISCUSSION

"The future ain't what it use to be" (Yogi Berra). The future is now! These "new technologies" that we have been talking about are not new. They have been around for years. They have been demonstrated in the academic environment and in the real soil survey world. It is time to quit talking about them and time to begin implementing them in soil survey project offices across the country.

As a National Cooperative Soil Survey we must find a way to get these technologies to the field. Our field soil scientists are innovative and creative and they are anxious to use technology to help them to work smarter.

RECOMMENDATIONS

1. Via the soil survey fund allocation process "encourage" each State Conservationist to establish an MLRA soil survey project office that is staffed with a GIS/Remote Sensing Specialist and is equipped with the GIS hardware and software necessary to utilize DOQ's, DRG's and DEM's.

2. Ensure that each State and Regional staff has the GIS expertise to provide the hardware, software and application support to soil survey project offices.

3. Charge each State Conservationist/State Soil Scientist to implement at least one soil survey project utilizing DOQ's, DRG's, DEM's, Landscape Classification models, on-screen digitizing, etc.

4. Establish cooperative agreements/partnerships at the highest level possible to co-research, Co-test and co-release hardware, software, protocol and procedures for digital data collection and dissemination.

5. Establish a national "soil survey technology clearinghouse" to review, test, and disseminate technology to soil survey project offices.

6. Cooperate with BLM to revise and update the original Technical Note 379 to include ILA approach and "Tool Box" concept.

7. Publish Illinois' Landscape Classification protocol.

8. Provide PEN technology to at least I soil survey project office in each state.

9. Develop a national "soil survey technology training" program cadre to develop manuals, courses, etc. to ensure soil survey staff is adequately trained in GIS and related technology.

10. Develop a national "soil survey technology information and education" program to promote digital technology and deliver web based applications.

ERODED SOILS COMMITTEE REPORT
NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE
St. Louis, Missouri
T.E. Fenton
June 28, 1999

This report presents a solution to the problems arising from the use of taxadjuncts in the classification of eroded phases of soils. The effects of accelerated erosion have been researched and discussed in the following forums:

NC-174 Regional Research Project -Impact of accelerated erosion on soil properties and productivity-1983-present

Des Moines conference-1992

NCR-3 Committee-1993 and 1994

National Committee-1995

Regional Committees-1996

National Committee-1997

NCR-3-1999

Interest in the effects of accelerated erosion as it relates to soil surveys dates back at least to the 1930's. Guides to the definition of erosion classes and the mapping of erosion phases are given in the 1937 Soil Survey Manual. In the 1938 Yearbook of Agriculture, it is stated that the effects of soil erosion had not been accurately appraised and to that date only reconnaissance surveys had been made. The discussion of and guides for the definition of erosion classes and the mapping of erosion phases were expanded in the 1951 Soil Survey Manual and was continued in the 1993 Soil Survey Manual. The recognition of accelerated erosion as a part of the soil survey program is not new. In Iowa, and I assume other states, a reconnaissance erosion survey was conducted in 1934 as a part of a national survey made by the Soil Conservation Service of the United States Department of Agriculture. The 1937 Soil Survey Manual discusses erosion phases. In the late 1930's and early 1940's erosion phases were shown on the soil survey field sheets. Field work in two of the earliest Iowa counties modem sod survey was complete prior to 1947 and 1949, respectively, prior to the publication of the revised Soil Survey Manual in 1951. The soil scientists followed the guidelines given in the 1937 Manual stating that the information regarding erosion conditions be shown in greater detail on the field sheet than on the published map. Measurements of surface thickness and erosion phase were given by delineation on the field sheets with a scale of 1:15,840 but the compiled maps were published at a scale of 1:31,680. Therefore, eroded units were correlated and published but the more detailed information on the field sheets was available for land use planning, The current Soil Survey Manual (1993) and the National Soils Handbook maintain the recognition of erosion classes and mapping of eroded phases as standard operating procedure. The effects of accelerated erosion on productivity have been well documented by field research and the publication of the results in scientific journals. Members of NC-174, a North-Central Regional Committee, who studied the effects of erosion on productivity, published over 50 journal papers on this topic. A southern regional research committee also documented the detrimental effects of erosion in the southern U.S. There have been few problems associated with the recognition and mapping of eroded phases. The major problem arises when the map units are correlated and named according to Soil Taxonomy. Therefore, we need to revise our system so that the traditional genetic links maintained by the erosion phases will not be buried in Soil Taxonomy.

These genetic relationships are important to maintain in terms of understanding the effects Of soil loss On productivity and the changes in properties resulting from accelerated erosion. At the recent International Conference on Erosion, many papers from the U.S. and other countries stated that there is no systematic recording of soil degradation. However, many states have included the identification of eroded phases in their map units and thus there is a current record of soil degradation. Other current problems that can benefit from knowledge about erosion phases relate to carbon sequestration and depth distribution, the greenhouse effect, soil quality, recognition of ecosystems, and telling the story of the land. This is information that is timely and is needed to make informed decision. If Soil Taxonomy is to be most effectively utilized, this information must be a part of our delivery system

The solution we propose is to recognize accelerated erosion as a diagnostic soil characteristic and add exception statements at the appropriate places in Soil Taxonomy. This procedure parallels the present statement that waives aquic conditions ie .... aquic conditions for some time in most yew (or artificial-drainage).... for Alfisols, Andisols, Entisols, Inceptisol, Mollisols, Oxisols, Spodosols, Ultisols, and Vertisols. The phrase (unless eroded) should be added at the appropriate places in Sod Taxonomy. An additional change that should be made is to incorporate the recognition of erosion into the official soil series description where appropriate. The series classification should be based on the uneroded or slightly eroded series for those series for which erosion phases are recognized. The classification of the eroded phases according to Soil Taxonomy should be given as a part of the official series description.

The following items are a list of those properties considered to be clues to be used in the identification of eroded conditions. They should be listed under "Other Diagnostic Sod Characteristics (Mineral Soils)" in Soil Taxonomy. An eroded soil will have two or more of these properties. The section should also include a discussion of accelerated erosion and reference the appropriate sections of the *Soil Survey Manual* and the *National Soils Handbook*. The reality of accelerated erosion should also be mentioned in the definition of the mollic epipedon and the ocbric epipedon

THE FOLLOWING ITEMS ARE A LIST OF THOSE PROPERTIES CONSIDERED TO BE CLUES FOR ERODED CONDITIONS OF SOILS AS COMPARED TO THE UNERODED COUNTERPARTS. THE SURFACE HORIZON REFERS TO THE AP HORIZON OR THE UPPER 18 CM (7 INCHES) OF THE SOIL AFTER MIXING.

1. DECREASED SURFACE OR SURFACE PLUS SUBSURFACE HORIZON THICKNESS.

2. LOWER ORGANIC MATTER CONTENT.

3. HIGHER VALUES AND\OR CHROMA.

4. MIXING OF SUBSURFACE AND/OR SUBSOIL WITH SURFACE HORIZON.

5. LACK OF TRANSITIONAL HORIZONS BELOW THE SURFACE HORIZON.

6. DECREASED SOLUM THICKNESS.

7. SHALLOWER DEPTH TO THE BASE OF A SUBSURFACE DIAGNOSTIC HORIZON.

8. HIGHER CLAY CONTENT IN SURFACE HORIZON.

9. DEPTH DISTRIBUTION OF CIAY IN PROFILE. (DEPTH TO CLAY MAXIMUM DECREASES WITH INCREASING EROSION)

10. SHALLOWER DEPTH TO CARBONATES.

11. CONCENTRATION OF COARSE FRAGMENTS, IF PRESENT, IN OR ON SURFACE HORIZON.

12. SOIL CHEMICAL SUBSOIL PROPERTIES SIMILAR TO UNERODED SITES.

13. PRESENCE OF GULLIES.

14. DETERIORATION OF STRUCTURE IN SURFACE HORIZON.

15. DARK ORGANIC STAINS IN UPPER PART OF THE ARGILLIC HORIZON.

16. CS^{137} ACTIVITY IN THE AP HORIZON IS <50 PERCENT OF THE CS^{137} ACTIVITY OF THE SURFACE HORIZON OF A NON-ERODED REFERENCE PEDON

17. FLY ASH PRESENCE, DEPTH, CONCENTRATION, AND MAGNETIC SUSCEPTIBILITY.

Example 1: Under Key to Soil Orders

1. Other soils that have both of the following:

1. Either.
   a. A mollic epipedon (unless eroded); or
   b. Both a surface horizon etc.

Example 2: Under Affisols

JEJZa - Other Hapludalfs that have a mollic epipedon, an Ap horizon that meets all the requirements for a mollic epipedon except thickness, or materials between the surface to a depth of 18 cm that meet these requirements after mixing (unless eroded).

Example 3: Under Ultisols

HCGN. Other Hapludults that have a color value, moist, of 3 or less and a color value dry, of 5 or less (crushed and smoothed sample) in either (unless eroded)

Report to the National Soil Survey Work Planning Conference
South Region
St. Louis, Missouri

June,1999

J.T. Ammons, L.T. West and J.N. Shaw, The University of Tennessee, Knoxville, The University of Georgia, and Auburn University

INTRODUCTION

This report is a brief overview of the types of soil survey activities currently in progress in the South Region. The narrative represents a cross-section experiment station activities and concerns related to National Cooperative Soil Survey. Selected activities are presented from Alabama, Georgia, and Tennessee.

Alabama

Several research projects are in progress or are published. Image rectification for NRCS maps recompilation and digitization is a project that is currently underway and presented at the southern ASA (Beck and Shaw, 1999). Hydraulic and transport properties of Kandiudults with sandy and loamy argillic horizons was presented at the national ASA meetings (Shaw et. al., 1998). These activities represent the experiment stations commitment to collecting data and providing interpretations for land use within Alabama. An ongoing thesis project is focused on correlation of soil mapping units with compaction effect following timber harvest. Most research is directly related to National Cooperative Soil Survey Activities.

Georgia

Three projects related to soil survey are underway or completed in Georgia. One completed project was the development of relationships between redox features and duration of saturation for soil horizons in Southwest Georgia (Typic and Aquic Kandiudults primarily). Results indicated that horizons with iron concentrations without 2 chroma depletions were saturated about 20% of the year, horizons with chroma 2 or less iron depletions were saturated about 40% of the year, and horizons with a chroma 2 or less matrix were saturated about 50% of the year.

A second project that has been completed was development of an soil/geomorphology based ecosystem classification for an 11,000 ha plantation in southwest GA. In this study, vegetation at 140 never-cultivated sites was characterized, and the soils at each site were described, sampled, and analyzed. From this sample set, 17 vegetative ecosystems were identified, and each of the 17 ecosystems was directly related to soil properties. A 1:6,000 soil survey of the plantation was used to develop an ecosystem (potential ecosystem) map of the property. An ongoing project evaluation of the applicability of soil survey to prescription farming is currently being conducted. Cotton yield has been successfully related to soil map unit from an order 1 survey (1:2,500 scale) of a 110 ha field in Crisp County. No nutrient limitations were present in the field. Thus, yield differences appear to be related to differences in water available for crop growth. Differences in water availability appear to be due to both soil physical differences and landscape re-distribution of water related to runoff/run-on as determined by geomorphic relationships. Organic C contents -for surface horizon for this field has been mapped through image analysis of bare soil color photos. In addition to the above, we do what we can to support the survey through sample characterization and participation in field reviews.

Tennessee

Selected soil characterization in concert with the National Sods Laboratory was completed on the Cumberland Plateau and the Eastern Highland Rim (see photos). In conjunction with these activities, the Soil Scientists Association of Tennessee arranged for a field trip for private, state, and federal soil scientists to observe how a full characterization sampling was conducted. Field trips and field reviews are important information sharing venues between the various soil scientists in the state (see photo). These activities 'bring to light" needs of the soil scientists in the state.

Three thesis and one dissertation project were completed over the past two years all of which contribute to the soils inventory in Tennessee. The projects are as follows:

Oliver, Melissa C. 1997. An Investigation of Two Landscapes on the Holston Formation in McMinn County, Tennessee. M.S. Thesis. The University of Tennessee, Knoxville (Major Professor).

Smith, D.E. 1998. A Geomorphological Investigation of Soils Forming on the Humbolt Terrace in Western Tennessee. M.S. Thesis. The University of Tennessee, Knoxville (Major Professor).

Branson, J.L. 1998, Soil Genesis and Classification in the Whiteoak Mountain Fault Block in East Tennessee. Ph.D. Dissertation. The University of Tennessee, Knoxville (Major Professor).

BOYCE, M.J. 1998. Characterization of Mineralogy and Permeability of the Proposed Hard Labor Soil Series (fine, kaolinitic, thermic Oxyaquic Kanhapludults). M.S. Thesis. The University of Tennessee, Knoxville (J.T. Ammons and L.T. West).

Selected publications and abstracts cover interest areas of minesoil classification to investigations of soils in the Ridge and Valley MLRA (see photo). The following are some publications and abstracts covering these activities:

Sencindiver, J.C. and J.T. Ammons. 1999. Minesoil Genesis and Classification. R.I. Barnhisel, W.L. Daniels, and R.G. Darmondy (eds.). In Reclamation of Drastically Disturbed Lands. SSSAJ

Freeland, R.S., R.E. Yoder, and J.T. Ammons. 1998. Mapping Shallow Underground Features that Influence Crop Production and Contaminant Transport. Journal of Applied Geophysics-Special Issue of GPR'96. Elsevier Scienc B.V. (Accepted, in press)

Freeland, R.S., J.C. Reagan, R.T. Burnes, and J.T. Ammons. 1998. Sensing Perched Water Using Ground Penetrating Radar--a Critical Methodology Examination Applied Engineering (accepted and in press).

Khiel, A.R., and J.T. Ammons. 1998. Origins of Ancient Alluvium on the Eastern Highland Rim in Tennessee. Soil Survey Horizons. Volume 39.Number 3. P.69-74.

Phillips, D.H., J.T. Ammons, D.A- Lietzke, and S.Y. Lee. 1998. Deep Weathering of Calcareous Sedimentary Rock and the Redistribution of Iron and Manganese in Soil and Saprolite. Soil Science. 163:71-81.

Phillips, D.H., J.T. Ammons, DA Lietzke, and S.Y. Lee. 1997. Morphology and Mineralogy of Saprolite and Selected Soils from the Maryville Limestone and Nolichucky Shale Formations in East Tennessee. Soil Survey Horizons. Vol.38, No.4. p. 107-120.

Branson, J.L, J.T. Ammons, M.E. Timpson, M.W. Morris, R.L. Livingston, A.O. Gallagher, and S.E. Gaither. 1998. Parent Material Differences in Soils of the Maryville Geological Formation in East Tennessee. In Agronomy Abstract, ASA, Madison, WI. p.267.

Phillips, D.H., J.E. Foss, J.T. Ammons, C.A. Stiles, J.S. Wah, and J.L. Branson. 1998. Pedogenesis of a Loess Derived Soil from the Eastern Highland Rim in Tennessee. In Agronomy Abstracts, ASA, Madison, WI. P.269.

Branson, J.L. and J.T. Ammons. 1998. Kandic Horizon Identification Properties on the Copper Ridge Formation in East Tennessee. Abstracts of Technical Papers, Southern ASA. P.6

Smith, D.E., J.T. Ammons, and J.L. Branson. 1998. An Investigation of Soils Forming on the Humbolt terrace in Western Tennessee. Abstracts of Technical Papers, Southern ASA. P.6

Ammons, J.T., P.E. Bock, D.E. Smith, J.L. Branson, and A. Brown. 1998. Soil Genesis Related to Land Form and Geology on Grasstree Hill, Victoria, Australia. Abstracts of Technical Papers, Southern ASA- P. 12.

Several technical papers are included in a list of additional publications at the end of the report.

One of the major concerns among cooperators is maintaining the continuos collection and updating of measured soil profile data. Special studies should be conducted and funded relating to a specific set of problems for an MLRA. Soil Survey Reports are a work in progress. As more pressure is put on these maps for land use decisions, more precise field and laboratory characterization data needs to be collected and interrelated to data (or sometimes no data) on hand. Money is the key to conducting these activities.

<u>Additional Publictions</u>

Beck, J. and J.N. Shaw. 1999. Image to image rectification for NRCS map recompilation and digitization. In ASA Southern Branch Abstracts, Memphis, TN. Jan 31st to Feb. 2nd.

Shaw, J.N, L.T. West, D.E. Radcliffe, D.D. Bosch, and C.C. Truman. 1998. Hydraulic and transport properties of Kandiudults with sandy to loamy argillic horizons. In Agronomy abstracts. ASA, Madison, WI.

Freeland, R.S., J.D. Bouldin, R.E. Yoder, D.D. Tyler, and J.T. Ammons. 1999. Use of Ground-Penetrating Radar to Map Soil Features that Influence Water Content. Engineering Principles For Conservation Cropping Systems. Southern Cooperative Series Bulletin no. 392.

Ammons, J.T., R.J. Luxmoore, and R.E. Yoder. 1999. MLRA 123. In Water and Chemical Transport in Soils of the Southeastern United States. Prepared by Southern Regional Research Project, S-257: Classifying Soils for Solute Transport as Affected by Soil Properties and Landscape Position.

Ammons, J.T., R.J. Luxmore, and R.E. Yoder. 1999. MLRA 125. In Water and Chemical Transport in Soils of the Southeastern United States. Prepared by Southern Regional Research Project, S-257: Classifying Soils for Solute Transport as Affected by Soil Properties and Landscape Position

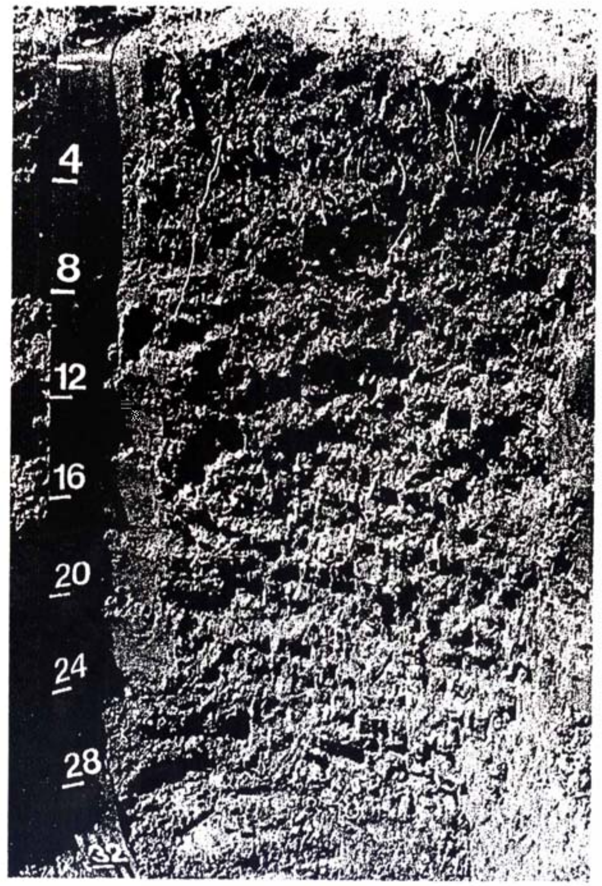
Ammons, J.T., R.J. Luxmoore, and R.E. Yoder. 1999. MLRA 128. In Water and Chemical Transport in Soils of the Southeastern United States. Prepared by Southern Regional Research Project, S-257: Classifying Soils for Solute Transport as Affected by Soil Properties and Landscape Position.

Yoder, R.R, D.C. Yoder, C.R. Mote, M.E. Essington, J.T. Ammons, T.C. Mueller, and D.D. Tyler. 1998. Subsurface Water Movement on an Agriculture Watershed. In Proceedings of ASCE 1998 International Water Resources Engineering Conference.

Ammons, J.T., R.J. Lewis, J.L. Branson, M.E. Essington, A.O. Gallagher, and R.L. Livingston. 1997. Total Elemental Analysis for Selected Soil Profiles in Tennessee. Tennessee Agricultural Experiment Station Bulletin 693. 31 pp.

USDA-NRCS SAMPLING OF SELECTED SOIL PROFILES ON THE CUMBERLAND PLATEAU(MLRA 125)

USDA-NRCS SELECTED SAMPLING OF SOIL PROFILES ON THE EASTERN HIGHLAND RIM IN TENNESSEE MLRA 122



Soil Scientists on Field Tour of the Brotherton Bench Overton County, Tennessee.

Field Reviews and Special Field Trips are Attended by Federal, State and Private Soil Scientists. Information is exchanged to all parties with these activities.

BASIC SOIL INVESTIGATIONS AND CHARACTERIZATION NEED TO BE EXPANDED TO POPLUATE THE DATA BASES

THESE INVESTIGATIONS REQUIRE MONEY

STRATEGY FOR MARKETING SOIL SURVEY IN MISSOURI
BY DENNIS K. POTTER
PRESENTED AT THE
NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE
ST. LOUIS, MISSOURI
JUNE, 1999

Background:

The Missouri Soil Survey Partnership is actively working toward the completion of the initial soil survey product. At the current time field soil scientists are producing > 1 million acres of 1st generation soil surveys each year. If we can maintain this pace, the first generation soil survey in Missouri will be completed by the end of fiscal year 2002.

Missouri's Soil Survey Partnership has a bright future. We have a unique opportunity to work toward the completion of this initial product and to immediately move into an update program due to a grass roots movement. Missourians have taxed themselves in the form of a 1/10th of 1 percent sales tax to inventory and protect the soil resources of the state and to maintain and expand the State Park System. The plan calls for update activities to be initiated in anticipation of the completion of the 1st generation and approached on an MLRA basis rather than that of a county by county. Financial support for individual counties or groups of counties is not necessary in Missouri due to this state wide tax support. In anticipation of the completion of the first generation soil survey in Missouri, the partnership is actively identifying users of the soils information, assessing the needs of these users and how these needs may be met.

In order to market our soils information, it is necessary for us to:
1. Identify our customers.
2. Assess the needs of these users and.
3. Determine how to meet their needs (market and deliver the product), is the my topic of discussion today.

IDENTIFICATION OF CUSTOMERS.
No fewer than 21 basic user groups have been identified. Examples are: Internal Customers; Other Federal and State Agencies; Private Consultants; Private Land Owners and Operators; Realtors; Educators; Students; Media; Developers; Utility Companies and Legislators, just to mention a few. These users were identified by using records of assistance provided during the last 12 months. It is anticipated that many more will be identified. In the past, soils information was marketed almost exclusively to the agricultural community, but not any more. A big part of the support for the Soils and Parks tax, here in Missouri, came from the urban areas.

In order to assess users needs, satisfaction and usability of the soil survey products, we are continually soliciting comments from our customers. We have concentrated on comments from three major users groups.

(Internal Customers) Field Office Employees and Soil and Water Conservation District Supervisors using a Soil Science Questionnaire.
(Partnership) Missouri Cooperative Soil Survey Partnership during the Missouri Cooperative Soil Survey Work Planning Conference.
(External Customers) General users of the Soil Survey Reports using a Soil Survey User Comment Form provided with all soil survey reports mailed out by the State Office.

SOIL SCIENCE QUESTIONAIRE

The audience included Soil and Water Conservation District Supervisors and the Field Office Staffs of District, Natural Resources Conservation Service (NRCS) and Missouri Department of Conservation (MDC) Employees. This questionnaire was administrated during the 1998 Annual Area Meetings. Background: All 114 Counties in Missouri have organized Soil and Water Conservation Districts and each District has 3 elected SWCD Supervisors. Most Field Office Staffs in Missouri include SWCD District Employees and several have MDC Biologists. The SWCD field office positions are funded by the 1/10th of 1 percent Soil and Parks Tax mentioned earlier. (Representatives of the Missouri Department of Natural Resources, the administrators of this tax, will give a brief presentation tomorrow during the field trip).

Back to the questionnaire:

Very basic questions were asked each of these individuals:

In your use of the published soil surveys:

Are they helpful? 100% positive reply

Are they easily understood? 90% positive reply

2. Would you like to have better access to MDNR and NRCS Soil Scientists to help you better understand the soil resource? 83% positive reply

3. Do you think MDNR and NRCS Soil Scientists should continue to improve and update soils information after the initial soil inventory for Missouri? 93% positive reply

Additional comments from those responding indicated specific needs for additional products that could be provided by soil scientists. These included: site-specific information, suitability for specific uses, more productivity data, and more use of soils information in watershed planning and whole farm conservation planning.

MISSOURI SOIL SURVEY WORK PLANNING CONFERENCE

The major emphasis of the Missouri Soil Survey Work Planning Conference was to outline issues associated with the refinement of the soils data and to identify customers and customer needs. Participants contributing to this conference included representatives from Missouri Department of Natural Resources (MDNR), Missouri Department of Transportation (MODOT), MDC, Missouri Department of Health (MDOH), University of Missouri (UMC), South West Missouri State University (SMSU), United States Forest Service (USFS), Division of Geology and Land Survey (DGLS) and NRCS.

All issues were placed into 11 specific user needs.

*Productivity data (species, crop management specific)
*More detailed information (site specific-application specific) i.e.; Order 1 survey products for precision farming.
*Hard data should be made available to users. i.e.; Detailed profile descriptions, transect data and laboratory data.
*User access to field experienced soil scientists. i.e.; technical soil services.
*Information on soil system functions (soil/landscape/hydrologic systems).
*Emerging private sector (assurance of quality) i.e.; delivery of soils information by groups other than the traditional federal and state agencies.
*Marketing of soil survey information. i.e.; education of users and soil information in digital format.
*Accessible central soils database for entering and extracting data.
*Certification standards for soil scientists.
*Future structure to facilitate(updates, training of users and access to expertise).
*Identify and organize existing data (DOT core data and consulting soil scientist data).

The group then prioritized these needs using the Nominal Group Method. All 11 specific user needs identified received points. Following are the 6 need receiving > 20 points.

Hard data should be available to users. (37 points).
Associated aspects of this need include: Format, compatibility, content, quality of data, platform, maintenance and support.

User access to field experiences soil scientists (36 points).
Available expertise, access, flexibility, field experienced.

More detailed information (33 points).
Variability of scales, quality control, archiving information, priorities and the development of standards.

Future structure: soil survey updates & Tech soil services (28)
Defined by user needs, define goal/services and design process to meet goals, continue to enhance the functionality of MLRA concept, evaluate delivery system, integration with other disciplines (GIS specialists, geologists, hydrologists), informing customers of services and options.

Information based on soil system functions (24)
Long term impacts of site-specific projects, we know more than we use, cumulative effects.

Accessible central soils database for entering and extracting data (21 points).

SOIL SURVEY USER COMMENTS

Starting in early 1998, a soil survey user comment form was included in all soil survey reports sent to requesting users. To encourage a response an addressed, stamped envelope is included. The intent of this comment sheet is to gather basic information related to the satisfaction of the user with the product and to assess the usability of the soil survey product. The 5 questions were kept simple and concise to encourage a response. To date, the response rate is about 70 percent.

Questions included in this comment form:

*How do you utilize the soil survey publication?

*What aspect(s) of the soil survey publication do you find most helpful?

*What aspect(s) of the soil survey publication do you find least helpful?

*Recommendation to assist in making this product more useful t you and others?

*General Comments

Those responding include:
Consultants; engineering firms; state emergency management agency; students; farmers; libraries; federal agencies (COE, USFS, EPA, NRCS, RD, FSA; State Agencies (MDNR, MDC, MDOT, MDOH and Land Rec.

Most responses are-very complementary when concerning the usability and content of the soil survey information. Many comment on the quick turn around time in providing them with the information.

SUMMARY OF OUTCOME OF THESE 3 INFORMATION GATHERING PROCESSES.

A. All three approaches of gathering customer input indicated that the soil survey product is well received, and most responses supported the concept of updating the initial product. Very little criticism of the product of questioning or accuracy of data was received.

The need to have access to field experienced soil scientists to update and interpret data was also a very common issue and ranked near the top in all three approaches. Technical soil services is needed and wanted by users. There is very strong support among the partnership for a future structure that would allow soil scientists to be involved in both the gathering of data and the delivery of the data to customers. A separation of the update soil survey activities and the technical soil services should be avoided if at all possible.

The need to provide access to hard data was a high priority and is mentioned in all three approaches.

The need for the opportunity to obtain more detailed information/site specific information is a reoccurring comment.

In a very broad sense, Missouri's marketing strategy is to continue to ask users what they want and to listen to those needs.

Marketing, in many cases is not rocket science. Studies show that 40 percent of the decisions made to make a purchase are based on advise from friends and family. Word of mouth is the key. Satisfied customers are our best marketing tool. The most common reply on the soil survey user form sent out with all soil surveys is: "Thanks for the quick turn around time." This is marketing. Recently I requested a soil survey report from another state and was told up front that it would be 6 weeks. This has been at least 8 weeks and still no soil survey has been received. This is unacceptable.

In conclusion, in the past, we have been remiss in asking the customer what they need and want in the soil survey product. We are prepared to make adjustments that will assist in responding to the users needs. In this state, the preoccupation with the need to complete the initial soil survey of the state has left a void in the delivery of the soil survey to not only the external customer but also our internal customer the field office staff. These questionnaires have provided the Missouri soil survey partnership with an insight to the needs and will assist in the development of a roadmap to the future.

Listen to our customers and respond. Ask-Listen-Respond!

Thank you!

Dennis K. Potter
Soil Scientist, Liaison
NRCS, Columbia, Missouri

NATIONAL SOCIETY OF CONSULTING SOIL SCIENTISTS ACTIVITIES

Information presented to the National Cooperative Soil Survey Conference
St. L6uis, Missouri
June 28,1999.

Barry L. Dutton RPSS, CPSS
President, NSCSS

The National Society of Consulting Soil Scientists represents soil scientists who are owners or employees of private consulting firms. Our members also include those interested learning about private consulting opportunities in soil science. Many members work full time as consultants but others spend part of their time in other soil science positions or in retirement activities.

The greatest thing NSCSS has to offer is a group of energetic, dynamic soil scientists who can provide detailed insights about the growth and nurturing of a successful business. These insights can help new consultants accelerate their business growth and avoid costly mistakes. Some benefits of NSCSS membership include:

- **A place to find out what private soil scientists are doing and the wide range of work options.**
- **Information on how to start a business, keep it going and expand into new areas.**
- **Professional liability insurance at bargain rates.**
- **Annual meetings with education, business development, recreation and other components.**
- **A registration program giving soil scientists credibility similar to professional engineers.**
- **A memorandum of understanding with NRCS which provides recognition and cooperation.**
- **One of the best newsletters around - full of ideas, contacts, upcoming events and other information.**
- **A place to give back something to the profession that has provided us our livelihoods.**
- **A great group of interesting, entertaining, dynamic individuals who are making a difference (yes - soil scientists!).**

The mission of the National Society of Consulting Soil Scientists, Inc. is:

- To advance the discipline and practice of soil science by professionals,
- To promote quality interaction between professional soil scientists and their communities,
- To represent the diverse consulting, service and business interests of soil scientists,
- To facilitate the exchange of business and soil science experiences within the Society, and
- To foster professional and ethical conduct in the soil science discipline.

RECENT ACTIVITIES OF NSCSS:

Production of a Guidebook on Establishing State Registration for Soil Scientists

Development of Earth Collapse educational materials for preventing accidental burial

Business seminars and presentations at other natural resource societies

Participation in the National Cooperative Soil Survey Program steering committee, regional conferences and national conference.

Participation in the Soil Survey Centennial celebration including development of the communication plan and organization of state activities.

NSCSS ANNUAL MEETING:

The next annual meeting of the NSCSS will be held in cooperation with the Soil Science Society of America October 31 - November 4, 1999 in Salt Lake City. NSCSS will conduct a one-day symposia on "The State of Soil Survey Practice." This symposia will summarize how private sector soil scientists are applying their expertise in the areas of hydric soils, private sector soils, precision agriculture, nutrient management, business and marketing, earth collapse, model ordinances and others.

NSCSS COMMITTEES:

Hydric soils
Private sector soils
Precision Agriculture
Nutrient management
Business and Marketing
Earth Collapse
Model Ordinances

FOR MORE INFORMATION CALL, WRITE OR VISIT OUR WEB SITE AT

www.nscss.org

Soil Survey Activities in the Northeast Region
James. C. Baker

Mr.Chairman, I am proud to be at these momentous meetings not only to carry out the work of this conference, but to celebrate the 100th Anniversary of the Soil Survey of the USA. I think everyone that has had any part in this very special, productive, long going, activity can be justifiably proud of participation in this endeavor. Soil Survey truly is something special. I am here to present a report on activities of the Northeast Regional Conference, but before I do that, I want to reminisce a moment.

