Research Agenda Committee

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Charges:

1. Review reports and recommendations from 2010 NCSS Regional Conferences.
2. Identify, document, prioritize, and address the critical research and development issues within the NCSS.
3. Discussion of Rapid Soil Carbon Assessment Activities in the NCSS. Identify opportunities for partnering on priority research needs. Identify potential for data sharing in national carbon assessment and modeling within the resources of the NCSS.
4. Identify opportunities for funding priority research needs.
5. Continue and update progress on **Task Force / Working Group** activities:
    1. **Benchmark Soils and Landscapes in Soil Survey.** The purpose of the Task Force will be to formulate a plan to re-establish a targeted measurement program of chemical and physical relationships in soil properties and conditions through NCSS partnerships on Benchmark Soils and Landscapes for the U.S. Soil Survey. This Task Force would also address compilation of NCSS cooperator laboratory databases of soil properties into the NCSS Characterization database. The NCSS Research Agenda Standing Committee will report the Task Force's progress at the NCSS.
    2. **Gypsum and Expanding Salts in Western States.** The purpose of the Task Force has been to formulate a plan to produce a targeted measurement program of chemical and physical relationships in soil properties and conditions through NCSS partnerships on Gypsum and Expanding Salts for the U.S. Soil Survey.
    3. **Open File Task Force.** The purpose of this Task Force will be to institutionalize the open file system and report progress of publications and content manager system within Web Soil Survey or other resources of NCSS.
6. Identify an Outstanding Research Project within the NCSS partnership to present at the National NCSS Conference.
7. The NCSS Research Agenda Standing Committee will be required to report its activities at each National Conference.

Activities and Recommendations:

The combined Research Agenda/New Technology forum included 13 presentations. Speakers and topics are listed in the NCSS conference agenda.

Charge 1 - Regional NCSS Conferences Research Priority Committee Reports

North Central Regional Conference

1. Gridded surveys (SSURGO):
    a. Need standards, protocols
    b. Proper scale representation
    c. Description of data and comparisons of data representations at multiple scales

2. Rapid assessment of soil C
    a. Organic soil method development
    b. Add data to database for developing RV's for mapping units
    c. Research on other properties where VNIR can be useful

3. ESD and dynamic properties
    a. Relate to water quality, soil erosion, soil quality, etc.
    b. Develop a protocol for high intensity agriculture soils for the North Central Region.

4. Digital mapping
    a. Standards protocols and method development
    b. Training on currently used methods
    c. Scale relationships
    d. Predictive ability of digital mapping with associated uncertainty.
    e. Use of LiDAR and terrain attributes.

5. Water table research and reduction
    a. Argillic vs. Cambic
    b. Illititic mineralogy class
    c. Global issues –Phosphorus related issues, hydraulic conductivity, bulk density scaling, North American Node of Global Soil map.
    d. Develop methods for stratifying applicability of pedotransfer functions
    e. Hazards research – high intensity rains, soil slippage.
    f. Urban soils – much needed research for predictions and estimating properties

Northeast Regional Conference

Short term soil survey mission needs

1. Revision of hydrologic soil groups (too many Group D)
2. Salinity classes (data?) for subaqueous soils
3. Nutrient and trace element fate and behavior in subaqueous soils
4. Data mining – have data; what does it mean

Global research areas that would benefit from pedological research and inclusion of soil survey concepts and data

1. Soil temperature and moisture data (SCAN)
    a. Valuable data for interpreting soil hydrology
    b. Other processes and functions
    c. Need more
2. Soil organic C fractions
    a. What do they mean
        i. Broad application?
        ii. Often developed in limited geographic region
3. Soil buffering capacity related to atmospheric deposition
4. Research that would enhance the Rapid Carbon Assessment initiative
    a. Urban/suburban data collection
    b. Landscape and landuse
    c. Sample archive
    d. Carbon fractions and meaning
    e. Urban/suburban data and models
5. Urban/suburban distribution, property, and behavior research

South Regional Conference

Research needed in the South Region to accomplish soil surveys

1. **Class criteria for gypsum content in soil interpretations.**
    a. At what gypsum content does piping occur within the soil?
    b. At what gypsum content does cavern formation occur in soils?

