

Conference Report
NGWA International Conference on Nonrenewable
Ground Water Resources
The Sociotechnological Aspects of Nonrenewable Ground Water Resources:
Half-empty, Half-full, Top-down, Bottom-up,
and Some Paths Forward
13-14 October 2008
Portland, OR
by
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*“All water discharged by wells is balanced by a loss of water somewhere...This loss is
always to some extent and in many cases largely from storage in the aquifer.
Some ground water is always mined.”*
-- C.V. Theis, 1940

**Historical Overview of International Attention on Ground Water Use and
Management**

Intensive use of ground water has received much global attention since 2000 with events such as WINEX, a closed workshop on *Intensive Use of Groundwater: Challenges and Opportunities*, held in Madrid, Spain, in 2001. WINEX was followed by the open *Symposium on Intensive Use of Groundwater (SINEX)*, held in Valencia, Spain, in 2002. In 2002 Robert Glennon's book, *Water Follies: Groundwater Pumping and the Fate of America's Fresh Waters*, served as the first hard look at intensive exploitation of ground water in the United States. In 2003, The World Bank, through its Ground Water Management Advisory Team – GW-MATE - developed a remarkable series of *Briefing Notes* on many different problems facing ground water users worldwide, with one specifically referencing *Utilization of Non-Renewable Groundwater*. In 2004, Mary Brentwood and Stephen Robar edited *Managing Common Pool Groundwater Resources: An International Perspective*, which focused more on a country-by-country survey of the policy and management aspects of ground water as opposed to the development of a policy tool box for specific ground water problems. In 2005, the *International Symposium on Groundwater Sustainability* was held in Alicante, Spain.

It is not until 2006 that United Nations Educational, Scientific, and Cultural Organization (UNESCO), in concert with The World Bank, published *Non-renewable Ground Water Resources – A Guidebook on Socially-sustainable Management for Water-policy Makers*. For the first time, case studies were presented on how the global community was dealing with the issue of “mining” ground water, citing such examples as: the Saudi Arabian aquifers; North Western Sahara Aquifer System (NWSAS); Nubian Sandstone Aquifer System; Great Artesian Basin, Australia; the Monturaqui - Negrillar - Piopzo Aquifer of Chile; and the Jwaneng Northern Wellfield, Botswana. Case studies of aquifer systems in North America were noticeably absent.

Conference Introduction

Fifty-five water experts from five countries and ten US states converged on the brew-pub capital of the world during mid-October 2008 to discuss what is known about nonrenewable ground water with a suite of international case studies, US case studies, economic and legal aspects, and mitigation measures. The term “nonrenewable ground water” is controversial because it refers to ground water resources where present-day replenishment is limited but aquifer storage is large (Foster and Loucks 2006), where replenishment is very long (100s to 1000s of years) relative to the time frame of human use (Foster and others 2003), or where the use of ground water storage is at a rate much greater than the renewal rate, essentially “mining” the ground water (Llamas and Custodio 2003). Polak and others (2007) suggest that nonrenewable ground water resources are essentially “decoupled” from the hydrologic cycle due to changes in the climatic conditions in the watershed. Yet in his keynote address, T. N. Narasimhan indicated that the definition of nonrenewable ground water extends beyond these “traditional” definitions, and includes aquifers where the storage characteristics of the aquifer have been permanently changed due to pumping, often referred to as “transient storage”.

International Case Studies

International case studies included Crevillente and La Mancha, Spain; Alberta, Canada; and the North China Plain. Lucia De Stefano and her colleagues at the Universidad Complutense de Madrid, Universidad de Alicante, the Royal Academy of Sciences of Spain and the Universidad de Almeria, chronicled the impacts of agricultural use on non-renewable ground water and the challenges associated with developing new policies to address the “silent revolution” of the thousands of unregistered wells. Eloise Kendy of The Nature Conservancy described the importance of integrating evapotranspiration from irrigated crops into the equation to determine “sustainable” pumping rates (see Kendy, 2003). Kevin Parks of the Alberta Geological Survey cited the challenges in classifying and regulating nonrenewable ground water, especially in light of the tar sand “oil boom” underway near Fort McMurray.

United States Case Studies – Part I

The first session on case studies in the US was initiated by John Shomaker, who described his concept of “mining” the Albuquerque basin through a perpetual pumping scheme (Shomaker, 2007). Susan Stover of the Kansas Water Office presented the state’s efforts at conserving the High Plains Aquifer by leveraging a Conservation Reserve Enhancement Program (CREP) in partnership with the USDA. David Morgan and colleagues at the USGS showed the technical approach to their ongoing assessment on ground water availability in the basalt aquifer systems comprising the Columbia Plateau. Ken Rainwater of Texas Tech and Judy Reeves of Cirrus Associates discussed the increased use of the little-used Dockum Aquifer – traditionally considered a low-

yielding aquifer with marginal water quality – as a replacement for the Ogallala aquifer in the Texas Panhandle region.

While the deep aquifers within the Denver Basin of Colorado are being mined at an alarming rate, the Denver Museum of Nature and Science has employed many different methods of “geovisualization” to portray the architecture and dewatering of the ground water systems. Bob Raynolds showed the value of using simple block diagrams and three-dimensional GIS as part of public outreach efforts. Stephen Ragone, consultant to the NGWA, built upon the importance of engaging the public with the notion that ground water management can be an agent of social change. Stephen originally developed his Post-Modern Water Balance concept in preparation for the Alicante Declaration (Ragone, 2007a and 2007b).