For myself this centennial conference has special meaning, and attending this meeting, here in my home state of Missouri, is more than just a visit back home. Forty years and fifty pounds ago, in June 1959, I started mapping soils with the University of Missouri Agricultural Experiment Station, Department of Soil Science, later to be come the Department of Agronomy. I was a member of the "Henry County Soil Survey Party". It was a party. Dr. Clarence Scrivner was the leader of that group, and about to become a new Ph.D. in 1960. Serving on that party were some familiar names to this group, all UMC graduates. Fred Gilbert, now retired State Soil Scientist with NRCS from New York, whose home was in Henry County, was a member of that team and was here earlier this week. It was wonderful seeing Fred. He hasn't aged at all. Richard "Chick" Fenwick, now retired from the National Office, was also on that crew. In addition to myself, Bobby J. Miller, (now deceased), was to go on for a Ph.D. and become Professor of Soil Science at LSU. Joe Roe Eagleman, received a Ph.D in Atmospheric Science and is now Professor of Atmospheric Science at the University of Kansas. Kenneth Vogt, now retired former Assistant State Soil Scientist in Missouri, joined the Henry County crew a year later. Those truly were formative years for all of us. I don't think any of us realized at the time, the importance of the activity we were in or the magnitude and effect those early career choices would have on all our lives. For all of us, those early decisions were the basis for life long friendships and life long careers working as a part of the National Cooperative Soil Survey. We all made the right choice.

After hearing the reports on the activities and accomplishments that the Missouri Cooperative Soil Survey has made, and the excellent program NRCS and the Missouri Department of Natural Resources have developed, I am very pleased to know my home state is doing things right, and I commend you for that.

I left Missouri and migrated to Virginia where, for the past 21 years, I have coordinated the Virginia Tech portion of the National Cooperative Soil Survey. Virginia Tech has been in the Soil Survey business for a long time. The early Virginia work was under the direction of Dr. Sam Obenshain. His vision was to initiate the Urban Soils Interpretative Program that has served as the prototype for soil interpretations nationally. That program is still thriving in Virginia. Doc. Sam, celebrated his 94th Birthday in June of this year.

NORTHEAST

COOPERATIVE SOIL

SURVEY CONFERENCE

BANGOR, MAINE

JULY 19 - 23, 1998

AGENDA

Sunday - July 19

Registration - Lobby of Ramada Inn, Odlin Road, Bangor, ME

5:00 P.M. - 7:00 P.M.

Monday - July 20

Moderator, David Wilkinson, NRCS, Soil Resource Specialist, Lewiston, ME

8:00 - 8:15 A.M.
Welcome to Maine
M. Darrel Dominick
State Conservationist
Orono, ME

8:15 - 8:30 A.M.
Wekome
Edward McLaughlin
Commissioner of the Maine Departmer

10:45 - 11:00 A.M.	***NASIS Update*** Russ Kelsea, NSSC Soil Scientist Lincoln, NE
11:00 - 11:15 A.M.	***Criteria and Indicators of Forest Sustainability*** Connie Carpenter, USFS Hydrologist Durham, NH
11: 15 - 11:30 A.M.	***Forest Soils Research*** Rich Hallett, USFS Research Ecologist Durham, NH
11:30 - 11:45 A.M.	Dr. John Sencindiver, WVU Professor of Agronomy & Soil Sciences Morgantown, WV
11:45 - 1:00 P.M.	Lunch

Moderator, Andrew Williams
NRCS, Soil Scientist
Amherst, MA

1:00- 1:10 P.M.	***Maryland NRCS & University Report***
1:00 - 1:20 P.M.	***Delaware NRCS & University Report***
1:20 - 1:30 P.M.	***Vermont NRCS & University Report***
1:30 - 2:00 P.M.	***National Cartography*** ***Geospatial Center Status Report*** Dick Folsche, NCG Director Hof Owen, SSURGO Support Ft. Worth, TX
2:00 - 2:30 P.M.	***Soil Quality Institute - Technology Transfer*** Debra Dirlam, NRCS GIS Specialist Ames, IA
2:30 - 3:00 P.M.	***Carbon Sequestration*** Bob Ahrens, NRCS, NSSC, Soil Taxonomy Lead Scientist Lincoln, NE
3:00 - 3:30 P.M.	Break
3:30 - 5:00 P.M.	**Committee Meetings:** **Committee 1 - Research Needs** **Committee 2 - Soil Taxonomy** **Committee 3 - SSURGO/Map** **Committee 4 - Role of Experiment Stations in NCSS** **Committee 5 - Site Specific/ High Intensity Soil Survey**
5:30 - 7:00 P.M.	***Social - Hospitality Rm***
9:30 P.M.	***NEC-50 Meeting*** ***NRCS Technical Soils Consortium***

Tuesday - July 21

8:00- 10:OOA.M.	**Committee Meetings:** **Committee 1 - Research Needs** **Commiftee2 - Soil Taxonomy** **Commiftee3 - SSURGO/Map** **Committee4 - Role of Experiment Stations in NCSS** **Committee 5 - Site Specific High Intensity Soil Survey**
10:00- 10:15 A.M.	Break

Moderator, Dr. Mark Stolt,
University of Rhode Island, Asst. Professor
Department of Natural Resources
Kingston, RI

10:15- 10:20A.M.	***East Region Activities*** Maxine Levin, NRCS Soil Scientist Beltsville, MD
10:20 - 10:30 A.M.	***Soil Related Activities In State of Maine Govt*** David Rocque Dept. of Agriculture State Soil Scientist Augusta, ME
10:30 - 10:55 A.M.	***Outlook for Soil Survey & Resource Assessment*** Dr.. Maurice Mausbach, NRCS Deputy Chief for Soil Survey & Resource Assessment Washington, DC
10:55- 11:10A.M.	***Soils Related Activities at the University of ME*** Ivan Fernandez, University of Maine Prof. of Applied Ecology & Environmental Sciences Orono, ME

11:10- 11:25A.M. *Canadian Soils Program in the Maritimes*
Herb Reese
Potato Research Center
Agriculture and Agriculture Canada

11:40 A.M. *Penobscot Nation GIS Activities*
Theresa Hoffman
Penobscot Nation Staff Geologist
Old Town, ME

11:50 A.M. *Connecticut NRCS & University Report*

11:50 - 12:00 *New Hampshire NRCS & University Report*

12:00 - 1:00 P.M. Lunch

Moderator Shawn McVey, NRCS
Asst. State Soil Scientist
Storrs, CT

1:20 P.M. *Maine Association of Professional Soil Scientists*
David Marceau,
President of MAPSS

1:20 - 1:30 P.M. *New Jersey NRCS & University Report*

1:30 - 1:40 P.M. *New York NRCS & University Report*

1:50 P.M. *Pennsylvania NRCS & University Report*

1:50 - 2:00 P.M. *Rhode Island NRCS & University Report*

2:25 P.M. *Soil Survey and Soil Climate Interface*
Doug Miller, Research Associate
Penn State
University Park, PA

2:25 - 2:45 P.M. *State of the Soils for the Centennial of Soil Survey*
Ronnie Taylor, NRCS
State Soil Scientist
Somerset, NJ

3:15 P.M. Break

3:15 - 3:45 P.M. *Regional Soil Taxonomy Proposals*
Bob Ahrens, NRCS, NSSC
Soil Taxonomy Lead Scientist
Lincoln, NE

3:45 - 4:15 P.M. *Update on Soil Survey Centennial Activities*
Gary Muckel, NRCS
Soil Scientist
Lincoln, NE

4:15 - 4:30 P.M. *Regional Technical Committees for Hydric Soils*
Mike Whited, NRCS
Soil & Wetland Scientist
Wetland Institute
Lincoln, NE

4:30 - 5:00 P.M. *Gelisols*
Bob Ahrens, NRCS, NSSC
Soil Taxonomy, Lead Scientist
Lincoln, NE

5:00-5:05P.M. *Logistics for Field Trip*
Norman Kalloch, NRCS
Asst. State Conservationist for Soils
Orono, ME

5:30 - 7:00 P.M. *Social Hospitality Room*
Computer Demonstrations
Soil Science Education
K-12 Globe Program
CD ROM Surveys
NASIS
Dr. Elissa Levine, NASA
Physical Scientist
Greenbelt, MD
Russ Kelsea, NRCS
Soil Scientist
Lincoln, NE

Wednesday - July 22

8:00 A.M. - 5:00 P.M. Field Trip

5:00 P.M. - 9:00 P.M. Banquet

Thursday - July 23

Moderator, Dean Cowherd, NRCS
Asst. State Conservationist
Annapolis, MD

8:00 - 9:00 A.M. *Break Out Session*
NRCS
NEC-50

9:00 - 9:10 A.M. Massachusetts NRCS & University Report

9:10 – 9:20 A.M. Virginia NRCS & University Report

9:20 - 9:30 A.M. ***West Virginia NRCS & University Report***

9:30 - 9:45 A.M. ***The Use of Soil Information by the National Park Service***
Nigel Shaw
National Park Service Representative
Boston, MA

9:45 - 10:15 A.M. **Break**

10: 15-10:30 A. M. ***MO- 12 Report***
Bruce Thompson, NRCS
MLRA Office Leader
Amherst, MA

10:30-10:45 A.M. ***MO-13 Report***
Steve Carpenter, NRCS
MLRA Office Leader
Morgantown, WV

10:45-11:00 A.M. ***MO-14 Report***
John Kelly, NRCS
Soil Data Quality Specialist
Raleigh, NC

11:00-11:10 A.M. ***Technical Committee #1 Report***
11:10-11:20 A.M. ***Technical Committee #2 Report***
11:20-11:30 A.M. ***Technical Committee #3 Report***
11:30-11:40 A.M. ***Technical Committee #4 Report***
11:40-11:50 A.M. ***Technical Committee #5 Report***
11:50 - Noon ***Technical Committee Reports Questions & Discussions***

12:00- 1:00 P.M. **Lunch**

Moderator, Tim Craul
Super

Northeast Cooperative Soil Survey Conference - Committees

Committee 1: Research Needs
Chair: Maxine Levin, Beltsville, MD
Charge: The major goal of the Committee is to improve communications of soil survey research needs and activities in the NE Conference area within the NE NCSS at all levels.

Committee 2: Soil Taxonomy
Chair: Bob Ahrens, Lincoln, NE
Charge: The major goal of the Committee is to sponsor or coordinate workshops on soil taxonomy in the conference area, sponsor proposals for soil taxonomy changes and look over proposals or changes in soil taxonomy in detail.

Committee 3: SSURGO/Map Finishing
Chair: Caroline Alves, Williston, VT
Vice Chair: Dr. Rick Day, University. Park, PA
Charge: The Committee has been in place since the 1994 Conference. The goal of the Committee is to identify barriers to achieving NRCS-NCSS SSURGO goals for 2002, identify what progress has been made towards regional coverage of SSURGO certified products, and identify barriers and training issues for map finishing in the conference area.

Committee 4: Define the Role of the Experiment Stations in the future of the National Cooperative Soil survey in the Northeast
Chair: Jim Baker, Blacksburg, VA
Vice Chair: Jim Brown, Annapolis, MD
Charge: As the resources and infrastructure of the Agricultural Experiment Stations in the Northeast has been declining in the past 10 years, there has been a general concern sa to what the future holds for cooperation within the NCSS in the NE.

Committee 5: Site Specific Survey/High Intensity Soil Survey, NCSS standards
Chair: Henry Mount, Lincoln, NE and Steve Hundley, Durham, NH
Charge: The goal of this committee is to increase communication and knowledge of this emerging topic in the Northeast.

NEC-50 Report
Experiment Station Representatives

Submitted by John C. Sencindiver

1. Representatives to the 1999 National Cooperative Soil Survey Conference-

   Representative - Jim Baker
   Alternate - Ed Ciolkosz

2. Elected to Research Needs Committee - Ray Bryant and Harvey Luce

3: Representatives to Northeast Soil Taxonomy Committee

1996-1998	Martin Rabenhorst
1997-1999	John Sencindiver
1998-2000	Peter Veneman
1999-2001	Mark Stolt

4. The University of Maryland will host the 1999 summer graduate student pedology field trip.

   We discussed the coordination of research between the NRCS and the Experiment Stations. We want to affirm the cooperation that we have in most states, and to confirm our appreciation for those partnerships. However, we see an opportunity for better coordination and communication between the Experiment Stations and the NRCS, especially the National Soil Survey Center. Therefore, it was the unanimous decision of the Experiment Station representatives to request NRCS to take a more active role in coordinating research efforts between the Northeast Agricultural Experiment Stations and the NRCS.

East Region -- Soil Survey
NRCS-USDA

Maxine J. Levin
Soil Scientist for
Oversight and Evaluation, East Region
Beltsville, MD

NCSS Conference
Bangor ME
July 19-23, 1998

Staffing in the East Region:

There are presently 110 soil scientists in NRCS in the East Region:
9 State Soil Scientists (2 have dual duties as MLRA Office Leaders)
1 Soil Scientist, Regional Oversight & Evaluation
10 State Office Soil Scientists (Statewide interpretations & data responsibilities)
7 MLRA Office Data Quality Specialist Soil Scientists (MLRA regional correlation responsibilities)
26 Project Leader Soil Scientists
38 Soil Mappers
1 Wetland Institute Soil Scientist
1 Research Soil Scientist (NSSC-PA)

Northeast Cooperative Soil Survey Conference
NRCS Break Out Session
8:00 arn, Thursday, July 23, 1998

The minutes of the 1996 NCSSC break out session were read. Proposals made during this meeting will be presented at Business Meeting this afternoon.

I. Northeast Soil Taxonomy Committee -

The following 3 people were nominated as Soil Taxonomy Committee members for 1999-2001:

Ned Allenburger - PA - 1999-2001
Dave Kingsbury - MO, VYIV - 2000-2002
Karen Dudley - NH -.2001-2003

II. Selection of representatives to the National Conference

After discussion it was decided that format decided upon and added to by-laws in 1996 be adopted. Maxine will select someone who has not recently attended.

III. Host of 2000 Conference

Virginia was nominated and selected for the 2000 conference. New York was nominated and selected to host conference in 2002.

IV. Research Needs Committee

Dr. Richard Shaw, New Jersey, and Maryland State Soil Scientist, Jim Brown, Maryland was nominated as representatives.

V. Regional Hydric Soils Committee

Northeast Cooperative Soil Survey Conference acknowledges the established committees in the MidAtlantic States and New England with the appointment of an NCSS Liaison to these committees.

New York would belong to both committees. Formalize action to add Virginia to Mid-Atlantic Committee. NCSS liaison could be University representative.

Additional Topics of Discussion - Proposals

1. Charge for Technical Committee on Hydric soils NCSS conference 2000. It was suggested that subcommittees should meet at next session to discuss similarities and differences in their operations. Discuss problems each group is having on on-going issues.

2. Establish technical committee for 2000 conference to address field indicators for hydric soils in Northeast with Chair and Co-chair made up of Mid-Atlantic and New England hydric soils committee. At that conference it would be decided if the committee would continue after 2000.

George Teachman presentation on potential Army Soil Survey Workload.

Material presented discussed possible soil survey requests from Army. T'he Army has required that soil surveys be conducted by NRCS. NRCS will decide how surveys will be conducted. Army will pay all costs.

Possible workload for Northeast Region:

State	#	Acres
ME	6	12,400
VT	3	15,100
NH	2	100
MA	3	1,000
NY	4	31,400
CT	5	8,000
DE	2	300
MD	5	8,600
NJ	2	37,500
PA	5	28,700
VA	2	7,000

Northeast Cooperative Soil Survey Conference
Business Meeting July 23,1998

Maxine Levin, Regional Soil Scientist, NRCS-USDA, East Region opened the meeting.

Old Business:

1. New York offered to host the next Northeast Cooperative Soil Survey Conference. Virginia also offered their state as. well. Dean Rector pointed out that Virginia had deferred its turn 4 years ago. Virginia accepted to be the host for the next NE Cooperative Soil Survey Conference in the year 2000. The East Regional Soil Scientist, NRCS, will be the Chair of the Year 2000 Steering Committee. Dean Rector, State Soil Scientist, NRCS, VA will be the Chair of the Conference. Dr. Baker (or substitute), Professor, VA Tech., Blacksburg, VA, the, Co-Chair, and Norman Kalloch, NRCS-ME, the Vice-Chair. New York will host the NE Conference in 2002.

2. A discussion was opened as to whether the Hydric Soil Committee in the Northeast (New England and Mid Atlantic) should continue as separate entities or be combined as one regional group under the National Hydric Soils Committee.

   a. The National Hydric Soils Committee has delegated authority for regional groups to continue as separate entities. For those regional committees that want to have approval for new regional hydric soil indicators, a proposal should be submitted to the National Hydric Soils Committee by their next meeting. The National Hydric Soils Committee plans to have their next meeting at the National Agronomy Meetings in Baltimore, MD, Oct 18-23, 1998.

   b. Discussion questions that the group brought up and need to be addressed in a letter or by a committee:

      1 What is the future of the National Hydric Soils Committee? Is it being dissolved or reduced? Will it be an oversite committee for the regional committees?

      2. Can the Regional committees set their own regional indicators? they be recognized as official documents or as a subset of test field indicators for the National list?

   c. A proposal was made, seconded and approved to:

      - Endorse Regional Hydric Soil Committees which would support the National Hydric Soils Committee.
      - The Regional Hydric Soil Committees would act as separate entities from the National Committee.
      - The New England and Mid-Atlantic Hydric Soils Committees will continue as separate organizations but report progress to the NE Cooperative Soil Survey Conference

3. Participants approved and accepted the reports from the 1997-1998 NE Soil Survey
   Conference Committees:
   Soil Taxonomy
   SSURGO/Map Finishing
   Research Needs
   Site Specific/Precision Farming
   Future Role of the Agricultural Experiment Stations in Soil Survey

New Business:

1. The following committees are recommended for the next NE Cooperative Soil Survey Conference in YR 2000:

   Soil Taxonomy - standing committee
   SSURGO/Map Finishing - continued into the next conference
   Research Needs - standing committee
   Site Specific/Precision Farming - continued into the next conference
   Hydric Soils Committee - Regional Summaries

2. A proposal was made not to have the Business Meeting at the end of the Conference so that more participants with specific interests would be represented. Friday was provided as a travel day, however participants used Thursday afternoon (end of the Conference) to travel instead. The YR2000 Steering Committee for the next conference will consider the request

3. The NRCS East Regional Soil Scientist will coordinate upcoming conferences with other region so as to have inter-regional cooperation.

Meeting Adjourned.

North Central Soil Survey Conference Report
to the
National Cooperative Soil Survey conference
St. Louis, Missouri
June 28 - July 2, 1999
by
Delbert L. Molana
Michigan State University

Introduction

This report summarizes the research activities of the North Central Agricultural Experiment Stations which relate to the National Cooperative Soil Survey Program. The 1998 North Central Soil Survey Conference was held in Columbia, Missouri on June 14 - 18, 1998. The proceedings of the 1998 North Central Soil Survey Conference have not been published to date. The Conference did not have the usual committee structure, therefore, there are no committee reports.

North Central Agricultural Experiment Station Regional committee (NCR-3) activities related to NCSS:
1. Proposed definition of Hydric Soils in the North Central Region.
2. New Regional Soil Map is being prepared for the North Central Region. Changes in Borolls and Boralfs, digitization, and publication remain to be completed.
3. Continue to provide members on:
   - National Soil Taxonomy committee.
   - Eroded Soil Committee.
   - National Cooperative Soil Survey Advisory Group.
   - National Soil Survey Standards Committee.
   - National Cooperative Soil Survey Research and Development Agenda Committee.
   - Steering Committee for the NSSC. - National Soil Survey Laboratory Database.

North Central Agricultural Experiment Station Research Activities related to National Cooperative Soil Survey Program:

The following list includes some of the major research projects being conducted by the individual North Central states.

Illinois
1. Soil productivity and soil erosion relationships.
2. Evaluation of conservation tillage systems for the restoration of productivity of previously eroded soils.
3. Soil productivity index ratings for newly correlated Illinois soil types.
4. Soil erosion and sedimentation using fly ash from coal fired locomotives and steam engines as profile markers.
5. Update crop yield estimates for selected crops for all Illinois soil types.

Indiana
1. Monitoring water depth, reduction and water movement in several toposequences.
2. Studying the role of Fe, Al and Si in cementation of fragipans.
3. Detection and quantification of the amount of residue cover on fields using remote sensing (AVIRIS) data.
4. Relating map units of the STATSGO maps to the SOTER map project, and international soil and terrain map based largely on landforms.
5. Soil variability related to precision farming.

Iowa
1. Erosion - productivity project including soil quality.
2. Use of ground conductivity meters in soil survey.
3. Stratigraphic relationships under loess covered benches in Lucas County.
4. Savanna Ten-aces soil project (with NRCS).
5. Water table studies of selected soils.
6. Use of soil survey data in precision farming and yield mapping.

Kansas
1. Clay translocation and carbonate accumulation in the 16 - 26 inch rainfall zone of western Kansas.
2. Distribution and properties of clay minerals in Kansas soils with emphasis on applications to soil fertility.
3. Soil genesis and geomorphology on the Konza Prairie.
4. Parent material stratigraphy and genesis of soils developed in eolian materials in the Southern High Plains.
5. Development of a GIS that includes soils information, land use, soil suitability for crop land, and water resources for Finney County.

Michigan
1. Use of alternative on-site waste water treatment systems in slowly permeable soils.
2. Evaluation of mulch for the restoration of productivity of previously eroded soils.
3. Impact of cultivation on spodic horizon properties.
4. Development of methods and guidelines for local wetland protection and related land us6 planning.
5. Evaluation of yield monitor maps for obtaining soils information for precision farming.

Minnesota
1. Long-term monitoring of soil hydrology, redox, and soil temperature characteristics to characterize soil processes and associated soil morphologies along soil catenas in five physiographic provinces of Minnesota.
2. Assessment of the effects of soil/site specific herbicide management on losses in surface runoff and leaching from mini-watersheds.
3. Development and interpretation of multi-scale GIS database so soil, hydrological, land use, and topographic database for major watershed regions of Minnesota.
4. Evaluating and testing alternative individual sewage treatment systems.

Missouri
1. Study of urban storm runoff,
2. Carbon sequestration of selected soils.
3. Onsite waste water treatment in karst topography of the Ozarks.
4. Soil erosion on Sanborn Field.
5. Digitization of soil maps.

Nebraska
1. Loess stratigraphy an paleosol development in central Nebraska.
2. Changes in spectral reflectance of sediment, from loess soils, in water with increased concentrations of sediment.
3. Soil development in loess as influenced by sedimentary zones in the loess and ongoing dust deposition during soil development.
4. Study of organic C, base saturation and pH data in Valentine and Valent soils.
5. changes in soil properties in Keith soils over the past 40, years.

6. Development of protocol to merge soils and groundwate r data to indicate the vulnerability of groundwater to contamination by pesticides on a county basis.

North Dakota
1. Soil hydrology and wet soils monitoring.
2. Soil morphologic patterns in landscapes that affect water movement and retention and on trace metal distributions in shale-affected soils of northeastern North Dakota.

Ohio
1. Extent and impact of fractures in dense till on permeability.
2. Historic changes in C sequestration in soils of northwestern Ohio.
3. Impact of accelerated erosion on changes in classification of Alfisols.
4. Trace metal background levels in surface horizons of soils in the Sandusky River Basin and historic changes as determined by comparison with archived samples.
5. Influence of glacial till characteristics on the distribution of fragipan soils in northeastern Ohio.
6. content of water extractable Si in soils and the role of silica gel in development of soil brittleness.

South Dakota
1. Develop a productivity index system for MIRAs 102B and 107 (southeastern South Dakota).
2. Determine detailed soil properties on precision farming project including use of electromagnetic induction conductivity data.
3. Soil factors affecting EM 38 readings in eastern South Dakota soils.
4. Soil genesis in a loess/glacial till landscape in east central South Dakota.
5. Parent material stratigraphy and soil genesis of soils developed in colian materials along the Big Sioux River in Brookings county.

Wisconsin
1. 3-D visualization of soil landscapes.
2. Use of profile cone penetrometry for high resolution soil mapping.
3. Reexamination of the Catena concept in Uganda.'
4. Fate and transport of agricultural chemical in landscapes featuring closed depressions.

Status of soil surveys in North Central states.

Progressive soil surveys to compete the "once over" are in progress in about 20 counties in Michigan, Minnesota, Missouri and North Dakota. All states are involved in MLRA activities; updating or mapping. Most states have been digitizing soil surveys. Recently they have changed to digitizing soil surveys according to SSURGO standards.

Cooperative State Research, Education, and Extension
1890 Land Grant Colleges and Universities

Highlights of Soil Survey/GIS

Frieda Eivazi, Soil Science, Cooperative Research, Lincoln University, Jefferson City, MO
Fred Young, Soil Survey/GIS, Lincoln University, and USDA-NRCS, Jefferson City, MO

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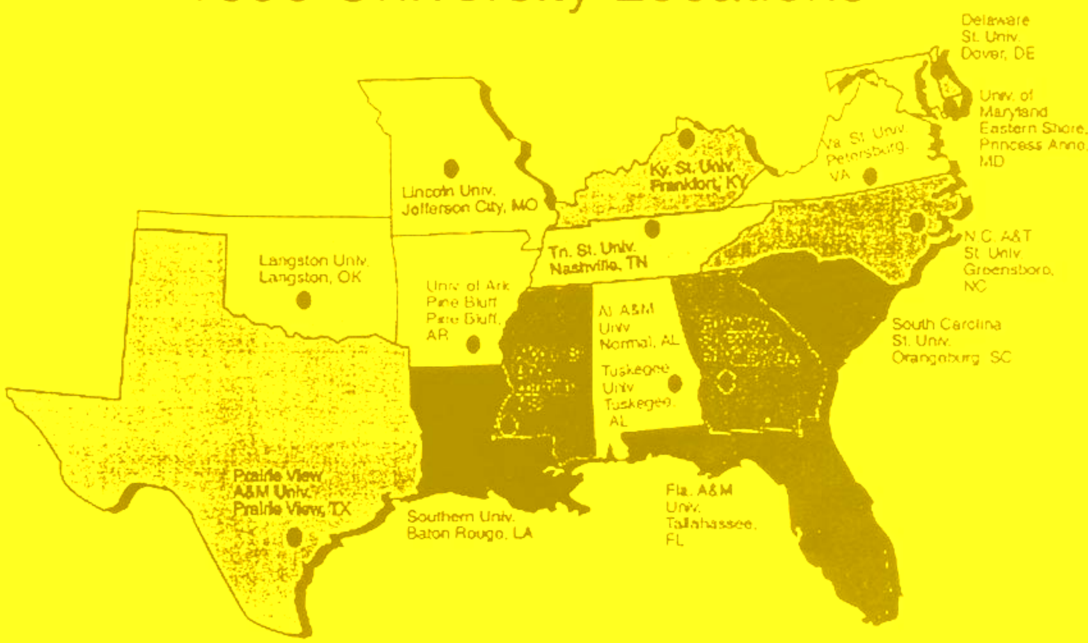
United States Department of Agriculture and the 1890 Institutions

1890 University Locations



Cooperative State Research, Education, and Extension
1890 Land Grant Colleges and Universities

Highlights of Soil Survey/GIS

Frieda Eivazi, Soil Science, Cooperative Research, Lincoln University, Jefferson City, MO
Fred Young, Soil Survey/GIS, Lincoln University, and USDA-NRCS, Jefferson City, MO

History of the 1890 Programs

The 1890 Land-Grant Institutions were created as a result of the Second Morrill act of 1890. Prior to this, the United States Congress passed the First Morrill Act of 1862, which authorized the establishment of a land-grant institution in each state to educate citizens in agriculture, home economics, mechanical arts, and other practical professions. The land-grant philosophy has been the foundation of America's agricultural productivity for nearly 125 years. The three cornerstones of the land-grant approach - teaching, research, and extension -- have improved the economic well being and quality of life for millions of Americans.

In the beginning, however, not everyone benefited from the land-grant system. Under the conditions of legal separation of the races in the South, blacks were not permitted to attend the original land-grant institutions. Although the Morrill Act of 1862 authorized "separate but equal" facilities, only Mississippi and Kentucky established institutions for blacks under this law, and only Alcorn State University was designated as a land-grant institution.

From 1866 to 1890, several southern states established normal schools to train black teachers. Although many of these institutions were similar to the land-grant universities, the federal government was unable to gain cooperation from the southern states in the provision of land-grant support to the black institutions.

This situation was rectified by the passage of the Second Morrill Act by the United States Congress in 1890, expanding the 1862 system of land-grant universities to include historically black institutions. Many of the black normal schools were incorporated into this system and became known as " 1890 Institutions." Each of those southern states that did not have a black college by 1890 established one later under the Second Morrill Act.

One exception to this historical pattern is Tuskegee University, which was created as Tuskegee Normal and Industrial Institute by an act of the Alabama legislature in 1881. Twelve years later, the state granted the school its independence and incorporated a semi-private board of trustees to govern it. Thus, Tuskegee University is not a land-grant college, despite the fact that it was granted 25,000 acres of land by the U.S. Congress in 1899. However, because Tuskegee has espoused the land-grant philosophy throughout its history, it traditionally has been associated with the black land-grant institutions.

From these humble beginnings, the 1890 Institutions evolved into a major educational resource for the nation. For over a century, they have provided a principal means of access to higher education for black men and women. Today, although their programs are available to all persons regardless of race, sex, creed, or socioeconomic status, the 1890 Institutions still continue to be a key source of black leaders who render valuable service to their communities, the nation, and the world.

USDA and 1890 Programs:

- USDA/I 890 National Scholars Program.
- USDA/1890 Centers of Excellence.
- Capacity Building Grants Program.
- Federal Excess Property Program.
- USDA/Wilson Foundation Fellowship program.
- USDA Campus Liaison Officers Program.

1890 Institution Capacity Building Grants Program

This program was initiated in FY 1990 to build the institutional capacities of the 1890 historically Black land grant colleges and Tuskegee University through cooperative linkages with Federal and non-Federal entities. The program addresses the need to:

(1) attract more under represented students into the food and agricultural sciences,
(2) expand the linkages among the 1890 institutions and with other colleges and universities,
(3) strengthen the teaching and research capacity of the 1890 land-grant institutions to more firmly establish them as full partners in the food and agricultural science and education system.

Centers of Excellence established as a result of the above program are as follows:

Established in 1994:
- Center of Excellence in Forestry at Alabama A &M University.
- Center of Excellence in Ornamental Nursery Crops at Tennessee State University.
- Center of Excellence in Aquaculture at the University of Arkansas at Pine Pluff.

Established in 1995:
- Center of Excellence Initiative in GIS and Wildlife Management at Lincoln University.
- University of Maryland-Eastern Shore in Food Safety and Animal Health..
- Center of Excellence in Regulatory Science at the University of Arkansas at Pine Pluff.

Established in 1996:
- Center of Excellence in Water Quality at Virginia State University.
- Delaware State University in Aquaculture and Food Safety.
- Center of Excellence in Swine Production and Marketing at Alcorn State University.
- Center of Excellence in Remote Sensing at Prairie View A&M University.

History of the Lincoln University GIS/RS Lab

Founded in 1866 by the 62nd and 65th Missouri Colored Infantries, Lincoln University is an 1890's Land Grant Institution located in Missouri's state capital, Jefferson City. Originally formed as Lincoln Institute to meet the educational and social needs of freed African-Americans, Lincoln University is one of the oldest Historically Black Colleges and Universities in the United States. Today, Lincoln University offers comprehensive academic services to a culturally and ethnically diverse student body of about 4,000.

In 1990, Lincoln University's Department of Agriculture, Natural Resources, and Home Economics received a grant of $163,000 from the USDA Soil Conservation Service and AT&T Corporation to establish a computer laboratory for University students. A secondary use of the lab would be to serve as a training lab for SCS and other federally employed personnel. In early 1991, the SCS/AT&T Agriculture Computer lab went "on-line". A combination DOS/UNIX network of an AT&T 3B2 minicomputer, 10 dumb terminals, and 13 386-based PC's, the lab was used heavily by Lincoln students, and hosted a number of successful training session for USDA personnel.

Computer technology advanced rapidly over the next few years. In 1992, another grant of $60,000 by.the SCS allowed the purchase of a Sun Sparcstation IPX, to be set up as a GIS workstation running the public-domain GIS software package GRASS 4.0. Students showed an interest in learning about GIS, and several students were employed by the SCS to do digitizing and other GIS-related work at the lab. Meanwhile, the aging AT&T equipment began to suffer from breakdowns and the demands placed by more modem Windows software. Rather than continue to fund the repair of what was quickly becoming obsolete equipment, the decision was made to concentrate efforts at developing the GIS aspect of the laboratory.

A Capacity Building Grant of $125,000 was used to purchase more equipment, including a Sun Sparcserver 1000, a Sparcstation 10, and a number of X terminals, as well as hire a full-time technician to maintain the lab network. Interagency Personnel Agreements with the SCS established two positions related to the lab: Dr. Wayne Weaver was brought on as a Photo Interpretation/GIS instructor, and Elizabeth Cook took on the responsibilities of GIS Analyst and Laboratory Manager.

