SUSTAINABILITY

USGS Goals for the Coming Decade

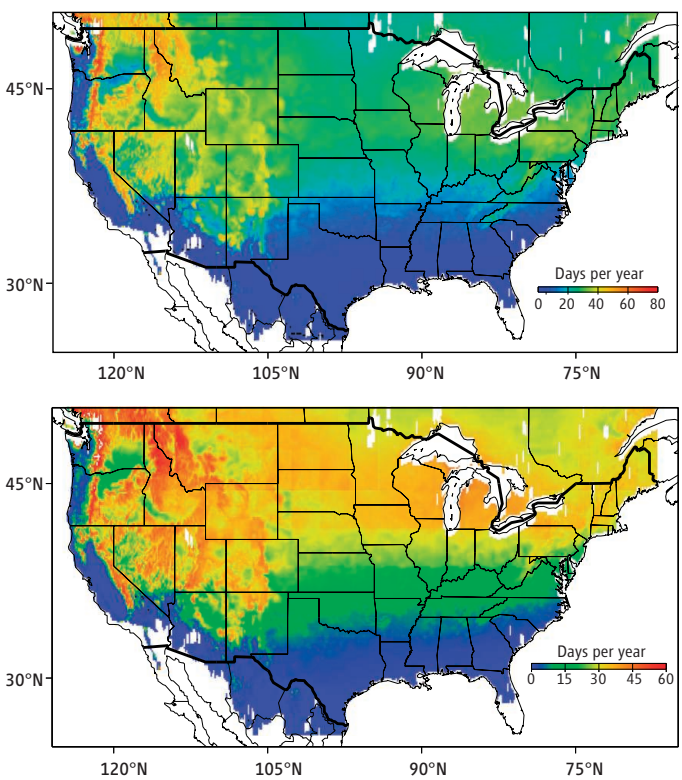
The U.S. Geological Survey (USGS) proposes six strategic directions for managing ecosystems along with modernization of observation networks of land, water, and biological resources.

M. D. Myers,[1]* M. A. Ayers,* J. S. Baron,* P. R. Beauchemin,* K. T. Gallagher,* M. B. Goldhaber,*† D. R. Hutchinson,* J. W. LaBaugh,* R. G. Sayre,* S. E. Schwarzbach,*† E. S. Schweig,* J. Thormodsgard,* C. van Riper III,* W. Wilde*

The United States and the world today face formidable challenges that have major implications for priorities in the conduct and direction of natural science, particularly government-sponsored science. With these challenges in mind, the U.S. Geological Survey (USGS) proposes six integrated multiscale strategic directions that will help the United States address complex environmental problems (*1*).

What sets this plan apart from previous efforts is a vision of integration across and among each of the science directions. For each, we will take a systems approach to evaluate broad causes and consequences of the use and management of natural resources and earth processes. This vision will be fostered by the integration of the talents of the USGS workforce of biologists, hydrologists, geologists, and geographers. The six directions described below are mutually reinforcing and ecosystem-based. They build upon, rather than supplant, existing areas of expertise within the USGS.

Understanding ecosystems and predicting ecosystem change. USGS will develop and convey a fundamental understanding of ecosystem distributions and their components and dynamics. In addition to forming a scientific basis for managing ecosystems, the information, understanding, methods, and approaches will serve as a critical underpinning for all other USGS science directions. To make these measurements, we will expand and modernize observing networks by colocating biological, biophysical, and biogeochemical measurements. USGS will systematically characterize the distribution, interactions, condition, and conservation requirements of organisms in terrestrial, freshwater, and coastal/ marine environments. We plan to provide a variety of services including maps, regular updates on the status and trends of species and resources, and plausible forecasts of potential shifts in environmental conditions. Data holdings indexed by subject, place, and time will be made available through Internet portals.



By documenting the number of days historically close to freezing, USGS has begun mapping vulnerability to warming. (**Top**) Number of days per year with mean temperatures between 0°C and –3°C (1950–1999) (*3*). (**Bottom**) Number of new days above freezing projected to occur at different degrees of warming, with probability-weighted distribution as determined from an ensemble using 18 projections in various climate models (*4*). Knowledge about how climate change affects seasonal snowpacks is used to forecast future changes in timing and amount of river flow and other ecological responses by vegetation and wildlife that rely on snow for moisture and habitat.

