



Water Security: The Role of Sound Groundwater Management and Governance

KEY POLICY MESSAGES

- Sound groundwater governance and management must consider local conditions, while simultaneously addressing groundwater as a large common-pool resource.
- Decision-makers must overcome data challenges posed by the location of aquifers below ground and scarce monitoring data.
- Groundwater allocation to different users should be transparent, equitable, and supported by data and science.

Savanna Landscape in National Park,
Kenya, Africa © Volodymyr Burdyak

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Sound groundwater governance faces unique challenges due to the invisibility of the resource, the diversity of biophysical landscapes, political jurisdictions, and socio-economic conditions spanning groundwater basins. Overcoming these challenges requires strong institutional arrangements and binding obligations developed through a collaborative, science-driven approach.

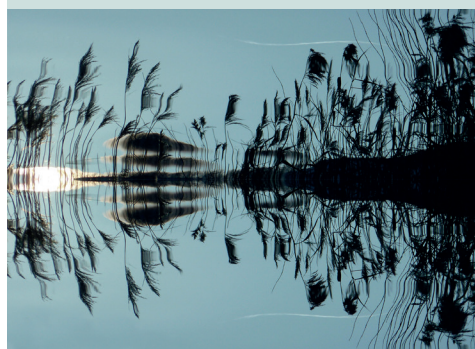
ADDRESS LOCAL CONDITIONS WITHIN COMMON-POOL MANAGEMENT

Each aquifer is unique in its environmental and physical properties, the social and cultural communities that rely upon its water, the economic activities it supports, and the political jurisdictions it lies under. These properties often vary widely, creating unique challenges for developing resource-sharing agreements.

Sound governance faces numerous obstacles. Groundwater use is local: pumping by one user can reduce the amount available to others. Aquifers can be interconnected in complex ways with each other and with surface flows. Groundwater use is also regional. In northern Chile, six administrative regions independently manage their portion of the aquifer, contributing to lowering of the aquifer's water level, salinity issues and the potential for conflicts.

Central questions for governing groundwater focus on:

- **WHAT** entity grants water rights?
- **HOW MUCH** water should be allocated to different users?
- **HOW** will rights be enforced and conflicts addressed?



Effective institutional arrangements for governing common pool resources can take many forms but require the explicit delegation of functions and roles between a centralized authority and state and local institutions. Some countries, such as Jordan and Israel, take a more centralized groundwater management approach specified through national policy. Others, such as Kenya, have shifted towards a more decentralized approach that delegates the authority to develop regulations and management to local groups. Experts generally recommend a groundwater governance system that allows elements of subsidiarity and local autonomy, while central authorities focus on supportive functions, particularly scientific and technical.

BUILD STAKEHOLDER TRUST THROUGH INCLUSIVE, OPEN COMMUNICATIONS

Successful implementation of groundwater governance requires trust among the different stakeholders. Institutions can build this trust through transparent negotiations and inclusive collaborations. For example, authorities in the Spanish part of the Douro (Duro) river basin nurtured a "space for collaboration" to develop new governance arrangements that are better suited and more responsive to the collective interest of all users. Management of Chile's Copiapó basin also benefited from the creation of collective water management associations, where multiple workshops brought users together to reach a consensus on the need to jointly manage the aquifer.

Gender is important in the management of groundwater. In areas lacking household water connections, it is usually women and girls who carry water from wells to their homes and farms. In the Stampriet



Patagonie, Chili © Wirestock

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Transboundary Aquifer System (STAS) in Africa, women and girls walk up to 6 km for water, which can impact girls' attendance at schools. However, the STAS areas rarely considered gender in the management of groundwater. This highlights the need to include women in decisions regarding groundwater management as well as to provide gender-sensitivity training for decision-makers.

ESTABLISH EQUITABLE, SCIENCE-BASED RULES FOR BENEFICIAL USES

The creation and implementation of groundwater rules that ensure equitable and sustainable use of aquifers depends upon sound scientific and technical knowledge on the state of hydrogeology, stream ecology, water quality, potential contamination sources, water supply availability and variability, water user demands, environmental services, socio-economics, and, importantly, the level of uncertainty and trends in all these areas. Thus, groundwater investigations require multi-disciplinary skills and collaboration among -disciplines.

The location of aquifers underground and out-of-sight, along with groundwater's three-dimensional movement through varied geologies, adds complexity to delineating aquifer properties adequately to make informed governance decisions and to develop management strategies. For example, the lack of critical information regarding water rights and water dynamics in northern Chile required planners to estimate water use with a "foreseeable use factor." This approach assumed that

agriculture would only consume 20% of its annual allotment, in part based on expected inefficiencies in extraction. Yet this approach has sometimes underestimated water use by not accounting for improvements in extraction efficiency, contributing to over-allocation and aquifer overdraft.