Currently, the lab operates in support of Lincoln University's fledgling program in GIS and Remote Sensing, as well as serving as a training site for USDA employees. The lab also has a contract with ESRI Corporations (makers of the popular Arc/Info GIS software package) to provide training in exchange for Arc/Info licenses.

<u>GIS/RS Laboratory Information</u>

The Lincoln University GIS/RS Laboratory became fully functional in early 1994. The GIS/RS Laboratory is located in 306 Founders Hall at the heart of Lincoln University's attractive campus. The lab houses a network of high-end UNIX workstations, terminals and servers running ARCANFO, ArcView, GRASS and Erdas Imagine. Scanning, digitizing and production of high-quality hard copy can be achieved using the lab's various peripherals.

The Lincoln University Geographic Information System and Remote Sensing (GIS/RS) Laboratory is an integral part of the University's Center of Excellence for Leadership in GIS and Wildlife Management. The Center initiative receives financial and programmatic support from the United States Department of Agriculture. Through Center activities, Lincoln University envisions becoming nationally and internationally known for academic excellence in GIS and wildlife management.

The GIS/RS Laboratory serves four important fi4nctions for both the University and region:

- The laboratory is an academic teaching facility in support of the Lincoln curriculum. Classes include Basic Photo Interpretation and Map Reading, Fundamentals of GIS, Survey of Applications in GIS, Fundamentals of Remote Sensing and Applications of GIS.

- Regional training short courses are conducted in the laboratory for government agencies and private industry.

- The facility and equipment are available to faculty and staff of Lincoln University and other academic institutions who wish to use GIS and remote sensing techniques in research endeavors.

- Lincoln University and Center staff are available to contract project applications of GIS, image processing or related technologies.

The GIS/RS staff at Lincoln University have years of experience in UNIX system administration and applying GIS and image processing to various resource issues. Combined with this experience, the staff stays up-to-date on new developments in these technologies--a necessity in fields that change so rapidly. By providing industry standard equipment, networks, software and trained personnel, the Lincoln University GIS/RS laboratory is able to offer its clients "real world" training in a comfortable environment.

Significant contributions to academic and regional applications of GIS and image processing:

- About 20 Lincoln University students per semester have completed coursework and laboratory exercises in GIS and remote sensing

- Center of Excellence funds have been used to employ 3-5 students each semester in the laboratory, allowing them to expand their classroom learning with project experience

- projects have been undertaken to assess landscape changes along the Missouri River due to the Flood of '93 for Natural Resources Conservation Service (NRCS), automate forest tract boundaries for Missouri Department of Conservation, transfer and automate hydrologic unit boundaries (NRCS), analyze Indiana Bat distributions and migrations for U.S. Fish and Wildlife Service's Recovery team and assist Missouri Army National Guard with an optimal siting study for a fueling station

- the laboratory has been designated as a regional training center by Environmental Systems Research Institute, Inc. for ARCANFO and ArcView and by1rdas, Inc. for Imagine

- short courses on photo interpretation and map reading, GIS, Global Positioning System, digital orthophotography and image processing have been conducted on behalf of various agencies • laboratory staff are assisting USDA personnel in Callaway County, Missouri with design and implementation of a Team USDA Field Service Center

Current GIS Course Offerings

- AGR 208 Photo Interpretation and Map Reading
  This introductory course emphasizes use of maps and aerial photography for resources inventory and assessment. Basic geographic concepts concerning map and photo scales, resolution and accuracy are covered, as well as projections and coordinate systems. Two hours lecture/two hours laboratory weekly (3 credit hours).

- AGR 316 Fundamentals of GIS
  This course examines basic concepts and techniques for computer analysis of spatial data. Topics include introduction to UNIX, data collection and digital conversion, data management and quality issues, analysis and computer cartography. Prerequisite: AGR 208 or permission of instructor. Two hours lecture/two hours laboratory weekly (3 credit hours).

- AGR 4 10 or GEO 495 Survey of Applications in GIS
  This survey course is designed for students and faculty interested in an introduction to GIS

capabilities, but who do not need to learn rigorous GIS analytical techniques. No prior experience with maps or computers is required (2 credit hours).

- AGR 411 Fundamentals of Remote Sensing
  Theory and techniques of digital image processing are examined in this course. Topics addressed include sources and characteristics of remote sensing data, radiometric and spectral enhancements, classification and integration with GIS. Prerequisites: AGR 208 and AGR 316. Two hours lecture/two hours laboratory weekly (3 credit hours).

- AGR 416 Geographic Information Systems Applications
  This course covers advanced topics of GIS, including acquisition, assessment and conversion of existing digital data, 3-D analysis, modeling, literature review and project

- budgeting and management. Prerequisites: AGR 208 and AGR 316. Three hours lecture/two hours laboratory weekly (4 credit hours).

<u>Staff</u>

Tracey Bumett~ Cartographer
Joel Capps, Systems Administrator
Adam Carrington, Center of Excellence GIS Technician
Brandon Collins, Center of Excellence GIS-Tech.nician
Elizabeth (Liz) Cook, GIS Analyst/Laboratory Manager
Terry Edwards, Center of Excellence GIS Technician
Blake Glover, Center of Excellence GIS Technician
Scott Rackers, Center of Excellence GIS Technician
Drenda Weir, Soil Conservationist
Fred Young, Instructor
Derrick Youngblood, Center of Excellence GIS Technician

Center for Hydrology, Soil Climatology and Remote Sensing
HSCaRS
ALABAMA A&M UNIVERSITY

<u>DESCRIPTION OF THE CENTER</u>

The Center for Hydrology, Soil Climatology and Remote Sensing (HSCaRS) at Alabama A&M University (AAMU) goal is to develop a comprehensive research program investigating hydrologic processes with emphasis on remote sensing measurements and modeling of soil moisture and to promote the participation of under-represented minority and women students in Earth Systems and global change sciences via student recruitment and enrichment programs. Faculty at AAMU have conducted research utilizing remote sensing and geographic information system technology for over 20 years. Through the Alabama Center for Applications of Remote Sensing (ACARS) laboratory, they have investigated a wide range of topics in soil science, environmental science, plant science, hydrology, land surface processes, ecology, forestry, and agriculture. Through collaborative research, the Center will draw upon the expertise of the Department of Plant and Soil Science, the Physics Department and the Computer Science Department at AAMU; the Global Hydrology and Climate Center (GHCC) and the Intergraph Corporation, Huntsville, Alabama, Marshall Space Flight Center, Goddard Space Flight Center and USDA Agricultural Research Service (Subtropical Agricultural Research Laboratory - Remote Sensing Unit) in Weslaco, Texas and Beltsville Agricultural Research Center (BARC) in Beltsville, Maryland.

GHCC consists of approximately ISO atmospheric scientists, hydrologists, geographers, mathematicians, computer scientists, engineers, information specialists and educators from NASA's Marshall Space Flight Center's (MSFC) Earth Systems Science Division and the Institute for Global Change Research and Education (IGCRE). IGCRE's partners include the University of Alabama in Huntsville (UAH) and the Universities Space Research Association (USRA), which is an international consortium of 78 universities with graduate programs in space sciences or aerospace engineering. Intergraph Corporation is a world leader in the development and manufacture of image processing and computer mapping systems.

Current research activities involves:

(1) the development of measurement /modeling strategy from low resolution satellite microwave data to derive soil moisture profile information and to determine its variability on a range of spatial scales,
(2) the development of a precise, inexpensive in situ technique to measure soil moisture to facilitate ground truth of remotely sensed data and validation of global and regional climate change models. The water content of soils is of fundamental importance to many hydrological, biological, and biochemical processes, playing a significant role in controlling the exchange of water and energy between the land surface and the atmosphere. Complex feedbacks between the hydrological cycle, the biosphere and weather patterns are not yet fully understood, but play a key role in long-term climate change. Previous modeling experiments have indicated that terrestrial hydrology significantly affects climate by controlling the availability of surface moisture (Yeh et al., 1984; Delworth and Manabe, 1989; Chang and Wetzel, 1991; Chen and Avissar, 1994). Similarly, research has provided evidence that mesoscale atmospheric circulations are influenced by strong moisture gradients (Avissar and Pielke, 1989; Fast and McCorcle, 1991). We intend to develop a plot- scale research test- bed at Alabama A&M University's Winfred Tbomas Research Station to test our in situ measurement and modeling strategies using ground- based microwave and thermal sensors.

The growth potential of HSCaRS is exceptional. The hydrologic modeling strategy coupled with evolutionary computing techniques developed herein is not restricted to the problem of soil moisture, but can be adapted to other water resources problems, such as water quality, contaminant transport, and soil erosion.

Remote Sensing and GIS Laboratory

Facilities:

HSCaRS is comprised of an Instructional Laboratory and a Research Laboratory equipped with multiple hardware systems and software packages to meet most training and research requirements. The facilities of HSCaRS are excellent for conducting short term introductory or advanced training courses in the application of remote sensing and GIS for managing agricultural lands, environmental and natural resources.

Hardware and software available to users at the HSCaRS & GIS Lab are as follows:

Hardware:
Sun SPARC 10 UNIX Workstation
64 megabytes memory
2 CPU processors
6.3 gigabytes disk storage
CDROM
8mm DAT tape drives
20 inch dolor monitor
Sun SPARC 10 UNIX Workstation
32 megabytes memory
gigabyte disk storage 20 inch color monitor
Intergraph TD-3
64 megabytes memory
27 inch color monitors
CDROM
gigabyte disk storage
Sun SPARCserver 1000E
128 megabytes memor
17 inch color monitors
CDROM
31.5 gigabyte disk storagel4-GB 8mm Internal Tape Backup
(10) DELL 486 DX 33 PC
(2) Macintosh
CalComp 9100 digitizing tablet
CalComp DrawingBoard III tablet
Tektronics 4696 color printer
Tektronics Phaser 220i color printer
EPSON Stylus Pro XL color printer
Intergraph 7585B Plotter
ENCAD - Novajet III Plotter
Hewlett-Packard LaserJet 4 Postscript printer
Hewlett-Packard ScanJet IICX Color Scanner
Polaroid CI-5000 Film Recorder
Software:
ARCANFO 7.0.3
ArcView 2.1 for Windows
ArcView 2.1 for UNIX
IDRISI 4.1
GRASS
Intergraph MGE
ATLAS GIS
MapInfo
ERDAS Imagine 8.1 and 8.2 for UNIX and PC ERDAS 7.5 ER
Mapper 5.0
NetScape 2.0
Sun PC NFS & Hummingbird Communications, LTD eXceed 4 for Windows and Windows NT
Word processors, databases, spreadsheets, and presentation graphics programs.

HSCaRS Personnel
DIRECTOR: Dr. Tommy L. Coleman
FACULTY/SCIENTIST:
AAMU - Plant, Soil and Animal Sciences

•Dr. Andrew Manu • Dr. Ahmed Fahsi • Dr. Zachery N. Senwo • Dr. Teferi Tsegaye •Dr. Karamat Sistani • Dr. Narayan Rajbhandari

AAMU - Physics
Dr. Robert Metzl • Dr. Anup Sharma • Dr. Manmohan D. Aggarwal • Dr. B.R. Reddy • Dr.M. P. Schamschula marius@caos.aamu.edu

IGCRE-GHCC
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MSFC - GHCC
Dr. Jeffry C. Luvall j luvall@xnsfc.nasa.gov • Dr. Dale A. Quattrochi dale.qua@,msfc.nasa.gov

GRADUATE STUDENTS:
Garland Robertson (Ph.D) • Frank Archer (Ph.D) • Jacques Surrency (Ph.D) • Constance Buford (Ph.D) • Christopher Ford (M.S.) • Wichaune C. Porter (M.S.) • Valerie Williams Gaines (M.S.)

Current Research Projects of the HSCaRS Center

1. Assessment of Soil Variability Within Cultivated Fields and Its Impact on Management Practices.

2. Assessing Vegetation Characteristics Associated with Land Cover Type as a Component of the Hydrology of the Middle Coosa River, Northern AL.

3. Plot-Scale study of Soil Hydrologic Properties Using Microwave Remote Sensing.

4. Local and Regional-Scale Hydrologic Modeling for Estimating Soil Moisture.

5. Development of a Soil Moisture Sensor Using Non-Traditional Materials. .

6. Development of a Soil Moisture Sensor Using IR and Raman Scattering Spectroscopy. .

7. Development of a Soil Moisture Sensor Using Fluorescence Spectroscopy.

8. Development of Computer Algorithms for Analyzing Multiple and Diverse Data Sets.

9. Development of an Educational Outreach Program for HSCaRS Research Activities.

10. Nonpoint Source Pesticide and Nitrate Monitoring of Private Wells

11. Integrating Remote Sensing and GIS for Natural Resource Management in Botswana

12. Vegetation Mapping of the Wayne National Forest.

13. Land and Resource Management Using Remote Sensing and GIS Technology.

14. Improved Management of Watershedi Using Remote Sensing and GIS Techniques.

Texas Gulf Coast Environmental Data Center (TEXGED)
Prairie View A&M University
A Part of the Texas A&M University System
Established on March 2, 1996
MISSION
Prairie View A&M University's Texas Gulf Coast Environmental Data Center (TEXGED) which is funded by the National Aeronautic and Space Administration (NASA), is an academic center for knowledge and technology of Remote Sensing. This center is the result of the partnership and collaboration from NASA, Major minority Universities, and TRW Space & Technology.

TEXGED will be a center for collecting data from space through the TRW HyperSpectral Imaging System. The center will establish a database management system which will provide researchers and decision makers with information they need in planning and assessing the environmental problems facing the southern region along the Gulf Coast of Mexico and the United States of America. TEXGED will provide services to local and state agencies regarding the environmental data analysis.

TEXGED span activities in four areas:
- Maintain data collection regarding envirorunent from space;
- Research;
- Education: The center will provide training for remote sensing and interpretation of imaging analysis; and
- Public outreach regarding environmental problems in the region.

RESEARCH
- Image analysis methodology.

- Simulation and modeling techniques to evaluate the geometrical quality of images collected by the HyperSpectral Imaging System.

- Remote sensing techniques for land monitoring and surveillance of marine environment around the Gulf Coast of Mexico. • Environmental Impace Assessment (EIA).

One of the main research themes of TEXGED Center is to explore the capability of Hyperspectral Imager to detect stress in agricultural crops. The study will be conducted jointly with Purdue University. In addition, Hyperspectral images will be collected from Waller/Harris Counties, Texas, and the geometrical quality of the images will be analyzed.

Information on ground truth is being collected based on reports and maps on soil survey and land use of the area.

Specific Areas of Research

1. Effect of water stress on spectral reflectance of some irrigated agricultural crops.

2. Image analysis of Gulf Coast sea surface temperature.

3. Ecological studies of Crayfish in the River Nile, Egypt.

EDUCATION

- Undergraduate Training: in remote sensing for the agricultural majors for studying land-use inventories, soil survey and water resources. For computer science majors, the training will be in the area of image analysis and simulation programming techniques.

- Graduate Training: will be in depth understanding of data analysis and remote sensing applied to land-use. This will include area frame sampling analysis.

OUTREACH

- Faculty & Students intern from other schools and universities. •Workshops and seminars in remote sensing and its application for detecting and monitoring any environmental problems.

FACILITIES

Laboratories:
TEXGED is building an environmental database to which will retrieve remotely sensed image and other data sources for ground truth. In addition to ground survey, analysis of relevant data will be conducted at Prairie View A&M University Laboratories.

Sun Workstation and Software:
TEXGED Center has:

- Two Sun Workstations [Ultra Sun 140] with a total of 20 Gig hard drive.
- Tapedrive.
- CD ROM.
- A high quality scanner (ScanJet ADF, Hewlett Packard).
- Laser printer (Hewlett Packard).
- A rewritable CD ROM.
- Are/INFO and ArcView GIS Software.
- IDL (ENVI) Image Analysis Software.
- Oracle. Database System.

Database:

- Digital Chart of the World at a scale of 1:1 million topologically structured to support a wide range of geographic information system (GIS) applications.

- ArcWorld 1: 3 million database which contains extensive cartographic basemap. It includes cartographic, index, and statistical information suitable for a wide range of mapping, reference and analytical in GIS applications.

- ArcUSA contains a broad range of data at a scale of 1:2 million. It includes cartographic features (state and county boundaries, roads, rivers, lakes, cities); indexes (latitude/longitude, USGS topographic maps, Landsat scenes); and statistical attributes for states and counties (population, major soil types, agricultural products, etc.).

- ArcScene USA Tour is a selection of satellite images for use with Arc/INFO and ArcView.

TEXGED TEAM
Dr. Safwat H. Shakir, Director
Dr. Berhane G.G-Wahid, Post-Doctoral Researcher
Savalas V. Jarmon, Senior, Computer Science Student, Web Master
For questions or more information please use the following information or contact
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References:
http://www.gis.lincolnu.edu
http://hscarsl.saes.aamu.edu/hscars4.htm
http://texjzed.ips4.pvamu.edu
httl2://www.reeusda.gov/1980/history.htm

SSURGO Status

National Soil Survey Work Planning Conference

6/28/99

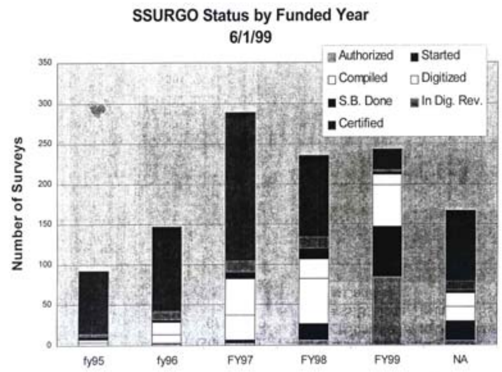
Ken Lubich

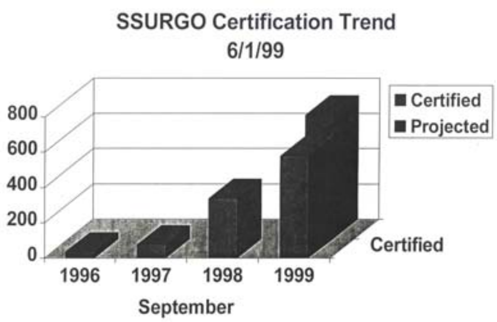
Interim National Soil Survey Digitizing Coordinator

(Wisconsin State Soil Scientist)

USDA NRCS

USDA Natural Resources Conservation Service

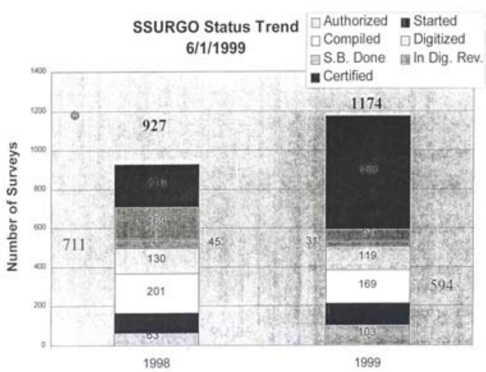




Time Line Improvements

- Certification review
- SSURGO Digitizing Centers FTP data to NCG
- Data on National Server within a few days

USDA NRCS



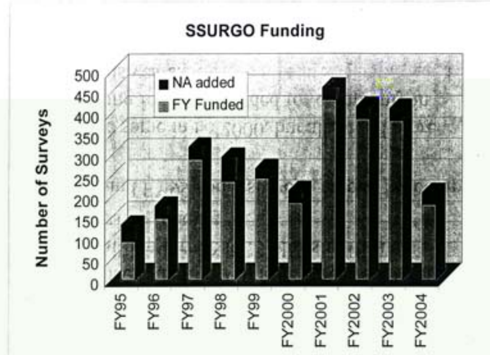
Distribution Format

- DLGS
  - NAD 27
  - NAD 83
- ARCINFO Coverages
  - Quad or quarter quad - NAD83
  - Survey area Patch - Geographic coordinates
- ARC Export Files
  - Quads
  - Survey area patch

USDA NRCS

Digitizing Funding Issues

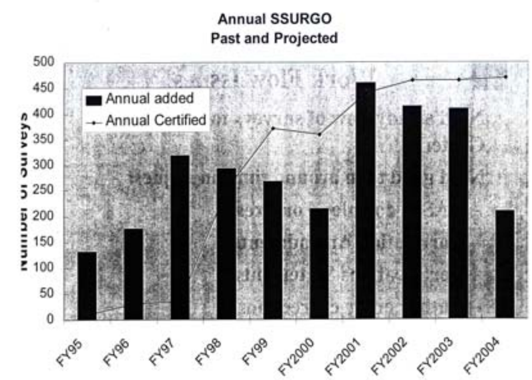
USDA NRCS — USDA Natural Resources Conservation Service



Money and Numbers

- **SSURGO QIT, estimates $18 Million for 6 years complete 2300 surveys by end of 2002 ($3 million Partners and $15 million NRCS)**
- **GIS Strategy report $15 Million starting in FY2000 and complete 2600 surveys by end of 2004**
- **Likely only $7.5 Million for FY2000 and start about 185 to 200 new surveys**
- **Certify 400/per year gets 2700 done by end of 2004 (actually about 3290 soil survey areas in country)**
- **Do 2900 by end of 2004 with project soil surveys?**

USDA NRCS — USDA Natural Resources Conservation Service



Trends

- Have been funding 240 to 270 per year with with $7.5 million form NRCS plus significant partnership funding
  - FY98 and FY99 some surveys funded for comp only.
  - Will do same in FY2000, but also fund more digitizing for those funded for comp only in previous years.

USDA NRCS

Work Flow Issues

- **Need steady flow of surveys to Digitizing Center**
- **Need good turn around time on request**
  - **NASIS download or fixes**
  - **Correlation Amendments**
  - **Certifications Statements**
  - **Author error corrections**
  - **Join Resolutions**

USDA NRCS

Program Challenges

- Most surveys mapped on orthophotography are completed or at least started.
- Most low density larger acreage su

We have hit the compilation bottle neck.

- Need to increase staffing for compilation
- And need to implement more automated technology

USDA NRCS

Summary

- Excellent progress
- Need continued cooperation of MO's, States, Digitizing Centers, NCG and Partners.
- Need continued and increased funding
- Need to implement new technology

NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE
TOUR
JUNE 30,1999

7:30 A.M.-DEPART HOTEL

8:15 A.M.-ARRIVE CAHOKIA MOUNDS STATE HISTORIC SITE

8:30 A.M.-VIEW 17 MINUTE PRESENTATION "CITY OF THE SUN"
AND OPEN TIME IN HISTORIC CENTER INTERPRETIVE CENTER

9:15 A.M.--"SOILS AND PREHISTORIC CAHOKIA"
DR. WILLIAM I. WOODS. SOUTHERN ILLINOIS UNIVERSITY AT EDWARDSVILLE

(REFRESHMENTS PROVIDED BY MISSOURI ASSOCIATION OF
PROFESSIONAL SOIL SCIENTISTS (MAPSS)

11:00 A.M.-DEPART CAHOKIA MOUNDS STATE HISTORIC SITE

12:00 NOON-ARRIVE DR. EDMUND A. BABLER MEMORIAL STATE PARK

"LANDSLIDES IN THE ROCK CREEK WATERSHED"
GRANT BUTLER, NRCS AND DAVID SKAER, NRCS

12:30 NOON-LUNCH (PROVIDED FOR ALL TOUR PARTICIPAINTS)

1: 15 P.M.-WILD HORSE CREEK TOUR
DR. R. DAVID HAMMER AND STEPHANIE H. LICKERMAN

2:30 P.M.-DEPART WILD HORSE CREEK

3:00 P.M.-ARRIVE CAULKS CREEK CUTBANK

(REFRESHMENTS PROVIDED BY THE MISSOURI ASSOCIATION OF
PROFESSIONAL SOIL SCIENTISTS (MAPSS)

4:30 P.M.-DEPART CAULKS CREEK CUTBANK AREA

5:30 P.M.-ARRIVE AT HOTEL

TOUR OVERVIEW

Buses will depart the Hotel promptly at 7:30 a.m. and travel across the Mississippi River to a site near Collinsville, Illinois. This 30 minute ride will take us to Cahokia Mounds State Historic Site where we will view the remains of the most sophisticated prehistoric Indian civilization north of Mexico. Studies by Archeologists and Soil Scientists have revealed much about his ancient civilization and their attempts to alter the- landscapes to suit their needs. We will tour the structures designed by these ancient people and discuss their accomplishments and failures.

Dr. William Woods of Southern Illinois University at Edwardsville will present information about the Cahokia site and an overview of his studies of the site. The Missouri Association of Professional Soil Scientists (MAPSS) will provide refreshments.

The buses will depart Cahokia Mounds State Historic Site at 11:00 a.m. and travel back across the Mississippi River to Missouri and arrive at Dr. Edmund A. Babler Memorial State Park about 12 noon. This Missouri State Park is named for a prominent St. Louis surgeon whose kind and generous works during his life inspired his brothers to donate the land to the State of Missouri. The park is twenty-five miles west of the Gateway to the West memorial Arch in downtown St. Louis. The park occupies over 2,400 acres and is known for its heavily wooded terrain.

A brief presentation "Landslides in the Rock Creek Watershed" will be provided by local NRCS Soil Scientists Grant Butler and David Skaer. Also a brief overview of the Missouri Soils and Parks Tax, will be provided by Missouri Department of Missouri Representatives, Soil Survey Manager, Dean Martin and Park Naturalist, Dale Kannawurf.

At about 12:30 p.m. lunch will be provided to tour participants. An outdoor cookout is planned where brautwursts and hamburgers with all the fixins will be served in a scenic outdoor setting.

Following a fine Missouri cookout, at 1:15 p.m., a short walk will take the participants to a site on Wild Horse Creek. This site illustrates a small, unaltered, healthy Ozark Border stream in a watershed dominated by woodlands where urban development has not taken place.

At 2:30 p.m. the tour participants will board the buses and travel a short distance through an area where urban development is taking place and arrive at the Caulks Creek Cutbank area at about 3:00 p.m. The tour participants will once again be treated to cold refreshments provided by the Missouri Association of Professional Soil Scientists (MAPSS).

The Caulks Creek watershed, in contrast to that of Wild Horse Creek is experiencing rapid urban growth. Increased runoff within this watershed overloads this stream with water running off of new roads, parking lots and other hard surfaces that make subdivisions and shopping malls possible. This tour stop will provide a contrast to the undeveloped Wild Horse Creek watershed viewed during the previous stop. Dr. David Hammer of the University and Stephanie H. Lickerman of the City of Wildwood will provide a discussion of these very different watersheds.

At 4:30 p.m. the tour will conclude with the trip back to the hotel. We will plan to arrive back at the hotel at 5:30 p.m.

Acknowledgments:

Many individuals and groups have contributed to the planning of this tour. We would like to thank the following:

Mr. Grant Butler, Natural Resources Conservation Service
Mr. Mike Chalfant, Missouri Department of Natural Resources
Dr. R. David Hammer, University of Missouri, Columbia
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SOIL SURVEYS FOR ENVIRONMENTAL PROBLEMS: A SOIL SURVEY LABORATORY PERSPECITVE

(Highlights from a "Power Point" presentation)

By: M. Dewayne Mays

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Introduction

Past Soil Survey Laboratory (SSL) activities related mostly to standard characterization analysis in support of active soil surveys.

Analytical demands usually far exceeded the staff capacity at the Lab. However, special needs have often demanded documentation and support data to prove scientific merit, as well as, legal validation.

Past Activities of SSL

ENVIRONMENTAL
1. Background/Baseline level of elements
2. Anthropogenic soils
3. Others

Background/Baseline Level

Radioactive Materials as Plant Stimulants - Field Results
By: L.T. Alexander (1948-1949)

Dolomitic Limestone and Radioactive Material (radium bromide and uranyl nitrate) Study.

Conclusion: no effect, beneficial or harmful.

World-Wide Sampling Program for Stronitum^{90}
By: E.P. Hardy, Jr., L.T. Alexander, R.J. List, J.S. Allen, L. Machta, and M.W. Meyer (1953-61)

Found:
1. Time location of detonations
2. Greatest amounts of Sr 90
3. Wind-action is the important carrier
4. Soils provide good measure of Sr9o

Background/Baseline Level Con't.

Cd, Pb, Zn, Cu, and Ni in Agricultural Soils of the United States of America
By: G.G.S. Holmgren, M.W. Meyer, R.L. Chaney, and R. B. Daniels

- Food-Chain levels of toxic metals for agricultural soils
- > 3,000 soil samples taken with paired plant samples
- Generalized background map

A Relative Index For Pesticides and Soils for Nebraska
By: P.J. Shea, L.N. Mielke, and W.D. Nettleton (1992)

- Used hydraulic conductivity, OC, pH, and CEC to develop a soil vulnerability index for the 17 most extensive soils.
- While statewide a map was not constructed using these soils, a layer map of RIPS could be constructed.

Anthropogenic Soil

Trace and Major Elemental Analysis Applications in the U.S. Soil Survey Program By: R. Burt, M.A. Wilson, M.D. Mays, T.J. Keck, M. Fill ore, A.W. Rodman, E.B. Alexander, and L. Hernandez (1999)

Mined Soils - The Deer Lodge Valley Soil Survey (MT)

- Objective: To distinguish potentially toxic level of trace metals for interpretation purposes.
- Kinds of plants and reduced plant growth and vigor were often related to contamination; however, plant growth and communities alone cannot always be used as field indicators.
- Soils mapped based on impact from smelting prodess.

Soil Survey of New York City

- Complex problems include trace metals, reclamation of landfills (Central Park), etc.
- Concerns included elevated levels of heavy metals that affect human health, and weathering of materials in the old landfill area.
- Initial metal analysis show elevated levels occur near surface and decrease with depth.

Other Soils

Acid Rain Study (EPA)

- Mainly industrial NE pollutants
- Over 5300 samples included in this study
- We started to recognize the importance of the organic layer

Other Soils Con't

Trace and Major Elemental Analysis Applications in the U.S. Cooperative Soil Survey Program
By: R. Burt, et al.

Yellowstone National Park Survey

- Hydrothermal altered soils
- Used both total and trace metal analysis to design map-units and to categorize soils into 3 groups:
  1. Acid Sulfates
  2. Neutral Chlorides
  3. Carbonatic
- Data assisted in understanding genetic processes and soil factors impacting plant species

Conclusions

1. Laboratory analysis parallel critical documentation to soil survey characterization.
2. Documentation of soil survey data is demanded by the public and mandated in litigation. Soil survey and SSL are addressing important *agricultural-related* issues, but our efforts on urban-reldted issues have been limited.

What we have learned

1. Health related issues tend to give value/importance to soil surveys.
   A. How do we make soil surveys so that health related issues are an important part?
   B. How do we integrate the needs of both Urban Centers and Agriculture into a survey?
2. Baseline studies are important because they provide information so that users can draw their own conclusions.
3. Aerial contaminants follow jet stream patterns, however once deposited, contaminant distribution is influenced by vegetation, land contour, rainfall, wind, and surface transmission.

Challenge: Make soil surveys so important that decision-makers can't do without them.

References

Alexander, L.T. 1950. Radioactive Materials as Plant Stimulants - Field Results. Agronomy J. 42:252-255.

Burt R., M.A. Wilson*, M.D. Mays, T.J. Keck, M. Fillmore, A.W. Rodman, E.B. Alexander, L. Hernandez. 1999. Trace and Major Elemental Analysis Applications in the U. S. cooperative soil survey program. Presented at the International Conference, Soil and Plant Analysis Council. Brisbane, Australia.

Hardy, E.P. Jr., L.T. Alexander, R.J. List, J.S. Allen, L. Machta and M.W. Meyer. 1962. Strontium - 90 on the earth's surface II - Summary and interpretation of a world-wide soil sampling program. 1960-1961 results. Health and Safety Laboratory - U. S. Atomic Energy Commission, Weather Bureau - U. S. Department of Commerce, Soil Conservation Service - U. S. Department, p. 2 1.

Holmgren, G.G.S., M.W. Meyer, R.L. Chaney, and R.B. Daniels. 1992. Cadmium, Lead, Zinc, Copper, and Nickel in agricultural soils of the United States of America. J. Environmental Quality, 22:335-348.

Shea, P.J., L.N. Mielke, and W.D. Nettleton. 1992. Estimation of Relative Pesticide Leaching in Nebraska soils. University of Nebraska Agricultural Research Division Institute of Agriculture and Natural Resources, Research Bulletin 313-D, p. 37.

NOTES ON THE PANEL "Soil Survey for Environmental Problems"

By: Barry L. Dutton, CPSS, RPSS
President, National Society of Consulting Soil Scientists

Soil survey information can be used for a wide variety of environmental problems. The challenge is to help users understand how to use soil survey surveys for specific projects and the limitations of the survey. I have used soil survey data in numerous projects and sometimes in a way that gave my proposals a competitive advantage over those of other consultants. I will highlight a few examples of how we are using soil survey information on environmental projects.