Climate variability and change. The USGS will build on its strengths in paleoclimatology and past interactions of climate with landscapes and ecosystems and apply the knowledge gained to understanding potential future states and processes. Expanded and modernized USGS observing networks of land, water, and biological resources will be crucial to rigorous analyses of future responses of biological organisms, hydrological conditions, and ecosystem conditions to climate change. The USGS will increase its capability to provide output from predictive and empirical models for managers to test adaptive strategies, to reduce risk, and to increase the potential for hydrological and ecological systems to be self-sustaining, resilient, or adaptable to climate change and related disturbances. Coupled modeling and long-term monitoring in the western United States already show strong responses of ecosystems, streamflow dynamics, and sea level to climate change and variability; results that have been put to use for setting climate-change policy in California. Although some findings have been applied in the past, the expanded effort will extend capabilities across the United States in response to the need of management agencies.

Energy and minerals for America's future. USGS will move beyond documenting the origin and occurrence of today's dominant mineral and hydrocarbon resources to a global-scale interdisciplinary research approach. We will expand the portfolio of commodities addressed and will assess the flow of materials through our economy, as well as their impacts on the environment. The result will be an enhanced understanding and evaluation of how the complex "life cycle" of occurrence, genesis, extraction, use, and waste influence, are influenced by landscape, hydrology, climate, ecosystems, and human health. USGS will integrate assessments of energy resources such as geothermal, gas hydrates, and oil shale with the consequences of developing and using fossil and alternative fuels, including

[1]Director, U.S. Geological Survey, USGS National Center, Reston, VA, 20192, USA; *Science Strategy Team Authors in alphabetical order.

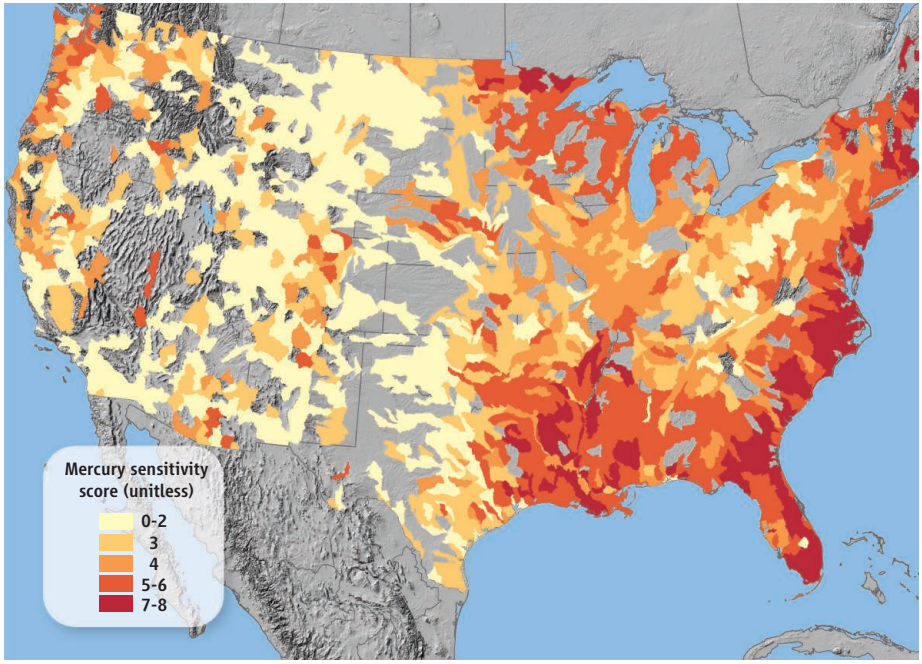
†Author for correspondence. E-mail: mgold@usgs.gov

Published by AAAS

changes in atmospheric carbon dioxide levels, land-use change, and climate change. USGS will expand existing research efforts on the carbon cycle and carbon sequestration in geological and biological reservoirs.

