HydroView

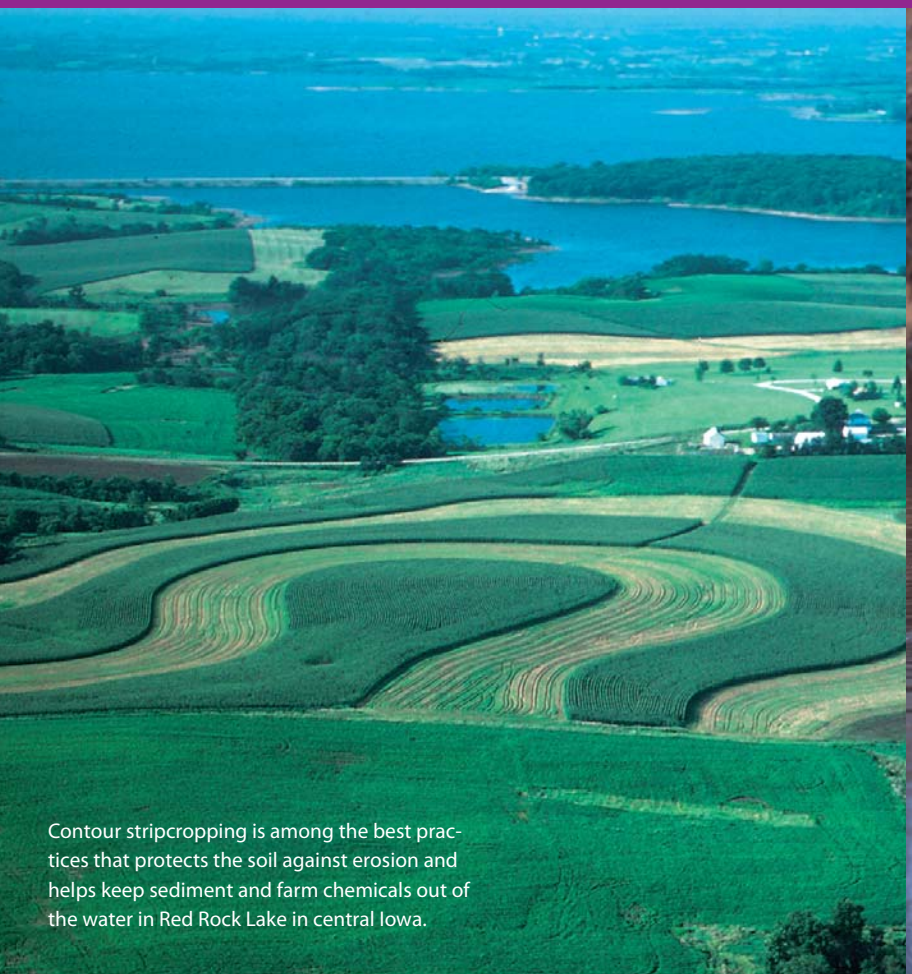
Integrating Research in the Hydrologic Sciences

HydroView

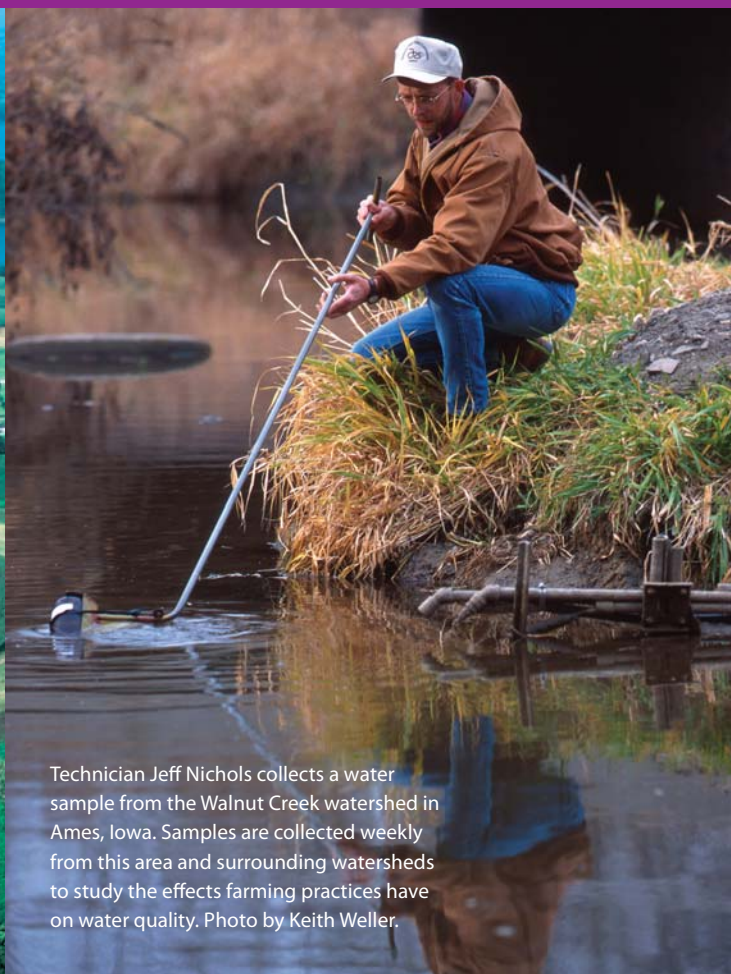
HydroView is the first nationwide, coordinated effort to collect, synthesize, and disseminate the hydrologic information required to address pressing environmental problems, from contaminant transport to sustainability of water resources to the hydrologic influence on ecosystem functions. As a large, coordinated program, HydroView will catalyze hydrologic science research, leading to a deeper understanding of the hydrologic cycle.

