



**Addressing Groundwater Resilience under Climate Change**

**THEME IV**

**Groundwater governance,  
management & policy**

A woman pumps water, India  
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**KEY POLICY MESSAGES**

- Groundwater governance is multi-scalar, from households to local, state, national, and global.
- Solutions are varied, contextualized, and situated increasingly within the water-energy-food nexus.
- Self-organization and collective action are crucial for addressing groundwater problems.
- Approaches should be adaptive, context specific and with systems thinking.

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*Groundwater is the world's most widely distributed store of freshwater, but in many places, it is under threat. Depleted groundwater tables can lead to a loss of base flow in surface streams, subsidence of land, intrusion of seawater, and poorer quality resulting from higher concentrations of pollutants. Better governance is fundamental. Yet like groundwater itself, these challenges are often out of sight and out of mind.*

## GO BELOW THE SURFACE TO GOVERN GROUNDWATER

Both natural and human forces shape groundwater governance. Climate change is responsible for a change in seasonality and intensity of rainfall. Some areas are likely to become hotter, and drier, with shorter but more intense monsoons and more erratic weather patterns. By compromising groundwater recharge capacity, these factors are likely to exacerbate overall water stress. Humans extract groundwater during water shortages and droughts. Yet without governance to ensure recharge, this buffer can become a critical vulnerability when over-extracted and depleted.

Water users – including smallholder farmers, commercial agricultural and industrial enterprises, and cities – can threaten groundwater where extraction is poorly regulated. Climate change threatens to further deplete groundwater reserves, often to the disadvantage of vulnerable users. Traditional cropping and land cultivation, combined with population growth and water-intensive crops, can also lead to over-extraction. Further, political or humanitarian crises can add stresses to areas that depend on groundwater.

Groundwater governance includes regulation of pumping, assignment of water rights, strategic pricing, monitoring and evaluation, and community-based approaches. Unfortunately, implementation problems are common.

Monitoring is handicapped by insufficient methods and tools to collect and analyze data, notably in rural, 'under-developed,' or resource constrained areas.

Groundwater governance is also heavily influenced by policies concerning agriculture and energy as well as water. For example,

groundwater extraction in India increased with rural electrification, power subsidies, and agricultural pricing dynamics that encouraged wasteful use.

## INCLUDE ALL PARTIES AROUND THE WATER TABLE

Groundwater governance is moving away from top-down management towards blending regulatory and market mechanisms complemented by self-regulation and multi-level governance. This policy hybridization works when adapted to local uses (agriculture and industry), natural conditions (weather patterns) and human factors (social conflicts and economic forces).

*Sustainable groundwater governance requires that all stakeholders have access to data.*

Groundwater pumping out of a pipe into an irrigation canal in California  
© Community Water Center (CWC)





Groundwater policies and monitoring systems cannot be left to technical specialists. To work effectively, they must also be inclusive and participatory. Incorporating local or indigenous knowledge can benefit from overlooked stores of knowledge. Proper institutions can also lead users to treat groundwater as a shared resource.

The mechanics of stakeholder engagement are well known: public discussions, feedback, and dialogue-based activities. Yet stakeholder participation initiatives are often poorly executed, done perfunctorily or without considering local conditions.

A principal benefit of stakeholder participation is that it enables co-production of knowledge and 'social learning.'

Ensuring a balance between expert input and public participation requires clear procedures for collaborative action. For example, in Guanajuato, Mexico, a framework for aquifer management institutionalizes policy visions, accounts for stakeholders, determines performance metrics, and incorporates risk management. India's 'water stewardship initiative' undertakes action-based research

to develop equitable models for resilience and ownership through grassroots management. Water politics is present and often conflictive at all levels. Groundwater extraction can also be seen through the lenses of power struggles and marginalization. The health of lower-income Latinx farmworkers in California, particularly women in traditional family roles, is disproportionately threatened by unstable groundwater supply due to over-extraction. Groundwater issues are also ones of gender, race and justice.

## NAVIGATE THE PERFECT STORM

Climate change, compounding political, social, and economic complexity, threatens groundwater governance. Innovative and creative practices have sought to address whenever possible these threats, both immediate and long-term.

Practical steps include identifying stress points, projecting demographic, economic, and social trends, predicting behavioral effects of market mechanisms and other incentives, and modeling scenarios based

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*The crucial factor is inclusion of users in policymaking.*





on climate change. For this, the collection, analysis, and communication of timely, relevant, and representative data is crucial. While being flexible enough to accommodate multiple scenarios across different scales, policies must respect local contexts and political situations.

Creative technical solutions have emerged at the micro level. For example, in India, timing agricultural practices like sowing and limiting power supply for pumping reduced extraction and facilitated monitoring. In Indonesia, where piping infrastructure is under-developed (including 'last mile' delivery), micro-level and community-based supply efforts have been essential – including dry borewells as dormant infrastructure to divert rain runoff for groundwater recharge.

At a broader governance level, the range of interventions and instruments is wide. For example, in Hebei Province, China, scientific efforts to decontaminate rivers were complemented by collaborative models for managing discharge and by capabilities for monitoring pilot programs. In the UK, a government-funded program uses social media to circulate information about the impacts of extraction on lower-income communities in Africa.

Government departments often intervene with proprietary policy tools (e.g., agriculture subsidies in India, water transfer in China, and hydropower in South Asia). Groundwater governance can also be a transboundary concern, requiring 'water diplomacy,' not just international but between states or provinces, such as in the U.S. states overlying the high plains aquifer.

## VIEW GROUNDWATER FROM THE GROUND UP

How groundwater is viewed can change governance practices and private behaviors concerning over-extraction. A common-pool perspective, exemplified in India's doctrine of 'public trust,' supports a collaborative, community-based, and thereby sustainable approach. This perspective is important amidst extraction pressures and stressors like climate change.

At the individual level, changes in attitudes and analytical capacities can improve groundwater governance. Research in cognitive science supports not only managerialist interventions but also 'nudging' that foregrounds socio-cultural norms, aimed at altering attitudes about resource stewardship and individual responsibility.

In most places, the returns to infrastructure and technocratic approaches are diminishing. Managed aquifer recharge, wider and deeper monitoring capacity, and refurbished infrastructure make short-term progress, but the crucial factor is inclusion of users in policymaking.

*The human right to water must be honoured where communities struggle to meet basic needs. Efforts to institutionalize sustainable groundwater practices must complement efforts to improve living conditions and public health.*

### ADDRESSING GROUNDWATER RESILIENCE UNDER CLIMATE CHANGE

IWRA/UNESCO-IHP Online conference, 28-30 October 2020

[Proceedings \(abstracts, presentations and posters\).](#)

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#### ACKNOWLEDGEMENTS

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