A national hazards risk and resilience assessment program. The risk to society and environment of the combined effects of such natural hazards as coastal erosion, earthquakes, floods, geomagnetic storms, landslides, tsunamis, volcanoes, wildfires, and zoonotic diseases will be assessed and communicated. USGS will also address the influence of climate variability and change on the frequency and intensity of natural-hazard events. Accurate forecasts and predictions of hazard losses depend on a thorough understanding of the processes controlling hazard occurrence, distribution, timing, and severity, as well as the effects of the hazard on the landscape, built environment, and human safety. USGS will expand its present strength in hazard process research to advance improvements in forecasting probabilities of hazards, as well as to improve understanding of societal vulnerabilities to hazards. Reduction of losses from natural hazards requires the best information about hazards themselves, as well as an understanding of risk and the cost effectiveness of mitigation and response strategies. It also requires commitment and involvement with communities. USGS will increase efforts to communicate how communities are at risk from natural hazards, about what makes communities more resilient to extreme events, and about ongoing changes in the environment that relate to natural hazard vulnerability.

The role of environment and wildlife in human health. USGS scientists have a longstanding multidisciplinary focus on environmental aspects of human health. USGS scientists are among the world's experts on wild-animal disease transmission to humans, drinking water contaminants, air-dust-soil-sediment-rock contaminants, pathogens in recreational water, and the use of wild animals as sentinels for human health. USGS is the primary governmental agency responsible for wildlife research and has, for example, been heavily involved in tracking bird deaths from West Nile virus. It has worked in close collaboration with the U.S. Department of Agriculture to monitor and assess the potential for Avian Influenza introduction to the United States by migratory birds. USGS scientists also conducted the first national reconnaissance of emerging contaminants such as pharmaceuticals, hormones, and other organic wastewater contaminants in our streams. What has been lacking is a systematic organization and communication of these data in a human health context. USGS proposes to develop an online data atlas of potential environmental health threats and to develop a periodic reporting of how conditions are changing at the national and regional level.



A nationwide mercury-sensitivity map is being developed at USGS for aquatic ecosystems in the contiguous 48 states. On this map, greater scores represent more sensitive ecosystems. The primary route of methylmercury exposure for both people and fish-eating wildlife is mercury in fish. This map is derived from more than 55,000 water-quality sites and 2500 watersheds. [USGS mercury information (*5*)]

A water census for the United States. The USGS will develop a National Water Census for the first time in 25 years to meet the need for a comprehensive, scientific accounting of the status and trends in freshwater quantity and quality for human and ecological needs of the nation.

The USGS water census will focus on the 21 water-resource regions of the United States, including their watersheds and associated aquifers (*2*), as well as offshore extents. Each region has local and regional aspects of water supply and demand that must be considered in determining where the water is located, how much fresh water is present, the quality of that water, the amount of water used, and if that supply of fresh water is stable, increasing, or decreasing. New research will better define the characteristics of watersheds and aquifers that constrain how much water can be stored, transmitted, and used for societal or environmental purposes. New directions will include estimates of water use and water availability, as well as quantification of the dynamic freshwater resource needs of aquatic ecosystems and their biota. The water census will inform the public and decision-makers about forecasts of likely outcomes for water availability, water quality, and aquatic ecosystem health caused by changes in land use and land cover, natural and engineered infrastructure, water use, and climate change.

Conclusions. Initial steps toward implementing the six strategic directions can be made with existing funding, but the realization of the full benefits to the nation will require an infusion of new resources. The benefits to the nation will be substantial. Sustainability not only requires that scientists document the condition and trends of Earth's resources, but also implies that scientists effectively inform nonscientists on the drivers of change so that society may effectively manage natural resources and can avoid crossing thresholds leading to disasters. The USGS chooses the above science directions because they are critically important and will require the best of the organization to fulfill, and because we believe these are the science directions that can and must provide information for resolving some of the most critical natural resource challenges facing the nation and the world.

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10.1126/science.1147228

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