HydroView will collect, synthesize, and disseminate data to:

- refine predictions of short- and long-term risks related to floods and droughts
- advance understanding of streamflow generation
- identify dominant processes controlling water quality
- provide critical data for improving watershed restoration, wetland engineering, and urban planning
- stimulate sensor development for water research
- make results publicly available to aid decision-making



Contour stripcropping is among the best practices that protects the soil against erosion and helps keep sediment and farm chemicals out of the water in Red Rock Lake in central Iowa.



Technician Jeff Nichols collects a water sample from the Walnut Creek watershed in Ames, Iowa. Samples are collected weekly from this area and surrounding watersheds to study the effects farming practices have on water quality. Photo by Keith Weller.

Overview

One of the most pressing issues facing our nation today is ensuring the availability of sufficient water of appropriate quality to meet the country's needs and maintain the integrity of its ecosystems. To adequately address this issue requires increased understanding of the terrestrial hydrologic cycle, of the climatic and biogeochemical cycles that are closely coupled with it, and of the human and ecological influences on these cycles. The research necessary to further understanding must be done at larger spatial scales, over longer time periods, and more comprehensively than ever attempted.

Stresses on society that are related to water are becoming more apparent. Climate extremes have produced years of severe drought in the High Plains, devastating crops and straining water supplies in the intermountain West where the population is rapidly expanding. Florida's Everglades are in crisis from decades of man-made water controls and over-fertilization of adjacent fields. Communities are unable to comply with provisions of the Clean Water Act despite having invested millions of dollars in sewage treatment works. The list of critical water issues that must be addressed keeps growing.

HydroView's network of calibrated river-basin observatories will provide scientists with the tools, observations, and measurements necessary to better understand how water moves through the terrestrial hydrologic cycle. This information will permit more reliable predictions of how human development will stress existing water supplies so that solutions can take into account economic, environmental, and social factors.

Twenty hydrologic landscapes within the conterminous United States will be part of the HydroView hydrologic observatory network, encompassing a range of natural and modified hydrologic systems. Recent technological advances in remote sensing, modeling, *in situ* sensors, and communication make possible data collection required to identify dominant hydrologic processes across all important spatial and temporal scales.

- Core data collected at all hydrologic observatories will enable quantification of the stores, fluxes, flow paths, and residence time distribution of water, sediments, nutrients, and contaminants.
- A modern cyberinfrastructure will collect and disseminate data and to provide "telepresence" in the field, allowing for remote operation of field experiments.
- A common facility will support a diverse array of instrumentation, ensuring efficient equipment sharing and consistency among the hydrologic observatories.
- A synthesis center will serve as a nexus for working groups and visiting scholars to work on interdisciplinary research in hydrologic science.

The Consortium of Universities for the Advancement of Hydrologic Sciences, Inc. (CUAHSI) will coordinate HydroView programs and infrastructure, assuring their effective integration and responsiveness to the needs of the hydrologic science community.

Front Cover. False-color image of the midwestern United States, produced from data collected on January 15, 2002, allows for the numerous small lakes that are found in this region to be seen more clearly. Normally overshadowed by the lush, green vegetation in a true-color image, the lakes, colored a dark blue here, clearly stand out against the lighter colored background. Also visible in this image is the Mississippi River, which starts at the top-center of the image and progresses south where it empties into the Gulf of Mexico.

Where Does the Water Go?

Freshwater has become the strategic resource that constrains future development in many regions in the United States and abroad and influences international relations around the world. Water plays a central role in shaping the land surface, dissolving minerals, transporting chemicals, and determining species distribution. Current predictive understanding of the terrestrial water budget, which determines the availability of freshwater resources, is inadequate to support management of this strategic resource in a changing world. If we are to successfully adapt to alterations and uncertainty in our freshwater resources, we need to improve understanding of, and our ability to characterize and predict, the storage, movement, and transformation of water. We need to understand the factors that influence the choice of pathways a drop of water takes on its journey from the atmosphere to a lake, river, or aquifer.

