Water Resources

Position Statement. To ensure the availability of safe and reliable fresh water resources, The Geological Society of America (GSA) encourages partnerships that improve fundamental scientific understanding and analyses of water resources; enhance collection, management, and accessibility of water resource information; increase stakeholder involvement in all aspects of water resource education, assessment, and decision making; and broaden education and outreach to foster collaboration among government agencies, educational institutions, industrial and agricultural users, and the public.

Purpose. This position statement (1) summarizes the consensus views of GSA on water resource issues; (2) advocates improved adaptive management of water resources through collaboration of water professionals, concerned citizens, and decision makers at all levels of government; and (3) provides a communications tool for geoscientists.

RATIONALE

Humans need water to sustain life. Without sufficient water, civilizations, economies, and ecosystems collapse. Changing demographics, natural variability of the hydrologic cycle, and climate change all pose significant present-day challenges to ensuring that water of sufficient quantity and quality is available when and where it is needed. Energy production and agriculture are currently the world's largest users of fresh water, and future needs will be greater. Increased production of biofuels and unconventional hydrocarbon resources boosts water demand and can significantly degrade water quality. An inadequate supply of fresh water can lead to disease and death, drought, fire, ecosystem degradation, species loss, and severe socioeconomic disruption.

One example of increasing stresses on hydrologic systems—systems that may be unable to meet future demands—is drought. Drought is common worldwide, varying only in intensity and locale, and more severe and prolonged droughts are forecast. For example, the U.S. Global Change Research Program 2014 report on Climate Change Impacts in the United States (nca2014.globalchange.gov) notes that during the 20th century, periods of drought increased in a number of areas of the West and that climate models consistently predict substantial future declines in precipitation, particularly in the Southwest. Droughts have exacerbated the multi-decadal conflict over shared water resources in Georgia, Florida, and Alabama. Threats of water export to drier regions prompted development of the Great Lakes Compact. The U.S. Bureau of Reclamation has identified many more areas, particularly in the West, where water conflicts are likely by 2025 (permanent.access.gpo.gov/lps36032/Water2025.pdf).

In other areas of the world, recent droughts have contributed to dramatic shrinkage of Lake Chad, widespread famine in Somalia, and failed harvests in Australia and Russia, leading to severe restrictions on grain exports. These examples represent a cross-section of the types of water scarcity issues facing human populations around the globe. The Office of the Director of National Intelligence released a report in 2012 (www.dni.gov/ICA_Global_Water_Security.pdf) that stated, in part, "Water challenges—shortages, poor water quality, floods—will likely increase the risk of instability and state failure, exacerbate regional tensions, and distract countries from working with the United States on important policy objectives… ." Further, "As a consequence of water challenges globally, the demand for U.S. assistance and expertise will increase providing the U.S. with opportunities for leadership… ," and, "Between now and 2040, fresh water availability will not keep up with demand absent more effective management of water resources."

Another example of increasing stress is water quality. Water quality is threatened by a growing list of pollutants, and water-related disease is a leading cause of death worldwide. The effects of degraded water quality can be amplified by reduced water quantity. Cost-effective and reliable hydrologic monitoring technologies are available, yet water-resource assessment and management is hampered by the lack of comprehensive and reliable data.

Whether people rely on surface water, groundwater, or a combination, ensuring a safe and reliable supply of fresh water requires an understanding of the complex challenges of hydrologic systems. Sometimes spanning geopolitical boundaries, geologically and topographically defined hydrologic basins are a natural unit of water-resource assessment and management. Storage of surface water and groundwater in hydrologic basins helps mitigate the natural variability in supply resulting from both short-term changes in weather and long-term changes in climate. The interconnectedness of many surface-water and groundwater flow systems can also dampen the impacts of natural variability; a stream may lose water to an underlying aquifer in one area and gain water from an aquifer in another. Water flowing in many perennial streams and rivers is dominantly groundwater discharge. Surface-water reservoirs, constructed in an effort to increase stability of water supplies or to produce power, can have adverse hydrologic and ecosystem impacts, such as impaired agricultural productivity and infrastructure failures. In many regions, sufficient surface-water resources are absent, and populations and economies rely solely on groundwater.

Climate impacts river flow and watershed hazards. Climate change will continue to alter the availability of safe and reliable water supplies in both surface-water and groundwater systems to a varying degree around the world, and local and regional increases in extreme drought and flooding and changes in glacier/snowpack storage are documented hydrologic consequences. Prediction of the magnitude, timing, and location of the hydrologic impacts of climate change is hampered by an incomplete understanding of the complex interactions of the atmosphere, hydrosphere, biosphere, and land surface. Local-scale studies of small watersheds and related ecosystems can improve understanding of those interactions.

