

The Freshwater Imperative: Water and Watersheds at the National Science Foundation

by

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Five years ago, a group of federal and private sector scientists launched an effort to further environmental sustainability of inland aquatic systems. This effort, known at first as the Freshwater Initiative, and later as the Freshwater Imperative, has the near-term objective of promoting interdisciplinary and institutional cooperation to improve our understanding of freshwater systems in the context of environmental change.

Freshwater problems integrate research challenges with human needs and they reflect the global urgency of many strategic, socioeconomic and environmental crises. Issues of water availability (quantity, quality, timing), aquatic ecosystem integrity, and human health and safety provide the framework for FWI efforts.

The FWI is represented by a coalition of aquatic professionals from the federal government, academia and the private sector. Within the federal government an *ad hoc* Coordinating Council² is comprised of individuals from the Departments of Energy, Interior, Defense, and Agriculture; NASA; NOAA; EPA; NSF; and the TVA. In addition to this group, a steering committee³ of academicians and resource managers coordinates communication with many aquatic science societies, consortia, and non-governmental organizations. The FWI Coordinating Council works closely with formal federal coordination bodies such as the Subcommittee on Water Resources and Coastal and Marine Environments of the Committee on Environment and Natural Resources⁴. The FWI coalition is pursuing or planning a variety of activities in four parallel areas of emphasis: **Science, Information Management, Decision Maker's Needs, and Education and Outreach.**

The FWI Research Agenda (Naiman et al. 1995) is the first tangible product of the FWI effort, and is described in another article in this issue of *Water Resources Update* (Magnuson et al). By prioritizing research needs, outlining needed connections between research and management, and recommending implementation options, the FWI Research Agenda is poised to have a very positive effect on the science and engineering that underpin decision making in the policy and management spheres. The Agenda also helps to frame important fundamental research needs in the integrated context of

people, institutions and ideas -- three elements that too often are considered separately.

While the FWI effort was growing and developing, several staff at the NSF were convinced that there was a need within the agency for new and more flexible institutional arrangements for the freshwater science fields (Firth and Wyngaard 1993). The NSF had recently established a program in Hydrologic Sciences⁵, but many other Divisions across the Foundation supported freshwater work in less visibly-freshwater programs (e.g. Ecosystem studies, Ecology, Climate Dynamics, Biological Oceanography, International Programs, Polar Biology and Medicine, and several others). Coordination between these programs did occur--typically bilaterally--but the research community interested in developing interdisciplinary or systems-approach proposals was met with a confusing array of programs, none of which seemed appropriate to support this type of research.

During planning for NSF's fiscal year 1995 (FY95) environmental research initiative, Water and Watersheds was selected as a focus area. A number of NSF Divisions began planning to leverage their resources to put together a small competition in this area for FY95. The draft FWI Research Agenda was very useful in defining specific areas for consideration in this competition.

At the same time, the NSF and the Environmental Protection Agency (EPA) began developing plans for a partnership to support extramural, investigator-initiated, peer-reviewed research in the environmental sciences and engineering. The Water and Watersheds topic was one that was brought to the table for consideration by the two agencies for joint support. By the time the Memorandum of Understanding between NSF and EPA was signed in early December 1994, Water and Watersheds had been selected as one of three areas in which the agencies would cooperate in funding research for FY95⁶. In February 1995, an Announcement of Opportunity entitled NSF/EPA Partnership for Environmental Research was released (NSF 95-48). The Water and Watersheds competition is described in this announcement⁷.

The goal of the Water and Watersheds competition is to develop an improved understanding of the natural and

anthropogenic processes that govern the quantity, quality, and availability of water resources in natural and human-dominated systems, and an understanding of the structure, function, and dynamics of the terrestrial and aquatic ecosystems that comprise watersheds. The research is expected to help provide the foundation for conducting assessments of the relative risks faced by the nation's aquatic resources as well as options for management activities to remediate existing problems and reduce future risks.

The Water and Watersheds competition is intended to support research that cuts across a variety of disciplines and aims at elucidating important principles for understanding, protecting, restoring and wisely managing water resources and watershed processes in the U.S. and in other regions of the world. The intent is to help develop the intellectual infrastructure necessary to enable advances in our understanding of water and watersheds.

The announcement highlights four objectives:

- 1) To develop an enhanced predictive understanding of the processes and mechanisms that govern the dynamics and properties of surface and subsurface water and watershed ecosystems.
- 2) To provide the knowledge base necessary to better understand human factors affecting water and watersheds and to create management strategies by which these systems can provide for environmentally sustainable economic and social development.
- 3) To assess and integrate information on water and watersheds and the needs of management and policy decisionmakers as a base for developing comprehensive models and identifying areas where improved understanding is needed.
- 4) To improve understanding of the impacts of extreme events such as floods, droughts, and hurricanes on continental and coastal ecosystems and the means to mitigate effects of these events through better planning and use of preventive measures.