    Findings:
        i. Piping – in dry climates (<5”/yr), piping is not prevalent; with higher rainfall and irrigation, piping occurs at gypsum contents of 1-5%, especially in siltier soils
        ii. Cavern formation – time-dependent and water dependent, >15% gypsum will get cavern formation; >60% gypsum cavern formation decreases

    Recommendations:
    Reports from South and West Research Priorities/Needs committees and from University research studies will be combined and presented to the National Leader for Soil Interpretations for interpretation development and testing.
2. **The “new soil survey” needs sampling requirements for dynamic soil properties.**
    a. Identify existing data sets in the South Region that can be used to determine the spatial variability of near surface dynamic soil properties.

    Findings:
    Sampling requirements:
        i. First DSP study on agricultural soils just completed in Texas – once these results are compiled, methods that may need further study can be identified; one that has already been recognized is estimating aggregate stability in the field

ii. Is geomorphic position part of the DSP sampling protocol? If not, this should be part of the sampling requirements or emphasized.
iii. Soil moisture needs to be better quantified at time of sampling, could cause errors in C estimates, bulk density
iv. Evaluate methods of estimating bulk density, Ksat

Identify existing datasets:

ARS, NRCS grazing, no-till, etc. studies, Forest Service, USGS, university research projects, agricultural experiment stations, tillage experts, state foresters – all these were identified as potential sources for DSP data

Recommendations:

i. Continue to refine sampling requirements via research, testing, and detailed field studies.
ii. Search the literature for DSP datasets.

3. **Identify and/or suggest methods to predict highly variable soil properties such as infiltration from less costly measures.**

Findings:

i. Texas Tech – estimating infiltration from soil temperature in playa lakes
ii. TAMU – using resistivity to measure infiltration in medium-textured soils

Questions:

i. Could these techniques be used in estimating stormwater runoff infiltration in the east (preferential flow is an issue)?
ii. Are there other methods to estimate organic matter/carbon other than VNIR?

Recommendations:

Continue to refine sampling requirements via research and detailed field studies.

4. **Identify known elements of groundwater Spodosol formation and develop models to predict their occurrence in landscapes.**

Findings:

i. University of Florida has submitted a research proposal to study groundwater Spodosols across a sandhills/ flatwoods landscape
ii. NC State is also interested in pursuing research in this arena
iii. Similar soil landscapes occur all along the Atlantic Coast and possibly Gulf Coast coastal plains

Recommendations:

Continue to support and encourage the NSSC to provide research funds for the study of groundwater Spodosols in benchmark soilscapes in the South region.

5. **Evaluate and identify ways to integrate soil spectroscopy tools into soil survey activities.**

Findings:

Develop proximal sensing tools to facilitate soil survey activities to investigate methods for optimizing VNIR spectral libraries for regional applications or specific mapping campaigns to design field sensors for specific soil survey use to identify and test new sensor technologies that may show promise

Discussion:

i. Can VNIR be used to determine mineralogy (kaolinitic, illitic, smectitic)? Yes. TAMU has used VNIR to estimate mineralogy.
ii. NSSC is running VNIR on all samples that come through the lab

Recommendations:

Continue to identify, develop, and research other uses for soil spectroscopy tools.

Suggestions for further Research Priorities.

1. Validating soil hydraulic properties on benchmark soils.
2. How does climate change affect soil properties?
3. How soil properties change – water tables (coastal areas with sea level rise), in Piedmont with storm events there is an effect on water table fluctuations
4. Climate change effects on cracking in Vertisols
5. Saltwater intrusion
6. Oxyaquic concept not consistently used; what soil properties should be used to define or predict oxyaquic?
7. Relict features are not well-defined especially in relationship to determining seasonal high water tables.
8. Urban soils
9. Predicting compaction, relating to runoff
10. Storm water design -- how and where to evaluate the soil (A vs. B vs C horizon etc); dispersal of clay
11. Low-impact development; objective is to maintain hydrology, soils typically are not considered
12. Very fine sands – distinctions between vfs and silt
13. Urban development and its effect on surface and drinking water quantity, quality, and distribution
14. Loss of prime farmland soils
15. Wastewater treatment and dispersal
16. Fate and transport of pollutants in both terrestrial and subaqueous environments
17. Data mining from the Soil Mechanics lab
18. Reinvigorate the soil geomorphology studies on large-scale physiographic, higher land use intensity areas to incorporate new technologies; suggestions are:
    Texas-Louisiana Gulf Coastal Plain
    Edwards Plateau
    Cumberland Plateau
    I-85 corridor in the eastern Piedmont (Richmond-Atlanta)

