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# Water Resources Issues for the New Millenium: Geographic Perspectives

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**T**his issue of *Water Resources Update* contains papers from nine geographers in the field of water resources. The papers represent ideas communicated at a panel discussion held at the Association of American Geographers (AAG) national meeting in New Orleans in March 2003. The panel was sponsored by the Water Resources Specialty Group of the AAG and was inspired by the fact that the United Nations General Assembly declared 2003 the International Year of Fresh Water (IYFW) (A/RES/55/196, December 20, 2000). The goal of the IYFW has been to increase the awareness of the importance of freshwater. The panel discussion in New Orleans was directed toward that goal as is this issue of *Update*.

The oral panel presentations and discussions in New Orleans demonstrated several new directions for future, water resources research. It was equally clear from the active audience participation that geographers have considerable interest in these topics. This interest should not come as a surprise. Water resources issues are growing in importance at all scales, ranging from watershed councils and process studies at the local level, to national water policy coordination concerns and environmental process research at the national scale, to issues of impending water scarcity, food security, and hydrologic monitoring at the global scale.

Several movements in water resources science and management, such as integrated watershed, water resources, and floodplain management, continue to gain momentum and acceptance. Several of the papers in this issue elaborate on various aspects of these coordinated approaches to

management and governance (e.g. Galloway, Hooper, Lant). Calls to foster interagency and interdisciplinary cooperation reflect the need for water resources practitioners who can communicate across intellectual and institutional boundaries. Furthermore, the growing need to minimize vulnerability, inequities, and environmental impacts and to encourage sustainable practices is forcing greater integration of the physical and social sciences and broadening the basic nature of water resources research. Consequently, water policy formulation has been rapidly entering a period of exchanges in which broadly trained professionals are needed for their intellectual diversity and practical experience. Geography as a discipline has long been engaged in bridging the sciences, natural resource management, environmental ethics, and policy formation. It has provided an intellectual incubator for the development and exposition of integrated approaches to water resources and watershed policy as well as for studies of watershed processes and human-environment interactions. The papers in this issue are not directly about geography, but they provide a stimulating sampler of water resources research being conducted by geographers. Neither the panel discussion in New Orleans nor the papers in this issue of *Update* cover all the essential topics in current water resources research, but hopefully they provide a glimpse into the great variety and significance of topics in this field.

## This Issue's Papers

As is typical in the discipline of geography, the nine papers in this issue cover a wide range of topics

from a variety of perspectives and spatial scales. The diversity of authors' backgrounds and viewpoints can be discerned from the paper topics and the authors' biographies. In spite of this diversity, certain issues reappear as key concepts in several papers from different perspectives. These core concepts include the need: to develop a national policy for water resources coordination and cooperation, to implement integrated water resources and watershed management, to include ecosystem integrity in valuations of water resources management options, and to restore the physical integrity of rivers. The papers do not fall neatly into categories, so their grouping below into three sections is unavoidably artificial. Although these categories impart the semblance of organization to the varied collection of papers, the structure should not be interpreted too rigorously. Many of the papers are concerned with topics broader than what is implied by the section title. The papers by Galloway, Hooper, and Lant address various aspects of the need for greater integration of water resources activities. The papers by Dziegielewski, Matthews, and White differ considerably from one another but share a common concern about water-supply and water-use issues. The papers by Graf, Hirschboeck, and James speak to the interface between water resources policy and environmental systems. Much of White's paper also falls under this broad category. The remainder of this introduction briefly describes each of the papers.