Soil Surveys can provide excellent baseline data to document conditions prior to the proposed project or activity in question. Lawsuits involving land uses can often use soil survey to identify conditions before the controversial action.

There are many ways the soil survey information can be re-formatted for specific projects. Many reclamation projects need a map of topsoil depth. When acid rain has lowered soil pH and heavy metals are present, the soil is amended with lime to raise the pH. Soil Surveys can be adapted to provide the "lime requirement"on these area. Soil surveys are also used in reclamation to identify sources of materials such as gravel and sand.

We also make new, often higher intensity, surveys for specific projects. These surveys are often focused on single purposes or uses. Examples of these surveys are for surface soil texture, surface organic content, pH, heavy metal content and others.

Ecological risk analyses can use soil surveys as a component of a risk matrix. In Montana, my company developed a risk matrix for animal waste water quality impacts that includes soil as one factor along with distance to surface or groundwater, size of the operation and other concerns. We developed a septic system carrying capacity model that predicts the number of septic systems per acre that can be installed without increasing groundwater nitrate levels above a target. Phosphorous breakthrough is also computed for septic systems in Montana based on soil features. We are currently looking at using soil survey information where shrink-swell soils create home foundation problems.

Regardless of the environmental issue, soil survey can provide a wide variety of information. We still need soil scientists to work with other natural resource professionals to help them understand how.

Adding Value to Soil Surveys

Craig Ditzler, Director
USDA-NRCS-Soil Quality Institute

For my part on this panel discussion about using soil surveys to focus on environmental problems, I want to briefly discuss the need to find ways to add value to our current soil survey. It is very fitting that as we celebrate the centennial of the soil survey program, and as we see an increasing amount of activity to "update and modernize" existing surveys, we think carefully about what we can do to build on the product we have. We must find ways to make it even more useful to our customers as they face challenges related to land management in solving environmental problems.

As we move into production of the next generation of soil surveys we are presented with significant challenges and opportunities. At the field level, I believe a significant challenge involves the mechanics of how we do soil survey on a daily basis. For the past 100 years the job of soil survey has involved putting map unit boundaries on maps. Now we are giving our field soil scientists completed maps with the charge to "update them". With the difficult work of creating the original soil map behind us, we need to think carefully about how we target our limited resources. We need to preserve what is good in the existing product and look for ways to enhance it. What does this mean?

There are a number of things that can (and should) be done to make our surveys better. Some of these activities include updating classifications, refining the lines, updating estimates of productivity, describing soils to 2 meters (or more), digitizing, and packaging on CD-ROMs and the world-wide web. All of these are appropriate. Today, I would like to suggest that in addition to these activities, we should consider the addition of information about the ways land use and management profoundly affect some of the properties of the soil (often referred to as "use-dependant" properties). Our traditional soil surveys have done an excellent job of describing inherent (static) soil properties such as texture, color, horizon sequences, etc. We have not done an adequate job however of describing properties that change with different land use and management. These are generally expressed in the surface layer and include things like permeability and infiltration, bulk density, structure, aggregate stability, organic matter content, biological activity, CEC, and others. Our interpretations have been driven by the concept of a "typical pedon" and except for map unit phase differences (such as slope and erosion), generally present a "one-size-fits-all" set of data for the dominant condition of the soil.

For example, a soil map unit that is predominantly found in conventionally tilled cropland, will have estimated property data based on that condition. We know that areas of this map unit in forest or long term no-till will likely have surface layer properties unlike those reported, but we don't indicate what these differences are. Here are two examples to illustrate why this is important. Suppose a client wants to compare the potential beneficial effects on water quality resulting from a switch from conventional to no-till farming. We know that infiltration rates, organic matter content, and CEC are likely to change significantly and these properties will in turn affect amounts of run off and through flow, as well as the fate and transport of agricultural chemicals. Computer models are readily available to make the comparison, but the soil survey does not indicate which values to use for the critical model inputs.

Currently, one of the hot topics in our nation is the possibility of sequestering carbon in soils as a partial offset to global warming. There is great interest in determining current baseline levels of carbon in our soils. This of course will vary with land use and management within each soil map unit. Providing basic estimates of organic matter levels in the dominant land use and management combinations in a survey area would greatly improve our ability to provide these base line estimates. There are many other examples of how including information about the effects of use and management on key soil properties would greatly enhance the usefulness of soil surveys to address current environmental problems.

This is not a new idea. Many of you have heard Bob Grossman advocate this in the past. In a recent guest editorial in the SSSA Journal (May-June, 1994), Johan Bouma wrote the following: *"Soil series in the future should not only be characterized in terms of one representative pedon and its properties and limitations, but as a series of pedons, each to be sampled infields with distinctly different soil management. Thus, a characteristic range of subtypes can be defined for that particular series."* I believe we should make an effort to report this kind of information in the next generation of soil surveys.

Two of the Soil Quality Institute's staff members have collected this information in preparation for a no-till field day to be held later this year at the experiment station at Milan, Tennessee. I want to share their results with you because it illustrates the situation nicely. They used the Soil Quality Test Kit to compare several physical, chemical, and biological properties on the surface layer of a 25 year no-till field and a conventionally tilled field of Memphis silt loam (fine-silty, mixed, active, Typic Hapludalf). The following table presents the average of 4 subsamples from each field.

	Physical			Chemical			Biological	
	Infilt. (In/hr)	Bd (Mg/ m^3)	Aggregate Stability %	pH	Organic Matter %	Elec. Conduct. (dS/m)	Respir. (Lbs. $C0^2$_C/ a/d)	Earth Worms (# per Ft^3)
No-Till	3.3	1.3	44.5	6.1	2.3	0.07	12.9	10.3
Conv. Till	0.4	1.3	5.3	5.7	1.1		25.3	0.0

Of the physical parameters tested, the percentage of water stable aggregates and infiltration rate are significantly higher for the no-till treatment. Of the chemical properties, organic matter percent in the no-till field is double that of the conventionally tilled field. Values for pH and EC show no significant difference. The two biological tests indicate that these treatments have a significant effect on the biological activity. Respiration rates were twice as high on the conventionally tilled site as on the no-till, and this is reflected in the lower OM. No earthworms were observed in the conventionally tilled soil, while an average of 10 per cubic foot were found under no-till. This surely has a significant impact on the greater infiltration rates of the no-till site. Our current soil survey does not reflect these differences. One set of data for organic matter content and permeability are given. No information is provided regarding the biological component of the soil. Other parameters may also be different. For example, one wonders if the higher percentage of water stable aggregates should be reflected in a lower K-factor for the no-till condition.

While it -is not practical to map land use and management differences separately on the field maps, NASIS will allow us to add data for these conditions as components of the overall map unit. Data then would be available for our users to pick from, based on the particular site of interest. To accomplish this, we must first train and encourage our field soil scientists to recognize and describe differences in key near-surface properties resulting from land use and management. We should seek out and sample key soils under contrasting land use and management combinations. Once we begin to see how various classes of soils respond, we can then develop techniques to extend this information to other similar soils in each survey area. We can then develop ways to incorporate the data into NASIS and to present it in our soil survey reports in a way that is easily understood by our clients.

The addition of use-dependant property inf6rmation to our next generation of soil surveys is one way to add significant value to our product. The current "one-size-fits-all" approach is often not adequate for those wanting to use models to predict environmental outcomes. In addition, it does not provide clear information applicable to the potential risks or benefits when considering alternative management systems. The increased emphasis on updating and modernizing our existing soil surveys presents a golden opportunity to add value to our soil survey product. The collection and reporting of soil property information as it relates to land use and management should be a key part of the process.

International Activities of the World Soil Resources Office

Paul F. Reich

Introduction

The World Soil Resources office is part of the Soil Survey Division of NRCS in National Headquarters located in the South Agriculture Building of USDA in Washington, DC. Dr. Hari Eswaran is the National Leader, World Soil Resources. He's also the Chairperson of the International Union of Soil Science's, Working Group on Land Degradation and Desertification. Russ Almaraz is a soil scientist and a GIS specialist. He's also working on his PhD at George Mason University. Paul Reich is a geographer specializing in working with global raster GIS databases using IDRISI and ArcView GIS programs.

WSR Major Activities

Some of our major activities include the collection and development of GIS data. We work with global, regional and country level map databases. We're also involved in the production of some educational slide sets on soils. Whether we're developing databases or maps or educational materials, our main goal has always been to provide our customers with useful information. We're trying to focus on ways to give the public easy access to databases and information we produce. And we're also involved in assisting countries with their soil survey programs. This is technical assistance with using Soil Taxonomy and utilizing soil laboratory methods. For example we've worked with the Department of Land Development Soil Survey program in Thailand for about 15 years. They've been using Soil Taxonomy for many years and now they're mapping the country at 1:50,000 scale and have completed a general soil map of Thailand at 1:1,000,000 scale. Recently, Hari has been working with the soil survey program in Turkey with the goal of completing a general soil map of the country in 2 or 3 years.

GIS Data Development

Over the past 10 years or so, we've worked on developing and collecting GIS databases at country, regional and global scales. We have a large climate database that we used with the Newhall model to estimate soil moisture and temperature regimes and interpolated the point data resulting in a raster soil climate map. We used the digital FAO Soil Map of the World with the global soil climate map to create a Soil Taxonomy map at the suborder level.

The map of Global Soil Climate Regions shows the major soil moisture regimes and soil temperature regimes. It's based on climatic data from over 25,000 stations. Each station has data on mean monthly air temperature and precipitation for a 30 year period. We ran the data through the Newhall model and interpolated the results.

The Global Soil Regions map shows the distribution of the 12 Orders and it is a reclassification of the FAO Soil Map of the World. The database is at the suborder level so we are able produce regional maps by suborders.

Interpretive Maps

The soil climate map and soil regions map are interesting for geographers and are useful to soil scientists, but they are certainly less meaningful to other people. So the next step was to try to make some interpretations that would help people understand what the distribution of these different soils really means in terms of global land resources and the quality of those resources. Some of our customers are interested in land degradation and desertification on a global scale, so we've produce maps on desertification and soil erosion vulnerability. Each of these interpretive maps is based on an empirical reclassification of the soil climate map and soil suborders map.

The first interpretive map is the Major Land Resource Stresses map. There are 25 classes shown on the map. Each class is a major soil condition or stress that can adversely affect the potential for grain production under rainfed conditions. For simplicity we determined only a single major stress or condition for a given area even though there are likely multiple stresses. There are a few areas which did not have any of the 24 stresses and these we identified as having few constraints - these are the prime agriculture lands and major areas of these lands are found in the US, Argentina and Ukraine.

In the map of Soil or Land Quality we have grouped the 24 stress classes from the Stresses map into 9 Land Quality Classes. The classes are numbered I through 9, 1 is the highest quality class and 9 is the lowest quality. We defined land quality in terms of low, medium or high levels of soil performance and soil resilience. Soil performance is a relative measure of the suitability of the soil for grain production and soil resilience is how well the soil can resist degradation. Class 1, 2 and 3 land occupies only a small fraction of the global ice-free land surface (only about 12.7%). These lands are generally free of major constraints for most agricultural uses. Class 4, 5, and 6 land occupies about one third of the earth's ice-free land surface. The soils of these areas require considerable management inputs and conservation practices. The remaining large area of land in Class 7, 8 and 9 (covering more than half the earth's surface), which includes the desert and the tundra regions, is either too dry, too wet, too cold or too steep and is thus unsuited for sustainable grain production.

Another interpretive map we've made is on vulnerability to desertification. Vulnerability to desertification is assessed using the information on soils, climate, and the land resource stresses. Desertification, as defined by United Nations' Environment Programme is, "land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities". Excluded in the definition are areas which have a "hyper-arid or a humid" climate. Areas on the map in red have a high vulnerability, the yellow areas are moderate, and the light green areas are low. The dark green humid areas are excluded, as well as the blue cold regions and the gray and regions. This map shows areas that are vulnerable only from the biophysical point of view. The other important dimension to understanding desertification is the affect that people can have on the land, depending on how the land is used and managed.

One way of looking at the human dimension is by using a human population density map. The dark red areas have population densities of 101 to 500 people per square kilometer and the magenta areas have greater than 500. We then overlaid this map on the desertification vulnerability map. The resulting map is an assessment of the Risk of Human Induced Desertification. The areas shown in red are regions of very high risk of human induced desertification. The very high risk class was defined as those areas that are both biophysically highly vulnerable and have a high population density. Large areas of very high risk occur in West Africa, especially Nigeria, and in Turkey, Afghanistan and in India and Thailand.. It is in these areas that sustainable land management policies are most critical to help minimize land degradation. If we look again at Africa, 46 percent of Africa's land area is vulnerable to desertification and about 500 million people are affected.

Another map highlights the areas of Very High Risk in green and the other risk classes are in white. We also used a database from the International Peace Institute in Europe that identified the locations of violent conflicts from 1987 to 1997, where more than 1,000 people were killed. The red stars on the map indicate each of the locations that had a violent conflict. It's interesting to note that more than half of these conflicts occurred in areas of very high risk. Why do we see this pattern? Is it coincidental, or is it simply because the population densities are so high or is there some relationship between population pressure and land degradation and social instability that could possibly lead to large scale violence?

A very important factor in land degradation is soil erosion. A vulnerability map identifies areas that are especially susceptible to water erosion and that require effective land management to help prevent land degradation. About 41% of the earth's ice-free land area is vulnerable to water erosion. We've also created a vulnerability map for Wind Erosion. About 37% of the world is vulnerable to wind erosion. As was done for desertification, we also overlaid the human population density map on water erosion vulnerability to produce the Risk of Human Induced Water and Wind Erosion maps.

WSR Customers/Partners

Our customers are mainly from Universities that are interested in our map data and soils information for teaching and research activities. We work with many soil scientists from many different countries on every continent. In the past few years we've been fortunate to have had visiting soil scientists from Albania and Cameroon work with us in Washington. We frequently provide information and advice to policy makers at USAID and The World Bank. The World Resources Institute has used our data in some of their global environmental assessments. The USDA-Agricultural Research Service has used our data to develop their Germplasm Resources Inventory database. They have used the global soil climate map to delineate germplasm sampling regions so that they can better assess their needs. And the USDA-Economics Research Service is using the Major Land Resource Stress map and the Land Quality map in their research on agricultural productivity and global economic trade models.

Educational Materials

Besides our work with GIS databases and maps, we've also been creating educational slide sets on soils. We have now completed sets on Aridisols, Oxisols and Vertisols. The Vertisol set was just completed in June 1999. It has 200 slides with about 40 pages of text. We're now digitizing the slides and will make it available on our web site and also on CD-ROM. We produced the Oxisol set a few years ago and we have it available on our website and on CD using the Adobe Acrobat PDF file format. And now we're working on a global slide set that will be designed to complement the 2nd Edition of Soil Taxonomy. This new slide set will have about 400 slides and will cover all 12 soil orders and will have sections on diagnostic features as well. We hope to have this completed by November 1999. We've received many slides from the State offices and Universities as well as from other countries. We are always happy to receive slide contributions, so if you have any good soil profile slides that you'd like to share, please let us know. We're also interested in slides of people in the NCSS who were involved in the development and improvements of Soil Taxonomy and the US Soil Survey Program. If you have any slides of people or profiles please send them to us, we'll make copies and send the originals back to you and we'll acknowledge you if we use your slides in the set.

Information Dissemination

Making the data and information that we produce available to the public is the most important activity we do. We frequently present papers and posters at National and International meetings. About a year ago our desertification vulnerability map was published in the Washington Post newspaper. We have a website that we are constantly updating. I invite you all to visit our web site at www.nhq.nrcs.usda.gov/WSR. The site allows you to access some of our papers and maps. There's a section on our online educational series of slide sets, links to online references, professional organizations and other agriculture and natural resources related sites. It also has a link to a new website related to the activities of the Working Group on Land Degradation and Desertification of IUSS.

International Programs Division

The International Programs Division of NRCS in headquarters helps to manage international outreach programs. The USDA Scientific Cooperation program and a parallel program: The NRCS Scientific and Technical Exchange Program, helps to promote the management and conservation of natural resources globally. It provides some good information on how NRCS employees can get involved in international activities.

Canadian Soil Survey Activities

Charles Tarnocai

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Introduction

Although isolated soil surveys were being carried out about eighty years ago in Canada, systematic surveys did not begin until the 1930s, when the federal government organized a national soil survey program with the cooperation of the provinces and universities. The impetus was the large-scale soil degradation and management problems occurring on the Prairies at this time. A milestone in the development of this national program, which focused on the soil resources of Canada, was the first National Soil Survey Committee meeting in 1940. At that time most of the soil surveys were being carried out on the Prairies, but some were also being conducted in other agricultural areas of the country. During the 1950s and 1960s, as part of the Agriculture and Rural Development Agency program, this activity was extended to other areas with potential for agriculture and to areas of interest to other resource industries (e.g., forestry and wildlife). As a result of extensive energy development during the 1970s and 1980s, soil and land resource data acquisition activities were extended to the northern areas of the provinces and to the Yukon and Northwest Territories.

During this period, a great amount of soil and land resource information about the vast Canadian landmass was accumulated by Agriculture and Agri-Food Canada. This information is currently stored in and handled, nationally, by the National Soil Database of the Eastern Cereal and Oilseed Research Centre (ECORC) in Ottawa and, regionally, by Land Resource Units (LRUs) at various agriculture research centres across the country.

ECORC is the only place in Canada that has soil and land resource data for the entire country. This data, which is of national importance to Canada, is currently used not only by the agriculture sector, but also by other industries, government departments, levels of government and universities in Canada and internationally.

The Canadian soil and land resource databases are internationally recognized because of their advanced nature, high level of standardization and applicability to a large landmass, and for the careful correlation between the provinces and with the United States.

Changes due to downsizing

Downsizing of the federal government, which began in 1995, has resulted in numerous changes to the federal soil survey program. This downsizing affected both the pedology staff and the soil survey program. In the federal soil survey, the pedology staff was reduced by approximately 65% (from 41 before 1995 to 14 at present). In addition, the centrally organized federal soil survey ceased to exist and the provincial LRUs began reporting directly to the regional agriculture research centres, instead of to Ottawa. This resulted in the virtual disappearance of a national body dealing with soil data, national standards relating to this data, correlation of this data across Canada, and the national soil classification. An informal network of pedologists, known as the Canadian Land Resource Network (CLRN), has been trying, through informal contacts and occasional meetings, to maintain awareness of national and regional issues among the remaining staff.

Recent developments

As result of recent environmental and climate change activities, increased emphasis has been placed on the need for soil data. The disappearance of the soil survey program and the increased need for spatial soil data prompted reviews of the role of soil and land resource activities in Agriculture and Agri-Food Canada this year. Two reviews were carried out, one in the Prairie or Western Region, the other in Ottawa. The recommendations arising from these reviews have not been finalized, but they recognize the importance of the LRUs in the regions, and that the ECORC soil staff, located in Ottawa, should continue to be responsible for national and international issues, national soil correlation and the maintenance and upgrading of the national databases.

Major national activities

Soil mapping
Southern areas of the country (about 18%, or 175 690 km^2 of the country) have been mapped at detailed and/or reconnaissance scales over a span of approximately 50 years (Figure 1). The soils of all areas of Canada (10 million km^2) have been mapped at a scale of 1:1 million and this information is now stored in the Soil Landscapes of Canada (SLQ database. No active soil surveys are currently taking place in Canada except for small areas of nature reserves and mining sites being mapped by private sector pedologists.

Upgrading of the National Soil Databases
The soil databases, such as the Soil Landscapes of Canada, cover the entire country and were developed using the data collected over the last 50 years. In order to maintain the usefulness of these databases, it is necessary to update them (with regional participation) as new soil data become available. Upgrading of the Ontario, Alberta, Saskatchewan and Manitoba portions of the SLC has already started or will begin this year.

Development of Integrated Databases
Linkage of soil inventory data with information in other databases *(e.g.,* hydrological, census of agriculture, wetlands, soil carbon and climate) has provided a wealth of information for use in environmental assessment, program development and land evaluation. It is foreseen that the need for this type of integrated spatial information will continue to grow at the national level. This has led, at the request of Environment Canada, to development of a system of ecological stratification for Canada and to collaboration with Natural Resources Canada in setting up a peatland database needed for global change studies.

Land Resource Analysis and Applications
Some of the main applications of our soil and land resource databases are the global change studies, including topics such as soil carbon sequestration, and environmental issues such as toxic elements (including pesticides) and soil and water quality. These types of studies require scaling-up of point or plot data within a framework provided by these soil databases.

Soil Taxonomy Research and Standards
Soil taxonomy is an essential component of the soil and land resource databases. The third edition of the Canadian System of Soil Classification was published in 1998. We also cooperated in the development of 1he Gelisol order of the US Soil Taxonomy and the Cryosol major soil group of the VVRB.

International activities

The databases and database systems we developed have gained both national and international acceptance. This work has also led to cooperation with the United States (USDA) and Mexico on the development of the North American soil carbon database (for determining possible effects of climate change, both nationally and continentally) and the North American multi-layer soil database, and to cooperation with American (USDA), Russian, Chinese, western European and Icelandic scientists on the development of circumpolar soil and land resource databases.

Summary

The soil survey program in Canada has gone through a very difficult time during the last four years. As a result of the downsizing begun in 1995, the national soil survey has almost disappeared, with only small remnants remaining in some regions of the country. It is hoped that the recent program reviews carried out by the Research Branch of Agriculture and Agri-Food Canada will stabilize the situation. It is expected, however, that future activities will concentrate on upgrading the older soil surveys and databases and that the pedological staff in Ottawa will continue to be responsible of national coordination, standards and soil taxonomy.

Figure 1. The dark gray areas have been covered by detailed and/or reconnaissance level soil surveys. Soils in all areas of Canada have been mapped at a scale of 1:1 million.

Soil Survey Activities in the National Park Service

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Mission Statement

The National Park Service preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. The National Park Service cooperates with various partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

Introduction

From the spectacular mountain ranges and glacier fields of Alaska to the Sonoran deserts of the American Southwest, from the volcanic landscapes of Hawaii to the magnificent barrier islands of the northeastern United States, the National Park Service acts as steward for natural resources that have inspired, awed, and brought enjoyment for more than a century. Responsible for nearly 80 million acres of public land, the National Park Service preserves and protects some of the world's most scenic and important natural resources.

Unfortunately, many National Park Service units are being subjected to a wide variety of impacts. Air pollution degrades the magnificent views of Grand Canyon, while water quality and quantity problems threaten the delicate aquatic ecosystems in Everglades. Many parks today face urban encroachment; many more suffer from the impacts of excessive visitation. Left unchecked, these factors of change could threaten the very existence of many biotic communities within the parks.

In 1991, the National Park Service published its Vail Agenda, a comprehensive strategy for serving America's noble trust into the 21st century. To meet our resource stewardship responsibilities, the Vail Agenda action plan calls for park managers and superintendents to have solid natural resource information at their disposal.

- Park managers must have comprehensive information about the nature and condition of major biotic and abiotic natural resources placed under their stewardship.
- Park managers need to know how resource conditions change over time.

Only by having reliable scientific information can park managers take corrective actions before those impacts severely degrade ecosystem integrity or become irreversible.

Natural Resource Inventory and Monitoring Program

The Natural Resource Inventory and Monitoring (I&M) Program was established to help prevent the loss or impairment of significant natural resources in more than 250 of the 368 units of the National Park System. Many natural resources in the system are subjected to unfavorable influences from a variety of sources, for example, air and water pollution, urban encroachment, and excessive visitation. Left unchecked, such effects can threaten the very existence of many natural communities in the units.

The principal functions of the I&M Program are the gathering of information about the resources and the development of techniques for monitoring the ecological communities in the National Park System. Ultimately, the inventory and monitoring of natural resources will be integrated with park planning, operation and maintenance, visitor protection, and interpretation to establish the preservation and protection of natural resources as an integral part of park management and improve the stewardship of natural resources by the National Park Service.

The detection of changes and the quantification of trends in the conditions of natural resources are imperative for the identification of links between changes in resource conditions and the causes of changes and for the elimination or mitigation of such causes. Inventory and monitoring provides important feedback between natural resource conditions and management and trigger specific management and evaluation of managerial effectiveness.

<u>Guidelines for the acquisition of natural resource inventories on NPS units are as follows:</u>

- Data collected for each park unit will contain a "core" set of data for universal park planning and management purposes

- All data will be collected and maintained in accordance with clearly defined protocols and quality-assurance standards.

- Data will be compatible for use at ecosystem and other broad levels

<u>Recommended minimal dataset for all natural resource parks:</u>

- Natural Resource Bibliographic Database

- Base Cartography

- Soils

<u>Recommended minimal dataset for all natural resource parks (continued)</u>

- Geology

- Vegetation

- Species Survey and Distribution

- Water Resources/Water Quality

- Air Quality

- Climate

Soil Management Policies

Management Policies and Guidelines for soil resource management are contained in **NPS-77 - "Natural Resources Management. "** The NPS Management Policies states:

The NPS will actively seek to understand and preserve the soil resources of parks and to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resources.

Resource managers, with the assistance of the Inventory and Monitoring Division, will acquire appropriate, detailed soil maps, define the distribution of soil series, determine their physical and chemical characteristics, and provide interpretations needed to promote soil conservation and to guide resource management and development decisions.

Potential impacts on soil resources will be routinely monitored. Management action will be taken to prevent, or if that is impossible, to mitigate adverse, potentially irreversible impact on soils. Conservation and soil amendment practices may be implemented to reduce impacts. Importation of off-site soil or soil amendments may be used to restore damaged sites. Off-site soil will normally be salvaged, but it will not be removed from pristine sites if such actions would impair the ecosystem overall. If off-site materials are used, a soil management specialist will develop a prescription and select materials needed to restore the original native soil physical and chemical characteristics. Caution will be exercised to avoid introduction of nonnative species.

Soil Management Objectives

Soil management objectives follow from the overall resource management objectives in NPS management policies. The objectives are not mutually exclusive, and, typically, more than one objective applies in a given situation. Soil management objectives are as follows:

1. Preserve intact, functioning, natural systems by preserving native soils and the processes of soil genesis in a condition undisturbed by humans.

2. Maintain significant cultural objects and scenes by conserving soils consistent with maintenance of the associated historic practices, and by minimizing soil erosion to the extent possible.

3. Protect property and provide safety by ensuring that developments and their management take into account soil limitations, behavior, and hazards.

4. Minimize soil loss and disturbance caused by special use activities and ensure that soils retain their productivity and potential for reclamation.

Soils Inventory and Mapping Status

In 1997, I&M Program staff assisted parks with identifying soil mapping needs and priorities so that park objectives could be met through appropriate data collection. National Park Service is currently working with the Natural Resource Conservation Service (NRCS) and private contractors to complete Order 3 soil surveys in all parks, except where more detailed surveys are required for park management. All surveys will follow National Cooperative Soil Survey (NCSS) standards, and will be digitized following SSURGO standards.

The Natural Resources Conservation Service has completed soils mapping on survey areas which cover 141 NPS units, and is currently conducting soil surveys that cover 37 NPS units and will continue to support soil mapping until the project is completed.

Soil map digitization has been completed through SSURGO certification and archival on 29 soil survey areas which cover NPS units, with 10 currently in process of being digitized, and an additional 53 surveys planned to be digitized over the next few years.

Future Directions

The National Park Service is committed to continue its relationship with the National Cooperative Soil

Soil Survey Deep Investigations - Executive Summary

Introduction: We are pleased that the Association of American State Geologists has expressed interest in ongoing and planned Soil Survey Activities. Environmental concerns such as nutrient management, water quality, and on-site waste disposal require a strong linkage between Soil Surveys and other Earth Science inventories. To accomplish this end will require cooperative efforts by various federal and state agencies including NRCS and the State Geological Surveys.

Background: The National Cooperative Soil Survey is a current, as well as, historic contributor to the understanding of earth materials within and below the soil. Soil Survey activities include detailed geomorphic investigations (e.g. The Desert Project) and a large number of field observations, which are used to build robust soil landscape models with linkages to subsurface sediments or bedrock. The Deep Investigations Team and the Soil Hydrology teams at the NSSC are the focal point to specifically deal with soil and the linkage to other Earth Science data and inventories and water issues.

Agency Goals (Why do this?): 1) To better understand and predict soil patterns, which can be greatly influenced by a) the earthy materials or bedrock they form upon, and b) the movement of water and contaminants through them. 2) Improve land management, which is directly affected not only by soil but also by materials and water immediately below them.

Approach (What does this initiative provide?): The main goal of Soil Survey is to understand the distribution, behavior, and site history of Soil Landscapes. The linkage to earthy materials is a necessary component of that process and the resultant integrated resource management advocated by the NRCS (see **Attachment**). The most comprehensive information on soil patterns, properties and behavior must be linked to subsurface materials to address water quality, ecosystem and watershed response, resulting in improved land-management decisions. Our thrust is to clarify and quantify the linkages or interface of soil to 1) the distribution and nature of unconsolidated materials and weathered rock, and 2) water flow through soil and above the groundwater table (vadose zone).

Partnerships (Who is involved?): The NCSS has a long history of interaction with State Geologic Survey personnel (sharing scientific concepts and field observations, joint participation in field trips, etc.). We also need to include geologists and soil scientists from Land Grant and other universities, other government agencies (US Forest Service, Bureau of Land Management, Bureau of Indian Affairs, US Geological Survey), and the private sector professionals. (See Attachment #1 for partial list of specific partners)

Opportunities for Cooperation with AASG:

- Extend an invitation to the AASG group for the up-coming meeting of NRCS geologists in Bozeman, MT. (Oct. 4-9, 1999 - contact Jerry Bernard, NRCS, Wash., DC).
- Encourage the expansion of state-level collaboration between NRCS and State Geological Survey in support of the National Cooperative Soil Survey (share current resource information, co-participate in training and field trips particularly in support of MLRA soil survey updates).
- Suggest their group participate in the regional and national Work-planning Conferences.
- Request a more formal mechanism (group / individual) for joint communication.
- Recommend that a representative from the National Soil Survey Center be available for this or future meetings (provide a technical contact).
- Suggest that an NRCS or NCSS representative be put on the AASG annual meeting program (June,2000)
- Develop cooperative protocols that formally or informally link soil map units with geologic map units.

Contacts: Philip Schoeneberger - Deep Investigations Team leader, & Soil Hydrology Team Leader; or Berman Hudson - Lead Scientist for Landscape Analysis; NRCS, Lincoln, NE.

Attachment

Deep Investigations Team and Related Projects
Executive Summary:

History: The Deep Investigations Team was formed in 1994 in conjunction with the Soil Hydrology team on the recommendation of the Field Sampling Committee, a former National Soil Survey Laboratory technical workgroup.

Current Major Projects:

Title:	**Protocol for Describing Deep Materials** *(Deep Investigations Team)*
Scope:	National
Partners:	NCSS Standing Committee on Deep Materials
Project:	Produce an initial set of protocols & conventions for describing materials below the soil solum and above hard rock. Provide these protocols for NRCS and NCSS review and ultimate inclusion in the National Soil Survey Handbook.

Title:	**Saprolite and weathered rock** *(Schoeneberger):*
Scope:	National
Partners:	Univ. CA - Riverside (Graham), NC State Univ. - Raleigh (Buol)
Project:	Utilize existing NRCS databases (STATSGO, OSD's, NSSL characterization database) to determine the national distribution and major types of weathered rock in close proximity to ground surface. Phase 1: Determine and present the geographic distribution of weathered rock in the continental US; also includes a more detailed look at 3 states (CA, WY, NC); completed 12/31/98. Phase 2: Provide representative properties and behavior of major types of weathered rock identified in phase I (initial survey complete; awaiting renewed funding).

Title:	**Deep loess and stream terraces** *(Wysocki)*
Scope:	Lower Mississippi River valley (AR, LA, MS)
Partners:	Univ. AR - Fayetteville *(Rutledge)*, USGS *(Markewich)*
Project:	Use loess stratigraphy to refine soil series distribution in MLRA 131 and to understand the geomorphic history of the Western Lowlands

Title:	**Paleosols: nomenclature, types, behavior** *(Wysocki, Nettleton, etc.)*
Scope:	National
Partners:	Univ. Nebraska -Lincoln *(Kuzila, LaGarry)*
Project:	To develop a comprehensive descriptive protocol to describe features of buried soils both in unconsolidated materials and in the rock record.

Title:	**Geophysical Investigations - general** *(Doolittle)*
Scope:	Local projects, nationwide
Partners:	Project specific (e.g. NRCS, USGS, US Dept. Defense, etc.
Projects:	Numerous and diverse; primarily utilizes Ground Penetrating Radar, Electromagnetic Induction (EM) techniques, and stratigraphic investigations. Example - Investigation of the contact between soil and bedrock in karst terrain of southern Illinois using geophysical techniques *(Indorante, Doolittle).*

Title:	**Geomorphic & Geologic Investigations** *(Schoeneberger, Wysocki, etc.)*
Scope:	Local projects, nationwide
Partners:	Project specific (e.g. NRCS, State Geologic Surveys, US Forest Service, etc.)
Projects:	Numerous and diverse; provide geomorphic and geologic training, tours and technical support on landforms, stratigraphy and geologic materials to NRCS and NCSS cooperators as part of the cooperative soil survey.