West Regional Conference

Research priorities

1. Construct an atlas or geospatial database of land use history.
    How would this be constructed?
    Over what time frame?
2. Is fractured bedrock or tubular bedrock (limestone), a C horizon? The focus should be on hard bedrock that transmits water as opposed to saprolite which is no longer hard.
    Is this material lithic?
    How does this effect classification and hydrologic soil groups?
    Ecosystem classification?

3. Can diffuse reflectance spectroscopy (VisNIRand MIR) be used to characterize andic soil materials and/or ultra-mafic soils?
4. More work needs to be done on the use of remote sensing techniques for digital soil mapping.
5. Differences in properties of playas.
6. Rock mulch. A more comprehensive way to describe it, sample it

Charge 2: Research priorities are grouped into three broad categories; **Short-Term Priorities, Global Priorities, and Application of Soil Survey Data.** Specific priority research topics recommended by this committee at the 2011 NCSS conference include:

Short-Term Priorities

- Soil change*
- New technology*
- Ecological site descriptions*
- Subaqueous soils*
- Landscape hydraulic function and soil water relationships (hydropedology)
- Gypseous and salt-affected soils
- NCSS database harmonization

* Specifics will be left to NCSS committees and working groups that address these topics.

Global Priorities

- Scaling/extrapolation
    - Use Rapid Assessment of Carbon project as potential model
- Landscape-scale carbon processes and accounting
- Integration of soil organic carbon and land use
- Soil adaptation and prediction of soil CO_2 sequestration and mitigation strategies for climate change
- Maintenance of soil ecosystem services
    - resistance
    - resilience
- Soil function
- Development and testing of decision support tools

Application of Soil Survey Data

- Integration of carbon and land use data into conservation planning and related activities
- Data validation
- Urban/suburban interpretations

The committee also recognized important issues that were more regionally based. These include:

- Criteria for site specific soil evaluations in urban/suburban ecosystems

- Aquods - genesis, landscape distribution, water table heights
- Plinthite - landform related processes, water movement, identification (slaking)
- Anthropogenic soils (mine soils)

Other committee recommendations:

1. The committee supported the concept of concentrating Soil Survey Division research efforts on a limited number of aerially extensive "Soil Systems" (may be better referred to as benchmark landscapes).

   The working concept is that these landscapes would be intensively evaluated including soil hydraulic properties, distribution and properties of soils, horizons, and features important in the soil system, hydraulic properties (Ksat, infiltration rate, etc.) of landscapes/soils/horizons, genesis of soils and soil features/diagnostic horizons, dynamic soil properties, nutrient and soil C distribution and relationships, and other properties and relationships deemed important for the soil system. Local MLRA Soil Survey Offices will be involved in all aspects of research in these areas, and involvement of scientists from other agencies would be welcome. Involvement of university cooperators would also be solicited and welcome and small amounts of funds may be available to help support student projects in the areas chosen for study. Sites of intensive data collection could be used in the future as training sites for soil scientists wanting or needing to understand soil-landscape relationships for the soil system.

   Actions: West and the NSSC research staff will develop a white paper describing the concept to be widely circulated for comment (draft attached as an appendix to this report).

   West will organize a task force to define operational and research considerations of these efforts. Volunteers for the task force include: Paul McDaniel, Joey Shaw, Bruce Vasilis, Patrick Drohan, and Mike Wilson. Others will be added to increase input from all potentially involved.

2. The committee supported research into assessing salinity and sodicity in the Great Plains. Salinity was not consistently mapped in the Great Plains, observational data suggests the area of salt affected soils is increasing, and crop losses from salinity are estimated to be $10s of millions. However, there has not been a comprehensive evaluation of salinity and sodicity across the region, especially an evaluation of parent material, landform, and soil hydrology effects. Digital soil mapping concepts, EMI, and/or landscape models have not been comprehensively applied to improve mapping of saline and sodic soils across the Great Plains. In addition, considerable research has been done on effects of low levels of

sodicity on soil behavior since introduction of Soil Taxonomy. New taxonomic classes to better recognize salinity and sodicity in the landscape may be needed.

