DEPARTMENT OF THE INTERIOR

Principal Areas of Focus

Department of Interior (DOI) / U.S. Geological Survey (USGS) research and observations contribute directly to CCSP strategic goals, principally through integrated multidisciplinary data-collection networks and studies designed to understand the interactions between climate, earth surface processes, and ecosystems on time scales ranging from years to millennia. By combining the expertise of hydrologists, geologists, biologists, geographers, and remote-sensing scientists within one organization, USGS supports truly interdisciplinary research and assessment of trends in resource condition in the following major focus areas:

- Studies of climate history and impacts on landscapes and ecosystems
- Hydrologic impacts of climate change
- Carbon cycle science
- Land-use and land-cover changes
- Decision-support research and development.

The goal of global change research at USGS is to improve knowledge and understanding of the Earth's past and present climate and environment, the forces bringing about changes in the Earth's climate, and the sensitivity and adaptability of natural and managed ecosystems to climate changes.

Program Highlights for FY 2009

USGS is beginning a focused effort to develop decision-support tools for policymakers and resource managers to assess our ability to cope with and adapt to the various effects of climate change. The USGS Climate Effects Science Network (CESN)—coordinated through all DOI resource management Bureaus—will integrate climate- and environmental-change data sets with conceptual and digital models across disciplines including remote sensing, geography, geology, biology, and hydrology to better understand impacts to natural resources, agriculture, and human populations on episodic to decadal and millennial time scales, local to global spatial scales, and weather to climate process scales. The goal of the network is to develop a systems-level understanding of biogeochemical processes resulting from changes in climate, to link these changes to the sustainability of ecosystems, wildlife, subsistence cultures, and societal infrastructure, and to apply the knowledge gained for decision support. USGS is in a unique position in the Earth science research and applications community because of its ability to leverage and integrate research and monitoring results across the Earth system science disciplines with *in situ* data collection capability, space-based and airborne observational platforms, high-end computing capabilities, data and information management systems, and decision-support tool development.

Monitoring, understanding, assessing, and predicting changes in Earth processes and the associated impacts to decisionmaking will be a central focus of CESN during its initial development within the Global Change Program and will continue as the focus for the network through 2009 and beyond. For example, individual USGS programs and projects such as the MIT-USGS Science Impact Collaborative (MUSIC) and the Policy Analysis and Science Assistance Branch of USGS's Fort Collins Science Center are developing decision-support tools from monitoring data sets, research results, and model projections that are products of the network. In 2008, USGS initiated a pilot integrated research area in northern Alaska, where permafrost thaw and sea-ice melting are resulting in rapid and poorly understood

changes to regional ecosystems. In 2009, USGS will expand collaborations with the above-mentioned and similar programs across the Federal, State, and academic sectors to develop a nationally integrated network that will provide state-of-the-art environmental observations, research, and applications. The main objective of this initiative will be the development of cost-effective strategies for adaptation to and mitigation of the effects of climate change through the creation of science-based decision-support tools and, in the longer term (next 2-3 years, 2009-2011), decision-support systems.

USGS Global Change Programs

Earth Surface Dynamics

The Earth Surface Dynamics (ESD) program is USGS's primary provider of scientific information on past climates and their implications for Earth and human systems. ESD has the following specific research objectives:

- Document the nature of climatic and environmental change and variability on time scales ranging from years to millennia
- Develop fundamental understanding of interactions between climate, earth surface processes, and marine and terrestrial ecosystems on time scales ranging from years to millennia
- Seek to understand impacts of climate change and variability on landscapes and marine and terrestrial systems
- Model and anticipate the effects of climate change and variability on natural and human systems
- Provide information on the relative sensitivity, adaptability, and vulnerability of ecosystems, resources, and regions to climatic change and variability to support land and resource management and policy decisions.

Research to understand Earth surface processes and climate change impacts provides both rigorous background science and perspectives on consequences for policymakers and for use by land and resource managers. Research activities include projects that study past climates and environments, investigate the effects of past and present climate change and climate variability on landscapes and ecosystems, study the processes involved in landscape change, and forecast the effects of climate change and variability on landscapes and ecosystems.

Investigations of climate and environmental history are conducted in a wide range of locations to ensure that the program provides policy-relevant information on past climatic conditions for a wide range of ecosystems and landscapes. Projects range in location from the North Slope of Alaska to the southwestern United States, from the Mississippi Valley to the Everglades, and from the Channel Islands to the Chesapeake Bay. Many of these projects provide information on such factors as land use, erosion and sedimentation, and thawing permafrost, and the implications and impacts of these to directly support land and resource management decisions. Partners and customers include Federal land management agencies (including the Fish and Wildlife Service, National Parks Service, the U.S. Forest Service, and the Bureau of Land Management), other Federal agencies (including NOAA and NSF), State governments and consortia, international partners (including the Canadian government and Canadian federal agencies), universities and university scientists, tribal organizations, and non-governmental organizations such as the Chesapeake Bay Program.

Geographic Analysis and Monitoring

Research is directed to the understanding of the rates, causes, and consequences of landscape change over time. This knowledge is used to model processes of landscape change and to forecast future

conditions. Studies are designed to document and understand the nature and causes of changes occurring on the land surface; to assess the impacts of land surface changes (including urbanization) on ecosystems, climate variability, biogeochemical cycles, hydrology, and human health; and to develop the best methods to incorporate science findings in the decisionmaking process.