Site Specific Soil Mapping Standards for New Hampshire and Vermont
Based on the Standards of the National Cooperative Soil Survey

National Cooperative Soil Survey Conference
Saint Louis, Missouri
July 1, 1999

Steve Hundley, State Soil Scientist
NRCS, Durham, New Hampshire

Many of you are aware of the efforts to established site-specific standards in New Hampshire and Vermont. You may remember a technical committee was established at the last National Conference in Baton Rouge two years ago to address the issue of site-specific standards and I had an opportunity to talk about progress in New Hampshire. We have come a long way since then.

For those of you who are not aware of these efforts I will start with a short history of the development of these standards. Site-Specific Standards in New Hampshire have been evolving since 1992. The initial efforts came through requests from the Society of Soil Scientists of Northern New England and the New Hampshire Association of Consulting Soil Scientists. Our first versions of the standards were referred to as Order 1 soil mapping standards and we later changed to site-specific soil mapping standards because the public, state and local officials could relate more to what is meant by site-specific than Order 1.

In 1995, with endorsement from the Soil Survey Division, the NRCS in New Hampshire entered into an MOU with NH State Board of Certification of Natural Scientists which serves four primary functions. First, it provides private soil consultants with access to all NRCS documents pertaining to the standards of the National Cooperative Soil Survey. Second, it requires private consultants to receive training in NCSS standards, and to receive a certain number of CEUs pertaining to the NCSS standards in order for them to maintain their certification to do soil survey work in New Hampshire. Third, it provides for an NRCS soil scientists to serve on the board of certification, in an advisory capacity and as a liaison to the NRCS to address issues pertaining to the NCSS. And fourth, it provides a vehicle for quality assurance and quality control on soil map products produced by the private soil consultant. This is an important aspect when allowing the private sector soil scientist place a label in the lower right-hand comer of their soils map that says: "This map product is within the technical standards of the USDA National Cooperative Soil Survey. " Federal employees are not permitted to review the mapping completed by a private soil consultant, this must be done through the State Board of Certification. This MOU provides the vehicle to do this, as appropriate or as needed.

One example of the quality control incorporated into the standards covers, under certain situations, a requirement that the private consultant must provide the State Soil Scientist with taxonomic unit and map unit descriptions. Collecting this information not only helps to provide field documentation to support the NCSS program, but it provides an indication of the consultants knowledge of how to properly describe soils and understand the concept of a map unit as well as properly use NCSS terminology. One can tell a lot about the capability of a soil scientist through the written field documentation provided. If the soil scientist does not provide the information as requested, then the State Board of Certification gets a letter from the State

Soil Scientist expressing concerns over the professional behavior of the private consultant. The Private consultant does not loose his or her right to map soils in the State, but it is a negative mark against the individual which they don't wish to have. Also, if at any time, anyone would like to have individual's mapping verified, so long as there is sound reasoning why this request is being made, the State Soil

Scientist will write a letter to the State Board requesting the mapping be verified as complying with NCSS standards. By state law, the Board must comply with this request. As State Soil Scientist, I have indicated I will not hesitate to write that letter to the Board because I do not want the integrity of the National Cooperative Soil Survey be questioned. So far, I have not had to write a letter to the board, but two consultants have gone through an ethics review process by the board. One individual is no longer working in New Hampshire.

In June of 1997, Version 1 of the standards were published by the Society of Soil Scientists of Northern New England with full support and endorsement from New Hampshire Office of State Planning and the New Hampshire Department of Environmental Service.

In December of 1997 all hell broke loose when correspondence was submitted by the New Hampshire Septic System Designers and Installers to the Office of State Planning with copies to the Governor indicating these standards were developed by a special interest group intent to promote their own self interests without any regard to the safety or welfare of the citizens of this State. The New Hampshire Septic System Designers and Installers are over 400 strong in the State, they have their own full time legal council and paid lobbyists at the State House. They carry a great deal of political influence in the State. In a scathing nine page letter, they did everything they could to discredit the private soil consultant, the soil science societies and the standards of the National Cooperative Soil Survey. Jeff Taylor, Director of the Office of State Planning was not a happy camper. In retrospect, that letter was the best thing that could have happened because the standards held up through a year of very intense scrutiny, and they held up remarkably well. And, through this process the National Cooperative Soil Survey was thrown into the limelight. It was great recognition and great publicity. Today, there is a large sector of society that had never heard of the National Cooperative Soil Survey that now know who we are and what we do.

As a result of this letter, in the Spring of 1998, a special committee was formed, established by the Office of State Planning and Department of Environmental Services, to assess the validity of the standard and their application in New Hampshire. At the same time a charge was given to the committee to establish an easy-to-understand guidance document for planning boards to use when reviewing site-plans. This committee met every two weeks for most of 1998. The makeup of the committee included representatives from the New Hampshire Septic System Designers and Installers, New Hampshire Municipal Association, NH Association of Conservation Districts and Conservation Commissions, New Hampshire State Board of Natural Scientists, NH Association of Consulting Soil Scientists, NH Association of Wetland Scientists, the Homebuilders Association of New Hampshire, regional planning commissions, and the Natural Resources Conservation Service.

It was truly an educational and challenging experience for me, not just wrestling with the politics that has influence in the direction this committee took, but the realization that the regulatory world and the natural world will never agree. One of the difficulties to deal with is the fact that the Standards of the National Cooperative Soil Survey are not intended to be hard and rigid rules and regulations. They are intended to serve as guidelines and are intended to be flexible in their application. Once the NCSS standards get placed into administrative rules, they become hard and inflexible.

Perhaps the most time-consuming issue and the most challenging was explaining and defending the accuracy of soil line placement. Where as we, as soil scientists are more interested in the behavioral characteristics of soils within a soil line, the only thing the regulatory people care about is how accurate is the placement of the soil line. They want a tolerance level-how many feet, plus or minus, is the soil line from the actual boundary between "series x" and "series y". Then one tells them it's not possible to place a tolerance factor on soil line placement because that would imply there is an actual boundary from which to measure, and there isn't one. And then when one tries to explain the difference between a soil series name and a map unit ... and further, try to explain that delineations are like snow flakes; that no two delineations are exactly alike in the composition of soils contained within them.

The regulators got so confused, they didn't understand how soils could be mapped at all with any degree of reliability, and certainly not enough to base land use regulations. To help them understand, one of the first things that had to be driven home to them is that a map of anything, at any scale, at best, is only an approximation of what is really there. It is humanly and mathematically impossible to show everything. So how much information is enough? And how much is one willing to pay to get a little more information knowing he or she will never have it all?

I usually like to use a "good news - bad news" story. The bad news is that you will never be able to know everything there is to know about a parcel of land. The good news is, you don't want to know everything. If you did, you would have information overload to the maximum. You wouldn't be able to make a land use decision because you couldn’t sort all the information into a manageable form that would be meaningful or understandable.

Over several months, and long days of explanation, they came to appreciate the value and importance of soils information. Throughout the year of negotiations and explanations the standards of the National Cooperative Soil survey were never compromised. Understand, these are not standards of the National Cooperative Soil Survey, they are New Hampshire and Vermont Soil Mapping Standards, that conform to the standards of the National Cooperative Soil Survey. These standards are owned by the Society of Soil Scientists of Northern New England. From the very beginning, back in 1992, when the private consultants came to me requesting assistance in developing standards, I agreed to assist, with the understanding that at no point in the process will I consider compromising the integrity of the NCSS standards.

In May of 1999 the committee published a guidance document for planning boards that has a broad base of support. The document is titled: "Data Requirements for Site Review: Guidance for Planning Boards". In this document, it states: "The Committee recommends the following as the best available guides for on-site resource characterization and mapping, consistent with State Statutes and administrative rules: Site-Specific Soil Mapping Standards for New Hampshire and Vermont and the Field Book for Describing and Sampling Soils, Version 1.1, National Soil Survey Center, NRCS, 1998.

The site-specific standards have been incorporated into the revised DES Administrative Rules on subsurface wastewater disposal has made it through the public review process, and are due to become official adopted rules on July 17, 1999. The site-specific standards are also in the DES rules for land application of municipal sludge. Many towns are writing the standards into their land use ordinance pertaining to the review and permitting of site plans and subdivision plans.

Recently, funding has been provided by the NH Association of Conservation Districts to put on workshops around the state to explain the document to municipalities and planning commissions.

Although these site-specific standards were established primarily for subdivision and site-plan review, they have other applications as well. One of the biggest selling points of the site-specific standards is that they produce a multipurpose product that is equally as useful for precision farming as for subdivision review. In Vermont site-specific soils mapping is being conducted by the University of Vermont, with NRCS technical assistance, to address Phosphorus loading and runoff concerns within the Lake Champlain Basin.

Through-out this process of developing Site-Specific Soil Mapping Standards, I have kept in communication with the National Association of Consulting Soil Scientist. Mark McClain, and the Site-Specific Soil Mapping Committee have provided feedback and recommendations concerning the development of these standards. The standards are on the Website of the National Society of Consulting Soil Scientists at: www.nscss.org/sssms. The file has been loaded as a straight word document and has some formatting problems when one attempts to download it. The file has been provided to the society in pdf format, and will go on in that form shortly, which will make them easier to read and download.

This past January I attended the Annual Meeting of the National Society of Consulting Soil Scientists in Washington D.C. to talk about the progress made in the establishment of site specific standards. Also, last month, I presented a poster on the site-specific standards at the Keep America Growing Conference in Philadelphia. At these conferences, consulting soil scientists from around the country have approached me with concerns that detailed soils mapping is going on in their state, with no standards, and as the need for this mapping increases, the concern for lack of mapping standards is increasing.

I have compiled a list of states where I have been communicating with soil scientists that have expressed concerns about the lack of site-specific soil mapping standards. These states are Kentucky, New Jersey, New York, Oregon, Delaware, Georgia, Maryland, Virginia, Pennsylvania, California, North Carolina and Ohio. I am sure there are many other states that have site-specific soils mapping taking place without standards. I think these initial contacts provide an indication that the increasing need for uniform standards.

In summary, there are four issues I would like to quickly address.

1. Site-specific soils information is needed to answer site specific questions about land use. It is important to educate the public and regulatory people that there is a big difference between accuracy and precision, and that you can't blow up a county soil survey to 1:100 and make sound land use decisions based on that information.

2. One of the biggest selling points of the NCSS standards in New Hampshire is the fact that they produce a multi-purpose product. We recently received a new section for the National Soils Handbook pertaining to Order 1 mapping standards. I think it was very well written and will be very valuable for states having to deal with site-specific mapping standards. There is one school of thought, however, that Order 1 standards and Site-Specific are not necessarily the same, or should be the same. In New Hampshire, the site-specific standards are synonymous with Order 1 standards. There are some real benefits:
   A. Site-Specific mapping uses the same state-wide soils legend as the NRCS uses in doing Order 2 mapping.
   B. B) All of the soil attributes in NASIS are applicable to site-specific mapping. Many towns in New Hampshire now have arcview as well as scanning capabilities. They can scan in a site-specific soils map for a proposed subdivision and apply NASIS soil attributes to display a some very graphic interpretive maps of the soil resources on site.

3. It is important that the State adopt site-specific standards. Being consistent with State Statutes and Administrative rules provides more strength and value for their use. Providing a guidance document for planning boards to use is where the rubber meets the road. Planning boards don't have a clue as to what they need to ask for, when its appropriate or not appropriate. And when they do get something, they don't have a clue as to what to do with it, or how it can help them make land use decisions. Having a process clearly defined, that is consistent with state regulations is very important in applying the standards in the manner in which they were intended to be applied.

4. Finally, it is important to emphasize these standards are legally defensible. This aspect is so vitally important to the private soil consultant. This also adds a considerable level of security for a municipality that establishes land-use ordinances based on site-specific mapping. These standards are legally defensible first because they are science based which provides reproducible results. The opposite of this might be politically or economically influenced standards, or standards that use

ambiguous terms that can be easily misinterpreted. We have already talked about the importance of science based soil resource information at this Conference.

Secondly the standards are legally defensible because they are technically sound. That is, we have a reservoir of knowledge that has been building for a 100 years. When we say a soil is expected to behave in a certain manor under a specified kind of land use, the client can be assured it will behave in that manner.

Now, I am not an attorney, (but I play one on TV), however, I have received some legal council pertaining to the legal defensibility of using the standards of the National Cooperative Soil Survey. I have accumulating examples of case law where the standards of the NCSS have held up in court decisions. (I do not have access to Lexis-Nexis, and I am still trying to collect examples of case law from around the country where the NCSS standards have been used. If you know of any case law, I would certainly appreciate a way to identify the case so I can look up the specifics. In my legal pursuits, there are two issues here that are important to note:

There are two very important questions asked in courts of law, the first question is: what is the appropriate standard of conduct, and did the defendant live up to that standard? This question ties back to a legal term called "industry custom" which refers to the normal, and widely practice standard for the industry. Case law has proven than the standards of the National Cooperative Soil Survey have set the standards for the industry.

The second question is: What is the appropriate level of care that should be provided and did the defendant demonstrate he or she provide that level of care? To answer this question, the courts do a cost-benefit analysis. The court asks if the benefits of taking an increased level of care outweigh the cost of providing that care. If the answer is yes, then the extra care must be provided. In other words, a cost benefit analysis is completed on whether or not there was a need to have a site-specific soil survey.

In New Hampshire, the cost of providing a site-specific soil survey costs between $45.00 and $75.0 per acre. Pre-developed land values in Southern New Hampshire average around $20,000 an acre. So the cost for a site-specific; soil survey costs somewhere in the neighborhood of $1.00 of cost for every $400.00 in land value before development. Now, to my knowledge, it hasn't been tested in court yet, but I would venture to guess that when the court does a cost/benefit analysis, they will say the benefit of a site-specific soil survey outweighs the cost of providing one.

Funding has recently been provided to the New Hampshire Association of Conservation Districts to organize a series of presentations that will be given to municipalities around the state. These presentations will keep the communication lines open, and provide the training necessary for planning board members, and other municipal officials to properly apply the site-specific standards.

Soil Mapping Using GIS, Expert Knowledge, and Fuzzy Logic

A-Xing Zhu, James E. Burt, and Ken Lubich

1. Introduction:

Detailed soil spatial and attribute information is required for many environmental modeling and land management applications at the watershed level [Beven and Kirkby, 1979; Burrough, 1996; Corwin et al., 1997; and Jury, 1985]. Currently, soil maps produced through conventional surveys are the major source of soil spatial information for these applications. However, standard soil surveys were not designed to provide the detailed (high-resolution) soil information required by some environmental modeling (Band and Moore, 1995; Zhu, 1999a] and crop management applications (Peterson, 1991). The inadequacy is the incompatibility of soil maps with other landscape data derived from detailed digital terrain analyses and remote sensing techniques [Band and Moore, 1995; Zhu, 1997a; Zhu, 1999a]. This inadequacy is largely due to the limitations of the discrete data model and polygon-based mapping practice employed in conventional soil surveys.

Zhu (1997a), Zhu (1999b), Zhu and Band (1994), Zhu et al. (1996), and Zhu et al. (1997) developed a soilland inference model (SoLIM) to overcome the limitations in conventional soil surveys by combining the knowledge of local soil scientists with GIS techniques under fuzzy logic to map soils. The approach is based on the soil factor equation by Dokuchaeiv (Glinka, 1927) and Hilgard (Jenny, 1961) or the soil-landscape paradigm concept described by Hudson (1992). This concept contends that there exist relationships between soil and its formative environmental factors. If we know the relationships between soil and its environment for an area, then for a given location in that area we would be able to infer what soil might be at that location from its environmental conditions. The SoLIM approach employs GIS/remote sensing techniques to characterize the soil environmental conditions and uses a set of knowledge acquisition techniques to extract soil-environmental relationships from local soil experts. A set of inference techniques constructed under fuzzy logic links the characterized environmental conditions with the extracted relationships to infer the spatial distribution of soils.

This paper describes and assesses the SoLIM approach from perspectives of improving soil surveys. The next section provides a background on the limitations of conventional soil survey and its soil maps. Section 3 describes how some of the limitations are overcome or reduced in the SoLIM approach, which is followed by the assessment of SoLIM in Section 4. Summaries are presented in Section 5.

2. Limitations of the Model and Process Used in Current Soil Surveys

The ability of soil scientists to conduct soil surveys accurately and efficiently is largely limited by two major factors: the polygon-based mapping practice and the manual map production process. The polygon-based mapping practice is based on the discrete conceptual model (Zhu, 1997a), which limits soil scientists' ability to produce quality soil maps. Under this model, soils in the field are represented through the delineation of soil polygons with each polygon depicting the spatial extent of a particular soil

The second limitation of the polygon-based mapping practice is that the polygons represent only the distribution of a set of prescribed soil classes (ideal concepts of soils), not individual soils in the field which often differ from the prototypes of these prescribed classes. In order to map soils, field soil scientists have to assign individual soils in the field to one and only one of these classes (referred to as *Boolean Classification).*

Once assigned to a class the local soil is said to be typical of that class; thus the local conditions of that soil are lost. Local soil scientists may know that the local soil differs from the typical type of the assigned class, but this expert knowledge cannot be conveyed using polygon-based soil mapping. This approximation of local soil conditions by the typical type of a prescribed soil class is referred to as ***generalization of soils in the parameter domain*** (Zhu, 1998). This generalization forces soil scientists to map soil spatial variation as a step function, which means that sod variation appears only at the boundaries of soil polygons. Field experience tells us that although abrupt changes of soils over space do exist, changes in soil properties often take a more gradual and continuous form than what the polygon-based mapping practice allows.

The manual soil map production process limits soil scientists' ability to update soil surveys rapidly and accurately. During the manual production process soil scientists first detect different soil formative environments: through their visual interpretation of geological, topographic maps and air photos. The spatial extents of these soil formative environments are then used to delineate soil polygons based on soil scientists' understanding on the relationships between these environmental conditions and the soil mapping units. The boundaries of soil polygons may initially be delineated on a set of air photos and then be transcribed onto a base map for map compilation purpose. There are several major limitations associated with this process. First, subtle yet important changes in environmental conditions may not be easily observed visually due to the limitation of visual perception and the limitation of visually processing many variables simultaneously. This can result in small soil bodies not being mapped. Secondly, visual interpretation is not only a time-consuming but also an error-prone process, since it is very likely to make mistakes after staring through a pair of stereoscopes for many hours. As a result, misinterpretations can often occur during the soil boundary delineation process. Thirdly, the process of transcribing soil polygon boundaries from a set of air photos to a base map is not only time-consuming but could also be error-prone, further degrading the quality of soil maps. Fourth, much of soil scientists' time is devoted to this soil polygon delineation process, preventing them from further investigating soils and their environment in the field and from improving their understanding of soils for future updates. Finally, this entire soil map production process must be repeated for each future soil survey update. This makes soil survey updates very inefficient.

As a result of these limitations, current way conducting soil survey is very time-consuming. There are approximately 2.2 billion acres in the United States. The current rate of soil survey updating is about 10 million acres per year. This means that at current rate it will take us 220 years to update all of soil surveys. If the effort is doubled as more staff is shifted from initial soil surveys to updates the survey update will still be at a century cycle (over above three generations of soil scientists). A radical change is needed to move soil survey to a more acceptable update rate and to a product that can be continually updated efficiently and accurately.

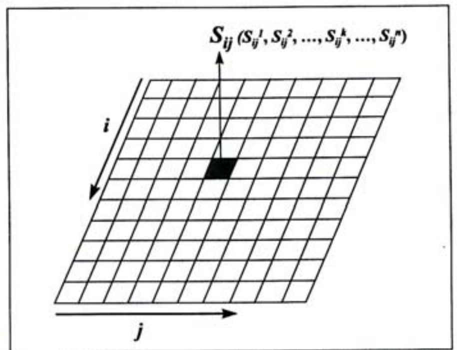

Figure 1: The raster soil database. Soil bodies are presented as pixels in spatial domain and as similarity vectors in parameter domain.

3.2 Populating the similarity model: automated soil inference under fuzzy logic

The similarity model provides only added flexibility for representing soil spatial variation. The degree of success in using this model depends on how the model is populated or how the soil similarity values in the vector at each pixel are determined. The SoLIM approach determines the soil similarity values using the soil factor equation outlined by Dokuchaeiv (Glinka, 1927) and Hilgard (Jenny, 1961) or the soil-landscape paradigm concept described by Hudson (1992). T his concept contends that soil is the result of the interaction of its formative environmental factors over time as described in Equation [1].

$$S^1 = \int f_1 (E) dt \qquad [1]$$

where S' is soil, f is the relationship of soil development to the formative environment, *E*, which generally includes variables describing climate, topography, parent materials, and vegetation factors, and *t* is time. Since it is difficult, if not impossible, to explicitly describe the t factor at every location across landscape and information on t is sometimes implicitly expressed in other formative environmental factors such as topographic positions and in local soil scientists' knowledge, under the SoLIM implementation Equation [1] is simplified to:

$$S' = f(E) \qquad [2]$$

Data on soil formative environmental conditions (E) can be derived using GIS techniques (Figure 2) (Zhu et al., 1996 and McSweeney et ah, 1994). The soil-environmental relationships *(1)* can be approximated by the expertise of local soil scientists (Zhu and Band, 1994; Zhu, 1999b) or using techniques such as artificial neural networks (ANN) (Zhu, 1998), case-based reasoning (CBR) (Kolodner, 1993; Schank, 1982; Shi and Zhu, 1999), and supervised fuzzy classification (Wang, 1990). The acquired soil-environmental relationships can then be combined with data characterizing the soil formative environment conditions to inferS' under fuzzy logic (Zhu and Band, 1994; Zhu et al., 1996). S' is a measure of similarity between the characterized soil formative environment for the typical case of a given soil class and the characterized soil formative environment at a given local location. Since the similarity measure of a local soil to the central concept of a particular cannot be determined without examining the local soil in details, which is prohibitively expensive, S' is used to approximate S (the soil similarity measure) under the SoLIM approach.

The actual process of inferring S' is automated (Zhu and Band, 1994). The acquired soil-environmental relationships are stored in a database (referred to as a *knowledgehase).* Data characterizing soil formative environments are stored in a GIS database. A set of inference techniques constructed under fuzzy logic (collectively called the fuzzy inference engine) are used to link the knowledgebase with the GIS database to derive soil similarity vectors (Figure 3). In general, for pixel (*i*,*j*), the inference engine takes the data on soil formative environment conditions for that pixel from the GIS database and combines the data with the soil environment relationships for soil category *k* from the knowledgebase to calculate the similarity value of the local environment to the typical environment of soil category *k*, $S'ij^k$, which is then used as a surrogate to S_{ij}^k. Once all of the soil categories are exhausted by the inference engine the soil similarity vector ($\mathbf{S}_{ij}$) for this pixel is created. The inference engine then moves onto the next pixel in the GIS database and repeats the process of deriving the soil similarity vector. When all of pixels in the GIS database are exhausted, a similarity representation of soils (a raster soil database) for the entire area then is derived.

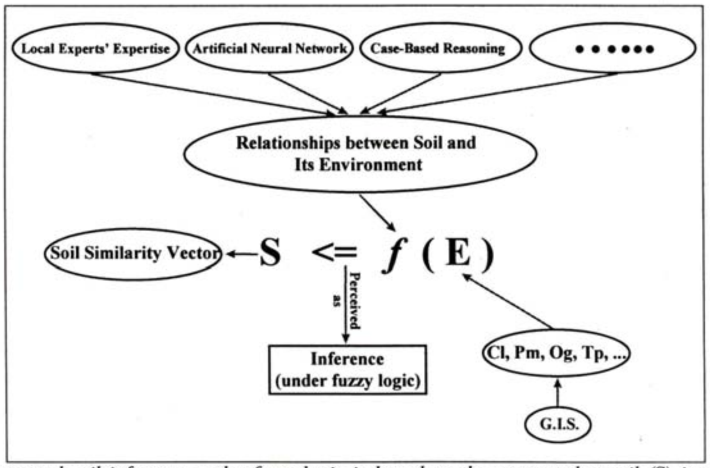

Figure 2: The automated soil inference under fuzzy logic is based on the concept that soil (S) is a function (f) of its formative environment (E).

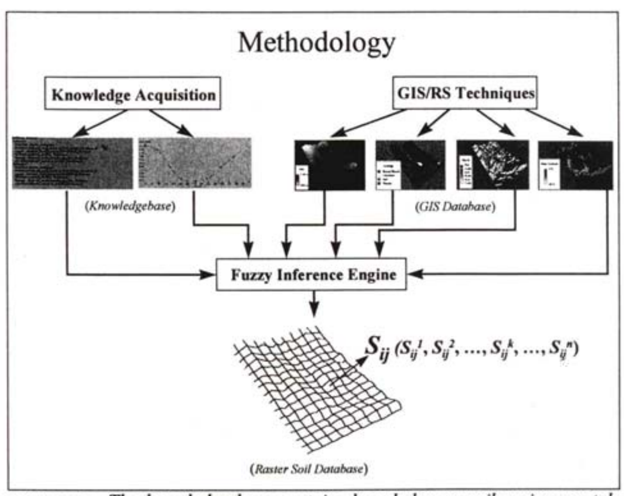

Figure 3: Soil inference process. The knowledge base contains knowledge on soil-environmental relationships. The GIS database contains spatial data on soil formative environmental conditions. The fuzzy inference engine combines the relationships in the knowledge base with the spatial data in the GIS database to produce a raster soil database for the study area.

3.3 Deriving soil information products: uses of the similarity model

The information represented under the similarity model can be interpreted as needed for different uses. Some of the uses are discussed below. The first is the derivation of a spatially detailed soil type map that is created through the hardening of the similarity vector (Zhu, 1997a). The hardening is done by assigning each location the label of the soil class that has the highest membership value in the similarity vector for that point. For example, a similarity vector at a point is (0.2, 0.4, 0.1, 0.3) with values representing membership in Soils A, B, C, and D, respectively. Hardening will result in the soil at the point to be labeled as Soil B since the local soil bears the highest membership in Soil B.

The second use is to assess the quality of the soil type map produced through the hardening of the similarity representation. Zhu (1997b) used two indices computed from the similarity vector to estimate the uncertainty in producing a soil type map through hardening the vectors. The first index, the exaggeration uncertainty, measures the error introduced when assigning a soil type to a local soil that is not the typical case of the soil type. In other words, the exaggeration uncertainty approximates how much the local soil is exaggerated to be the soil type assigned to. The second index, the ignorance uncertainty, measures the error occurred when ignoring the similarity of the local soil to other soil types other than the type being assigned to. This index approximates the loss of information when ignoring the intermediate (between-type) nature of the local soil. Zhu reports (1997b) that these two indices were useful to portray the spatial variation of soil map quality. This quality information is very critical for assessing the usefulness of soil maps and also for effectively allocating future update efforts.

The third use is the derivation of a spatially continuous soil property map for an area (Zhu et al., 1997; Zhu, 1997a). Although other ways of generating soil property maps from the similarity representation are possible, Zhu et al. (1997) used the following linear and additive weighting function to estimate the A-horizon depths.

$$V_{ij} = \frac{\sum_{k=1}^{n} S_{ij}^{k} \bullet V^{k}}{\sum_{k=1}^{n} S_{ij}^{k}} \qquad [3]$$

V_{ij} is the estimated soil property value at location *(i,j)*, V^k is the typical value of a given soil property of soil category *k*, and *n* is the total number of prescribed soil categories for the area. This function is based on the assumption that the more the local soil formative environment characterized by a GIS resembles the environment of a given soil category, the closer the property values of the local soil to the property values of that candidate soil category. The resemblance between the environment for soil at *(I,j)* and the environment for soil category *k* is expressed as S_{ij}^{k}, which is used as an index to measure the level of resemblance between the soil property values of the local soil and those of soil category *k.*

4. Assessment of the SoLIM Approach:

4.1 Assessment of the quality of products from SoLIM:

The SoLIM approach was tested in a watershed in western Montana, the Lubrecht Experimental Forest watershed (Zhu et al. 1996). The results from that case study are discussed here to provide an assessment of the effectiveness of the SoLIM approach in deriving detailed and accurate soil spatial information. The assessment will be conducted through the comparison of the products derived from the SoLIM approach with these derived from conventional soil maps. Two soil products (soil type map and soil property map) will be examined in this section.

The soil similarity vectors can be hardened to produce a soil map. The hardening is done by assigning each location the label of the soil class that has the highest membership value in the similarity vector for that point. The SoLIM-derived soil map and the conventional soil map over the Lubrecht study area are shown in Figure 4. It can be observed from the two maps that the SoLIM-derived soil map contains much greater spatial detail than the conventional soil map of the area. In a semi-arid to semi-humid area like western Montana, moisture condition is the dominant factor in the soil forming process. The moisture conditions in the small draws (shallow but very wide gullies, ravines or valleys) are often very different from the respective major slopes on which these small dr

Table 1: Comparison between SoLIM and the Soil Map Against Field Observations at the Series Level

	Overall		
	Correct	Total Samples	Percentage
SoLIM	52	64	81
Soil Map	39	64	61
	Mismatches		
	Correct	Total Samples	Percentage
SoLIM	17	24	71
Soil Map	4	24	17

To further assess the SoLIM approach, two soil property maps depicting the spatial variation of A-horizon depth were derived: one from the similarity representation of SoLIM using Equation 3 and the other from the conventional soil map. Figure 5 compares the two soil A-horizon depth maps. It can be clearly seen that the depth map inferred from SoLIM shows a more continuous spatial variation than the depth map from the conventional soil map, which shows the changes occurring only at the boundaries of the soil polygons. Changes in soil property values occurring only at the boundaries of soil polygons are not realistic in this study area. Field observation of A-horizon depths at 33 sites suggests that the inferred depths at these 33 sites matched the observed depths better (with R^2=0.602) than did the depths derived from the conventional soil map (with R^2=0.436).

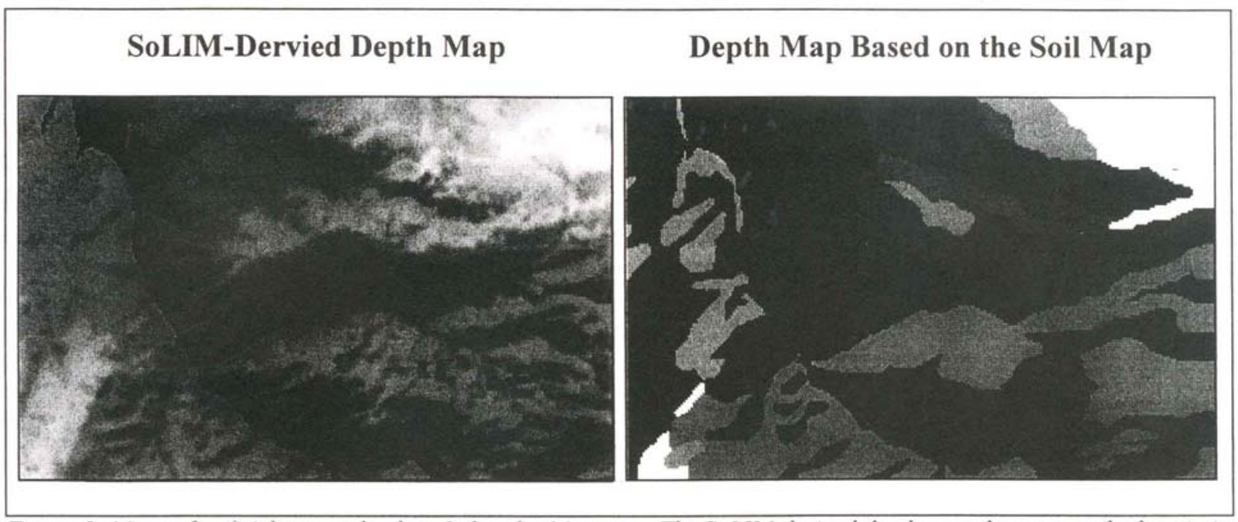

Figure 5: Maps of soil A-horizon depth in Lubrecht, Montana. The SoLIM-derived depth map shows a gradual variation of soil A-horizon depth while the depth map from the conventional soil map shows abrupt changes at the boundaries of soil polygons.

The high quality soil products from SoLIM are related to three aspects of SoLIM. First, environmental variation can be quantified in great detail within GIS due to the capability of digital data processing and the ability for handling many variables simultaneously in a GIS environment. The availability of this detailed data on soil formative environments makes it possible to greatly reduce soil inclusions and misinterpretations. Second, the soil similarity model allows local soil conditions to be expressed at pixel resolution, thus allowing the occurrence of small map unit components in the landscape to be expressed at a level of detail impossible in conventional soil maps. Third, the fuzzy logic used in the soil similarity model allows the soil at a pixel to be expressed as an integrade rather to be approximated by only one typical soil type. Fuzzy logic allows the properties of a local soil to be more accurately estimated.

