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Solution Brief

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Integrated Regional Management: Solving the Groundwater Challenge

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The Challenge: Reducing the impact of groundwater depletion on water users, overlying landowners, and groundwater-dependent ecosystems

Unconstrained groundwater use poses a major hurdle to sustainable water management in California and the West as a whole. Increasing groundwater uses, plus failure to protect sources and areas of groundwater recharge, have led to sizable "overdrafting" – where extraction exceeds recharge. Overdrafting depletes groundwater, forces pumpers to drill deeper and use more electricity to raise water to the surface, causes surface subsidence, deprives surface vegetation of water and draws salt water into coastal freshwater aquifers. Overdrafting also can reduce flows of connected surface springs and waterways, to the detriment of surface-water users and the species and ecosystems reliant on those flows.

One potential solution to these challenges is *integrated regional management*, in which local entities holistically manage groundwater, surface water and land use. Pumping levels can be set to protect, not only groundwater users, but also landowners, users of connected surface streams and groundwater-dependent ecosystems. Land-use planning can account for recharge needs and water availability. Groundwater and surface water can be managed as interchangeable, with the choice between them depending on cost, relative availability and impact.

The Groundwater Challenge

Groundwater today provides approximately 30 percent of the water in California in a normal year (40 percent in the West), and the percentages are increasing. Although most western states, including California, proscribe overdrafting, few states actually have stopped excessive pumping. At the same time, impermeable surfaces have grown faster than populations, reducing the opportunity for surface precipitation to recharge aquifers. As a result, water tables have dropped often hundreds of feet throughout much of the West.

About the Authors

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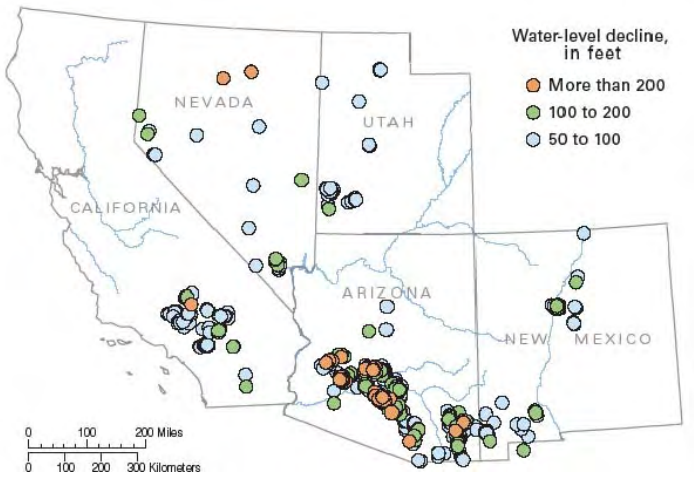

Historic Declines in Groundwater Levels in the Southwest. (Source: S.A. Leake, U.S. Geological Survey)

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Overdrafting presents a myriad of problems. To start, overdrafting is not sustainable. At some point, continued pumping is uneconomic, and users must either find other water sources or do without. Dropping water tables also force pumpers to drill deeper and pay more for electricity. The surface can subside (as illustrated from the San Joaquin Valley), damaging buildings, roads and other infrastructure, and raise flood risks. Overlying land also can "desertify," as the roots of plants no longer reach the water table. Overdrafting of coastal aquifers can lead to intrusion of salt water from the ocean, reducing or eliminating the usability of the aquifer for irrigation, industry or domestic consumption. Overdrafting also can reduce water quality by mobilizing groundwater contaminants.

Surface water and groundwater are also hydrologically connected, although the law historically treated them as largely separate. Groundwater overdrafting thus can also affect springs, surface flows, and associated wetlands and water bodies. Perennial stream flow in the West is less than half of what it was a century ago, due in part to groundwater overdrafting. In California, groundwater depletion has deprived the Cosumnes River of traditional summer and fall flows, often leaving it dry and threatening the migration of fall-run Chinook salmon. In Texas, overdrafting of the Edwards Aquifer has led to the listing of five species of fish, salamanders, and plants as endangered or threatened under the federal Endangered Species Act.

Texas blind salamander.

Illustration of subsidence in the San Joaquin Valley of California. (Source: U.S. Geological Survey, 1977)

Integrated Regional Management

Just as the challenges are interrelated, any effective solution must also be integrated. Management of groundwater must take into account the impacts of overdrafting on the users of both groundwater and surface water, as well as overlying landowners and groundwater-dependent ecosystems. Management of land use should reflect the impacts of development on groundwater demand and recharge. Management of surface water can benefit from considering the opportunities to store surface water in groundwater aquifers for later use and to substitute surface water for groundwater, and vice-versa.

