Climate change has emerged over the past several decades as a scientific and political issue that has both focused our attention on a changing planet as well as distracted us with politics and press coverage too often largely devoid of science. The evidence continues to mount, however, for notable changes ahead in our climate system. Historical changes in our climatology based on empirical data for temperature and precipitation do not suffer from the uncertainties of modeled projections for the future, and the data clearly confirm we have been experiencing novel rates of change in our climate system. It remains factual that greenhouse gas concentrations in the atmosphere are increasing. In 2013 and 2014, we saw the release of the latest climate change assessment reports by the Intergovernmental Panel on Climate Change (IPCC, 2014) for a global perspective and the National Climate Assessment (Melillo et al. 2014) for a national assessment in the United States. In the northeastern U.S., patterns of change in temperature and precipitation in recent decades show a climate system that is warmer and wetter. Considering the projections for greenhouse gas emissions into the future, there are compelling reasons to expect more change in the climate system in the decades ahead. Soil scientists have long been students of the climate system, particularly as one of the five classic soil-forming factors (Jenny, 1941). We often viewed a changing climate through the lens of geologic time as it influenced soil formation. Modern rates of change in the climate system present new opportunities and challenges to soil scientists and our work in service to society.

Paradigms

There is an undeniable momentum in society for a greater appreciation of soils. My general perception of Western society is that this is a real trend beyond the natural and agricultural science communities driven by public demands for improved air and water quality, concerns for droughts and floods, a desire for increasingly healthy and locally sourced foods, the public journey from dirt to soil health, and yes, numerous aspects of a changing climate. The “Dig It!” soils exhibit spent time at the Smithsonian and is currently on tour, the United Nations has declared 2015 the International Year of Soils, and there has never been a broader interdisciplinary collective of people intensely interested in the study of carbon in soils of all ecosystems. Two aspects of this trend I find particularly important and encouraging.

Ecosystem Services

The concept of ecosystem services has gained significant attention and utilization over the past decade, significantly enhanced by the United Nations Millennium Ecosystem Assessment (MEA, 2005) initiative called for by then U.N. Secretary-General Kofi Annan in 2000. For many, this raised our collective consciousness for a much wider array of values that soils provide to society beyond food systems. Comerford et al. (2013), in this publication, did an excellent job summarizing the work of a Soil Science Society of America task force describing the wide array of soil ecosystem services, including economic aspects, and calling attention to key challenges in this area of work. Because of the complex nature in which a changing climatology and soil resources interact, a broad framework like that of soil ecosystem services is essential to encompass the work ahead. We are at once called on to improve soils as we simultaneously draw more intensively on the services they provide.

Long-term Soils Studies

There has been an emerging need to understand soil change over time, particularly soil change on multi-decadal
time scales that reflect environmental and land use policies and increasingly the climate signal. This has resulted in increased attention to long-term soil studies that are essential to support our knowledge of soil function with empirical observations. One example is the work of Dan Richter at Duke University who has worked extensively on this topic and led the development of a global inventory of long-term soil experiments. These studies represent a tremendous resource for us to understand soil change in the 21st century that reflects a wide array of anthropogenic stresses, including a changing chemical and physical climate. Recognition of the importance of long-term soils research resulted in the establishment of the Northeastern Soil Monitoring Cooperative in 2006, with a Steering Committee chaired by Greg Lawrence of the U.S. Geological Survey, designed to “…advance the use of repeated soil monitoring as an indicator of environmental change in the northeastern United States and eastern Canada.” These efforts, combined with soil monitoring activities that are part of various federal programs (e.g., USDA FIA, NSP Vital Signs, NSF LTER, LTREB, and NEON), are increasingly valuable for us to understand contemporary soil change. Coordination among these long-term studies also offers opportunities to identify weaknesses in soil monitoring and assure that critical data, like long-term soil temperature and moisture monitoring, are strengthened. Emerging sensor technologies will be particularly important to the future of this work.

Pragmatism

We may look back on the early 21st century as an era in soil science where the utilization of soils information, and the incorporation of that information into decision-making, moved from the work of specialists to a common endeavor by a much more diverse segment of society. What used to be a somewhat static approach to soils information largely for specialists, such as the National Soil Information System (NASIS), is increasingly becoming more dynamic source of soils information such as the Web Soil Survey (WSS) that puts personalized soils information at our fingertips, not to mention various applications for mobile devices of all sorts that can do the job. As society is rapidly developing strategies and tools to respond to a changing climate, access to and utilization of soils information will be more widely pursued and utilized than possibly any time in the history of the National Cooperative Soil Survey. A contemporary example is the U.S. Climate Resilience Toolkit that provides resources about decision frameworks as well as specific tools to use in this work. If you search the site for soils information, the first on the list of tools is the Web Soil Survey.

Increasing visibility and access to soils information brings with it its own challenges. The practical nomenclature we typically use to convey soils information to users is the soil series or closely related nomenclature. Part of that taxonomy in the U.S. is built on characteristics of the current climate system, such as soil temperature and moisture regimes, and those properties of the environment are rapidly changing. In the northeastern U.S., the National Climate Assessment reported an air temperature increase of ≈2°F in the last century, with an increase in precipitation by ≈10% and dramatic increases in intense precipitation events in the last several decades. How are these changes being incorporated into soil survey information over time? Soil resources are not unique in being influenced by the changing climate system. For example, in 2012 the USDA issued new Plant Hardiness Zone maps in light of the shifting climatology of the U.S.

Ongoing efforts by the NRCS in data quality, like improving the “join” in soil surveys between states, will continue to add value and public confidence in soils information. It seems important for this work to also include information about the interaction between soil nomenclature and the changing climate signal. This could include educating users on how they can interpret possible changes in soil names as they are becoming aware of increasing evidence for the value of utilizing soils information in their decision-making. This may be of particular importance in regions at the boundaries between current soil temperature regimes (Fig. 1) throughout the country because these temperature regime boundaries are undoubtedly on the move.

Fig. 1. Soil temperature regimes of the contiguous United States.

The goal of making soils information dynamic and responsive to user needs is nothing new in the U.S. Quoting from Dick Arnold’s “Soil Survey: Past, Present, and Future” (1999) about the tenets of pedology,

“We believe that sharing pedological knowledge with others is relevant to their making informed land use and environmental decisions. Our mission is to communicate effectively with our customers to help them better understand soils, their properties, functions and behavior.

“We believe it is important to explain the reliability of our knowledge of the pedosphere, its formation, and its responses to changing environmental conditions.”

References