4.2 Assessment of the process of soil survey using SoLIM:

In addition to the high quality of its products the SoLIM approach has several other advantages over the conventional approach in terms of the process of soil survey.

- ***Rapid soil survey updates***. Since both the GIS database and the knowledgebase for a given area are stored in a digital environment and reusable, the SoLIM approach can produce new versions of the raster soil database for an area very rapidly by taking advantage of high processing speed of computers in its inference. This can be done in a matter of hours or days rather than over months or years as in the current survey process. The ability to quickly update soil spatial databases allows soil surveys to keep up with the rapidly changing spatial data processing technology and the advancement in our understanding of soils. For example, the knowledgebases can be re-applied to produce updated soil surveys when high resolution GIS and remotely sensed data become available. The readily available knowledgebases can also be studied and conveniently updated by soil scientists. The updated knowledgebases can be reapplied to produce soil surveys containing our most recent understanding of soils.

- ***Reduced cost***. Since the GIS databases, the knowledgebases, and the fuzzy inference engine are all reusable, most of the investment during the initial soil surveys or initial updates retains its value. The modular design of SoLIM (compiling the GIS database, acquiring knowledge, and performing inference, see Figure 3) allows each module to be updated independently in subsequent updates. Future soil survey updates will need only to improve the GIS databases, update the knowledgebases, and perfect the inference engine. There is no need to start everything from scratch again. This means not only saving human and material resources, but also improving the efficiency of conducting soil surveys.

- ***More focused soil scientists***. The modular design in SoLIM divides the. whole soil survey process into tasks with each task being performed by the most suitable professionals. For example, compiling GIS databases and performing inference are most suitable for professionals in GIS or information sciences. Acquiring knowledge about soil-environmental relationships is best suited to the talent of soil scientists since they are the ones with the trained eyes. De-coupling the study of soil-environmental relationships from soil map-making will liberate soil scientists from time-consuming map-making tasks and allow them to focus on what they do best: studying soils and discovering soil-environmental relationships.

- ***Maintaining knowledge continuity***. A large portion of local expertise is lost each year as experienced local soil scientists retire. It is desirable to document this expertise to maintain continuity of knowledge on soil-environmental relationships between different generations of local soil scientists. The soil environmental relationships in the knowledgebases used by SoLIM can be a major source of knowledge for new generations of soil scientists.

- ***Digital products***. The output from the fuzzy inference engine is already in digital format. The soil data can be directly used in any GIS applications without going through the tedious digitization process, which not only consumes a lot of labor and adds to costs, but also degrades the quality of the final products due to possible errors in the digitization process.

5. Summaries

The success of the SoLIM methodology is due to the integration of knowledge on soil-environmental relationships with the power of GIS under fuzzy logic. The similarity model overcomes the limitations of the conventional discrete conceptual model and allows the representation of soils as continua in both the spatial and attribute domains. The capability of GIS for processing spatial data enables soil formative environmental conditions to be quantified in great detail. A set of fuzzy inference techniques effectively couples this ability of GIS with the knowledge of soil-environmental relationships to infer soil spatial information under the similarity model. The SoLIM approach to soil survey not only improves the quality of soil information products from the survey, but also makes the survey updates more efficient and less costly. Due to these advantages and with the continuing improvement of information gathering and process technology, we argue that the SoLIM approach has the potential to significantly advance the way soil surveys are conducted in the next century.

6. Cited References:

Band, L.E. and I.D. Moore. Scale: Landscape attributes and geographical information systems. Hydrological Processes. 9:401-422. 1995.

Beven, K.J. and M.J. Kirkby. 1979. A physically-based variable contributing area model of basin hydrology. Hydrological Science Bulletin, Vol. 24, pp. 43-69.

Burrough, P.A. Opportunities and limitations of GIS-based modeling of solute transport at the regional scale. p. 19-38. In D.L. Corwin and K. Loague (ed.) Applications *of* GIS to the Modeling of Non-point Source Pollutants in the Vadose Zone. SSSA Special Publication No. 48. SSSA, Madison, W1. 1996.

Burrough, P.A., R.A. MacMillan, and W. Van Deursen. 1992. Fuzzy classification methods for determining land suitability from soil profile observations. Journal of Soil Science, Vol. 43, pp. 193-210.

Burrough, P.A., P. Van Gaans, and R. Hootsmans. 1997. Continuous classification in soil survey: spatial correlation, confusion and boundaries. Geoderma. Vol. 77, p. 115-13 5.

Clayton, L. and J.W. Attig. 1997. Pleistocene Geology of Dane County, Wisconsin, Bulletin 95, Wisconsin Geological and Natural History Survey, Madison, Wisconsin, 64 pp.

Corwin, D.L., P.J. Vaughan, and K. Loague. Modeling nonpoint source pollutants in the vadose zone with GIS. Environmental Science & Technology, Vol. 3 1, No. 8, p. 2157-2175. 1997.

Glinka, K.D. 1927. *The Great Soil Groups of the World and their Development* (Translated from German by C.F. Marbut.) Edwards Bros., Ann Arbor, MI.

Hudson, B.D. 1992. The soil survey as paradigm-based science. *Soil Science Society of America Journal*, Vol. 56, pp. 836-841.

Jenny, H. 1961. E.*W Hilgard and the Birth of Modern Soil Science.* Farallo Publication, Berkeley, CA.-

Jury, W.A. Spatial variability of soil properties. p. 245-269. *In* S.C. Hem and S.M. Melancon (ed.) *Vadose Zone Modeling of Organic Pollutants.* Lewis Publication, Chelsea, MI. 1985.

Kolodner, J. 1993. *Case-Based Reasoning,* Morgan Kaufmann Publishers, 668 pp.

McBratney, A.B. and J.J. De Gruijter. 1992. A continuum approach to soil classification by modified fuzzy *k* mean with extragrades. *Journal of Soil Science*, Vol. 43, pp. 159-175.

McBratney, A.B. and I.O.A. Odeh. 1997. Application of fuzzy sets in soil science: fuzzy logic, fuzzy measurements and fuzzy decisions. *Geoderma.* Vol. 77, p. 85-113.

McSweeney, K., P.E. Gessler, D. Hammer, J. Bell, and G.W. Petersen. 1994. Towards a new framework for modeling the soil-landscape continuum. p. 127-145. *In* R.G. Amundsen et al. (ed.) Factors of soil formation: A fiftieth anniversary perspective. Soil Sci. Soc. Am. Spec. Publ. no. 33. SSSA, Madison, WI.

Odeh, I.O.A., A.B. McBratney, and D.J. Chittleborough. 1992. Soil pattern recognition with fuzzy c-mean: application to classification and soil-landform interrelationships. *Soil Science Society of America Journal,* Vol. 56, 505-516.

Peterson, C. 1991. Precision GPS navigation for improving agricultural productivity. *GPS World,* 2(l):38-44.

Quinlan, J. 1986. Introduction to decision trees, *Machine Learning,* Vol. 1, No. 1, pp. 81-106.

Schank, R.. 1982. *Dynamic memory: a theory of reminding and learning in computers and people.* Cambridge University Press, 234 pp.

Shi, X. and AX Zhu. 1999. A case-based reasoning approach to soil mapping under fuzzy logic: the basic concept, p. 266-374. *In* Bin Li et al. (ed) *Geoinformatics and Socioinformatics: The Proceedings of Geoinformatics'99 and the International Conference on Geoinformatics and Socioinformatics,* University of Michigan, Ann Arbor, June 19-21, 1999.

Wang, F. 1990. Fuzzy supervised classification of remote sensing images, *IEEE Transactions on Geoscience and remote sensing,* Vol. 28, No. 2, pp. 194-20 1.

Zhu, AX. 1999a. Fuzzy Inference of soil patterns: implications for watershed modeling, p. 135-149. *In* D.L. Corwin, K. Loague, and T.R. Ellsworth (eds.) *Application of GIS, Remote Sensing, Geostatistical and Solute Transport Modeling to the Assessment of Nonpoint Source Pollution in the Vadose Zone,* Geophysical Monograph 108, American Geophysical Union, Washington, DC 20009, pp. 135-149.

Zhu, AX. 1999b. A personal construct-based knowledge acquisition process for natural resource mapping using GIS. *International Journal of Geographic Information Science,* Vol. 13, No. 2, pp. 119-14 1.

Zhu, AX. 1998. Populating a similarity model: the neural network approach. Annual Conference of GIS/LIS'98, November 10-12, 1998, Fort Worth, Texas.

Zhu, AX. 1997a. A similarity model for representing soil spatial information. *Geoderma,* Vol. 77, pp. 217-242.

AX Zhu. 1997b. "Measuring uncertainty in class assignment for natural resource maps using a similarity model". *Photogrammetric Engineering & Remote Sensing,* Vol. 63, pp. 1195-1202.

Zhu,AX, L.E. Band, B. Dutton, and T. Nimlos. 1996. Automated soil inference under fuzzy logic, *Ecological Modelling,* Vol. 90, pp. 123-145.

Zhu, AX, L.E. Band, R. Vertessy, and B. Dutton. 1997. Deriving soil property using a soil land inference model (SoLIM). *Soil Science Society of America Journal,* Vol. 61, pp. 523-533.

Zhu, AX, and L.E. Band. 1994. A knowledge-based approach to data integration for soil mapping. *Canadian Journal of Remote Sensing*, Vol. 20, pp. 408-418.

Committee One Report on:
Data Acquisition for Problem Solving

National Cooperative Soil Survey Conference
St. Louis, Missouri
27 June - 2 July, 1999

Committee One Charges:

Address, issues relating to soil survey data needs, data collection, quality assurance of the data, archiving data, population of databases, identification of data gaps, data ownership, data accessibility, and information technology issues concerning the hosting and delivery of data. We approached this charge by formulating a series of questions pertaining to the charges, circulating these questions for comment among committee member, and summarizing the results into this report. We took some liberty in emphasizing certain areas over others.

I. The Role of NRCS. *An overarching issue relating to soils data acquisition for problem solving is the future role of the Natural Resource Conservation Service in the field of soil resource assessment in the United States.*

- As in the past, the NRCS will continue to take the leadership in the collection and management of soil resource data. Without this leadership and central coordination, the standards and quality of soil survey databases will deteriorate.
- The primary role of the NRCS is changing to that of a gatekeeper and the maintainer of soils data rather than the primary collector of soil data.
- NRCS will have to work in closer partnership with other data gathers and providers in other agencies as well as private industry. A possible model is the process by which the U.S. Geological survey creates topographic maps, and orthophotography and other sources of geodata. To varying degrees, portions of the data collection and processing steps are subcontracted with a cooperative agreement to other entities that can, in theory, perform these tasks more efficiently than a single government agency. Partnerships have always played a critical role in the NCSS, and probably more so in the future.

  The NRCS should provide leadership the following areas:
  - specialized interpretations
  - coordinating activities among researchers, technical experts, and soil survey users
  - leadership in developing educational materials and programs in support of the use of soil survey data
  - database standards
  - assist in NRCS programs

In summary, as the nation's population has grown, so have the demands on its lands to provide multiple resources for a diverse clientele. The role of the NRCS will need to change as other entities become more involved in the collection and analysis of soil survey information. We want to avoid the situation where others may collect significant soil resource data in isolation of the NCSS. We will always need a strong coordinating agency in leadership, but the effective role of NRCS is moving more towards the coordinator rather than the doer. These partnerships are also critical if the NCSS is to remain relevant and receive continued public support. Agencies without this support usually cease to exist.

II. Data Needs. Over the past 100 years, the use of soil survey information has evolved from traditional agricultural management to address much broader issues of land management. Management of public lands has become increasingly complex, requiring sophisticated technologies and accurate information to serve a wide range of environmental, economic and recreational needs. Soils information and accompanying ecological site information are essential in managing lands. One of the key references to help land use determinations and healthy land assessments is quality soil survey information that can be conveniently and effectively communicated. ***Emerging areas where the demand for soil survey and related information include:***

- Increased demand for developing products to support precision agriculture
- Soil quality (land health) assessments
- Soil diversity (pedodiversity)
- Input data for an array of agricultural and ecological simulation models. Environmental modelers are and will probably continue to be one of the primary users of the NCSS database.
- Estimates of background levels of heavy metals and other immobile
- contaminants
- Soil carbon - estimates of bioavailable, not just total with supporting soil
- property data (bulk density, rock fragment content, etc.)
- Existing data gaps within the NASIS database
- Soil aggregate stability
- Particulate Matter (PM) in microns (μ) - PM_{10} and $PM_{2.5}$
- Soil climate -soil moisture status temperature
- Flooding - frequency, duration, and month
- Soil Structure

Does the current suite of soils data provided through the NCSS meet the needs of our'user groups (now and into the foreseeable future)?

In general, the types of data seem to meet the needs for most current applications; however, the quality of this data varies. Basic characterization data are good, but we can improve estimates of hydraulic properties such as saturated hydraulic conductivity, flooding, and depth and duration of seasonal water tables. On a somewhat related note, our database is not readily useable for many GIS applications, primarily due to the one-to-many relationships among the tables. This often results in either misuse (table joins that ignore the one-to-many relationship, and may result in joins to inappropriate records), or default use of the dominant component. Use of the dominant component may or may not be appropriate. We (collectively) need to come up with user-friendly ways to at least make GIS users aware of the multi-component nature of the database. Some current efforts at on-line delivery of soil survey information show some promise in that area by providing custom user interfaces to the soil survey database for specific applications. This approach would lead the user through the use of the data, rather than leave the user to figure it out themselves.

What, if any, other types of soils data needs to be provided?

We need to focus on data collection to better describe the central tendency and variance of both soil taxonomic classes and areas of the landscape (soil mapping units). More emphasis should be placed on soil mapping units since most practical queries are with regard to areas rather than taxonomic classes. As such, our soil survey database should provide quantitative descriptions of landscape and terrain attributes for map units. Other specific types of desired data include:

- Soil thresholds relating to soil health.
- More geologic interface information relating to inherit physical, chemical and behavioral characteristics - particularly in areas of shallow and moderately deep soils (arid and semi-arid rangelands and wildlands).
- Soil microbiology
- Nutrient cycling
- Hazardous materials - Soil quality/Health
- Salinization and pH changes
- Heavy metal contents
- Better estimates of hydraulic properties
- Water states (depth and duration of seasonal water tables)
- Quantification of temporal and management-induced changes in surface horizon properties.
- Soil climate - soil moisture status and soil temperature
- Soil structure
- Soil aggregate stability
- Flooding - frequency, duration, and month

Do we need soils information at more intensive spatial scales?

More intensive spatial data is needed for both agricultural and urban site-specific applications, i.e. prescription farming, septic systems, building site, etc. Current scales are only useful for broad planning purposes. Intensive scale data will only be required in certain areas and probably for specific purposes. As such, large-scale projects should be targeted for specific purposes, rather than as a broad, comprehensive survey. It is doubtful that the NCSS will be able to supply surveys with the level of detail needed for these applications. Surveys for site specific applications should probably be made by the private sector, but with some degree of collaboration and coordination with the NCSS.

III. Data Acquisition:

How can we fill perceived gaps in the soil survey database in terms. of additional types (fields) of data not currently provided and populate the existing database fields?

To fill gaps in the database, NCSS will need to enhance its efforts in data collection. For data needs that require laboratory analysis, such as native metal levels, an organized sampling and analysis plan should be developed (there may be the possibility of using archived samples). Creative spatial and statistical analysis should allow limited data sets to be extrapolated over wide areas such as the MLRA and possibly farther. For organic C/soil quality, water table, hydraulic conductivity, and temporally variable data, the NCSS has a relatively large group of intelligent, well trained, and interested field soil scientists who can collect large volumes of these data in a relatively short time span (a few years) if they are equipped and asked to collect the data. There may also be remote sensing or spatial analysis techniques that can be used to collect or extend data over large areas. Some of these tasks can and should be conducted in collaboration with other agencies, private industry, and Universities.

How can data collected through the private sector or other agencies be incorporated into the NCSS database?

The tradeoffs here are fairly evident. Given the expense associated with collecting soils data, it is certainly desirable to include as much information as possible. On the other hand, the quality of this data must be insured or the reputation of the entire database will fall into question. University and agency data can be incorporated into the database, but it will take a concerted effort to find the data, make a judgement to its reliability, and reformat it to fit into the database. Another suggestion was to establish a separate database for data collected from other sources that could be linked to the NASIS. For example, a user would find the standard information collected via the traditional partners in the NCSS, but could also link to a separate database containing other information collected via private industry (or other entities). While not part of the "official" database, ancillary data could be made available in this manner.

Do we need to distinguish among data fields that are created from remote sensing techniques; modeled or interpreted from other soils and ancillary data; and field observations?

An understanding of the source of the data and the associated advantages and limitations is a key component of any database. A data field should be associated with each database element that alerts the user to the source of the data (i.e. field observation; laboratory measurement; proximal field sensor; remote sensor; modeled value; or interpretation). However, beyond just identifying the source, as the soil experts, we need to provide some guidance to database users as to the significance of the data source and the degree of reliability they should place in any specific value or class. In certain cases, the specification of distributional statistical (mean, median, variance, etc.) or application of fuzzy set theory to acknowledge the possibility of multiple class memberships are appropriate tools to begin to quantify uncertainty. Where available, information on measurement error associated with analysis should be determined and presented to the user. Additionally, the spatial resolution associated with a given measurement should be reported as well. For example, a determination of pH may rely on a 10g sample taken from a soil horizon, whereas measurements with certain proximal and remote sensors may consider from cm^3 to m^3 of soil volumes or surfaces; and descriptions landscape, climate, or terrain attributes may be based on measurements of m^2 to km^2 of interpolated surfaces.

Who owns the soil survey data in the database (especially if it contains data collected by the private sector?

Common sense dictate s that whoever paid for the data, owns the data. The existing NCSS database is owned by the public since most of the data was collected by p*ublic institutions using pubic funds. Private sector data is "owned" by the clients. If private sector data is incorporated into the database, the individual or company will have to agree to its public distribution. An alternative is to purchase the data from the individual or company, but this may not be feasible from a bureaucratic perspective.

There has been some emphasis on developing models to estimate certain variables within NASIS. While this may be desirable from a pragmatic viewpoint of filling in all the blanks, there are some serious questions as to the validity of some of the predicted values. A very clear distinction must be made between true observational data and model predictions based on possibly unknown assumptions. We must clearly separate, for the user, what we measured from what we predicted or interpreted to maintain the integrity of soil survey databases.

With regard to spatial data (soil boundaries and symbols), the following information should be available to the user

- information on vintage of the mapping and available soil attribute data

- original base map photography
- spatial scale of the original field mapping (minimum map unit area)
- procedure used to recompile to ortho base map
- other standard metadata reporting standards required for federal agencies distributing digital geographic data

Additionally, the NCSS should be rethinking the basic presentation of spatial information to the user. For example, we all know that certain soil boundaries actually represent rather spatially-discrete transitions of soil conditions, others represent a spatial average of a gradual transition, and others are inferred with little or no field checking. In geologic mapping, different line types (bold, dotted, dashed, etc.) are used to represent the "certainty" of line placement. A similar approach could be adopted within the NCSS. Additionally, digital technologies provide opportunities to explore alternative means of depicting soil variability (continuous surfaces, probability mapping, etc.) While these approaches will require substantial changes in our current soil mapping concepts, we need to be looking beyond the next few years and begin to formulate a vision for soil resource assessment to- carry us into the next century, not just the next decade.

IV. Database Management

Who will continue to maintain the soil survey database (NRCS, private sector, other)?

Recommend NRCS continue to maintain the NCSS soil survey database (designated as data base steward). However, if at some point in the future this is not feasible, its maintenance could be handled through a cooperative agreement (by USDA?) with another agency, with a university, or with the private sector. A private company might be willing to take over the database and sell it to users without a cooperative agreement. An arrangement NRCS should continue to explore is having either private industry or Universities (in close collaboration with NRCS) develop the information delivery tools (software, etc) required to provide soil survey databases to the public in a consistent, timely, and user-friendly fashion. The use of internet delivery tools presents the opportunity of central maintenance and updating of national and regional databases which can be linked to internet map and data servers to provide current information on a daily basis; minimizing the need for periodic publications to update printed materials and CDs.

How should soil survey data (spatial and attribute) be delivered to the public?

Given the inherent efficiencies and trends within our society, electronic distribution is the most logical choice. There will be some continuing need for a limited number of paper copies for users not capable of receiving electronic deliver and for archival copies, but this demand will certainly diminish with time. Users can always print hard copy reports of the portions of interest to them and we need to be sure our information delivery tools allow for this. Distribution methods should include:

Primary Emphasis:

- Internet servers designed for the distribution, analysis, and reporting of both soil mapping and associated attribute information.
- Data server sites (such as the Data Deli) used to deliver electronic database files (such as DLG or ARCEXPORT files) to users via the internet for GIS applications.
- Distribution of data files via CD for users who are unable to receive large volumes of data via the internet, at least for the time being.

Secondary Emphasis:

- Interactive CDs, such as the Soils Explorer
- Hard copy publications

The rapid technological explosion in database management and delivery over the internet presents many appealing possibilities. With regard to interactive map serving, we can begin to develop custom user interfaces accessible via the internet for specific applications (i.e. wetland delineation, septic field assessment, agricultural management, tax assessment) rather than with the one-size fits all approach the NCSS had to use in the past. Additionally, we have the opportunity to link together a small number of "official" national or regional database sites that can be routinely updated. As such, use of internet map server technology coupled with a networking of multiple soil databases allows us to provide the user with constantly updated information. Because the internet map servers and database engines reside on central, powerful servers; processing occurs on the server rather than on the end user's computer. Therefore, the user only needs a desktop computer, a reasonable internet connection, and an internet browser to realize some of the capabilities of GIS on their desktop. The technological challenges are not inconsequential, however the technology and expertise exists. This is an area where NRCS should seek outside assistance from professionals knowledgeable in the technology to insure efficient delivery. This includes both database managers and technical and scientific communication professionals who can help with the design and user testing of the information delivery system.

How do we educate our users as to the appropriate use of soil survey databases?

One approach is to follow same way we have educated (or failed to educate) them on proper use of map data. We can put all the disclaimers in the world on the data, but if someone wants to misuse the data, it will be misused. It seems the most common misuse of soil surveys and attribute data is associated with map scale, i.e. using broadly collected data for a specific site or using data collected at a specific site for a different site. Continued education, both for the public and in the school system, is needed to help reduce this misuse. Outreach efforts by all of the partners associated with the NCSS have been and will continue to be of great importance. As emphasis on "once-over" mapping declines, we should move our resources into both promoting education and getting ourselves (and our expertise) integrated into other scientific disciplines making use of our data.

In a somewhat different approach, as mentioned under the previous question, we have the opportunity to design customized information delivery systems over the internet (and via other methods of electronic distribution) where we can do a better job of educating users as they access the database. It is difficult to provide more than a broad overview when the information delivery tool is a comprehensive soil survey document designed to meet multiple user needs. However, this may be more manageable if we design specific, online, user interfaces for specific applications. Some will always choose to ignore this information, but if we present it in a focused, understandable format in the language of our specific user groups, perhaps we can minimize this problem. Develop exhibits for the users as examples for appropriate use of soil survey data.

Recommendations:

- Recommend to the Regional Steering Committees that a charge for their conferences in the year 2000 would be to develop a plan to prioritize the population of data elements in the NCSS database and for collecting measured soil chemical and physical properties and hydraulic conductivity measurements in the field and laboratory to populate new or.pTesent data elements in the NCSS database under the stewardship of NRCS.

- Establish a charge for the NCSS conference in the year 2001 to develop a national plan, using the plans developed by the regional NCSS conferences during 2000, to prioritize the population of data elements in the NCSS database and for collecting measured soil chemical and physical properties and hydraulic conductivity measurements in the- field and laboratory to populate the NCSS database under the stewardship of NRCS.

- Encourage the Director of the Soil Survey Division to:

  + allocate additional resources to accelerate field data collection including considering additional sample site selection and further evaluation of "data gaps."

  + work with subcontractors to collect data.

  + continue efforts to incorporate data from University Experiment Station soil characterization databases into a national database.

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  + do a national evaluation and revision of the methodologies used to sample data map units. ersidefedinbla charde c

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Training & Marketing Soil Scientists for
the Future
*National Cooperative Soil Survey (NCSS)
Committee - 1999*

The Role of Soil Scientists in the Future

- Understanding and Protecting the Soil Resource
- Integrating Soil Science into Natural Resource Decision-Making
- Environmental Consulting - Environmental Consulting Teams
- Interdisciplinary Teams - Natural Resource Decision-Making

Before we consider what training should be provided to soil scientists for the future, it is useful to define what the role of soil scientists is likely to be.

Soil scientists are uniquely qualified to look at environmental concerns over an entire landscape. They can see the big picture; that's where they work. Soils are an integral part of any resource concern that deals with the land. These include questions related to agriculture, development, waste treatment, ecology, recreation, and environmental planning and regulation. Soil scientists and environmental managers need to promote the integration of soil science into addressing the issues related to how we as a community, as a state, and as a nation use the land.

There is a growing need for soil scientists in the environmental consulting arena. Soil scientists bring unique knowledge to an industry historically dominated by engineers, geologists, and biologists. Our trained professionals know more about soils than any of these other disciplines, and soil and water are typically the natural resources of concern in this arena. There is an increasing dependence of communities and businesses on good quality soil inventories and, perhaps more importantly, soils interpretations. The soil survey database, generated through the National Cooperative Soil Survey (NCSS), is the most comprehensive, uniformly high quality, ecological database in the world. This was achieved by unprecedented quality control (that is, strict rules of soil correlation, controlled legends for soil mapping, rules for map unit construction and content, and standard methods of soil characterization, as now required by Soil Taxonomy). The most critical role for soil scientists in the future is to maintain, improve and update this invaluable database.

Soil scientists will continue to be parts of interdisciplinary teams dealing with environmental and agronomic endeavors. Soil scientists will provide a valuable interface between using the land for agriculture, recreation, and urban use while protecting our environment from degradation because of misuse of the land. The increasing need to use the limited soil resources of the United States, and the world, will provide abundant and very important work for soil scientists.

The role of soil scientists in private enterprise is basically two-fold. 1) as environmental consulting professionals and 2) as agronomic consultants. Agronomically, the recent emphasis on precision agriculture requires that we train highly technical professionals who have knowledge not only of in soil science, but geospatial applications as well. Universities a'-re working more of this their curriculums.

The Committee on *Training and Marketing Soil Scientists for the Future* was charged with addressing several questions. A consolidation of the various answers from committee members follows. Some of these overlap to some degree and are discussed in more than one section. We hope this paper win promote thought, discussion, and action for the future of soil science. A summary of recommendations is at the end of the paper.

Training Future Soil Scientists

Who? - Land grant colleges

How? - Class and field work

- Field internships (Natural Resources Conservation Service -NRCS, Department of Natural Resources - DNR, Consultants, and others)
- On the job training
- Continuing Education
- Technology, Geographic Information Systems, Interdisciplinary Focus, Customer Focus

The primary trainers at the start of a soil scientist's career are still the Land Grant Universities. ne basic qualifications for soil scientists are obtained in the universities systems across the United States. Colleges and Departments of Soils, Agronomy, or Environmental Science will train soil scientists in soil physics, soil chemistry, soil microbiology, soil fertility and plant nutrition, and pedology, as well as soil mechanics and hydrology. Soil scientists will continue to be trained in a classroom setting by masters and doctors level professors who have degrees in soils and related fields. Formal training must continue to cover soil mechanics, taxonomy, morphology, chemistry, hydrology and other related sciences. It is important for soil scientists to develop a strong background in basic sciences (physics, chemistry, biology, statistics and applications to ecology, geology, botany, and meteorology) as well as soil science. In addition, we need to make sure our students acquire and learn how to use the best tools available in their training. These tools include Geographic Information Systems (GIS), Geographic Positioning Systems (GPS), and other emerging tools and technologies.

In addition, it will become increasingly critical that soil scientists continue to upgrade their skills throughout their careers. This can be done using computer networks and remote learning systems as well as in the more traditional learning environment.

Unfortunately field training is very lacking in many of these programs; it would be beneficial if more internships were available for training of junior and senior students. From a field training aspect, class versus field training time should be no less than a 75% to 25% respectively. Particular emphasis should be given to soil descriptions and interpretations, and landform and landscape effects on soil development and hydrologic processes. Training should involve practical experience by spending time with a professional soil scientist employed in a soils related field. An internship with an agency or company that employs professional soil scientists can satisfy this. A method to augment field training could be computer simulation with landscapes, vegetation, geology, and other databases necessary to compile a detailed soils map and provide interpretations for soils applications. Providing special topic courses (directed studies) to obtain soil mapping experience for who wish to work in tins arena is one strategy to provide field training. This is not always possible, however. It would be of benefit if a program between the land grant colleges and the Natural Resources Conservation Service (NRCS) Soil Survey Division could be worked out to provide unpaid summer internships, (for credit through the University) for the purpose of providing training for soil classifiers and mappers.

Field training could be provided with cooperative agreements such as NRCS, State Departments of Natural Resources (DNR) and State Departments of Agriculture (DA) since these agencies employ people that specialize in fieldwork and soil interpretations. NRCS has provided several pre-graduation programs to provide a smooth transition of qualified students into the field of soil science. This student trainee program has proven to be very successful.

Soil scientists of the future will need a more diverse course of study and training than is currently being provided. They need a strong background in environmental sciences. They need to be able to integrate the soils information that they develop into the larger environmental picture. They need to increasingly interact with other natural resource disciplines as part of a team. They need the opportunity to go out on job sites and actually work with people earning a living dealing with soils. They need first-hand knowledge of the problems involved with using equipment on varying soil conditions. They need the opportunity to work on a farm and learn the problems involved with using equipment that works the soil. They need to take the time needed to acquire first-hand knowledge of a wide variety of such enterprises. This is the only way to learn the language and the needs of the wide variety of users that may request assistance.

After graduation, and consequent employment, there are several soil science courses and training opportunities that are offered by employers and professional organizations. Training is provided by the NRCS, other agencies, and universities. Also, after the initial classroom training is complete, soil scientists must continue to obtain education, training and practical experience on an on going basis. This can include specialized courses put on by the NRCS or by universities. NRCS has a series of courses for continued technical training, although budget problems have limited their availability. These include *Basic Soil Survey, Soil Correlation, Soil Science Institute, Soil Science Applications* and others. In Missouri, a specialized course is offered annually through the university to provide continuing education opportunities for DNR and NRCS soil scientists. (Last year it was *Forest Soils)*. The best training is obtained from years of experience on the job doing the work of soil science and learning from senior soil scientists and project leaders. Most, but not all, of these people are generally excellent trainers. Those who excel in training should be identified and then encouraged and rewarded for helping new soil scientists learn their craft.

Unfortunately, decreasing budgets have reduced federal soil science positions. Adding to this difficulty, many state programs are dependent on federal assistance or cooperation. Soil scientists who are close to retirement occupy many current positions. If replacements are not hued and trained within 5 to 10 years, few will be left to train new employees.

Most certifications in this field *(e.g. ARCPAC, National Consulting Soil Scientists, and State Licensing Boards* **-** Several states have licensing programs for soil classifiers or soil scientists) require that experience be gained under a certified professional in order to obtain full certification. In Georgia, this is being accomplished in the Soil Classifier circles by consulting soil scientists hiring recent graduates and putting them in a "member in training" capacity. This works to a certain extent, but it is not always possible to provide jobs for all recent graduates who want to enter this field. Thus, the acquisition of suitable experience for recent graduates can be a problem.

Opportunities for Soil Scientists

The Future has never been brighter

- **Soil inventories and surveys**
- **Soil interpretations -**
- **Site specific projects**
- **Public and Private**
- **Certiflication**

The future of soil scientists has never been brighter. Awareness of the fragile nature of the environment and the interactions of man with the environment will open many doors for professional work in soil science. The NRCS and other cooperators are working to make soil survey information available on CD-ROMs, the Internet, and other innovative media. The availability of this information in readily accessible formats should greatly increase the demand for soil interpretations and, therefore, trained soil scientists. There will be a learning curve associated with informing users of the availability and value of this information.

Soil scientists will continue to be vital for compiling detailed soil surveys and interpretation of soils information and in updating and improving existing databases. Soil remains the primary source for food and fiber in the world. As population grows, life spans increase and standards of living improve, the demand for soil scientists' expertise will play an important role in locating soils that can most efficiently provide food and fiber, in providing basic information for land use planning, and in helping to maintain the resource for future generations. The diminishing land available for agricultural production requires greater knowledge of the soil resource and greater efforts in applying science to soil conservation efforts. None of these activities can be carried out at the scale required in the future without vital information supplied by soil scientists - as a result, there will be unlimited opportunities for soil scientists.