Cataloguing and prioritizing beneficial uses serves as a good starting point for groundwater allocation and governance decisions. For example, to address the lack of data regarding water use and rights in Chile's Copiapó basin, researchers built a water rights database using historic real estate registry information. This became the basis to adjudicate groundwater rights and communities in the basin. Geolocating and cataloguing existing wells can be particularly helpful in data-poor and fragile context. This not only allows for collecting a range of information on water use and aquifer properties, but can also help protect existing users if new developers seek to extract more groundwater.

CULTIVATE ENABLING ENVIRONMENTS BY BETTER CHARACTERIZING SYSTEMS

The lack of information on groundwater basin characteristics and use in most locations, and the cost and specialized skills often required to obtain it, remains a challenge for groundwater management. Central authorities can provide support in collecting and analysing data to better understand the system's features including recharge, transmissivity, storage and extent, as well as existing resource use and tenure arrangements.

Groundwater's unseen three-dimensional movement through varied geologies makes it difficult to delineate aquifer properties adequately for informed decision making.

Table: Problems, barriers and solutions identified using the SES framework to improve groundwater governance in Copiapó Basin, Chile.

PROBLEMS	BARRIERS	SOLUTIONS
Over-allocation of water rights	Heterogeneity of the actors involved and no opportunities for conversation	Develop a neutral space where all stakeholders can debate; hire a neutral and technical mediator
Independent management of connected aquifer sectors, and management of surface-groundwater interactions	Disinformation regarding water available and granted water rights	Formally establish collective language and representation of all stakeholders in the legal documents
Poor or no groundwater management	Government bureaucracy problems	Clearly identify all members and their water rights and establish a common consensus on this registry
Conflicts and trust issues among users	Trust issues	Search for solutions "out of the box" to achieve strategies in a given formal and well documented institutional framework
	Lack of monitoring techniques	Be consistent and transparent to regain trust between users
	Financial barriers	Develop specific financial alliances with the public sector to implement a monitoring plan

Several qualitative and quantitative approaches exist for better characterizing groundwater systems and overcoming unknowns. As demonstrated through research in Chile's Copiapó basin, Ostrom's Social-Ecological Systems (SES) framework can help identify problems, barriers, and solutions to successful management of groundwater to achieve water security at a basin level. The application of the SES framework in Chile informed the development of diverse strategies to help improve groundwater governance and the conjunctive management of groundwater and surface water.

MONITOR AND ENFORCE EXTRACTION REQUIREMENTS

Binding obligations serve as legal mechanisms to cooperate on transboundary aquifer management and provide one tool to help resolve potential disputes. Authorities must not only establish policies, laws and regulations but also implement them. In both Jordan and Kenya, there remains a gap between written policies and clear, consistent implementation. Similarly, Mexican laws and regulations on groundwater exist, but the lack of aquifer monitoring and groundwater extraction measurements makes it difficult to enforce them. In Chile, the State lacks the financial, technical and human resources to implement all the provisions of the Chilean water law regarding water management and monitoring.

ESTABLISH REALISTIC EXPECTATIONS AND BUILD CAPACITY

Meeting goals for so-called "good" groundwater governance can be challenging, or even impossible, in countries with restricted public budgets, protracted crises, or high levels of corruption. In these contexts, it may be more effective to focus on finding entry points to the measurement, monitoring and management of groundwater whilst promoting a governance framework that can evolve towards effective management.

Capacity development and training among residents on groundwater governance and related issues such as climate change, sustainable development goals, gender-sensitivity, and public health issues, should receive greater attention to achieve water security. In Kenya, researchers noted the lack of capacity including staff, technical, and

financial resources as one of the greatest challenges to groundwater governance in Kenya. Further, the lack of capacity often leads to a lack of enforcement, which places the aquifer as an unmanaged common-pool resource.

While common elements to sound groundwater management are well documented, many obstacles exist to achieving them. Overcoming these challenges requires a strong and continued commitment to improving our understanding of groundwater use and functions and improving inter- and intra-institutional coordination and collaboration.

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IWRA Policy Brief Editor: Kara DiFrancesco
Policy Briefs Coordinator: James E. Nickum
IWRA Project Officer: Mary Trudeau
Layout: Nathalie Lyon-Caen



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Common elements of sound groundwater management

- Effective governance
- Use of science and sound data
- A clear legal framework
- Public participation
- Sufficient funding