How do patterns in rainfall influence predictability of floods and droughts?

Floods and droughts have long been considered random events. We now know that there are decadal patterns in rainfall and that rainfall recycles within the basin, thereby intensifying floods and droughts. Knowledge of the internal state of the hydrologic system, combined with information about external climate forcing, will help predict the occurrence of these hydrologic extremes.

What controls water quality at the river-basin scale?

Although we understand the wide range of processes that control water quality at the scale of meters, understanding how these processes combine to determine water quality at a large scale is still unknown. We need to understand whether processes are additive, or do certain processes dominate depending on where the water is flowing at a particular time. This knowledge will help predict the consequences of toxic runoff and help remediation efforts.

How do changes at the land surface impact local and regional water supplies?

Natural and human-induced landscape changes, such as forest fires, urbanization, and ecosystem restoration are constantly altering the vegetation and shape of Earth's surface. This is the critical zone of dynamic coupling among the hydrosphere, atmosphere, biosphere, and geosphere. To increase understanding, hydrologic, geomorphic, geochemical, and ecological principles must be synthesized.

The River Basin

A Fundamental Landscape Unit

A river and its tributaries drain a single river basin. As a discrete unit of landscape, the effects of large-scale processes can be measured and observed. Their simple boundary conditions make river basins excellent natural laboratories for which inputs and outputs of energy, water, and elemental budgets can be calculated.

When fully implemented, HydroView's observatory network will contain approximately 20 calibrated river basins covering twenty different hydrologic landscapes. To enable exploration of all the critical interfaces in the terrestrial hydrologic cycle, these river basins will each cover an area of approximately 10,000 km^2, substantially larger than any currently calibrated basin. Hydrologic observatories will cover natural landscapes and also human-modified landscapes where built infrastructure has altered the hydrologic cycle.

HydroView Elements

HydroView's four integrative program elements will enable scientific advances by leveraging existing small-scale, multidisciplinary studies in relatively homogeneous natural environments. Such studies include Long-Term Ecological Research funded by the National Science Foundation; watershed programs of the U.S. Department of Agriculture-Agricultural Research Service, U.S. Department of Agriculture-Forest Service, U.S. Geological Survey, and others; and large-scale monitoring and assessment data-collection programs of state and federal agencies. Each of the four facilities will have an educational and outreach component.

Hydrologic Observatories

Hydrologic Observatories (HO) will permit scientists to improve predictive understanding of the flow paths, fluxes, and residence times of water, sediment, nutrients, and selected contaminants across a range of spatial and temporal scales. Each HO will collect a core set of data:

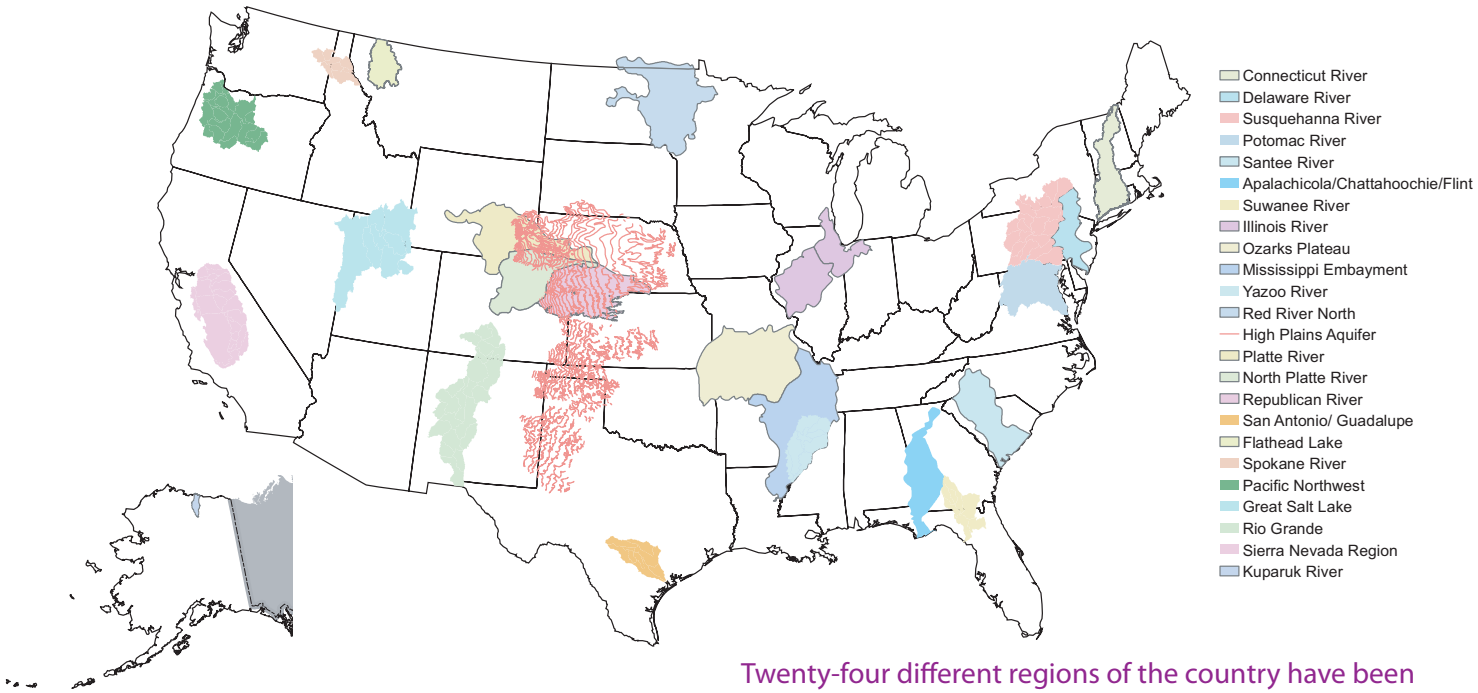
- watershed characteristics—high-resolution topographic information, detailed soils, vegetation, land use-land cover, and geologic information
- physical measurements—precipitation, groundwater levels, and stream discharge and evapotranspiration
- chemical measurements—the concentration of nutrients and contaminants in atmospheric deposition, groundwater, and surface water, and
- biological measurements on the structure and function of ecosystems—species assemblages, community respiration rates, and vegetation maps.