Regional processes, organized by watershed or groundwater basin, present the best opportunity for such integrated management. Because water systems and needs vary significantly from region to

region, local management can best contour policies to key physical and socioeconomic considerations. Local governments also have historically enjoyed legal authority over many of the key management functions, including land-use planning. Stakeholders often have better access to local processes. Finally, studies suggest that local governments tend to be more responsive, creative and adaptive in the face of changing conditions.

For almost 20 years, California has run an experiment in local groundwater management. Starting in 1992, California authorized the creation of groundwater management districts that could enact local management plans. To date, such districts have created more than 140 plans. The plans focus on groundwater management and do not constitute integrated regional management. An analysis of the plans, however, shows the diversity and innovation with which districts have approached their task. Districts have taken a variety of promising approaches to collaborating with stakeholders and local governments, collecting relevant management information, evaluating options, resolving disputes, controlling groundwater extraction, recharging aquifers and evaluating performance.

A number of the groundwater management plans also have gone beyond regulation of groundwater extraction and provided for often inventive approaches to conjunctive groundwater management, underground storage of surface water, protection of connected surface waters and minimization of impacts on groundwater-dependent ecosystems.

Cosumnes River. (Source: U.C. Davis Water Resources Center)

Several of the groundwater management plans, for example, provide for shifting of groundwater pumping from one area to another or from one aquifer to another to reduce the potential for overdrafting and saltwater intrusion. Some plans encourage pumpers who may be impacting surface waters to move their wells or switch to surface supplies.

The Eastern San Joaquin groundwater management plan uses its aquifer-recharge project both to avoid overdrafting and salt-water intrusion and to provide seasonal habitat for migratory waterfowl. Similarly, the Kings River Conservation District's plan uses a constructed wetland both to support wildlife and to provide "in lieu" water for former groundwater users. The Central Sacramento County Water Authority tries to reduce water losses from the Cosumnes River during the critical fall season by releasing water to pre-wet the river and thus diminish infiltration.

Moving Forward

Although local regions are well suited to engage in integrated regional management of groundwater, few are likely to do so without some form of external pressure or incentive. Few of the groundwater management plans discussed above are comprehensive, and most are better at setting goals than achieving them.

One option is for states to mandate specific performance goals (e.g., long-term sustainable groundwater pumping, integrated groundwater and surface-water use, protection of groundwater-dependent habitats) but then allow local governments the first opportunity to develop plans to meet the goals. States can reserve the authority to develop their own plans if local governments fail to develop an adequate plan, giving local governments an incentive to act. This approach resembles "cooperative federalism" under the Clean Air Act where the federal Environmental Protection Agency sets national ambient air-quality standards but allows states to develop and enforce the implementation plans. The Clean Air Act has worked well, with virtually every state developing adequate implementation plans. In a similar approach, recent Utah legislation provides that 15 percent of local groundwater users can demand that the state develop a plan, but then allows local users

to develop a plan in lieu of the state. Australia is in the process of implementing a Clean Air Act-type approach to better manage groundwater in its most important irrigation basins.

Short of such a mandate, states can promote integrated regional management by ensuring the availability of needed information (e.g., groundwater pumping amounts), an effective forum for discussing options and funding. Integrated regional management is expensive, so steps to reduce cost can eliminate a major hurdle that may prevent local stakeholders from coming together to manage their resources. In the mid-20th century, for example, California courts provided a useful forum for groundwater users to collect and analyze data and then enforce agreements against "hold outs." Today, unfortunately, judicial proceedings are too costly and uncertain to serve as useful forums in most regions of the state, although changes to procedural rules could make them more helpful.

In a few cases, lawsuits have provided the needed impetus for groundwater management. In Texas, for example, lawsuits under the federal Endangered Species Act ultimately forced the legislature to establish the Edwards Aquifer Authority to reduce groundwater pumping and thus avoid harm to the endangered and threatened species reliant on springs fed by the aquifer. In Hawaii, the state Supreme Court concluded that the public trust doctrine, as embodied in Hawaii's Constitution, required the protection of groundwater-dependent ecosystems.

Water In The West

Stanford's **Program on Water in the West** has embarked on a several-year effort to promote effective and integrated groundwater management in the western United States, including California. The program will work on four fronts simultaneously. First, the program will develop and demonstrate new scientific tools for characterizing and managing groundwater resources. Poor information today often prevents effective management. Second, **Water in the West** will closely scrutinize groundwater management approaches throughout the western United States and Australia to identify and define best practices, as well as methods of moving those practices forward. As our study of local groundwater management practices in California has revealed, the West is a hot bed of local, and sometimes state, innovation, but little is known about what works best and why, nor do we have a good understanding of how best to promote reform. Third, **Water in the West** will develop performance metrics and other information tools to both promote reform and measure success. Finally, the program will work with groundwater banks to advance new economic, financial, and institutional approaches to maximizing the benefits of banking operations.

For more information on Woods Institute freshwater research go to **http://woods.stanford.edu/freshwater**

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