Hydroclimatology

Research on effects of climate change and variability on the hydrologic cycle focuses on characterizing, and developing predictive methods related to, the hydroclimatology of North America. This includes identification of seasonal variations in regional streamflow in relation to atmospheric circulation (for regional streamflow prediction and flood/drought hazard assessment); the linkage between atmospheric circulation and snowpack accumulation (for forecasting spring and summer water supply in the western United States and for flood forecasting), as well as glacier mass balance; and the physical and chemical variability in riverine and estuarine environments in relation processing occurring in their contributing watersheds, and to large-scale atmospheric and oceanic conditions (to discriminate natural from human-induced effects on such systems). It also includes documenting the long-term behavior of hydrologic systems in response to past climatic variations and changes (from decades to hundreds of thousands of years) as well as more recent (decadal) hydrologic trends. The program maintains an active effort to develop improved representations of terrestrial hydrologic processes in general circulation and regional climate models. In broad terms, these activities are aimed at improving statistical and deterministic methods for predicting hydrologic hazards and related environmental conditions on monthly to interannual time scales.

Carbon Cycle

USGS conducts a broad range of carbon cycle research focused on North America, which includes:

- *Assessment of Carbon Stocks and Soil Attributes*—Determining the spatial distribution of carbon in the terrestrial environment in relation to historical natural and human processes, as a basis for initializing dynamic models of soil carbon. Measuring soil chemistry has focused on the Mississippi and Delaware River basins, the latter in collaboration with the USDA Forest Service Forest Inventory and Analysis Program.
- *Carbon Sequestration in Sediments*—Studying the re-deposition of eroded soils and sediments (and their associated organic carbon) which sequesters large quantities of carbon, buried at the base of slopes and in wetlands, riparian areas, and reservoirs.
- *Carbon Sequestration in Wetlands*—Field and laboratory process studies, spatial analysis, and modeling are being used in wetlands of the Lower Mississippi River Valley and the Prairie Pothole Region to quantify the influence of land-use change on carbon sequestration and greenhouse gas emissions and to identify environmental factors controlling carbon sequestration. These studies will provide recommendations and decision-support tools to resource managers to maximize carbon sequestration benefits consistent with DOI goals for restoration of ecosystem services such as habitat, flood storage, and water quality.
- *Landscape Dynamics and Vegetation Change*—Examining the long-term dynamics of vegetation change in relation to climate change and variability. A detailed history of vegetation change in the western United States is being constructed. Past changes are used to model vegetation response to climatic variables. This knowledge is applied in forecasting the effects of future climate change on the distribution of vegetation in the western United States.
- *Fate of Carbon in Alaskan Landscapes*—Expanding process studies and modeling to better understand both the historic and modern interactions among climate, surface temperature and moisture, fire,

and terrestrial carbon sequestration. Cold region forests (boreal ecosystems) contain large carbon reserves that are highly susceptible to changes in climate.

- *Exchanges of Greenhouse Gases, Water Vapor, and Heat at the Earth's Surface*—Employs field measurements, remote sensing, and modeling of carbon fluxes to develop estimates of gross primary productivity, respiration, and net ecosystem exchange at flux tower sites, and uses remotely sensed data to extrapolate these carbon fluxes to ecoregions.

Changes in Ecosystems

USGS global change research on ecosystems aims to determine the sensitivity and response of ecosystems and ecological processes to environmental factors, including existing climate and natural and anthropogenic impacts, at the local, landscape, regional, and continental level; to assess and predict how future environmental conditions may affect the structure, function, and long-term viability of natural and human-impacted ecosystems; and to provide scientific knowledge and technologies needed for conservation, rehabilitation, and management of sustainable ecosystems. Current USGS ecosystems research focuses on:

- The relative sensitivity of biological resources and geographic areas of the Nation to global changes in order to detect early changes and to prioritize action
- The causal mechanisms underlying ecosystem responses to global change
- The role of scaling in understanding and managing the spatial and temporal responses of biological systems to global change
- Development and testing of management options for adapting to the effects of global change and minimizing undesired effects of global change.

Satellite Data Management and Dissemination

USGS operates and continually enhances the capabilities of the Center for Earth Resources Observation System (EROS) to serve as the National Satellite Land Remote-Sensing Data Archive, by maintaining existing data sets, adding new ones, and converting older data sets from deteriorating media to modern, stable media. The archive's holdings are used for environmental research, land management, natural hazard analysis, and natural resource management and development with applications that extend well beyond U.S. borders. The worldwide community of archive users includes personnel in Federal, State, local, and tribal governments, researchers at academic institutions, private enterprise, and the public.

Land Use and Land Cover

The Land Cover Characterization Program was started in 1995, to address national and international requirements for land-cover data that were becoming increasingly sophisticated and diverse. The goal is to be a national and international center for excellence in land-cover characterization, via:

- Development of state-of-the-art multiscale land-cover characteristics databases used by scientists, resource managers, planners, and educators (global and national land cover)
- Contribution to the understanding of the patterns, characteristics, and dynamics of land cover across the Nation and the Earth (urban dynamics and land-cover trends)
- Pursuit of research that improves the utility and efficiency of large-area land-cover characterization and land-cover characteristics databases
- Serving as a central facility (Land Cover Applications Center) for access to, or information about, land-cover data.