Charge 3: Discussion of Rapid Soil Carbon Assessment Activities in the NCSS. Identify opportunities for partnering on priority research needs. Identify potential for data sharing in national carbon assessment and modeling within the resources of the NCSS.

As of March 31, 38% of the locations for the soil C assessment had been sampled. Plans are for 80% of the locations to be sampled by September 30. Processing of bulk density samples is on-going as are collection of the VNIR spectra. The goal for completion of sample processing is March 30, 2012. Cooperative agreements were established with various universities for student help in sample collection and processing.

Needs to help expand the U.S. soil C inventory and make it more robust include:

1. Samples from or access to long-term tillage and agricultural management research plots for collection of VNIR spectra. These data will be used to help verify VNIR models and place the data collected in perspective relative to other soil C research results.
2. Soil C data from urban and suburban ecosystems.
3. Data from long term monitoring studies to evaluate rates of change in soil organic C under different management systems or other types of disturbance.

The VNIR spectrometers will remain in the MOs after the initial soil C data collection is complete. These may be available for use by cooperators in additional projects to evaluate soil C and other appropriate soil properties.

Committee recommendations:

1. The committee recommended that the procedure for humic acid quantification developed at Northeastern University be further tested for interlab consistency. This should be accomplished through a sample exchange among cooperators. Samples for additional data evaluation and interpretation could include samples from the NSSC archive and archived Rapid Assessment of Carbon samples. Data from these and other samples could be used for development of relationships with SOC fractions, DSP, and dissolved organic matter.

   Action: West will help facilitate sample exchange for method evaluation.

1. The committee recommended that a task force be organized assist with organization, evaluation, and application of data from the Rapid Assessment of Carbon project. Issues that could be address by the task force include data organization, computational issues, application and interpretation of inorganic C data, framework and use of models to extrapolate the data, and data use and applicability. Task force members should include representation from NRCS and NCSS cooperators, including non-traditional cooperators. A workshop for the task force and others should be considered to discuss these and other associated issues. Funding for the workshop may be available from outside NRCS (AFRI?).

   Action: West will organize the task force and investigate potential funding for the workshop.

Charge 4: Identify opportunities for funding priority research needs.

The NRCS Soil Survey Division has made a limited amount of funds available for competitive research projects in 2011 to address priority areas. It is expected that similar funds will be available in future years as the budget allows.

Other potential funding sources include the NIFA soil processes program, EPA, NOAA, etc. NIFA funds will be limited this year.

Potential to establish partnerships through Global Research Alliance on Agricultural Greenhouse Gases (GRA). This international effort is not a source for research funds but could provide opportunities to develop international collaboration for proposals and potential funding.

Charge 5: Continue and update progress on Task Force / Working Group activities:

a. **Benchmark Soils and Landscapes in Soil Survey.** The purpose of the Task Force will be to formulate a plan to re-establish a targeted measurement program of chemical and physical relationships in soil properties and conditions through NCSS partnerships on Benchmark Soils and Landscapes for the U.S. Soil Survey. This Task Force would also address compilation of NCSS cooperator laboratory databases of soil properties into the NCSS Characterization database. The NCSS Research Agenda Standing Committee will report the Task Force’s progress at the NCSS.

Benchmark list is being revised by MLRA Soil Survey Offices. Benchmark pedons are being sampled for characterization and other properties; Ksat and infiltration rate are being evaluated by Soil Survey Offices.

Data from eight university characterization programs have been incorporated into the NCSS Soil Characterization database. Data from 20 additional universities are in process of addition to database.

Committee Recommendation: Since **t**here is no known membership or reports from the task force for these activities, the **committee recommends that the task force be disbanded.** Reports on these activities should be made to the Research Agenda committee and the Conference as a whole as needed.

b. **Gypsum and Expanding Salts in Western States.** The purpose of the Task Force has been to formulate a plan to produce a targeted measurement program of chemical and physical relationships in soil properties and conditions through NCSS partnerships on Gypsum and Expanding Salts for the U.S. Soil Survey.

