Communicating About Groundwater Depletion

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Global groundwater depletion

Five countries account for 60% of the world’s groundwater use

- India (25%)
- United States (11%)
- China (11%)
- Pakistan (7%)
- Iran (6%)
Foster and Chilton (2003)
“Houston, we have a problem,” Apollo 13

NASA photo
Northwest India: Groundwater Depletion from GRACE

Main Hydrogeological Provinces of India

DEEP WELLS AND PRUDENCE: Towards Pragmatic Action for Addressing Groundwater Overexploitation in India

Each monsoon, the total available storage of groundwater in hard-rock aquifers is variable and is strictly limited by the hard rock’s weathering characteristics and water-bearing properties. Water yields tend to drop very rapidly once the water table falls by more than 2–6 meters. Overall, these aquifers display a high degree of spatial variation in local storage characteristics and recharge processes.

Alluvial aquifers of the Indo-Gangetic plains. These include the Gangetic and Indus alluvial plains, large parts of which are within the command of primary irrigation.
Arsenic in Groundwater
The greatest shortcoming of groundwater governance has been called “its failure to grasp the central importance of the human dimension ... and the consequent neglect of stakeholders in governance and management.”

Hydrologic Cooperation Versus Hydrologic Insubordination
Bangkok, Thailand

Buapeng and Foster, 2008
Bangkok, Thailand

Buapeng and Foster, 2008
Denmark: Aquifer Protection

GEUS: Danish Geological Survey
Collaborative Modeling and Citizen Scientists—San Pedro River, AZ
Depletion of a small part of the total volume of groundwater can have large effects on surface water, water quality, or subsidence which become limiting factors to development.

- Upper San Pedro Basin, AZ
- Houston, TX
- Edwards Aquifer, TX
- Republican River Basin, CO, KS, NE
Figure 2.4.12. Rainbow trout in Joseph Creek in northeastern Oregon exhibit size hierarchy in occupying a cold-water refuge, with the largest individual in the coldest thermal zone (see Ebersole and others, 2001). When the availability and size of cold-water areas is limited, fish may elect habitats that are less desirable for growth and disease resistance (i.e., through crowding) in order to minimize deleterious physiological effects of high water temperature. Photograph taken by J. Ebersole in 1994.
Human vs Hydrologic Time Scales

Gleeson et al. (2012)
Streamflow Capture: Arizona

Leake, Hoffmann, and Dickinson, 2005
How resilient is groundwater?
Drought-proofing Groundwater

• Analyze GW systems for their resilience and vulnerability to climate perturbations rather than just assuming groundwater is a convenient backup supply

• Raise awareness about maintaining groundwater as a reserve
  -- Monitoring water use and water levels
  -- Potential for managed aquifer recharge

• Work toward laws, regulations, and incentives that encourage use of surface water during wet periods and prepare for increased groundwater use during droughts

Factors Contributing to Good Groundwater Governance

- Recognizing surface water and groundwater as a single resource
- Active engagement of local stakeholders in the decision-making process
- Pressure from external bodies to achieve suitable and workable solutions
- Public education on groundwater and its importance
- An emphasis on public guardianship and collective responsibility
- Integration of GW considerations into other policies (agriculture, energy, etc.)
Factors Contributing to Good Groundwater Governance (cont.)

- Adequate laws and enforcement
- Adequately funded and properly staffed groundwater management agencies
- Characterization of major aquifer systems
- Effective monitoring of groundwater status and trends by an independent agency
- Recognizing the long-term response of groundwater systems
- Recognizing the feedbacks between groundwater and climate
- Community leadership
Questions?

"Imagine a book about groundwater that reads like a novel, and is overflowing with interesting and essential knowledge about a much-neglected topic. This is the book."

Bruce Babbitt, former US Secretary of the Interior (and AZ Governor)