The continued inventory of the soil resource and the monitoring of soil production potential and soil quality will assure a firm base of employment for soil scientists in the future. These opportunities will not only be in the public sector, such as NRCS, EPA, US Forest Service, and state agencies; but also in the private sector in environmental consulting firms and related businesses. This work could include development of use-specific maps and information for land-use potential; site specific information for on-site waste disposal systems; planning and zoning issues; and for watershed-based planning.

States that have licensing of soils professionals will have additional opportunities for soil scientists. In states without licensing, others will do some of the soil science work. Soil scientists will have to have a diverse background so they can work on many environmental problems, not just soils.

Some current soil science opportunities:

a. Carbon sequestration studies.
b. Computer based precision farming.
c. Soil science-based regulations and alternative solutions, such as septic system siting requirements.
d. Conservation of natural resources from increased public awareness of conservation issues.
e. Recognition of the profession of soil science as demonstrated by states passing licensure requirements for persons practicing the art of soil science.

The opportunities for soil scientists in private industry are expanding Much 6ibis need arises fiom site assessment for on-site sewage disposal. Many regions in the United States are experiencmg rapid urbanization which has increased the demand for soil science professionals. In spite of increased needs for good soil science, it is apparent that opportunities for soil scientists are decreasing in the National Cooperation Soil Survey under the NRCS due to shrinking budgets. Private enterprise can compensate, to some degree, for this shrinkage and provide other opportunities. Some soil scientists now obtain most of their soil mapping experience working for private consultants.

Workforce Planning Needs for Basic Soil Science and Soil Survey

- **Maintain a viable workforce - replace retirees and other vacancies**
- **Update professionals with geospatial and database technology**
- **Workload analysis and funding support**

A plan is needed to maintain a viable soil scientist work force. A large number of soil scientists will be retiring in the next three to ten years. There is a general sense that the number of students currently enrolled in soil science curricula is not sufficient to meet the future needs of public agencies and private companies. A plan is needed to ensure a reliable source of replacements will be available and hired before the majority of experienced soil scientist have retired. In addition, the long-term value of soil scientists needs to be considered when addressing current budget constraints.

Work force planning should continue to emphasize, first, the solid preparation in basic sciences, formulating and testing of scientific hypotheses, and the fundamentals of soil science. In addition, planning should include opportunities to update capabilities in geospatial technology (including GIS, GPS, and computer training for data acquisition and manipulation), through revised university curricula and through continuing education avenues. We should strive to be invaluable within our organizations and to outside customers. The ability to locate ourselves more accurately (GPS) and merge our information into seamless data layers (GIS) to make integrated decisions is important If we do not keep up with new technology, we will not be effective in developing and providing needed soils information. Most all of the natural resources and engineering disciplines are incorporating more of this technology.

It is important to identify soil science needs and set up a priority system to best utilize existing personnel. An analysis of the workload should tell us how many soil scientists are needed for the assigned tasks. A reliable funding source should be directly associated with soil science needs.

Promoting Soil Science as a Profession

- **Do good work, document it, deliver it & tell people about it**
- **Emphasize - Good soils data saves money and protects the environment**
- **Involvement in multidisciplinary projects**
- **Registration and certification**
- **Mentoring, internships, and recruiting**
- **Public information (brochures, events, community involvement)**

The best way to promote soil science is to do good soil science work. Collect good science-based data that people need, make the data available in a user-friendly format, get it to people who can use it, provide service to them in explaining what the information means and how to use it, and let everyone who has a use for soils information know about the data and the related services. Good data provide for a more efficient and protective use of the land. We need to stress that it saves money, protects the environment and provides for a higher standard of living.

Get soil scientists involved in as many different projects and disciplines as possible. Sell the science by promoting the wide range of applications of soil information. Many states have gone through state licensing and certification for soil classifiers, which has revolved mainly on the on-site sewage disposal work. Engineering firms that hire soil scientists are almost always extremely pleased with their capabilities and the unique knowledge they bring. Our soil science graduates are the best ambassadors we have. We need to make sure our certification program remain strong, we need to strive to get licensing programs in every state and we need to be more visible.

There are several specific ways to promote soil science:

a. Maintain a positive and active working relationship with Land Grant Universities. This will insure that, within the university systems, they know what career opportunities exist in the private and public sector for trained soil scientists.
b. NRCS has selected individuals who set aside a significant percentage of their work time to work closely with 1890 Universities. This program is to insure that opportunities for minorities are advertised and made available for those who are interested and are qualified. This effort could be expanded to include a concerted recruiting effort to reach all universities' students.
c. Participation by soil scientists in local outdoor classroom activities, continued education program for teachers, visitations and presentations to primary and secondary students as part of cooperative extension courses and activities, and participation in land judging contests.
d. Pamphlets and other printed advertising for career choice awareness. Printing and distribution of information on soil science as a career option can be very effective. We need brochures from federal and state agencies that use soil scientists and have these promoted in colleges; we need lots of mentoring opportunities and internships.
e. Certification and licensing. Currently there is a national certification (ARCPACS) which is filling a valuable role. We need to get this certification as recognizable as a (Professional Engineer (PE) or Professional Geologist (PG)) certification. The institution of an exam and the stringent CEU program render ARCPACS a prominent certification. We need to make ARCPAC certification more visible to the public.
f. Professional cross-certification, registration or both, for example - a certified soil scientist is capable of doing soil analyses for engineers without a professional engineer's stamp.
g. Encourage membership in professional organizations, such as Soil Science Society of America and the American Society of Agronomy. To keep soil scientists current, employers should be encouraged to pay for registration, per diem, and travel costs to attend regional, state, and national meetings.
h. Develop a public relations program to educate the public, state legislators, and Congress of the value of the soil science profession.

Recruiting and Retaining Soil Scientists

- **Money!**
- **Encourage students to enter the field**
- **Provide adequate** pay and advancement opportunities

Money!! The profession must support stable, competitively salaried positions. A position must be available for which to recruit. Employees are retained by providing them with competitive salaries and benefits. The economy of America is based on supply and demand. Without a demand, the supply has little value. A marketing program to inform the public of the value of soil science will create a demand for the profession. Once a demand is established, the financial incentives will be available to support job positions.

Soil scientists can be recruited at career days at universities, special events, such as soil contests, offering student trainee positions and providing scholarships for soil majors. The soil science profession can be promoted by targeting students as soon as they enter high school. Many students are not aware of tins field as a career opportunity but by teaming up with local FFA and 4-H organizations, we can market the field of soil science. Public affairs officers could be utilized by having them contact schools and assist us to network with agriculture teachers to promote the field of soil science as a career choice. Students also need to be aware of scholarship opportunities. In areas that sponsor soil-judging contests, we should capitalize by marketing sod science at these activities. We should also increase the opportunity for summer jobs for high school students offering practical experience in the field so they can have some first-hand knowledge. This might be especially effective in rural communities or farming communities with limited opportunities for summer youth employment.

The retention of soil scientists is important since the cost of training is very high. NRCS has found that retention of their soil scientists is dependent, in large part on their positive perception of career advancement opportunities. In NRCS today, the opportunities for advancement, and very competitive pay, has never been better. This has kept turnover of soil scientists within our agency very low. Business, career, and promotion opportunities must be emphasized to foster the need for the worth of the Soil Scientist and the information that they can provide. Also with our MLRA updates, being able to stay in one central field office and complete several updates from that office is very encouraging and keeps field soil scientists from relocating every three to four years.

Other agencies have difficulty retaining soil scientists due to a lack of advancement opportunities and the inability to compensate them commensurate with their training and expertise. The career ladder should be reviewed to be more competitive with the private sector. To retain and recruit high-quality professionals, there should be salary differentials for people who have attained higher levels of expertise such as advanced degrees, or selected certifications.

SUMMARY-

Training and Marketing Soil Scientists for the Future

Soils information is becoming increasingly important in how we use the land. Soil scientists are an integral part of dealing with a wide variety of environmental concerns. As MLRA updates proceed, new information will be added to the database. The need to maintain high quality will only become more acute as increasing population, urbanization and improving standards of living put more and more pressure on the environment Soil scientists will certainly be called upon to predict soil-related environmental responses to that pressure.

They need to meet the future with optimism and hard work. Training of soil scientists will need to meet the future needs –

- to provide good science,
- to integrate soil science into a variety of environmental concerns,
- to provide service to users of soil science information, and
- to continue to learn and apply better tools to land resource questions.

Recruiting and retaining soil scientists requires competitive salaries and career opportunities for people who chose to be soil scientists. There is a concern about the number of people who will be leaving the profession and if there will be enough people left who have sufficient knowledge and experience to be effective in carrying out these responsibilities.

Marketing of soil scientists will depend on providing good science and service to the users of soils information, and then by making sure that the people who need the information or who can benefit from it are aware of it. The needs that people and various agencies have for soil science represent tremendous opportunities for soil scientists. Some people may not be aware of the benefits that they can realize from this information. The individual soil scientist must develop an entrepreneurial attitude about his or her profession; find needs and opportunities and meet those needs with good science and good service.

RECOMMENDATIONS SUMMARY - *Training and Marketing Soil Scientists for the Future*

1. Emphasize science - university programs should be based on physics, chemistry, biology, ecology and the application of soil science through the development and testing of hypotheses.
2. Hire more entry-level soil scientists in NRCS and cooperating agencies.
3. Promote field experience through lab and field classes and through internships.
4. Provide for on-going education, training, and professional meeting opportunities for soil scientists.
5. Maintain a high level of quality control.
6. Maintain and update the existing soil science databases as well as developing new surveys.
7. Provide competitive wages and promotional opportunities for soil scientists.
8. Provide a reliable funding source for soil science needs.
9. Integrate soil science into other environmental disciplines and work on interdisciplinary teams.
10. Establish rigorous certification and licensing programs for soil scientists.

NCSS COMINUTTEE REPORT ON SELLING SOILS TO SOCIETY

By: Barry L Dutton, CPSS, RPSS
President, National Society of Consulting Soil Scientists

The committee on Selling Soils To Society was not formerly organized before the St. Louis meeting but will be organized in preparation for the next regional and national meetings. The committee chair assembled ideas for committee activities and facilitated breakout sessions at the St. Louis conference. Breakout session participants were exposed to these ideas for review and comment and were asked to provide additional input. This report is a summary of the ideas for selling soils to society that were identified and discussed in these sessions.

1. The Centennial Celebration Communication Plan provides an excellent foundation for this effort. The plan identified three target groups - Educators, Land Users and Decision-makers and developed messages for each.
2. We need a clearinghouse of information about selling soils to society - a listing of what works, what doesn't and who to contact about specific projects/activities. Gary Muckel suggested that the National Soil Survey Center may be able to host this. This site would list education materials and programs, provide canned lectures and talking points and other information on soil
3. There is a need to market the soil survey to NRCS personnel and managers so they understand its utility and importance
4. Certification, Registration and Licensing are essential to raising the visibility and credibility of soil scientists in society. When it was suggested that perhaps the state soil scientist in each state should be licensed or registered or certified, field soil scientists commented strongly that they too want to participate.
5. Soil survey products need to be customized to individual user groups with custom map unit and soil description that highlight specific uses - development, animal waste, etc.
6. Soil Scientist/Soil Ambassador support materials should be developed to make it easy for people to give soil presentations. This could include canned speeches with scripts and graphics or simple talking points targeted to students, legislators, realtors and other groups.
7. We need more diversity in the profession of soil scientists including minorities and women.
8. Soil Scientists need to network more with other professionals especially engineers, hydrologists, crop consultants, foresters and others to have soil science recognized as a distinct science.
9. We need to turn all soil scientists into soil ambassadors by getting them involved in activities such as:
    - Lobbying for soil issues (private soil scientists or others in retirement)
    - Contacting city councilpersons, state legislators, congressmen to be sure they know about soil scientists, soil survey and soil
    - Making sure schools include soils
    - Talking soils to scouts, camps, classes
    - Participation in conservation districts, planning boards, elected positions

This committee will identify members and use these initial ideas to assemble a recommendation for Selling Soils to Society before the regional conferences in 2000. I think this committee and this issue is an essential part of the NCSS program. I believe it should be considered as a permanent committee.

1999 Task Force on Soil Survey Products of the Future

Report to the National Cooperative Soil Survey Steering Committee
Submitted by Adrian L. Smith, Task Force Leader
July 2, 1999, St. Louis, Missouri

Introduction:

The question of how to incorporate Geographic Information Systems (GIS) and the National Soils Information System (NASIS) into the development of soil survey products has been asked by the National Cooperative Soil Survey (NCSS) for several years. The Natural Resources Conservation Service (NRCS) presently has about 600 digital Soil Survey Geographic (SSURGO) data sets available at the *National SSURGO Data Access* node, with 300 more expected to be ready by the end of the year. This will account for over 1/4 of all published soil surveys, and translate roughly into 50 gigabytes of digital data! The challenge for NCSS will be to provide leadership in the transfer of this data to the public in useable formats and products.

The NCSS Task Force on Soil Survey Products of the Future was commissioned to address this question in part by developing templates for new interpretation guides that customers can use in evaluating environmental issues. Furthermore, these guidelines are to be constructed in association with a spatial component where appropriate. To accomplish this, the Task Force set out to solicit input from user groups, develop a few specialized interpretations, and look at the developmental possibilities for additional customized applications. The guidelines are to be presented at the 1999 NCSS Conference in St. Louis, Missouri, along with recommendations for future development.

Overview:

NRCS has long been the source for soil maps and interpretations. The historical majority of interpretation assistance has been delivered by NRCS personnel at the field and state office level. With the development of digital soil survey data, where spatial and tabular data are readily available over the Internet, a growing percentage of the public is making their own interpretations using GIS technology and not consulting with NRCS. This has both positive and negative consequences. The positive result is that the demand on NRCS time decreases while the public acceptance and use of soil survey data increases. A possible negative result may be the improper use of soil data base information.

One way to counter the possible misuse of soil survey data is to pre-determine additional soil interpretive needs by working with a broad range of local, national, and international user groups. These interpretive needs are not for the standard data base items such as flooding frequency and clay content of the surface layer, but for more in-depth interpretations such as determining plant suitability indexes, biofiltration ratings, slope stability indexes, and numerous others. By providing the capability for users to make these interpretations, NRCS will still be able to influence the proper scientific and technological use of soils data. This report should raise the consciousness of the agency as to both the need for such work and the willingness of dedicated staff to accomplish it.

Process:

1. Task force initiated
   - A leader was selected and group formed. The roster includes members with expertise in soil science, environmental issues, soil data bases, and/or GIS.
   - Task force met via teleconference in February, March, and April.

2. Guideline themes selected
   - Ideas for new interpretation guidelines were gathered from task force members and associates during February.
   - The team discussed the ideas during the March 11 teleconference, and agreed to work on three; a Site Stacking Suitability rating (ag waste management concerns), development of a baseline calculation for estimated soil organic carbon contents (carbon sequestration research), and phosphate loading (water quality issues). The information necessary for developing guidelines for phosphate loading did not become available from another group working on this problem. An interpretation for urban biofiltration was selected in its place.

3. Data Acquisition
   - Two geographic locations were selected by the team to serve as a spatial workbench for the task force. One location covered adjoining survey areas in Utah: Boxelder County, Western Part, and Tooele Area. The other covered survey areas meeting at a state line: Linn and Miami Counties, Kansas, Bates County, Missouri, and Cass County, Missouri.
   - NRCS staff in Utah and Kansas mapjoined their respective areas, and sent them to the National Soil Survey Center (NSSC) in Lincoln, Nebraska.
   - Saunders County, Nebraska was selected as the prototype soil survey area for the Site Stacking Suitability interpretation. The spatial data was already resident at NSSC along with other reference layers such as Digital Orthophotos (DOO) and field boundaries.

4. Development of guidelines
   - Criteria for the Site Stacking Suitability guidelines were developed based on a model used in Maine. A prototype interpretation was developed in NASIS for Vermont, and then ported to a desktop GIS where a spatial component was added.
   - Calculation for soil organic carbon content used similar criteria to that used for estimating carbon with STATSGO data (Bliss et al, 1995). The query was written to use data presently available in NASIS.
   - Guidelines for Urban Biofiltration Suitability were developed by NRCS staff in Idaho.

5. Review of templates
   - Documentation and criteria ' for Site Stacking Suitability were sent to NSSC from the sub-group in Vermont led by Steve Gourley. The criteria and prototype maps were sent out to all team members for their review and comment. The team met by teleconference to discuss. Staff in Vermont tested the VT Manure Stacking Rule and field-checked the ratings in Addison, Franklin, and Lamoille Counties, Vermont. Results of field work were reviewed by Pauline Pare, State Resource Conservationist, Vermont.
   - Documentation and prototype maps for the soil organic carbon calculation in NASIS were sent out to all team members for their review and comment. A sub-group of the team led by Adrian Smith reviewed several different graphical presentations of the results.
   - A sub-group of the team led by Dave Hoover reviewed the guidelines for Urban Biofiftration Suitability. The Plant Materials Center worked with the NRCS Resource Soil Scientist to develop the criteria for rating the soils in the county as to their suitability for these structures.

6. Results
   - The Vermont group thought the rule developed in NASIS for the prototype worked well, but needed a few small adjustments in the criteria. Staff at NSSC worked with Steve to make revisions as requested.
   - The SOC work served as a prototype for regional and state NASIS users interested in calculating values for chemical and physical soil properties. Maps generated from the SOC estimates brought attention to areas where soils data do not agree across political boundaries.
   - The Idaho group thought the criteria should work well, and have plans to field test at a few locations during June 1999.

7. Prototype GIS Application
   - Fred Minzenmayer developed a prototype application in Avenue's object oriented programming language for ArcView Desktop GIS. It demonstrates how soil attributes and map data can be linked to visually present interpretations in a user-friendly application. The prototype uses State Soil Survey Geographic (STATSGO) data, but could be revised to process SSURGO data as well. Several task force members tested the application and found it to be easy and fun to use. The map generated by the program would be suitable for use either by NRCS staff or the public. The application can be modified or customized for other types of soils data analysis.

Summary:

The task force completed templates for new interpretation guidelines and reporting soil properties. It looked beyond traditional ways of preparing guidelines, and took into account the kind of information customers ask for today. These guidelines used GIS technology during development, and port easily into a spatial environment. Using GIS tools allows soil scientists to have alternative presentations of the data, and to correct errors in criteria or base data before spending time in the field. Data mismatches will continue to be resolved as areas are mapped using the MLRA concept, and the soils data base is strengthened through geographic examination with more accurate information.

Development of a NASIS property script for calculating soil organic carbon served an important role In getting this kind of capability into the hands of regional and state NASIS users. The scripts allowed them to create estimates and provided higher resolution assessments of the organic carbon from their data bases.

The task force members discussed how serving up maps, algorithms, GIS applications and soils data via the Internet would be a logical next step for providing soils information to the public. The members certainly supp9rt any effort NCSS makes in this direction. Most of all, the combined Task Force and sub-group members hope that the work and ideas represented in this report will serve as a reservoir for the Steering Committee to draw from as they consider and plan for the future.

Task Force Recommendations:

1. When developing interpretations, interpretation values should be linked to spatial data when available and mapped as part of the field checking process. This would provide soil scientists with immediate feedback on performance of the criteria and data base, as well as identify problem areas.

2. Increase the download capability of NASIS to include formats commonly used in other agencies and the public. This will facilitate development of interpretations with criteria from other sources.

3. Develop thematic mapping capability for NASIS, or an interface that will permit mapping of query results with other applications.

4. Encourage development of data bases and products that are not influenced by political boundaries. Users should be able to select a geographic extent of their choosing, and have seamless attribute information available to them. Areas of non-matching attribute data are evident in several maps developed for this task force.

5. Develop national map legend keys for maps presenting soil properties such as soil organic carbon content estimates. Adoption of standard sets of legends and map scales will allow easier comparison of maps viewed on the Internet and in print.

6. Develop an interface for users to access soil survey data (tabular and spatial) over the Internet, select a user-defined geographic extent, and download information in a tabular or spatial format.

7. Develop GIS applications or scripts for a suite of interpretations that can be downloaded from the Internet.

8. Encourage development of innovative products such as the GIS application presented in this report that are user-friendly and yet handle the complexity of the soils data base.

Task Force Member Roster:
Bill Broderson, State Soil Scientist, NRCS, Salt Lake City, UT
Edward Ealy, State Soil Scientist, NRCS, Athens, GA
Steve Gourley, Soil Scientist Liaison, NRCS, Winooski, VT
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Chris Kendrick, Soil Data Bass Manager, NRCS, Columbia, MO
Elissa Levine, Soil Scientist, NASA, Greenbelt, MD
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Contributors to Task Force:
Russ Kelsea, Soil Scientist, NRCS, Lincoln, NE
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Martha Stuart, Soil Scientist, NRCS, White River Junction, VT
Mike Walker, SSURGO Specialist, NRCS, St.. Paul, MN
Sharon Waltman, Soil Scientist, NRCS, Lincoln, NE

Site Stacking Suitability

I. Report submitted by Steve Gourley

A. Introduction

The purpose of this prototype was to identify those map units that may have potential for site stacking prior to a field investigation. For a GIS application, Vermont wanted to know H the majority of the map unit met the criteria. For those map units with two major components, the determination could be based on the component that makes up the highest percentage of the map unit. For those map units with three major components, the determination could be based on the component that makes up the highest percentage of the map unit by evaluating all three components and determining what the dominant situation is.

B. Criteria

The following are design criteria for animal waste stacking (pads) facilities:

1. To the fullest extent possible, all clean or unpolluted water shall be excluded from the facility and loading area.
2. The field stacking facility site shall not exceed any of the property limits shown in Table 3. Stacking she shall be located at the top of slope or provisions made to divert site runoff away.
3. If any of the site limits in Table 3 are exceeded, an alternate site shall be found that meet the site limits or the site shall be modified to meet the site limits.
4. Planning for the location of the facility shall consider distances from resource concerns to minimize surface and subsurface water pollution and odor problems (minimum distances are shown in Table 4). Greater distances may be required by local, state, and Federal regulations. Deviation from these distance guidelines requires documented planning rational that location facilities closer to the resource concerns will not cause surface and subsurface water pollution or odor problems.

Table 3 - Property Limits for Siting Stacking Facilities

Property	**Limits**	**Units**
Maximum Slope	8.0	Percent
Maximum Permeability (Least Permeable Horizon Over 12 Inches Thick)	2.0	Inches/Hour
Minimum Depth to Bedrock	30.0	Inches
Minimum Depth to High Water Table	1.5	Feet
Minimum Flooding Event	1.0	per 25 years
Maximum Fraction 3 Inch Rock (Percent by Weight)	35.0	Percent

Table 4 - Minimum Distance from Potential Stacking Facility to Resource Concerns

Concern	**Minimum Downslope Distance From WSF(a)**	**Minimum Upslope Distance From WSF**
Residence or Well (Neighbor)	500 feet	500 feet
Adjoining Property Line	200 feet	100 feet
On Farm Well/Spring	300 feet	100 feet
Lake/Pond/RiverMater Body	300 feet	100 feet
Diversion (b)	100 feet	25 feet
Gully/Swale/Ravine(b)	100 feet	25 feet
(a) WSF - Waste Storage Facility (b) Sensitivity of waterway or diversion outlet shall be considered.		

C. Testing

Martha Stuart and I tested the VT Manure Stacking Rule developed at NSSC for NASIS. We tested Addison, Franklin, and Lamoille Counties in Vermont, and thought the results were fairly good, but had a few questions about the algorithm. It seemed to be testing against five criteria that was a combination of both the Maine and Vermont criteria originally submitted. Flooding, which is an important consideration for Vermont but not for Maine, was missing from the NASIS Rule. The oversight in the Rule was corrected by NSSC staff. We also decided that miscellaneous land components, such as pits, udifluvents, and udorthents should be excluded because of the nature of the map units, or at least call the unsuitable. In our map unit descriptions we are always saying that onsite investigations are needed for these map units.

D. Results

We noticed some components have a range of values. For instance, a Melrose map unit, MrA from Addison County. is rated suitable to unsuitable. We would like to see a report by county that gives a rating for each map unit and restrictive criteria why. For example:

AbA	Alpha sift loam, 0 to 3 percent slopes	suitable	
AbE	Alpha sift loam, 3 to 8 percent slopes	marginally suitable	slope
AbE	Alpha sift loam, 25 to 50 percent slopes	unsuitable	slope

I looked at all of the map units in Vermont and we actually have only 2 map units out of 1621 which meet all of the criteria perfectly. They are well drained, very deep to bedrock, have moderate permeability through out, and are on A slope. This application is only a first step in identifying areas for possible site-stacking. In reality any component with a score of less then 1 could be a possible site.

We also requested clarification of how "fuzzy logic" was applied, and confirmation about how the RV were actually calculated. We assumed that the actual number score for each component was the worst score on any one of the five criteria. Since the calculated RV are rounded up, a component with a score of 1 failed at least one of the criteria. If this was correct, then the Rule was performing to our satisfaction.

E. Technical Information

A reply came from Russ Kelsea, NASIS Data Base Manager, who said that our understanding of the fuzzy interp process was correct. The Rule evaluates each criterion and returns a "measure of truthfulness for the limitation" which ranges from 0.0 to 1.0. If a criterion is completely limiting then it returns 1.0; if the criterion is not at all limiting it returns 0.0; if it is partly limiting it returns an intermediate value between 0.0 and 1.0. Then the Rule considers the criteria collectively. Typically, we say a soil has limitations if criterionl is limiting OR criterion2 is limiting OR (and so on ....). In fuzzy math the OR function is equivalent to saying the MAXIMUM of the criterion values. So, if critedonl is 0.78 and criterion2 is 0.43, the maximum is 0.78 for the complete interpretation. We can then defuzzify the 0.78 into some statement like "marginally suitablile."

We now have the capability to interpret either the RV or the full range in values for a component. If we interpret the full range in values, then it is possible - even likely -- that we will create a range in interpretive results. If we interpret RV, there is still a chance we can create a range in interpretive results. Here's an example why. Suppose part of our interpretation depends on the RV depth to water table. Since we can record a different soil moisture profile for each month of the year, we can have a up to 12 different RV depths to the first wet layer. Thus, we can have a range in RV depths to water table. This range in depth to water table may produce a range in interpretive results.

While our data has always had the potential to create a range in interpretive results, we simply never reported the results that way. In the past we have always chosen the most restrictive interpretive result, based on the most limiting end of a range In values. Now, by using RV, we can report the most commonly expected interpretive result. A range in results, either from RV or the full range in values, gives us an Indication of the variability expected for that soil.

F. Summary

This needs to be presented as an initial screening tool and not the final answer. Follow-up field investigations should always be done because of the nature of map units and the application. It is clear that this application is going to meet our needs.

II. Spatial analysis of criteria

The NASIS rule written for the prototype was run for the demo soil survey area Saunders County, Nebraska. The results were downloaded into an ascil file, and then uploaded into ArcView, where they were joined to the SSURGO data for Saunders County. One of Vermont's resource concerns is minimum upslope distance from Waste Site Facilities (WSF) to water bodies. Using GIS, a buffer was constructed for the digital data using the interpretation guidelines, and areas within the zone then rated accordingly.

In Figure 1, the NASIS export file has been Imported into a desktop GIS and joined to the soils data base. The legend was constructed to show the calculated RV for each map unit as an index for site suitability from 0.00 (very good) to 1.00 (very poor).

In Figure 2, a 100' buffer has been created around water. The output grid from the map query returns True/False results. Either the center of the grid cell is within 100' of the water or it is not. For this exercise, the grid cell size was selected to be 10' by 10'.

Figure 3 shows the reclassified suitability site stacking index. The soils layer has been converted from vector to raster data, as required by the GIS application for this kind of spatial analysis. The grid cell size matches that of the buffer zone grid. The RV carried with the soils grid can now be edited according to where they are spatially located. The reclassified map shows the buffered area with an RV of 1.00. Because this value is now a part of the spatial data set, it can be used for other queries such as calculation of acres not suitable for site stacking within a watershed.

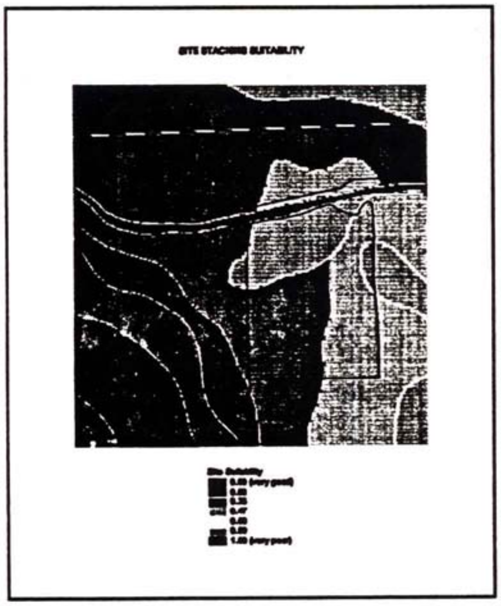


Figure 1

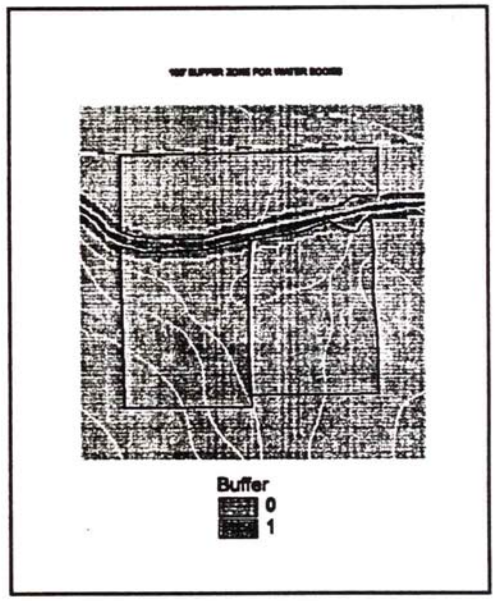


Figure 2

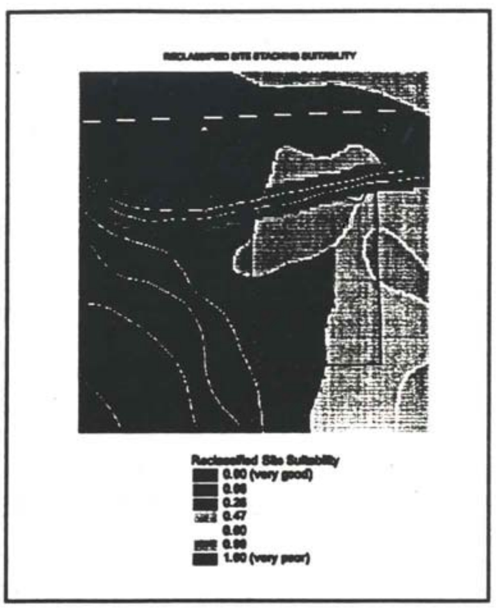


Figure 3

Soil Organic Carbon Content Estimates

I. Report submitted by Sharon Waltman

A. Introduction

The soil is most likely the best long-term natural containment facility we have for storage of carbon in the terrestrial system (Follett et al, 1999). NRCS is custodian of the national soils data bases, and has been asked to provide information about chemical and physical properties of the soil to researchers, land owners, and land managers. The maps created from this information will help identify those soil landscapes that possess potential to sequester more soil organic carbon (SOC). Presently, the only National geographic data base available for these kinds of calculations is STATSGO. For this template, nation-wide SSURGO digital data is anticipated, and a prototype query written to calculate SOC using NASIS.

In response to the request to develop soil organic carbon sequestration interpretations (E. Levine, NASA) for this team, the calculation for soil organic carbon content (SOC) in gm^2 for 100 cm depth estimates from STATSGO was offered as a starting point (Bliss et al., 1995). Soil organic carbon sequestration is expressed as a rate in units such as kg m^{-2} yr^{-1} or kg ha^{-1} yr^{-1}, and are often generated from simulation models for various land use history scenarios. The estimated properties data of NRCS (NASIS and STATSGO) do not contain these rate estimates. However, the estimate of SOC content provided by these sources can be used to compare soils from very different regions of the U.S. and their potentials to sequester carbon.

B. Development

The quality of these SOC estimates is dependent on data content quality of the data base sources with regard to bulk density, organic matter, and rock fragment contents. When the SOC content expressed as gm^{-2} is multiplied by the area of the soil map unit polygon, the total mass of SOC can be determined for each polygon. The mass for each polygon can be summed for the study area, providing baseline values for SOC in Tg (1 x10^{12} g) or MMT (million metric ton) for individual soil survey areas or counties and potentially for the entire nation covered by detailed soil surveys. These estimates are presumed to be superior to those already calculated from STATSGO, 52 Gt for 48 states and 13.5 Gt for AK (Gt -Gigaton or Pg -Petagram is 1 x 10^{15} g, Waltman at al, 1997) and will offer usef ul comparisons when complete.

