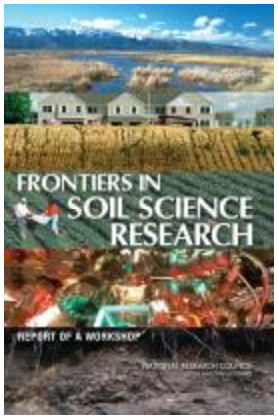

FRONTIERS IN SOIL SCIENCE RESEARCH
Report of a Workshop (2009)

Referred to as Earth's living skin, soil provides support for both natural and human systems. Soil is a biogeochemically dynamic natural resource that supports all critical components of ecosystems. There has been renewed interest in soil and soil science in recent years because of its role in global climate change, land degradation and remediation, the fate and transport of nutrients and contaminants, soil and water conservation, soil and water quality, food sufficiency and safety, global carrying capacity, wetlands function, and many other issues pertinent to the stewardship and conservation of land and water resources. Despite this attention, soil remains an undervalued and underappreciated resource.

Understanding the long-term implications of decreased soil quality and addressing the aforementioned challenges will require new information based on advances and breakthroughs in soil science research that need to be effectively communicated to stakeholders, policy makers, and the general public. A challenge for soil science is the need for interdisciplinary research involving classical soil science subdisciplines—soil chemistry, soil physics, soil biology, soil mineralogy, and pedology. While basic research provides an understanding of fundamental soil processes, increasing trends in land transformations, environmental challenges, and policy issues require interdisciplinary approaches. To successfully address major research needs, soil scientists will have to collaborate with each other and with scientists in related disciplines.

In December 2005 the National Academies convened a workshop, *Frontiers in Soil Science Research*, consisting of experts in soil science and associated disciplines to identify emerging research opportunities and expected advances in soil science, particularly in the integration of biological, geological, chemical, and information technology sciences. More than 120 people from around the world attended the workshop. The speakers and participants in the workshop were asked to address seven key technical questions while also considering the following topics:

- Challenges and priorities within basic soil science research
- Opportunities for inter- and cross-disciplinary research
- Technological and computational opportunities to advance soil science research
- Student and early career training issues

OVERARCHING CHALLENGES FOR SOIL SCIENCE RESEARCH

1. Placing a value on the soil resource. The need to place an economic value on soil and its contribution to ecosystem services became clear during the workshop since it is a critical element in obtaining funding for soil science research. Participants discussed how soil is a resource that provides ecosystem services and plays a key role in environmental quality, but in comparison to water and air, it does not receive the same attention or funding. More is known about water and air since effects of certain actions are directly visible, but relatively little is known about soil, where processes may occur at a slower rate and be invisible to the eye.

2. Integrating research across different spatial and temporal scales. Many participants noted the need for more study on the scaling up of processes. While small-scale research is often interesting and easier to fund, large-scale research is needed to apply the small-scale research to appropriate societal and global issues. The scaling down of research, for example, the effects of global climate change on regions or landscapes, to a more understandable scale is also important.

RESEARCH NEEDS AND OPPORTUNITIES

Workshop participants identified six key areas that offer new opportunities in soil science research:

Ecosystem Functioning. In order to place a value on the soil resource, key ecosystem services provided by soil need to be identified and quantified. Other research needs include developing appropriate indicators of soil function and developing measurements to extrapolate to the ecosystem scale.

Role of Soils in Human Health. The relationship between soil quality and human health needs to be better characterized. This includes relating virus transport and fate to human health and better understanding the linkages between soil quality and water quality and how this affects human health.

Transport Processes. The interactions between soil and the atmosphere, hydrosphere, lithosphere, and biosphere need to be researched and scaled up to global processes.

Plant-Soil-Microbial Interface. Basic research is needed at the plant-soil-microbial interface, including an emphasis on applying modern genomics techniques. The role of the interfaces on nutrient cycling, in contaminant fate, and in the weathering process needs to be characterized.

Coupled Reaction Processes in Soil. There is a need for improved understanding of feedback mechanisms between physical, chemical, and biological processes. Integrating in situ physical, chemical, biological, and imaging techniques may elucidate the coupling of soil processes.

Data Acquisition and Synthesis. Existing databases need to be standardized and synthesized and provide greater access. Modeling across spatial and temporal scales needs to be improved.

OTHER OPPORTUNITIES FOR SOIL SCIENCE RESEARCH

Many participants identified these additional research opportunities and issues:

Research Opportunities Using New or Different Tools and Techniques. Soil scientists can make greater use of existing tools and techniques, such as micro(spectro)scopy and isotopic tracers. Modeling can be improved through more computational capabilities. New tools need to be developed for in situ studies of the soil.

Opportunities for Soil Science in Interdisciplinary Collaborations. Breakthroughs in soil science research could come at the interface of disciplines. Soil scientists were encouraged to consider new models for interdisciplinary collaboration and participate in Earth-observation systems and other new multidisciplinary research initiatives. Such collaboration can help soil scientists relate their research to policy making.

Issues in Student Training. In order to keep a new generation of soil scientists active in the broader scientific community, workshop participants encouraged others to introduce their students to interdisciplinary research opportunities and to collaborate across departments for access to high-tech instruments.

For More Information

Copies of *Frontiers in Soil Science Research: Report of a Workshop* are available from The National Academies Press; call (800) 624-6242 or (202) 334-3313 (in the Washington metropolitan area), or visit the NAP website at www.nap.edu. For more information on the project, contact staff at (202) 334-2807 or visit the U.S. National Committee for Soil Science website at www.nationalacademies.org/usnc-ss.