### **Coordination of Water Resources Policy, Management, and Research**

Gerald Galloway's paper offers an appropriate opening for this issue of *Water Resources Update* because it addresses the need for a national water policy and also introduces a wide array of problems at various levels of government in the United States. Galloway reports on the recent *National Water Policy Dialogue* sponsored by the American Water Resources Association (AWRA) in Washington, D.C., and he argues for the creation and implementation of a national water resources plan to combat on-going problems with drought, water supply, floods, and water quality. He recognizes conflicts between calls for improved water-resources infrastructure and calls to remove obsolete infrastructure (e.g. dams) to improve ecosystem functionality. He also elucidates areas of agreement held by most participants at the AWRA Dialogue,

including the need for sustainability, integrated watershed approaches, government coordination and cooperation, education, security, and planning. Galloway describes the appeal to U.S. government leaders made in a letter signed by the AWRA President and the Dialogue Chair on behalf of the Dialogue participants that advocates four proactive measures: (1) develop a national water vision, (2) formulate a national water policy, (3) promote interagency and intergovernmental cooperation and coordination, and (4) take an integrated watershed approach. He laments the lack of subsequent governmental action on these recommendations. On a positive note, he states that House Resolution 135 to establish a 21st Century water commission was subsequently introduced, but no action has been taken in the Senate. Broad support for establishing a national water policy arises from the incontrovertible need for coordination of government activities and the obvious vacuum of existing policy.

Bruce Hooper addresses the concept of integrated water resources management (IWRM) and describes how it compares with earlier and alternative land and water management methods. He begins with an account of the early work of White, Burton, Kates, and other behavioralist geographers who wrote about natural resources, water resources, and flood hazards between 1930 and 1970. These geographers challenged the common assumption of fully-informed rational economic behavior and provided an important paradigm shift in resources management. Despite the early involvement of these geographers, natural resources management has since emerged as an independent field, and geographers have developed links to other fields such as hydrology and economics. Hooper describes IWRM at length. Unlike ecosystem and comprehensive approaches, which attempt to address all components in the system but are rarely feasible, IWRM limits its focus to selected system components that are perceived as controlling factors. However, its analyses also go beyond multi-objective management to include ecosystem functions, social goals, and stakeholder participation. Its investigations, which have been endorsed at several international forums, also incorporate physical, biological, and socioeconomic factors, often at the river-basin scale. Hooper presents a list of five essential elements for successful river-basin management that were recognized at the Second

World Water Forum and Ministerial Conference in the Hague, 2000. These elements include: basin-wide planning, participatory decision making with local empowerment, demand management, compliance monitoring, and development of human and financial capacities. Potential difficulties with the implementation of IWRM include the need for political will, for methods of distributive governance, and for definition of the role of law and stakeholder participation. Hooper recognizes that these difficulties, together with complexities of water-sector institutions, limit the confidence in and universal application of IWRM. However, he also points out six characteristics of river-basin organizations that make the successful application of the IWRM approach possible.

Chris Lant examines the governance of watersheds and identifies a basic dilemma in that watershed managers rarely have control over land use at the watershed scale. Factors driving watershed processes are often controlled largely by non-governmental entities motivated by private interests and justified by issues of private property. A brief review is presented of integrated watershed government initiatives from an ecological-economics perspective, demonstrating that this is not a new approach but one of great relevance and activity. Lant contrasts the careful allocation of rights to water use for productive and consumptive purposes to the relatively open and ill-defined rights for its use for dilution, distribution, and deposition of pollutants. Integration of agricultural and environmental policy is needed, as are incentives for changed land-use practices. Lant points out that political organizations at the watershed level often lack formal jurisdiction, suffer from changing representation, and have poorly specified objectives. Popular planning methodologies can seldom rise above the lack of authority and need for legitimacy. For example, decision-making by consensus often results in plans that are least obtrusive but ineffective at resolving difficult issues. Five elements of institutional structures are required for viable watershed management, including various types of authority, resources, and jurisdictions. These needs lead Lant to conclude that the primary authority for watershed governance must reside at the state level. He closes by calling for three basic changes:

1. Integrate into national environmental and agricultural policies economic disincentives for

actions detrimental to watersheds and incentives for actions that improve watersheds.

2. Accelerate federal and federal-local cost sharing to restore the physical integrity of rivers.
3. Empower local watershed institutions and provide them with needed scientific resources.