In addition, the announcement lists several areas of study that have been identified (by the FWI Research Agenda or other sources) as current needs:

- * Diagnosing the causes of environmental damage (including the combined, cumulative, and synergistic effects of chemical, physical, biological, and human stressors), developing predictive capabilities for specific restoration practices, and determining realistic environmental characteristics of rehabilitated or restored systems.
- * Linking documentation of biodiversity to an understanding of the importance of different species and ecological processes to human society and to ecosystem structure and function, especially in the context of biotic and abiotic manipulations, and invasions of exotic species.
- * Exploring the hydrological and chemical processes and mechanisms governing the behavior of nutrients, metals, microorganisms, and pollutants within and among surface waters, groundwaters, and soils, and developing models to predict transport, biogeochemical transformations, and solute/solid interactions.
- * Identifying and researching indicator variables, analytical methods, and other tools for determining waters and watersheds at risk and reducing the uncertainties of extrapolating information across broad spatial and temporal scales.
- * Interpreting relationships between populations and communities of organisms and the quality and quantity of water, particularly as these relate to ecosystem processes, land use patterns, and landscape structure.
- * Understanding the physical, biological, and socioeconomic legacies of extreme events and other disturbances, and their influence on future environmental conditions and the directions and rates of response of watershed ecosystem structure and function.

NSF's Strategic Plan⁸ underscores the advantages that result from advances in understanding, and it emphasizes the principles that have guided the Foundation from its beginning -- excellence, openness, stewardship, and impact on society. One of the long-range goals that the plan articulates for the NSF is to promote the discovery, integration, dissemination, and employment of new knowledge in service to society. NSF is committed to devoting a significant and balanced portion of its

portfolio to areas of strategic importance to the Nation. The Water and Watersheds competition is part of such a strategic area.

Water at the surface of the earth structures the physical landscape, is a central feature of climate, and exerts major influences on social, economic, and demographic patterns. The aquatic portions of watersheds are intimately coupled to the surface and subsurface terrestrial environment, to groundwater, to adjacent coastal environments, and to the overlying atmosphere. Human population pressures have made access to clean water and healthy watershed ecosystems paramount environmental issues in the U.S. and throughout the world.

The integrated nature of water and watersheds provides a strong rationale for supporting interdisciplinary science and engineering research that uses a systems approach. The development of a competition that embeds freshwater research in a systematic context has been an exercise characterized by persistence, cooperative leveraging, and trust. And serendipity. The near-term success of the endeavor will depend on effective management by the agencies involved, as well as the character and quality of the research proposals supported. The inspiration of human concern and the excitement of discovery that will be joined in Water and Watersheds research will help advance the goals of the NSF and the cause of the Freshwater Imperative.

In a larger context, the driving forces behind the Freshwater Imperative will not ease as we move into the next century. The complexities of a globalizing economy, a burgeoning population, unpredictable technological breakthroughs and a bewildering array of lifestyle choices all focus us on innovation and integration. There is no single "top-down" solution to the issues of fresh water. There is only an imperative: We need vision, leadership, cooperation, and knowledge.

Endnotes

¹ Any opinion, findings and conclusions or recommendations expressed in this paper are those of the author and do not necessarily represent the views of the National Science Foundation.

²Currently chaired by the author (pfirth@nsf.gov); the executive secretary of the group is Dr. Bill Chang of NSF (sychang@nsf.gov).

³Currently led by Dr. Bob Naiman of the University of Washington (naiman@u.washington.edu) and Dr. Gene Likens of the Institute of Ecosystem Studies (cacw%marist@vm.marist.edu).

⁴The CENR is a committee of the National Science and Technology Council.

⁵The Program Director for the Hydrologic Sciences Program is Dr. L. Douglas James (ldjames@nsf.gov).

⁶The other two areas are Technology for a Sustainable Environment, and Valuation and Environmental Policy (NSF 95-48).

⁷Support for the Water and Watersheds competition in FY95 is expected to be at least \$10 million. The projected award range is \$75,000 to \$500,000 per award per year, with an approximate duration of 2 to 3 years.

⁸NSF 95-24

Literature Cited

Firth, P. and G. Wyngaard. 1993. Limnology support at the National Science Foundation. Bull. Ecol. Soc. Amer. **74**(2):170-175.

Magnuson, J.J., R.J. Naiman, P. Firth, D.M. McKnight and J.A. Stanford. 1995. The Freshwater Imperative: A Research Agenda and Beyond. Water Resources Update (this issue).

Naiman, R.J., J.J. Magnuson, D.M. McKnight, and J.A. Stanford. 1995. The Freshwater Imperative: A Research Agenda. Island Press, Covelo, CA. 200p.

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