ground water

Editorial/

Climate Change: Why Should Water Professionals Care?

by Marios Sophocleous[1]

During the last 100 years, global climate has warmed by an average of 0.6°C, owing in part to greenhouse gas emissions from human activities (Intergovernmental Panel on Climate Change [IPCC] Third Assessment Report; *Climate Change 2001: The Scientific Basis*; Cambridge, United Kingdom: Cambridge University Press). Although such an increase in temperature may seem minor as a measure of everyday local weather, it is remarkable as a measure of global average climate. While the earth's natural climate has always fluctuated, today's climate change differs in both rate and magnitude. If greenhouse gas emissions are not dramatically reduced, climate models project another 1.4° to 5.8°C of warming over the next century, a marked contrast to the 2°C per millennium warming that occurred after the last ice age (IPCC 2001).

Climate change will significantly impact the hydrologic cycle. A hotter climate will cause more evapotranspiration, resulting in greater amounts of moisture in the air and in increased rainfall and frequency of heavy rainfall events. Floods and droughts will likely be more severe, making future water management even more difficult. This destabilization of the world's hydrologic systems will manifest itself in many different ways. Currently, mountain glaciers and snow cover are shrinking in most of the world (IPCC 2001), resulting in decreased spring and summer flow volumes in rivers fed by snow and ice, and increased winter flows. In arctic regions, warmer temperatures already have resulted in the thawing of permafrost and the unseasonably early breakup of ice on rivers and lakes (IPCC 2001). During the 20th century, sea levels rose by an average of 1.5 mm/yr (a factor of 10 higher than during the past 3000 years), and are projected to continue increasing significantly, threatening not only millions of people and coastal land, but also the viability of fresh water coastal aquifers (IPCC 2001). Ground water recharge patterns will also be affected by these hydrologic changes, as will ground water quantity and quality. Recent estimates suggest that climate change will account for ~20% of the projected increases in water scarcity.

Climate change is a reality for the 21st century. Existing greenhouse gases will remain in the atmosphere for decades, and declared commitments to reduce greenhouse gas emissions are insufficient to halt present climate change. Thus, adaptation to climate change appears inevitable. However, ground water professionals are largely unaware of the expected impacts of climate change on future water resources. Although aquifers are generally sensitive to changes in recharge, little work has been done on the impacts of climate change on particular aquifers, and on their recharge and water quality characteristics.

While climate change is a long-term problem, our decisions today will affect society's ability to adapt to increasing variability in tomorrow's climate (Bergkamp et al. 2003; *Change: Adaptation of Water Management to Climate Change*; Cambridge, United Kingdom: The World Conservation Union). As water professionals, we need to begin today to plan for the expected changes in water resources and how to manage them. We can no longer rely on past climate data as a reliable baseline from which to forecast climate variability and extremes in the future. Thus, a key challenge is incorporating uncertainty into water resources planning and management.

Because we cannot predict with certainty the rate and direction of climate change at the regional and local levels, water managers and users must learn to deal more effectively with risks and uncertainties. The following suggestions, outlined by Bergkamp et al. (2003), highlight useful strategies we can take, in spite of uncertainties.

1. Reduce the vulnerabilities of people and societies to shifts in hydrometeorological trends, increased variability, and extreme events. Examples include risk zoning, flood and drought preparedness programs, sharing information on climate change impacts, developing forecasting and early warning capabilities, and modifying existing infrastructure and operations to cope with variable and extreme conditions.

2. Protect and restore ecosystems that provide critical land and water resources and services. Examples include developing plans for restoring flood water storage areas (such as wetlands), protecting recharge areas and ground water to maintain water storage for dry years, raising public awareness and public acceptance of water resource protection measures to adapt to climate change, and restoring or preserving mountain forests to reduce erosion and peak flows.

3. Close the gap between water supply and demand. Examples include introducing greater flexibility in water allocations between competing demands; training farmers and other users in improved water use efficiency; implementing demand-side measures (such as end-use technology, recycling, and conservation); and, where appropriate, developing both conventional and nonconventional sources of supply.

Because climate change adds further risks and uncertainties to the management of water resources, water users and managers need to adopt integrated and adaptive management approaches based on monitoring and performance evaluation. Clearly, climate change will demand the attention of water professionals all over the world. It can also serve as a catalyst toward greater flexibility and innovation in the way we manage our water resources.

[1]Kansas Geological Survey, The University of Kansas, 1930 Constant Ave., Lawrence, KS 66047; marios@kgs.ku.edu