Referring to the mission or assignment of this team - to develop templates for new interpretation guides- the presentation or "mapping" of the SOC content values developed from NASIS and illustrated from the SSURGO spatial data base in a "national context" needs to be considered. These considerations are three fold: 1) d918 0 Tre3r Tw -1933aeraough varisources with

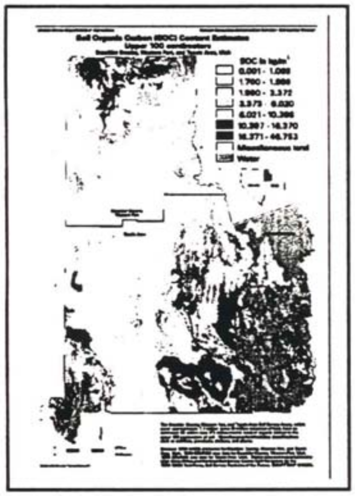


Figure 4

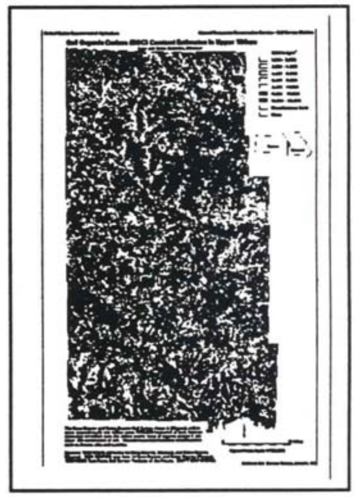


Figure 5

To achieve equity for a national audience, a prototype standard national legend (Figure 6) can be applied to each survey area. By using a standard national legend and common scale to present the SOC content estimates, the customer can now reliably compare different areas, as the legend breaks and category colors have the same meaning (Figures 7 and 8).

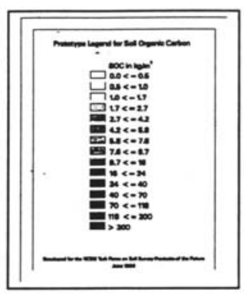


Figure 6

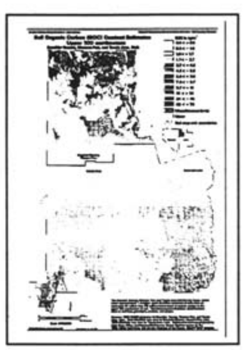


Figure 7

Figure 8

D. Results

A number of field and state office staff reviewed the maps that were generated with the results of the NASIS query, and assessed them to be a valuable tool for presenting our soils data. Scientists unfamiliar with the soils of an area were able to learn something quickly about the landscape. Features that at first viewing raised questions about data accuracy were either scientifically or technically explained. The scientists also thought that the application provided a good utility in checking data bases for quality and consistency. Errors in inconsistencies easily stand out in these visual presentations of large data bases.

The following discussion is provided to address the change in perception of the SOC estimates as presented in both a local and national context. The development of local legends and scales is always an option for the customer, however the equity given to the presentation of these data for individual soil survey areas will vary depending on local concern and hence local bias. An alternative presentation of these data may be through use of standard “MLRA” legends which nest together to provide a national view of these data and ultimately a continental view as well.

Urban Biofiltration Suitability

I. Report submitted by David Hoover

A. Introduction

Ada County, Idaho is an urban center containing the rapidly growing cities of Boise and Meridian. The county sought the assistance of the NRCS Plant Materials Center (PMC) located in Aberdeen, Idaho, in designing biofiftration areas. The objective for creating these areas was to capture street and parking lot runoff in a confined area, and allow it to soak into the soil.

B. Process

The first step in developing this suitability guide was for the PMC and the Resource Soil Scientist (RSS) to agree on the criteria to be used in rating the suitability for a biofiltration system. This process involved setting a rating scheme, assigning a value to all soil mapping units, developing a map of the county with that rating scheme (Figure 9), and looking at the actual location of both the suited and the unsuited areas. In this case, actual location was determined by the GIS process of displaying the suitability map over an on-screen image of 7.5 minute quadrangle maps. The rating scheme was then revised based on first-hand knowledge of the soils of the area..

The decision matrix (Table 1) used for the analysis works to incorporate both the soil properties that assist in water infiltration and plant growth as well as those soil properties that would help to reduce potential ground water contamination. These properties include depth to a restrictive layer, depth to seasonal high water table, permeability, texture, substratum, texture, and slope.

ELEMENT		RATING	
	Good	Fair	Poor
Restrictive layer, rippable, above 10 feet	none	thin	thick
Restrictive layer, non-rippable within 10 feet	none		present
Water table, within 5 feet	none		present
Permeability, whole soil, 5 feet	rapid	moderate	slow
Texture, upper 4 feet of profile	SL, LS, S	L, SiL	SiCL, CL, SCL
Substratum texture, >4 feet	L, SL, SiL	SiCL, SiC, C	LS, S, gravelly/cobbly
Slope	<1%	1-4%	>4%

Table 1

The next step will be the gradual refinement of the rating guide. The RSS is currently working on a gradation scale of numeric values for each soil polygon. This will include a weighting scheme for each of the criteria. For instance, deep percolation of runoff water may not be an issue in areas of the county where mean annual precipitation is under 15 inches per year (MAP ranges from 7 to 36 inches in the county) and would not carry as high a weight in those areas. The gradation scale will be important in the relative ratings of adjacent soil polygons.

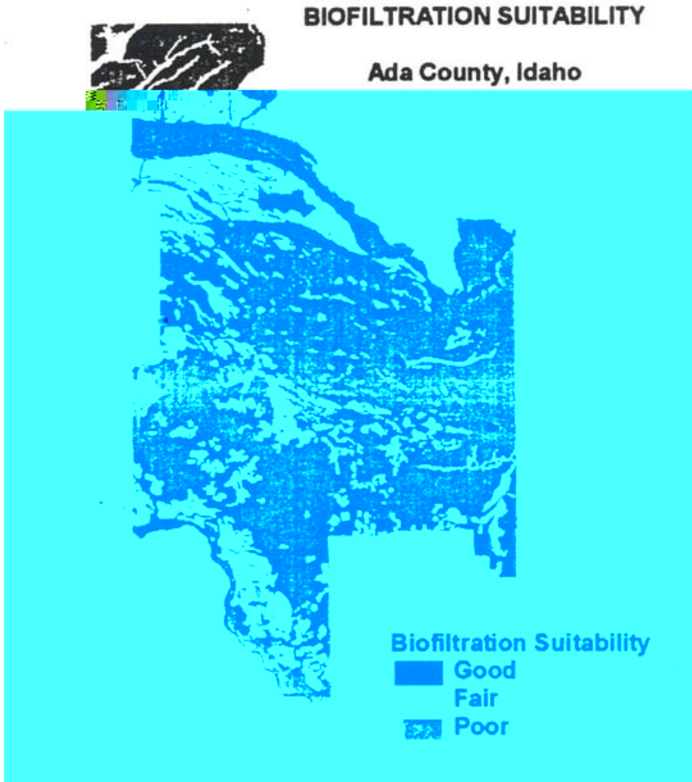


Figure 9

The last step will be actual field visits to representative sites of each legend class, to determine the accuracy of the rating guide. The entire process is not expected to be lengthy since the process is expedited by the use of the digital soil survey and GIS technology. The PMC and the RSS are currently working together to develop a gradation scale of values to eliminate the rigidity of a Good/Fair/Poor classification system. By using this method, land use planners will be better able to assess the relative quality of adjacent soil polygons.

Prototype Applications for Desktop GIS

I. Report submitted by Fred Minzenmayer

One of the problems facing STATSGO and SSURGO users is the depth and complexity of the soils data records. Interpretations are difficult to present using conventional map legends for map units with multiple soil components. Data that can be aggregated into three interpretive classes can be presented using a color triangle as the legend key. A prototype application now being developed literally makes creating an interpretative map with a color triangle simply a matter of point and click (Figure 10).

The legend symbol assigned to the map unit reflects the percent of the rating for each class. This allows presentation of instances where a map unit has more than one rating that could be interpreted from its components. Previously, these occurrences would probably be presented by a series of maps; one for each category. By using the color triangle, the rating percent for the map unit can be presented visually on one map.

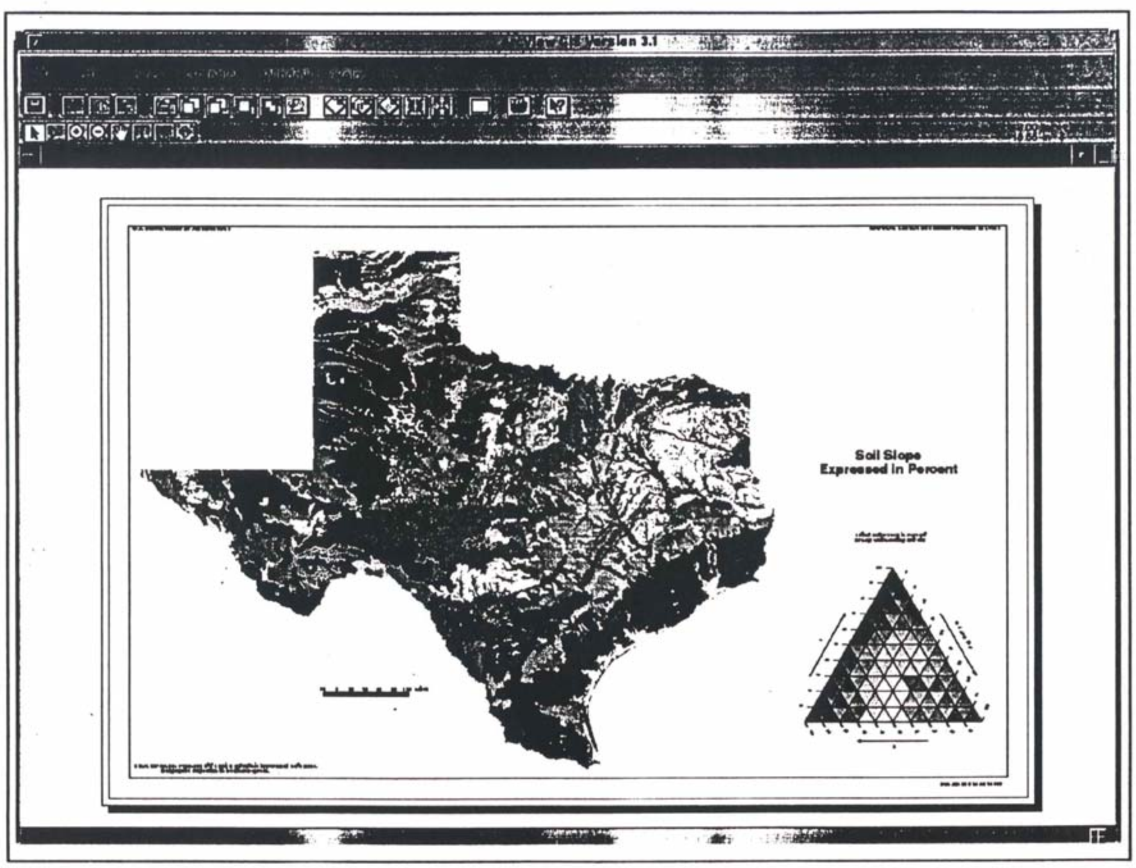


Figure 10

Figure 10

In Figure 10, the application has created an interpretative map for soil slope with user-defined classes of <3%, 3-8%, and >8%. Map units that have components in only one class will appear red, green, or blue. Map units that have components in several classes will appear more yellow, magenta, cyan, or gray, depending on the component percent of each class.

The application uses a color triangle (Figure 10) to present the three interpretative classes. The color triangle resembles the textural triangle in form, but uses the additive colors of red, green, and blue at the apexes instead of the basic texture classes of day, sift, and sand. The subtractive colors yellow, magenta, and cyan are located at the mid points along the sides. The triangle consists of 100 smaller triangles representing the component percentages of the three classes in Increments of 10 percent. The triangle is gray in the center, representing an even distribution of the interpretative rating across the components. The remainder of the triangle is filled with gradations of color across the points, sides, and center.

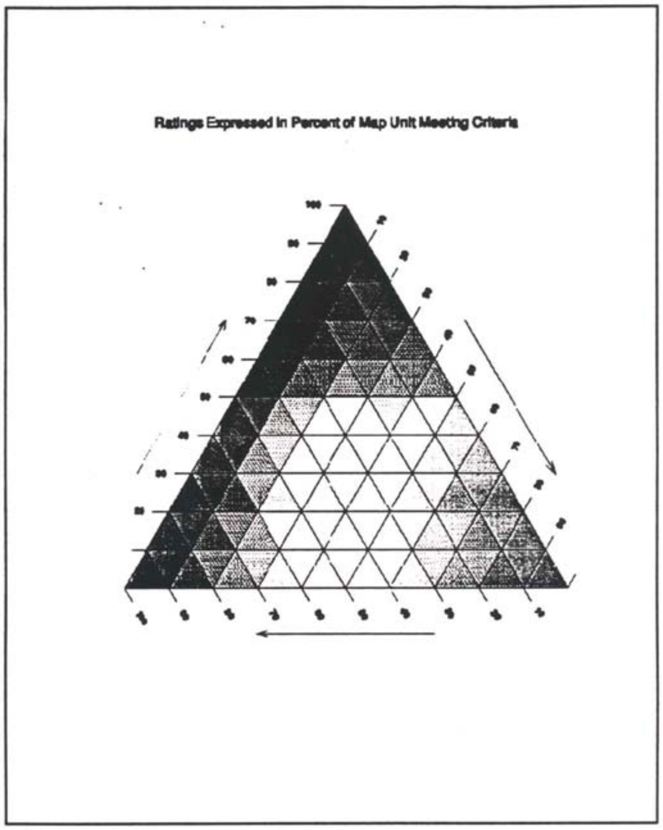


Figure 10

Interpretations that use ratings already populated in the data base, such as Corrosion of Concrete Susceptibility (Figures 11 and 12), are determined on component percent of the map unit. The user is given the opportunity to decide which classes should be combined if more than three ratings exist in the data base. Interpretations involving the layer table, such as Clay Content (Figures 13 and 14), are calculated throughout the profile, and weighted averages used for class values. Again, the user determines the range of the three classes.

Figures 11 - 14 compare traditional presentations of interpretations with those created by the application. The same data and method of generating ratings were used to develop each map. Figures 11 and 13 use a three-category legend to present the results of the data analysis. Figures 12 and 14 use the color triangle legend to present the same results.

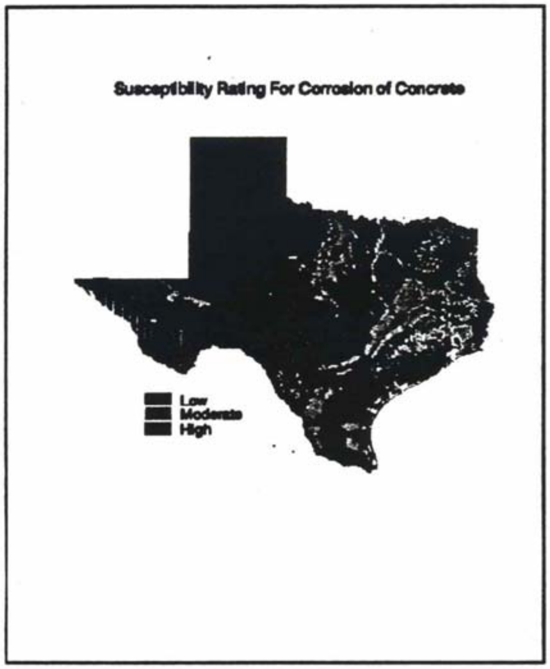


Figure 11

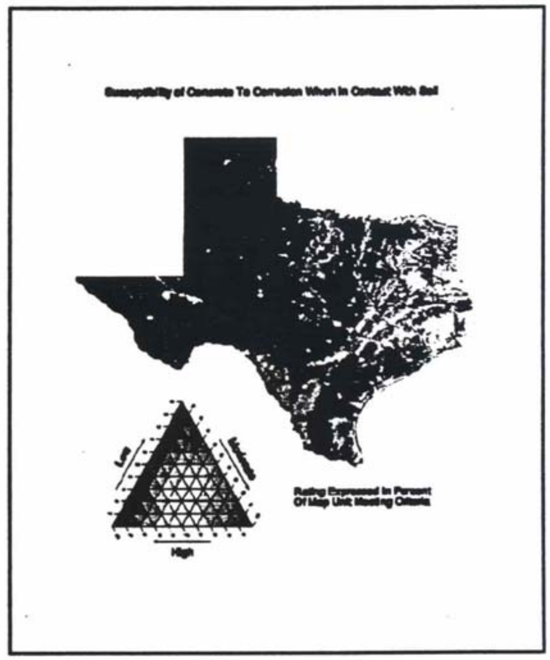


Figure 12

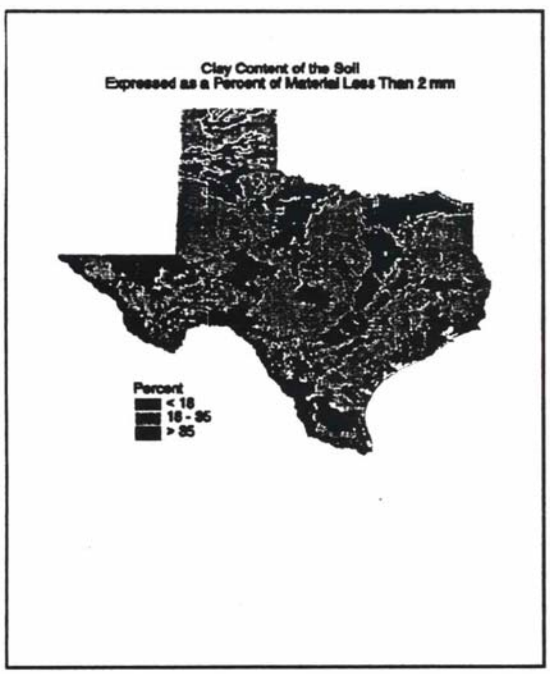


Figure 13

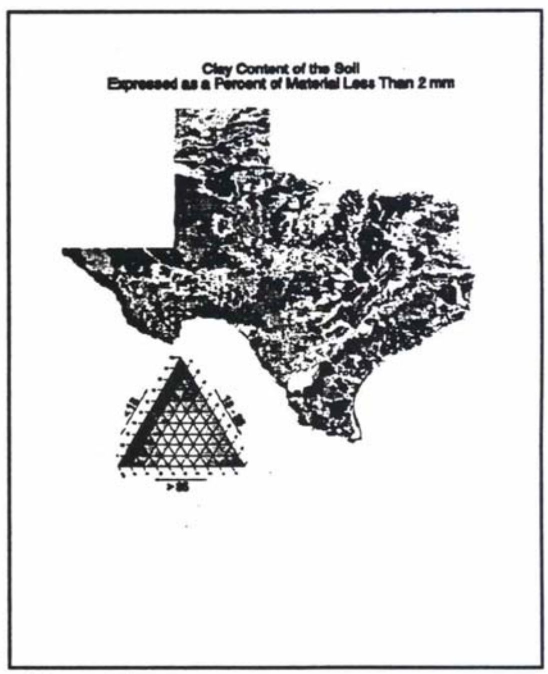


Figure 14

This application received positive reviews from the Task Force sub-group. Work to improve capabilities such as selection of multiple states for regional interpretations continues in the developmental stage.

APPENDIX A

Ideas and Comments On Future Sell Survey Products From Users and User Groups:

1. The Utah Fruit Association is looking for soils and climate info for possible movement of the Southern Utah County Sour Cherry operations. So I guess I would call that niche location for high value crop production. Septic system site locations is another “hot” topic.

-Bob Newell, Research Associate, USU, Logan, UT

2. I am currently trying to assist some water quality/watershed planning groups. We have SSURGO data, so I'm enthusiastically asking what soils data they want to see. I'm thinking something with permeability, kfact, capability class, leaching, etc. I get blank stares. Then, when you go one level deeper, and want to present soils data by some other category, like land use or slope, you really lose them. I guess the only reason I mention this is that we are really starting from the beginning. I like the Soils Explorer approach. Give them "the big hits” of soil data, in an extremely easy to use format (don't have to search dominant components and do one-to-many relates). Then we need it to be a generic GIS format, like shape files, so we can go the next step of using them in conjunction with other data.

-Liz Cook, GIS/RS Analyst, NRCS, Jefferson City, MO

3. We have noticed that virtually everyone who asks us for information is asking for it at a level one order. Wetlands is at level one, housing is at level one, some watershed projects are the same way. Once in a while we get asked about landfill suitability of certain sites. Again, they are after information down to the nearest 20 or 30 meters. It seems like tools of the future would do well to address this trend.

-Ray Grow, Soil Scientist, NRCS, Logan, UT

4. We have seen an increasing interest among users for the opportunity to access soils data over the Internet. The interest seems justified from both the customer and agency perspectives. With a flexible user interface designed into a Web page, it is possible to deliver the type of information sought in a format appropriate to the sophistication of each customer. For us, delivery over the Internet would mean greater ability to keep content current.

-MLRA Region 10 Staff, St. Paul, MN

5a. Trafficability Suitability Index

The NRCS in Idaho is involved in a reimbursable soil survey on a National Guard training range. One of the interpretations listed in the MOU is for 'trafficability" of the soils for tanks, armored vehicles, and other heavy equipment. This request has prompted the local NRCS office to consider other interpretations linked to construction and heavy machinery. The soil scientists will work in cooperation with the National Guard to develop this interpretation based on standard NASIS database entries.

5b. Forested Slope Stability Index

21% of Idaho is used for private forest. Many of the users of soil survey information are interested in slope stability on forested land when the land is used for timber production.

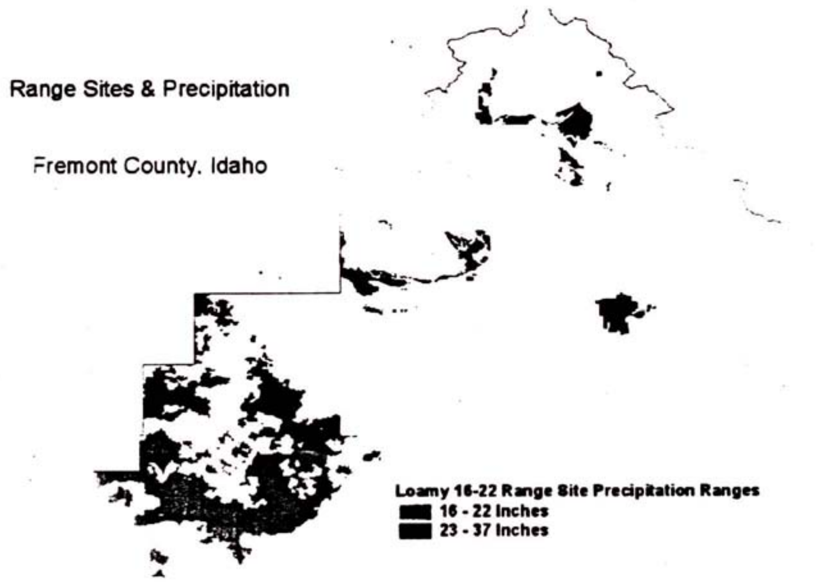
5c. Range and Climatic Information

41% of Idaho is nonfederal grazing land, including both range and pasture lands. As remapping efforts continue in the state, soil scientists and range conservationists are concerned about the old range site associations given to soil map units and their relationship to current climatic data. The state has looked as aggregate maps of range sites in a soil survey area and then intersected the range sites with DEM elevation and slope data and PRISM precipitation data in order to find any relationships. (Many of the counties in Idaho can vary 5000 feet or more in elevation and over 30 inches in mean annual precipitation.) These relationships are used to evaluate existing range sites as well as predict the location of similar range sites.

This is not strictly a new combination of soil interpretations like the previous examples. Instead, it was included here to show the need to incorporate soils data with other geographic databases, such as climate and elevation, in order to come up with new ways of looking at the utility of the soils databases.

Below is an example of just looking at where in a county a certain range site is located. In this example the “Loamy 16-22” range site was found in higher rainfall areas. This does not necessarily indicate an error, but rather a situation that needs to be looked at from both the soil mapping and the database entry perspectives.

-Dave Hoover, GIS Coordinator, NRCS, Boise, ID



6. I would like to see work done on developing ratings for soil intake for different kinds of irrigation systems.

-Robert Fish, Soil Scientist, NRCS, Roosevelt, UT

7. A university professor who makes recommendations about herbicide application rates (weed control) according to soil characteristics (where higher organic matter percentages and higher clay content generally translate into higher rates of herbicide application) is surprised to learn that high o.m. and day contents often occur in drainageways in the landscape. Because drainageways are associated with water bodies and wetlands, the standard recommendation could possibly lead to the farmer applying more herbicide in drainageways without adding the geographic rule to avoid herbicide application within the buffer surrounding water bodies. Both attribute and spatial aspects of the soil data need to be considered to make a wise decision about herbicide application. To ignore the geographic implications could have lead to recommendations promoting a serious environmental problem.

-Sharon Waltman, Soil Scientist, NRCS, Lincoln, NE

8a. We've been designing a lot of waste management systems for dairies lately and I'm sure we'll be doing more in the future. The Utah Department of Environmental Quality has permeability and depth to seasonal high water table standards for evaporation ponds for dairy wastewater. The way waste management systems have been designed locally these ponds hold water from the milkhouse and the washing down the holding pens rather then any liquid component from the feedlot. The shallow ponds are held to a permeability of less than 1 x 10-6 cm/second. This can be achieved by compaction alone in favorable soils. Water depth is 2 feet maximum. Deeper ponds are held to a standard of 1 x 10-7 cm/sec. This is less easily met with only compaction.

8b. Another possible product is a rating for the suitability for borrow material to line such ponds. At least here we have found it much easier and more economical, depending on haulage distance, to line ponds with a compatible import material rather than to attempt to mix bentonite with the native material. On part is the physical difficulty of mixing the materials and the gray gumbo produced as the mixture is wetted for compaction. Another difficulty is that these calcareous soils have a lot of Ca++ available and tend to flocculate the bentonite. As an aside some of the best material to import in this area is from weathered Tertiary ash deposits. I'm a bit scared of these deposits because they look and feel an awful lot like the tailings from the uranium mines south of Monroe.

-Vic Parslow, Soil Scientist, NRCS, Richfield, UT

9. Air quality -- Criteria used to generate risk ratings and maps would need to account for "regional" variability in conditions/parameters. A national template runs the risk of being oversimplified when, in fact, air quality parameters tend to be complex and variable from location to location. For example, soil wind erodibility factor, tillage practices (cover), and climate (wind speed, direction, and time of year when it blows) are important parameters for PM-10 risk in eastern Washington, but are probably not key in the San Joaquin Valley (and maybe other irrigated areas of West) where moist soils and/or heavier textured soils that don't blow may cause more PM-1 0 problems (via vehicle "track out", dust suspended from farm roads to orchard trees, then sharing at harvest, etc.). A few years ago EPA proposed an oversimplified risk “model” based simply on Wind HEL soils - it doesn't work in much of the West! We need to be careful with templates; they should be flexible enough so that they fit to science-based realities.

We should offer product that they (or the consultants that they hire) can add site-specific data and refinements to with ease. This might include databases which have easily expandable structure (to add delineations, map unit data, data elements, etc.). We should "tune up" some of the precision farming-related data we provide (or need to add to our databases) -- I'm thinking of things like organic matter, P retention, etc. Maybe we should leave blank data elements for certain properties in anticipation of the precision farming producers adding certain site-specific and/or temporal data as they obtain it. We should develop the ability to deliver geo-spatial data in farm-sized (or maybe USGS quad sized) packages that are compatible with the GIS software and other data layers and imagery that producers are using (stay current with state-of-the-art to the highest degree practical).

-Dave Smith, Soil Scientist, NRCS, Sacramento, CA

10. Climate analysis - needs to be done for virtually any environmental assessment whether it's water quality or pm10, etc. Climate always factors in somewhere.

-Randy Julander, Soil Scientist, NRCS, Salt Lake City, UT

11. Precision agriculture or variable rate technology will generate the need for new interpretive information. Our Ag interpretations usually have been based on simple yield. In the future, we may have to start interpreting soils for crop quality. For example, will a given soil produce grain with a high protein yield? Or will it produce a grain with high protein yield only in drier than normal years?

-Berman Hudson, Landscape Analyst, NRCS, NHQ

12. Are there some wetland issues in saline/alkaline soils that could be addressed? The precision farming idea is very important in the Midwest but may be harder to apply in the irrigated, flat, alluvial areas in Utah.

-Mike Domeier, Soil Scientist, NRCS, Salt Lake City, UT

13. We have Prime Farmland programmed in NASIS. I now think states need to be working on programming Statewide Important and Unique farmland into NASIS and generating statewide consistent lists.

-Chuck Gordon, MLRA Region 4 Leader, NRCS, Bozeman, MT

14. For animal waste disposal, what is needed for a GIS layer are things such as depth to water table, slope, distance to water if possible, soil restrictive layers, highly permeable soils (i.e. rocky, sandy, etc.) where nitrogen leaching might easily occur, and high salinity soils. It would be great if the template could identify the specified conditions, print a colored map showing the problem areas, and list required specifications for manure application.

-Kerry Goodrich, Conservation Agronomist, NRCS, Salt Lake City, UT

15. NRCS has always been very good at preparing base resource data, but that is just one-half of our job. The second half is delivering resource information to the public, which according to the Blue Ribbon Panel Report, we need much improvement. We typically think of improvements to our information In the form of more robust interpretations, web-based data viewers, or customized applications for desktop GIS. However, improvements to information delivery could also be in the form of public training sessions, field days, and seminars. Without understanding the role of soils in .the environment, land owners, managers, and policy makers will not benefit from the enormous wealth of data NRCS has collected over the past 100 years. We should be creating a cadre of technically competent, articulate, and politically astute people who can fill the role of providing education, information, and outreach services to the public.

-Russ Kelsea, Soil Scientist NRCS, Lincoln, NE

APPENDIX B

<u>NASIS Scripts Used for Calculating Soil Organic Carbon</u>

1 NASIS Report UTIL - Property Values (RV-Mapunit-Export) Description Provides a single value for each map unit from the numerical RV calculated by a PROPERTY. User chooses the PROPERTY when the report is run. The PROPERTY script calculates RV for each component in the selected set. The report calculates a weighted average of these values, based on component percent, to produce a BASE TABLE component. The PROPERTY script should calculate a numerical result, otherwise the weighted average calculation will fail. NULL values are calculated as zero.

Queries for the selected spatial areas were run in NASIS and the results downloaded into an ascii file. The file was used to create an infofile that could be joined to the digital soil polygons. The relate item was the map unit symbol.

3. NASIS Property Script

```
        base table component.

        # Calculates the organic carbon as a weighted average for any portion
        of the soil in the depths 0” to 40" (0 to 100 cm) or to a restrictive layer.

exec sql select hzdept-r. hzdepb-r, om-r, dbthirdba_r, dbtenthbar_r
from component, chorizon
where join component to chorizon and hzdepLr< hzdepb-r,
sort by hzdept-r, hzdepb_r
aggregate column dbthirdbar_r none, dbtenthbar_r none, om_r none.

# Determine the volume percent of fine < 2mm in diameter.
```

DERIVE fine_p from rv using “FINE EARTH % BY VOLUME”.

define om not isnull (om_r),? om_r: 0.
define db_r not isnull (dbthirdbar_r) ? dbthirdbar_r: not isnull
(dbtenthbar_r) ? dbtenthbar_r: 1.45.
define oc_r 58*(om * db_r (fine_p/l 00)).

Determine the LAYER THICKNESS IN RANGE; ABOVE A RESTRICTIVE LAYER.

DERIVE layer_thickness from -rv using “LAYER THICKNESS IN RANGE; ABOVE A RESTRICTIVE LAYER” (0,100).

Nulls in organic carbon are assumed to mean 0.

define oc not isnull (oc_r) ? oc_r: 0.

Find the organic carbon weighted ave.

define thickness not isnull (layer_thickness) ? layer_thickness : 0.
define oc_sum arraysum(thickness*oc).
define rv not isnull (oc_sum) ? oc_sum : 0.

References

Bliss, N.B., S.W. Waltman, and G.W. Petersen. 1995. Preparing a Soil Carbon Inventory of the United States Using Geographic information Systems. *In* Soils and Global Change (eds) R. Lai, John Kimble, Elissa Levine, B. A. Stewart Advances in Soil Sciences CRC-Lewis Publishers Boca Raton. pp 275-295.

Follett, R.F., S.E. Samson-Liebig, J.M. Kimble, E.G. Pruessner, and S.W. Waltman. 1999. Carbon Sequestration under CRP in the Historic Grassland Soils of the USA. American Society of Agronomy Symposium Publication (in preparation).

Waltman, S.W., B. Lacelle, C. Tamocai, N.B. Bliss, and F. Orozco-Chavez. 1997. Soil Organic Carbon Map and Database for North America. 89th Annual Meeting American Society of Agronomy Abstracts. October 26-30,1997. pp.259.