Limited Task Force activity since 2009 NCSS conference. A Soil Scientist field trip through Colorado and Utah with NSSC staff to observe and discuss soils with gypsum and salts was held in 2010. Pedons with salts and gypsum have been sampled and analyzed.

Committee recommendation: The committee recommended that the Gypsum Task Force be re-initiated and re-charged to address remaining issues associated with soils containing gypsum.

Action: West will contact potential task force members and develop new charges from the original charges that have not been completed. Wayne Hudnall, Nelson Rolong, and Curtis Monger volunteered to serve on the task force.

c. **Open File Task Force.** The purpose of this Task Force will be to institutionalize the open file system and report progress of publications and content manager system within Web Soil Survey or other resources of NCSS.

Open file system is still on agenda as part of content manager that will be part of NASIS database system. NSSC Soil Survey Investigations Report series is available in the interim.

Committee recommendation: The task force produced a user requirement document that has been considered as requirements for the NASIS content manager were developed. There has been no task force activity since the user requirement document was finalized. **The committee recommends the task force be disbanded**. Reports on progress of implementation of the open file system should be made to the conference as needed.

Soil System Evaluations

Draft; June 14, 2011

Geology, geomorphology, and climate create natural, distinctive soil regions within the USA that have been referred to by various names such as the Coastal Plain, Ridge and Valley, Great Plains, and many others. Within each region are distinctive landscapes and patterns of associated soils that will be referred to in this document as "soil systems". For this document, a soil system is defined as a recurring group of soils that occupies the landscape from the interstream divide to the stream (Daniels et al., 1999). A soil system will have similar parent materials, geomorphology, local relief, hydrology, and climate. Consequently, a soil system can be expected to respond in relatively consistent ways across its extent, and likely to behave differently than adjacent soil systems. A single soil system may be limited to a few thousand hectares or may extend for many hundreds of km^2. Similar landscape criteria along with agricultural practices have been used to define Major Land Resource Areas (MLRAs). A single MLRA, especially those that are aerially extensive, may contain multiple soil systems due to differences in stratigraphy; soil parent material texture, composition, or age; or other landscape characteristics that affect soil properties and distribution. It is also possible that a soil system may include more than one MLRA. The term "benchmark landscape" has been used in a manner similar to soil system, but "soil system" is preferred since it places emphasis on processes in and interactions among soils on the landscape and differences in landscape processes that may be affected by these soils.

The emphasis of soil system evaluations is elucidation and documentation of important soil and landscape characteristics, processes, relationships, and responses. Soil systems provide a simplified, yet substantive description of properties and processes for dominant soil groups in a region that can be used by Agency personnel and stakeholders to orient themselves in an area. The primary goal of the soil system approach is to improve accuracy and precision of soil maps and to strengthen interpretations of soil behavior. Improved understanding and representation of patterns of landscape-scale pedogenesis, connectivity among soils and soil properties, topography, and geomorphology, and soil property response to disturbance (including agricultural management and climate change) facilitates more robust land use decisions. An important accessory goal of soil system evaluations is to provide sites with extensive data for hands-on training and field experience in mapping techniques, sample design and collection, soil-landscape analysis, and digital and classical soil survey techniques to support soil survey and soil science.

Research type and focus to be conducted at specific soil system sites will vary depending on site characteristics and important questions identified by local soil scientists and cooperators. Research questions may include genesis of the soils and important diagnostic horizons, characteristics and behavior of soils in their natural setting, water movement through horizons,

pedons, and through the landscape, and soil response to management or other disturbance. Other research topics important to understanding and use and management of the soil system also may be addressed. Research results, soil-landscape models, pedotransfer functions, and soil change relationships derived from classical and/or modern digital techniques should be applicable over the extent of the soil system but not necessarily beyond.

Global objectives:

1. Develop models of genesis and landscape distribution of soils, diagnostic horizons, and soil features as related to parent material, climate, and geomorphology.
2. Describe properties of soils including spatial variability of static and dynamic properties.
3. Develop relationships among static properties, dynamic properties, and ecosystem characteristics.
4. Evaluate simulation models and pedotransfer functions for prediction of soil properties and behavior.
5. Establish sites with extensive data for hands-on training and field experience in mapping techniques, sample design and collection, soil-landscape analysis, and digital and classical soil survey techniques to support soil survey and soil science.