In short, mitigating present-day water shortages and managing future water resources requires broad, sustained efforts and active collaboration of scientists, engineers, managers, planners, policy makers, and the public.

Scientific and Public Policy Aspects of Water Resources

Accommodating population growth and socioeconomic development and mitigating foreseeable adverse water-related impacts requires broad, outcome-oriented water-resource science policies and initiatives. In turn, improved water-resource science and decision making requires better-quality and higher-resolution data, an increased fundamental understanding, more effective stakeholder interaction, and public education. Risk-based analyses can improve the technical basis for decision making and, as communication tools, can help stakeholders better understand the relative significance of important factors. Without such analyses and the data to support them, many critical water-resource decisions will continue to be based on inadequate information and limited understanding.

Scientists, engineers, planners, and managers seek better understanding, assessments, and management of water resources. They should also strive to share their knowledge with the public and to understand the public's information needs and concerns. Scientists should express clearly their confidence in the knowledge used to support decision making. An additional burden on policy makers and the legal system is considering the natural distribution and variability of water resources and identifying viable approaches when laws, compacts, or treaties are not consistent with the natural distribution or variability of water resources.

Recommendations

- *Improved fundamental understanding of the quantity, quality, distribution, and use of water resources is necessary to increase the reliability and use of water-resource management tools.* Improved representation of geological, biological, and ecological systems—including underlying physical and chemical processes and their interactions—is needed. More complete understanding is required in the areas of climate change, the role of soil moisture in the hydrologic cycle, and surface water–groundwater interaction. Computational, risk-based analyses yielding quantitative uncertainty estimates can be used to optimize data acquisition and enhance the scientific and socioeconomic basis of decision making for water resources management.

- *Increased public investment is needed to improve the scientific understanding of water resources.* New hydrologic data are required to improve the reliability and reduce the uncertainty of scientific analyses that support water resources management and policy decisions. Current hydrologic data and monitoring capabilities must be maintained, and new data sets and collection capabilities (e.g., using satellites) should be developed. Data should be collected at the frequency and scale needed to support model analyses and decision making and be automated to the maximum practical extent. Data collection and management should be organized by surface-water and groundwater hydrologic basins and be readily accessible on the Internet, consistent with the GSA Position Statement on Open Access to Data.

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About the Geological Society of America

The Geological Society of America, founded in 1888, is a scientific society with more than 25,000 members from academia, government, and industry in more than 100 countries. Through its meetings, publications, and programs, GSA enhances the professional growth of its members and promotes the geosciences in the service of humankind. GSA encourages cooperative research among earth, life, planetary, and social scientists, fosters public dialogue on geoscience issues, and supports all levels of earth science education. Inquiries about the GSA or this position statement should be directed to GSA's Director for Geoscience Policy, Kasey S. White, at +1-202-669-0466 or kwhite@geosociety.org.

Opportunities for GSA and its Members to Help Implement Recommendations

To facilitate implementation of the goals of this position statement, The Geological Society of America recommends the following actions:

- GSA leaders and members should seek opportunities to meet with stakeholders to identify information needs and to develop water-resource management goals and plans. Water-resource professionals and other stakeholders should collaborate to identify information needs and to develop water-resource management goals and plans. Stakeholders include water managers, land managers, water users, policy makers, regulators, and the public. Place-based science with stakeholder involvement improves professional and stakeholder understanding and can reduce bias and increase effectiveness of adaptive decision making.
- GSA leaders and members should participate in public education activities at the local level. Public education, a critical enabling element of effective water-resource management, is needed to foster partnership and collaboration among local, state, and federal governments; educational and research institutions; energy, industrial, and agricultural users; and the public.
- GSA leaders and members should participate in professional forums to help educate peers and the public about both water quantity and quality issues, including examples of how water quality is degraded by both contaminant discharges and reductions in water flow. Identifying ways that better data and analyses can help to prevent water pollution and improve water-resource management.
- GSA leaders and members should provide examples of important water-resource issues to improve effectiveness in communicating with decision makers and the public. Communication about water is aided by the use of analogies and examples of the way water issues affect people. For example, flooding along the Mississippi and Missouri Rivers in the United States regularly causes economic damage, and public expenditures support the development of property in flood-prone areas along river basins and coasts. Whether resulting from industrial activity or inadequate sanitation, water contamination affects human and environmental health in both the developed and the developing world.