

## **INTEGRATED HYDROLOGIC SCIENCE AND ENVIRONMENTAL ENGINEERING OBSERVATORY: THE CLEANER VISION FOR THE WATERS NETWORK**

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With increasing population and urban development, societies grow more and more concerned over balancing the need to maintain adequate water supplies with that of ensuring the quality of our surface and groundwater resources for the protection of both human and environmental health. Common practices associated with modern living often negatively impact the environment. For example, commercial fertilization of agricultural fields and the use of confined animal feeding lots for raising livestock can result in significant run-off of nutrients and microorganisms into nearby surface and ground waters. In some cities, untreated (or minimally treated) stormwater, containing substantial loadings of pathogens, nutrients and chemicals, is discharged into the nearest body of water. Along major rivers around the world, drinking water intakes are located downstream from wastewater treatment plants and industrial dischargers. In some cases, two or more of these stressors are impacting the same waterbody. Mitigating just one of these situations often depends on understanding how it relates to others and how stressors can vary in temporal and spatial scales. And because many of these issues are tied to where people choose to live and how they earn their living, scientists and engineers also must factor in the social and economic impacts, not just environmental science, when considering solutions to these problems.

To begin to understand these complex situations, scientists and engineers need to collect and integrate real-time data from watersheds, rivers, estuaries, coasts and cities throughout the country. Environmental engineering needs to integrate information from the laboratory or single field sites with information from larger scale, more geographically diverse, observatories in order to solve modern environmental problems. It is only now with the advent of grid computing, new data-mining techniques, and novel wireless sensors, that researchers are finally in a position to begin to answer cutting edge research questions about multiscale, spatio-temporally distributed hydrologic and environmental phenomena.

The goal of CLEANER (Collaborative Large-Scale Engineering Analysis Network for Environmental Research) is to transform and advance the scientific and engineering knowledge base in order to address the challenges of complex, large-scale, human-stressed environmental systems. As early as 2001, scientists and engineers began to discuss the need for such a network in order to enable them to better understand human-dominated environmental systems, their stressors, and the links between them. The idea of CLEANER evolved over the next four years as the Environmental Engineering Program at NSF sponsored workshops and a national symposium to gather community

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input. Preliminary paper studies were also conducted on the cyberinfrastructure and field facilities that would be needed to make this network operational. These community-wide discussions culminated in July 2005 with an NSF award of \$2 million to a coalition of 12 institutions, led by the University of Illinois at Urbana-Champaign (UIUC), to establish the CLEANER Project Office. The project office is co-directed by Barbara Minsker of UIUC, Charles Haas of Drexel University, and Jerald Schnoor of the University of Iowa. The goal of this NSF Project Office effort is to devise a plan for a national network of hydrologic and environmental observatories where scientists and engineers from multiple disciplines interact in gathering data and posing and testing hypotheses. Over the next year the project office, in coordination with CUAHSI (Consortium of Universities for the Advancement of Hydrologic Science, Inc.), will work together to develop the preliminary program plan for a **WATER and Environmental Research Systems Network (WATERS Network)**, which is envisioned to be a collaborative scientific exploration and engineering analysis network, serving the needs of both the hydrologic science and environmental engineering research communities. This program plan will identify the cutting edge research questions that the WATERS Network could address, as well as a network design that includes research and education plans, timelines, milestones, and the scope of facilities, resources, and research required for its ultimate success.

From the CLEANER perspective the grand environmental challenge facing the WATERS Network is how to better detect, predict, and manage the effects of human activities and natural perturbations on the quantity, distribution, and quality of water in near real time (CLEANER, 2006). Shifts in population and land use, changes in energy, water, and material resource use, and human-induced climate change are some of the critical human activities that are affecting our ability to sustainably manage our water resources. By developing the capacity to detect the effects of these drivers on the quantity, distribution and quality of water, the CLEANER Project Office envisions that the WATERS Network will foster collaboration among engineers, natural and social scientists, educators, policy makers, industry, nongovernmental organizations, the public, and other stakeholders via four main components:

- A network of highly instrumented research field facilities for acquisition and analysis of environmental data;
- An environmental cyberinfrastructure that provides data archives and information technology for engineering modeling, analysis and visualization of data;
- Multidisciplinary synthesis of research and education to exploit instrumented sites and networked information; formulate engineering and policy options to protect, remediate, and restore stressed environments and promote sustainable environmental resources; and
- A measurement facility that assists with and provides training on sensor deployments, measurement campaigns, and sensor development.

With the construction of the WATERS Network, individual investigators will have an unprecedented opportunity to leverage data from laboratory investigations and single field sites with data collected nationwide and to collaborate with their colleagues in real-time on complex environmental research questions. Ultimately the plan will lay the foundation for a new infrastructure that will transform how environmental research and education are conducted. This presentation will give an overview of the draft preliminary program plan for WATERS and next steps.

## REFERENCES

CLEANER (2006) CLEANER (WATERS Network), A Summary of the Grand Challenge It Seeks to Address, June 1, 2006 draft.