General methods/properties to be evaluated:

1. General characteristics of soil systems to be evaluated
    a. Benchmark and aerially extensive suites of soils/landscapes – maximum potential for extrapolation of results and broad impact
    b. Where appropriate, should be co-located with or include LTER, NEON, ARS watersheds and university research sites to leverage data availability and acquisition and to better understand long term soil behavior
    c. May include urban/suburban watersheds
    d. May include subaqueous soils as part of watershed
    e. Detailed data collection in one or more small (3-20 ha) watersheds including hydraulic data such as water table dynamics, Ksat, soil moisture status, etc.
    f. Less intensive evaluations over extent of soil system to enhance understanding of soil property variability
2. Soil/parent material/landform distribution/land surface age
    a. Existing maps and data
        i. Parent material and surface dating where needed and applicable
    b. Detailed maps of landforms, parent material, and soils for sub-watersheds
        i. Field observations and descriptions
        ii. Digital mapping techniques
    c. Extrapolation to larger watershed and extent of soil system

        i. Field observations
        ii. Digital mapping techniques
3. Characteristics of soils; major and other unique or important landscape components (concentrated in sub-watersheds but also across larger area as needed for specific questions/objectives; evaluation depth will not be limited to 2 m)
    a. Pedon characterization – static properties including trace elements if applicable
    b. Spatial variability of selected features/properties
    c. Ksat of horizons
        i. Variability – both spatial and temporal
        ii. Relationship to horizon properties and continuity, slope, parent material, etc.
        iii. Develop and evaluate pedotransfer functions for prediction
        iv. Modeling of lateral flow through and across landscapes
    d. Seasonal saturation monitoring
        i. Morphological indicators (redox features, other)
        ii. Perched water tables
            1. Relationship to Ksat and other horizon properties
            2. Relationship to landform/landscape position
            3. Relationship to parent material and stratigraphy
        iii. Shallow water tables
            1. Relationship to landform/landscape position and stratigraphy
    e. Soil temperature and moisture monitoring
4. Dynamic soil properties
    a. Matrix of major soils with major ecological sites and states and/or agricultural management systems (watersheds with different land uses)
    b. Replicate plots with replicate sample points over extent of soil system
        i. Infiltration rate
        ii. Carbon amount, depth distribution, dynamics
        iii. Bulk density, nutrients, etc.
        iv. Other properties in DSP minimum data set
        v. Other soil quality indicators
    c. Relationships among static soil properties, dynamic soil properties, and ecological site and state (ecosystem characteristics)
        i. Based on data from watersheds/plots with different land use/land cover including native vegetation
        ii. Impacts on infiltration/runoff, nutrients, productivity
        iii. Soil sustainability and resistance to change (soil climate change adaptation)

5. Data aggregation
    a. Data and relationships must be up scaled from points and small watersheds to broader landscape
        i. Existing SSURGO spatial data
        ii. Digital mapping techniques
    b. Soil functional groupings
    c. Model simulations
        i. Water movement – vertical and landscape redistribution
        ii. Available water
        iii. C and nutrient dynamics and landscape distribution/redistribution
        iv. Mineral weathering
        v. other
    d. Soil, soil property, diagnostic horizon, and soil feature genesis and relationship to landforms/landscape attributes

Products/Outcomes:

1. Enhanced data for soils in soil system including spatial variability of selected static and dynamic properties
2. Enhanced understanding and presentation of soil genesis and landscape distribution of soils and their properties in the region
3. Enhanced understanding of soil hydraulic properties including plant available water, seasonal water tables, and landscape redistribution of water
4. Evaluation of applicability of various models for prediction/evaluation of hydraulic properties and nutrient and carbon dynamics
5. Well characterized sites for hands-on training and field experience in mapping techniques, sample design and collection, soil-landscape analysis, and digital and classical soil survey techniques
6. Enhanced understanding of relationships among static soil properties, dynamic soil properties, soil resistance to change, and ecosystem characteristics
7. Functional groupings of soils based on hydraulic properties and/or resistance to change?
8. Evaluation of applicability of digital mapping techniques within region

REFERENCES

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