Sustaining Groundwater Resources: California's Shift Toward More Effective Groundwater Management

Vicki Kretsinger *– Luhdorff and Scalmanini Consulting Engineers and* ***T.N. Narasimhan, Ph.D.*** *– University of California, Berkeley*

Groundwater is an essential component of both the hydrologic system and the world's water supply. Globally, many factors contribute to our reliance on groundwater resources, such as continued population growth, climate variability, and uncertain surface water availability. These factors also affect groundwater availability. More effective management practices are being sought to ensure the future availability and reliability of groundwater resources.

This article summarizes a white paper the authors prepared on behalf of the Groundwater Resources Association of California (GRA), an outcome of the 2002 GRA Annual Meeting, "Sustaining Groundwater Resources: The Critical Vision."

Groundwater's Dynamic Equilibrium

Groundwater resources are found in diverse physiographic and geologic settings. Under natural conditions, a balance exists among the interrelated components of the natural resources system that include groundwater, surface water, soils, the atmosphere, and ecosystems. When disrupted by natural or imposed stresses, these components, including biota, adjust to attain a new equilibrium. Thus, where extensive groundwater development occurs, system dynamics invariably change due to such causes as pumping that intercepts regional recharge, deep percolation of irrigation water, and diversions that redistribute or reduce recharge.

When natural discharge mechanisms are disrupted in closed or partly open basins, soil and groundwater salinization tends to occur, particularly beneath irrigated lands. Transferred or imported water and innovative recharge and recycling approaches constitute an increasingly important part of the basin hydrologic budget. When imported water containing higher levels of dissolved salts than local sources is recharged into the basin, long-term water quality is impacted.

Many land uses contribute to widespread groundwater contamination. Once groundwater is impaired, restoring its quality is a challenge. Additionally, natural constituents that occur in the subsurface may become a concern when mobilized through natural or human activities. Excessive pumping that causes a persistent decline in groundwater levels may have other consequences, including overdraft, seawater intrusion in coastal aquifers, and land subsidence. As groundwater use increases, timely adaptive management approaches will be required to ensure the availability and quality of groundwater and to protect ecosystems.

California's Groundwater Use and Management

California's groundwater management practices stem from two common law traditions. One granted landowners private ownership of all groundwater beneath their land. The other is the public trust doctrine, which originated in early Roman law and held that certain resources such as air, running water, the sea, and lands adjoining the sea were available to all humankind by "natural law." The doctrine became part of the constitutions of many U.S. states, including California, and governments became responsible for ensuring that water is beneficially, and not wastefully, used. Legally, it can be argued that public trust applies only to navigable waters and tidelands, and the scope of public trust is restricted to surface water resources. However, from declarations in 1911 and 1921 that later formed California Water Code (Code) Sections 102 and 104, groundwater falls within the realm of public trust, if not within its legal fold.

> *Ultimately, sustainability requires congruity between resource management objectives, societal interests and demands, and nature's laws.*

In the 1880s, John Wesley Powell, the second director of the U.S. Geological Survey, suggested physiographic basins should be used as water management units, particularly in the arid lands of the American West (deBuys, 2001). At the time, his suggestion went unheeded. Now, however, some groundwater management plans recognize the intrinsic relationship of the components of the natural resources system. As a result of recently enacted legislation, attention is legislatively directed to basin-wide, integrated management and associated monitoring programs. Additionally, the California Department of Water Resources, in coordination with others (2003), developed guidelines on the essential and required components of local groundwater management plans to promote effective groundwater management.

Sustainability Premises

The GRA white paper defines sustainability as follows:

"Sustainability encompasses the beneficial use of groundwater to support present and future generations, while simultaneously ensuring that unacceptable consequences do not result from such use."

Sustainability of groundwater resources

entails four basic premises:

- Surface water and groundwater constitute a single resource.
- Groundwater is a finite resource and a component of a larger natural resources system. Actions on one or more system components generally affect the balance of the whole system.
- Groundwater replenishment is strongly influenced by climate variability, as well as natural and enhanced recharge processes. Consequently, groundwater resources development must adapt to the system's varying capacity for renewal.
- Communities need to share and manage groundwater resources so the natural resources system retains its integrity for the future.

Significant challenges lie in defining "acceptable" change. Customary practices and institutions pose challenges for a transition from historical, economically based water use to integrated, adaptive water management approaches. Ultimately, sustainability requires congruity between resource management objectives, societal interests and demands, and nature's laws.

Sustainable Management Tenets

Effective groundwater management will require new and comprehensive approaches to define and quantify sustainability, consideration of the long-term region-specific objectives and cost-benefit factors, and dissemination of current information to the public. Key tenets include:

Water Resources Management Units
To manage groundwater sustainably, the management area (basin or watershed) must be defined and the water resources management objectives determined.

Coordination Among Institutions
In guiding their activities, institutions must remain mindful of their roles within a larger integrated context. Basin-wide or watershed management requires cooperation among local entities.

Data Collection and Monitoring
Expanded water resources-related data collection, storage, and dissemination programs are needed to facilitate future groundwater resources evaluations, planning, and management. Ongoing systematic monitoring must simultaneously be undertaken to allow continual assessment of the effectiveness of actions implemented in meeting basin-wide management objectives.

Supporting Research
Research, basin-wide investigations, and public education programs require multidisciplinary collaboration and also federal, state, and local funding. Research efforts are needed to: improve methods and technologies for quantifying individual processes of the hydrologic system; examine and quantify the interrelated processes within the hydrologic continuum; develop climate forecasting methods that consider global influences; and develop methodologies for sustainable development, conservation, recycling, and reuse.

Economic Analyses
Future economic analyses of water resources must incorporate institutional and management tools to optimize sustainability within the constraints of the physical and chemical attributes of the natural resources system while considering the interests of future generations.

Public Outreach and Education
Sustainable water management depends on public understanding and support. It also requires educating and training multidisciplined water resources professionals.

Will these tenets present ongoing challenges? Are they common sense? Time will tell. Achieving sustainability hinges on whether stakeholders embrace the concept as a core element of future water resources management programs.

GRA continues to promote sustainable groundwater management through its symposia, annual meetings, outreach programs, and legislative activities. Visit www.grac.org. Contact Vicki Kretsinger at vkretsinger@lsce.com.

References

California Department of Water Resources, 2003. California's Groundwater, Bulletin 118 – Update 2003.

deBuys, W. (ed.), 2001. Seeing Things Whole: The Essential John Wesley Powell, Washington, DC, Island Press/Shearwater Books.

Narasimhan, T.N. and V. Kretsinger, 2003. Developing, Managing and Sustaining California's Groundwater Resources. A White Paper for the Groundwater Resources Association of California (at www.grac.org).