### **Managing Water Supply, Use, and Demand**

Ben Dziegielewski addresses water demand management beginning with a broad introduction to the nature of global water shortages. He then focuses on strategies for meeting or reducing demand and describes water demand management as well as the benefits of demand reduction. Subsequently, domestic, industrial, and agricultural demand management methods and technologies, as well as delivery systems, are outlined. Four strategies for water demand management—public education, water management programs, governmental regulations, and economic incentives—are provided with the recommendation that all be used in combination. Education and public information campaigns can be particularly effective when the public recognizes either a serious supply shortage, the importance of their efforts, or the equity of the applicable conservation measure. Dziegielewski notes that behavioral changes have a much greater potential for domestic water savings than technological improvements such as plumbing and bathroom fixtures. Water management can improve efficiency through a variety of methods including leak detection, metering, and measuring of water recycling. Government actions such as regulations and economic incentives can contribute to water demand management, although these tools depend on valid water-use data and are not commonly employed other than for the discharge of waste water. Economic measures in the form of water markets and pricing can be effective. A recent success with water marketing in California is described, although Dziegielewski acknowledges two common critiques of treating water as a commodity that need to be addressed. First, ecological systems often receive insufficient economic valuation (cf. White's paper in this issue). Second, water may be viewed as a human entitlement with intrinsic value beyond its economic value as a commodity. Water pricing can be used effectively in demand management because price increases are associated with substantial reductions in use in spite of inherent

inelasticities in water demand. Dziegielewski presents a table of price elasticities for various water-demand categories indicating that a one-percent increase in price would be associated with water-use reductions ranging between 0.2 and 0.9 percent. He concludes by recommending that national water-use data-collection programs be established, that governments provide funds for research and technical development, and that more scientific research on water demand management be conducted.

Olen (Paul) Matthews notes that some means of water reallocation is needed and that water markets may be preferable to regulations in achieving these transfers. He examines elements of water rights doctrine that restrict the use of water marketing in the West in order to establish the ground rules by which transfers must operate. Concepts include beneficial use and shared rights to water use as opposed to exclusive rights or actual ownership. Simplification of water rights law could hinder elaborate scientific modeling that is currently being explored to allow marketing. Matthews points out several benefits of water markets for water reallocation, especially where growing urban demands are out-stripping supplies. Markets can move water to higher economic uses and reduce waste, potentially on an equitable basis. The primary constraint on water reallocation in general and water markets in particular is the requirement and inability to anticipate impacts on third parties. Matthews notes that the usual means of avoiding these effects with water markets is to limit sales to consumptive use, but that this type of use is more difficult to track than total water diversions. Other constraints include restrictions on extra-basin water transports, and uncertainties in the actual water rights of the seller that often call for a water title search. Matthews recommends standardizing the use entitlement for both a diversionary amount representing the total that can be withdrawn and a smaller discount rate that can be sold after a portion is returned. Furthermore, he suggests that creating a title register could guarantee the validity of water rights and facilitate sales. He concludes that legal and institutional changes could streamline the effectiveness of water markets that are growing in importance.

Gilbert White examines two recent advances in scientific knowledge related to water resources,

including an improved understanding of domestic water issues in developing nations as well as an enhanced ability to evaluate benefits accruing from the ecological restoration of floodplains. These are two areas in which the author has long been an internationally acclaimed expert. White begins by describing a longitudinal study of domestic water use in a variety of African communities. Recent work has compared water use with data from the author's earlier work and situated it in a broader socioeconomic and political context. While White does not attempt to detail the findings of the new study, he notes a great variability of outcomes – even between similar communities – and suggests that nationally averaged water-use statistics may not accurately portray conditions if not supplemented by detailed studies. With respect to the second theme, White points out that the early emphasis in benefit-cost analyses on flood-control benefits obscured the economic benefits of flooding. In contrast to this early practice, recent attention to the economic value of ecosystem restoration represents a full evaluation of environmental systems. White also reviews a recent U.S. Army Corps of Engineers Institute of Water Resources study that demonstrates how the benefits of ecosystem restoration projects might be incorporated in future cost-benefit analyses.