Scientists will have the freedom to create specific, local experimental elements to enable exploration of fundamental hydrologic processes not currently possible.

Hydrologic Information Systems

Hydrologic Information Systems (HIS) will create a comprehensive data model consisting of a hydrologic information database coupled with tools for acquiring information and for analyzing, visualizing, and modeling the data contained within it. No such data model currently exists. The initial task of HIS will be to design and develop this data model, implement it at the pilot Hydrologic Observatories, and support hydrologic scientists in its use. This data model will enable not only HO scientists, but scientists from around the world, to access and analyze data collected at Hydrologic Observatories.

A Center for Hydrologic Information (CHI) will serve as the operational facility for HIS, and will implement the data model. The CHI will gather and integrate data collected at the HOs, and many other sources, into a common format. HIS will be an important means of interaction between CUAHSI and related scientific disciplines, such as geology, ecology, atmospheric science, and information science.



Twenty-four different regions of the country have been advanced as possible locations for Hydrologic Observatories.

Hydrologic Measurement Technologies Facility

The Hydrologic Measurement Facility (HMF) will greatly facilitate the way in which field research in hydrologic science is conducted. HMF's priorities are to equitably distribute cutting-edge technology, objectively pursue the most-needed equipment, and aid scientists in the deployment and use of sophisticated tools. Another important function of the facility is to train staff, students, and scientists in the proper use of available equipment.

HMF will make existing investments in instrumentation more available and efficient by facilitating equipment-sharing among universities and deploying the necessary resources. Creating specialized measurement technologies is essential to advancing hydrologic science. Sensor development will be a later focus of the HMF, bringing scientists and engineers together to collaborate on new technologies that address CUAHSI's science agenda. The HMF will offer contracted services for standard equipment necessary for any hydrologic field work.

National Center for Hydrologic Synthesis

The National Center for Hydrologic Synthesis (NCHS) will bring together scholars from different academic backgrounds to collaborate on complex, multi-faceted problems that lay at the interfaces of traditional sub-disciplines. Scientists will have the tools available to integrate information from the HOs, the HMF, and the HIS, facilitating cross-observatory comparisons and hypothesis-testing, and evolving the CUAHSI science agenda.

The NCHS facility will support scientific collaboration through working groups. Working groups could address various aspects of the HOs, information science, or measurement technology, or issues that are emerging within the community. In addition to supporting a group work environment, established academicians on sabbatical and postdoctoral associates could apply individually to be NCHS visiting scholars.

A watershed dam and upland terraces in a small watershed project in western Iowa.

CUAHSI
universities allied for water research

The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) is a nonprofit corporation composed of nearly 100 members that are research universities offering advanced degrees in hydrologic science. CUAHSI's mission is to develop and support a community science agenda, to identify and operate research services and facilities in support of that agenda, and to offer programs of education and outreach. CUAHSI will oversee HydroView operations and facilities for the hydrologic science community, enabling individual scientists to better pursue their own research; researchers, agencies, and practitioners to better serve society; and students and the public to better understand how hydrologic science affects their lives.

Consortium of Universities for the
Advancement of Hydrologic Sciences, Inc.
2000 Florida Avenue, NW, Washington, DC 20009
Tele: (202) 777-7306; Fax: (202) 328-0566
www.cuahsi.org