DYNAMICS OF WATER PROCESSES IN THE ENVIRONMENT

Goal: Increase our fundamental understanding of the Earth's freshwater systems and provide the scientific basis for decision-making about water resources.

Description and Scientific Rationale: One of our greatest environmental challenges is to ensure an adequate supply and quality of water for human use while maintaining the integrity of natural ecosystems. The economic vitality of the Nation relies on fresh water for agriculture, energy, manufacturing, and other industries. Understanding water dynamics is essential to understanding climate and environmental change. At multiple scales of time and space, water connects physical, geochemical, biological, and ecological processes. Water also links and integrates natural systems with human social systems. Nonetheless, there are many gaps in our basic scientific understanding of water dynamics and the impacts of human interventions and changing environmental conditions on them. Addressing this challenge will require integrated, multi-disciplinary, multi-scale research on the *Dynamics of Water Processes in the Environment*.

The NSF investment will:

- Promote fundamental research on the complex processes and feedbacks that affect the vulnerability and resilience of freshwater systems to climate and environmental change.
- Develop innovative, transferable concepts and models that can contribute to improved risk assessment, and mitigation and adaptation strategies; and to enhance decision-making in uncertain conditions.
- Enhance our ability to model complex freshwater systems from local to regional scales taking advantage of advanced observation networks, cyberinfrastructure, and integrated large databases.
- Develop a new generation of science and engineering investigators who are prepared to solve interdisciplinary problems in this field of research.
- Pursue new approaches to water re-use, conservation, and sustainability.
- Provide educational opportunities for students and the public.

The National Science Foundation draws scientists, engineers, and educators from across traditional boundaries to enable breakthrough research needed for better understanding of complex water systems and processes. Activities such as the Long Term Ecological Research program, the Critical Zone Observatories, the Coupled Natural and Human Systems program, and certain centers and collaboratories supported by the Biological Sciences, the Geosciences, Engineering, and the Social and Behavioral Sciences are well positioned to contribute to interdisciplinary research focused on these goals. Through NSF's excellent relationships with mission agencies that have responsibilities for water monitoring and management, the impact of NSF research is broadened for maximum outreach to stakeholders.

Potential for Impact: Improved knowledge of the Earth's water system is necessary for a robust economy and for our very survival. It is central to questions of the environment and climate change. It is essential for reliable forecasting related to agriculture, fisheries, energy production, human health, transportation, manufacturing, and waste management. NSF investment in this area responds to these national needs and transforms our understanding of freshwater systems.

Integration of Research and Education: Research on the Earth's water systems has appeal for students and the public, and this research will provide tremendous opportunities for collaboration, integrative training, and public outreach at the intersection of science and policy. This activity will promote institutional and educational curricular change that reflects the integrated aspects of environmental science and engineering.

Leveraging Collaborations: There are abundant opportunities for partnerships between NSF and other agencies, including the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA), the U.S. Department of Agriculture (USDA), the U.S. Environmental Protection Agency, and especially with the United States Geological Survey (USGS). USGS is a mission agency focused on providing reliable scientific information to better manage the Nation's natural resources, including water, and to minimize loss from natural disasters. Both NSF and USGS support tools and infrastructure in the form of observatories, networks, databases, and cyberinfrastructure. An example of a current collaboration is the Hydrologic Information System (HIS) developed at the University of Texas. This web-based system draws data from a myriad of digital hydrologic databases into a common format, enabling researchers to have easy access to data collected and stored by the USGS and other agencies. A new effort at this time will leverage the interest of the USGS to partner with NSF in this area. Working with them, other agencies, and the scientific community will clarify gaps in current understanding that are ready for exploration, consolidate partnership opportunities, and inform NSF's focus on fundamental research on water processes.

Urgency and Readiness: Drought and flooding were major news items in the past year, as were forest fires and landslides. These events focused public attention on their overwhelming economic impacts and highlighted the need to better understand how water systems determine the severity of these phenomena. Federal agencies must act quickly and in a focused effort to improve our understanding of the Nation's freshwater (e.g., reports of Science and Technology to Support Fresh Water Availability in the United States, OSTP-OMB Memorandum of 23 June 2006, OSTP-OMB Memorandum of 14 August 2007). In addition, water will be a key factor limiting the development of biofuels as energy alternatives.

Evaluation and Management: Assessment of the outcomes of this activity will be conducted through community workshops, principal investigator (PI) meetings, and Committee of Visitors reviews. In addition, Advisory Committees for the Geosciences, Biological Sciences, and Environmental Research and Education will help ensure that this activity meets its goals. The program will be successful if external evaluators judge that it has identified critical areas for future fundamental research and education, supported activities in those areas, built partnerships with other agencies that leveraged resources, was effectively and efficiently managed, defined a program with the potential to transform our understanding of the Earth's freshwater systems, and lead to innovations in water management and policy.

Funding: The Request is for $10.0 million in FY 2009.