### **Environmental Concerns of Water Resources Management**

Will Graf addresses changes in national policies towards dams and dam operation, shows why those changes are needed, and describes a set of opportunities that they provide. He also outlines the serious effects dams have had on the hydrology, geomorphology, and ecology of North American Rivers. He identifies the potential for dams to control watersheds and enhance ecosystem functionality. Examples given include dam operations both to control sediment below Glen Canyon Dam and to control ecosystem dynamics within the Everglades. Although Graf cautions that these studies are not yet conclusive, these operational policies might provide a way for ecological and other broad values to replace narrow, commodity-oriented goals. Graf also raises the question of *who* will make the needed decisions regarding future policies of dam maintenance, removal, and operation. He concludes that these decisions will be made at all levels of

government. Development of a valid dam management policy is complicated, however, because mandates and jurisdictions vary from one level of government to another. For example, the federal government may be concerned with the Endangered Species Act, states with water rights and compliance with the Clean Water Act, local governments with land management and construction codes, and tribal leaders with control of local resources. Graf concludes that dams have played an important role in shaping the economic and physical landscape but that changes in values will require new management policies.

Katie Hirschboeck addresses the issue of geographic scale in linking models of the atmospheric and surface runoff components of the hydrologic cycle. She argues that models must be sensitive to the geographic scale at which environmental processes actually operate; a cloudburst in one small portion of a basin will produce far more runoff than the same amount of less intense precipitation spread throughout the basin. For this reason, she concurs with other scientists who insist that the downscaling of global circulation models (GCM) to predict the effect of climate change on runoff in specific basins is fraught with uncertainties. The primary exceptions prove the rule: GCM-based estimates are more accurate where runoff processes are widespread and temperature-driven, such as when snowmelt is the dominant runoff process, or in predicting low-flow due to widespread drought conditions. She proposes (as an essential complement) a strategy for upscaling of drainage-basin level analysis that directly utilizes knowledge of the types of precipitation systems that affect specific basins as well as the effect of climate change on the specific climatic causes of floods.

Finally, Allan James discusses the need for water-resources expertise that was generated by the 1987 amendments to the Clean Water Act (CWA) and the ongoing non-point source (NPS) pollution problem. The successes and failures of the CWA are briefly described and put into the context of both national water-quality trends and Congress' broad goals of protecting and restoring the physical, biological, and chemical integrity of the nation's waters. James then critiques the EPA's present emphasis on chemical water quality, asserting that it neither provides balanced protection of the physical integrity of waters nor controls NPS effects on

sedimentation and flood hazards. Present CWA implementation policy also has exceedingly stringent requirements for medical proof of human health risks before standards are set or regulatory actions are taken. James argues that the ongoing decentralization of federal government functions has detrimental effects on water quality protections because some degree of unified standards and authority are needed. The move toward local government involvement in watershed scale organizations is good, but it does not replace the need for coordinated national policies or water resources expertise. The paper outlines four traditional geographic research areas of relevance: flood hazards, fluvial geomorphology, geographic techniques, and global studies. James concludes that the CWA act has presented both an opportunity for water resources specialists with training in NPS pollution and a call to service in an area of much-needed research.

### Conclusion

Geographic research is always differentiated and often lacks a core disciplinary theory. Yet, when synthesizing the papers in this issue, wide differences in perspective are over-shadowed by a focus on core issues related to watersheds and river basins and their management as well as an apparent consensus on the changes that are needed to advance these issues. Understanding watersheds and river basins as systems that respond to driving forces, such as climatic and land use change, and whose functions and services can be restored—through such means as selective dam removal and better land use—is the essence of geographic research in water resources. Likewise, it is essential to understand how humans, responding to risks and economic conditions, actually behave in relation to water. This understanding leads to a conclusion that there is an urgent need for action to develop a mechanism for coordinating water resources policy. However, more important than the development of this mechanism is its application to address issues that primarily reside at the scale of watersheds and river basins.