Sociotechnical Aspects

The original emphasis of the conference was on increasing the dialogue on the social, economic, and legal aspects of nonrenewable ground water given the work summarized by Foster and Loucks (2006). This session was lead by hydrogeologist and water ethicist Professor Ramón Llamas of the Universidad Complutense de Madrid. Many scholars in sustainability science have argued that mining of ground water is unsustainable, and therefore unethical. Llamas’s presentation built upon his seminal work on water ethics (Llamas, 2004), where he proffered that the ethics of ground water mining must be tied to: (1) quantification of ground water reserves with acceptable capacity; (2) long periods of the rate of depletion, say from 50 to 100 years; (3) the fact that environmental impacts can be assessed and considered less significant than the socio-economic benefits from ground water mining; and (4) solutions envisioned for the time after the ground water has been mined.

The next generation of water professionals and analysis were represented by several graduate students from the Water of the West (WOW) Program at the University of Idaho. Led by Japanese linguist and socio-economic expert Katie Bilodeau, the group of graduate students walked the crowd through the intricacies of an integrated analysis of the decision making process in the Palouse Basin in Idaho and Washington. The project is still underway but appears likely to offer lessons learned which could be transferred to other settings (see webpage for project at <http://water.uidaho.edu/pbcs.htm>).

Building upon a stellar presentation at the 2008 Ground Water Summit held in Memphis, TN, Rima Petrossian of the Texas Water Development Board provided an update on the Ground Water Management Area (GWMA) process in Texas. GWMA’s have until 2010 to develop a plan for a “desired future condition” for relevant aquifers. Yet, few of the GWMA’s are making progress, almost waiting for another GWMA to “blink” with only one GWMA having a plan in place to date. Interestingly, one of the GWMA’s, the one overlying the Ogallala aquifer, decided that embracing “sustainability” was not how they wanted to manage the ground water and was not a desired future condition. They wanted to derive economic benefits now.

Denise Fort of the University of New Mexico School of Law initiated a trio of papers focusing on the legal and economic aspects of nonrenewable ground water. She was direct in stating that state policies regarding mining of ground water are minimal, and those state policies that do address mining of ground water are “comically dysfunctional”. Todd Jarvis of the Institute for Water and Watersheds addressed the concept of “unitization” – an institutional approach used by states and the federal government to slow the premature depletion, or minimize the damage to the storage characteristics, of petroleum reservoirs. He built upon the economic work of Libecap (2005) to show what a ground water “unit” might look like and also discussed that *de facto* unitization is already occurring in areas undergoing ground water mining in northeastern Oregon. Gabriel Eckstein of the School of Law at Texas Tech University discussed international law and nonrenewable ground water. His presentation touched upon the corollaries between the management of oil and gas versus water and the discussion between water as a commodity versus a human right. He indicated that on October 27, the General Assembly of the United Nations will consider a draft Convention on Transboundary Aquifers where nonrenewable ground water is vaguely addressed (see <http://www.ens-newswire.com/ens/oct2008/2008-10-23-01.asp>).

United States Case Studies - Part II

A second session dedicated to US case studies was introduced by Victor Heilweil of the USGS who is working on the Great Basin Carbonate Aquifer System that is targeted by the Southern Nevada Water Authority for use in Las Vegas through a multi-billion dollar pipeline. The USGS work is very early in the conceptualization phase and is politically sensitive since the aquifer is shared by Nevada and Utah. John Porcello of GSI Water Solutions, Inc. showed a southern California case study where modeling of different land use and growth scenarios lead to future water development planning so the ground water system would not become nonrenewable. John Tracy of the University of Idaho Water Resources Research Institute presented work on Walker Lake in Nevada, where decades of issuance of water rights and ground water pumping drained the ground water discharge to an inland desert lake, thus increasing the lake’s total dissolved solids (TDS) from 2,560 milligrams per liter (mg/L) to over 13,000 mg/L today.

Mitigation of Nonrenewable Ground Water

The options for new sources of supply are few and far between. Bruce Thomson of the University of New Mexico Department of Civil Engineering offered some options that include treated wastewater, brackish ground water and, by-product water from oil and gas or mineral extraction. He indicated that the brackish water treatment option has many of the same pitfalls as using potable nonrenewable ground water – that the resource is also nonrenewable, and that the energy use and disposal options for treatment by-products associated with inland resource development may simply delay a disaster. And his work with Kerry Howe on assessing the challenges to inland desalination technologies revealed that brackish water may be potentially more problematic due to the geochemistry of the brackish waters (more dissolved silica among other divalent analytes) as opposed to the primarily monovalent seawater.

Jason Keller and colleagues with GeoSystems Analysis, Inc. presented an interesting case study of using stormwater runoff in urban areas in California as a tool to mitigate loss of nonrenewable ground water. The challenges are obviously linked to stormwater detention pond maintenance, primarily reducing the turbidity and suspended solid content in the stormwater to minimize armoring the bottom of the detention pond. Their work is especially relevant to the ongoing interest in utilizing abandoned aggregate quarries as potential managed recharge sites in California (see <http://www.scsextra.com/story.php?sid=78390>).

Barry Hibbs of California State University, Los Angeles provided an example of the role of induced infiltration in unlined portions of the Rio Grande. In related work, he also discussed the unintended consequences of lining the All-American Canal on wetlands and associated habitat at the Dos Palmas Preserve.

Closing Statement

While the conference did not garner a larger audience due to many factors including, but not limited to, large increases in travel costs associated with the energy crisis, scheduling of other conferences with a ground water theme in close temporal proximity, and the fact that some scholars and workers in the ground water industry simply consider all ground water a renewable resource, the excellent presentations and degree of speaker and audience interaction were exceptional and comparable to smaller venues such as the Theis Conferences offered by NGWA. The audience was in general agreement that the topic needs to be revisited in two years, perhaps at a venue experiencing the direct influences of developing nonrenewable ground water.

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