

A comprehensive exploration of groundwater governance challenges and solutions

Yamuna N^{1*}, Mahantesh R Nayak¹ and Rakesh N²

¹University of Agricultural Sciences, Dharwad, Karnataka 580 005

²ICAR-Mahatma Gandhi Integrated Farming Research Institute, Motihari, Bihar 845 429

Groundwater, comprising 97% of accessible freshwater, is vital for over two billion people, supporting agriculture, industry, and domestic use. Despite its critical role, over-extraction and pollution threaten its sustainability, particularly in India, the world's largest groundwater user. Effective governance is hindered by legal ambiguities, inadequate enforcement, and unsustainable practices. Solutions lie in transparent regulations, participatory management, and innovative approaches like the Jyotigram Scheme in Gujarat. Global examples, including Integrated Water Resource Management, underscore the need for coordinated efforts. Urgent action from policymakers, communities, and stakeholders is essential to safeguard this invaluable resource for future generations.

Keywords: Challenges, Groundwater, Regulations

Groundwater, constituting an impressive 97% of the world's readily accessible freshwater, is a silent force that sustains the lives of over two billion people globally. This invaluable resource caters to more than 60% of irrigated areas and meets the drinking water needs of approximately 85% of the population. As groundwater increasingly becomes the backbone of our survival, the need for effective governance and management has never been more crucial.

Pervasive role of groundwater

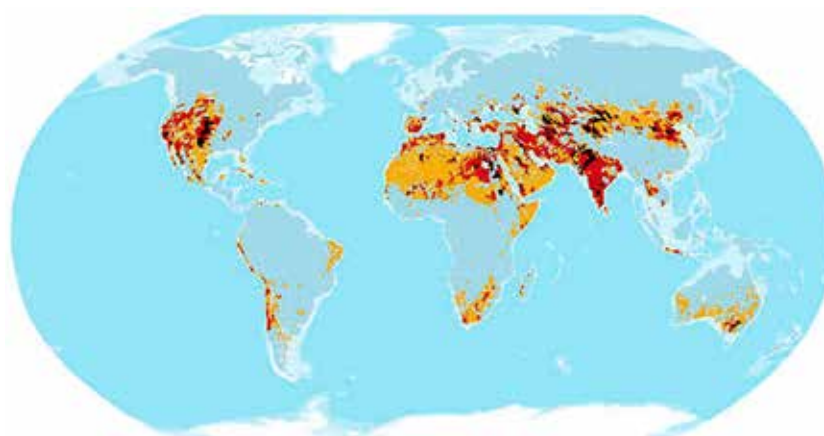
Groundwater is not just a critical component of the global water cycle; it is a lifeline for agriculture, industry, and domestic use. In the last four decades alone, 84% of the net addition to irrigated areas has come from groundwater. This invisible resource has become synonymous with private property, often leading to challenges related to its over-exploitation, pollution, and the widening gap in income distribution. The increasing recognition of the fundamental

right to water, embedded within the right to life under Article 21 of the constitution, underscores the urgency for robust governance.

Complex legal landscape

Groundwater management in India is complicated by the absence of a proper legal regime to hold large farmers accountable for the

use of groundwater, potentially at the expense of smaller farmers. As per the Government of India Act, 1935, groundwater falls under the jurisdiction of the states. The lack of a unified legal framework to address these challenges perpetuates issues like pollution, over-extraction, and the overall sustainability of this vital resource.



DEPLETION LEVELS



Global water depletion
Source: Water Share: Executive Summary

Key principles of effective groundwater governance

- **Openness:** Groundwater governance should be open, allowing anyone—not just stakeholders—to participate in decision-making processes. Recognizing water as a public trust rather than private property is essential for fostering collective responsibility.
- **Transparent rules and regulations:** All rules and regulations governing groundwater use should be clearly communicated and understood by everyone involved. Farmers and communities need to be aware of their responsibilities and the consequences of neglecting sustainable management practices.
- **Participation:** Each farmer and community member should be involved in the regulation and management of groundwater. A participatory approach ensures a diverse range of ideas, experiences, and perspectives contribute to the development of effective management strategies.
- **Accountability:** Groundwater governance should maintain accurate records of property, documents, and funds. This ensures accountability and transparency, allowing for scrutiny and answering queries from concerned parties.
- **Effectiveness:** Groundwater governance practices must be effective in real-time implementation. It is not enough to have statements of laws and policies; they must be effectively enforced to address challenges such as over-extraction and pollution.
- **Coherence:** Coherence in groundwater governance implies a unified, orderly, and consistent approach involving different institutions and organizations. This coherence is crucial for managing the complexities of groundwater resources effectively.
- **Efficiency:** Efficient use of resources, including financial

and water resources, is vital. Investments should be targeted and effective to ensure sustainability in the utilization of groundwater.

- **Communicative:** Rules and regulations should be communicated promptly and comprehensively to users. Lack of awareness can lead to unintentional violations, hindering the efforts of those interested in conserving water.
- **Equitable:** Regulations must be applicable to all members of society, irrespective of power, religion, or status. Equitable distribution of groundwater resources is essential to avoid disparities in access and use.
- **Integrative:** Groundwater management should adopt an integrative approach, combining cooperative management, public governance, individual participation, state regulation, and the interests of private organizations.
- **Sustainable:** Any groundwater management practices should have a long-term perspective, focusing on preserving groundwater for future generations. Sustainability should be a core principle guiding all decisions and actions.
- **Ethical:** Governance should adhere to ethical principles, ensuring that decisions and actions align with values that prioritize the common good and the responsible use of resources.

Approaches to groundwater governance

- **Privatization:** Privatization incentivizes conservation and efficient resource allocation but can lead to challenges in equitable distribution. Striking a balance between economic efficiency and equitable access is crucial in this approach.
- **Cooperative approach:** Encouraging community-based cooperation allows for effective conservation and regulation. Models like the Orissa Panipanchayat Act and community-based water schemes in Maharashtra

showcase successful cooperative governance.

- **State regulation:** Widely adopted in India, state regulation involves government intervention to manage and control groundwater use. This approach is pivotal in enforcing rules and regulations but may face challenges in implementation.

Global Scenario

Before the 20th century, groundwater management was largely absent worldwide. Global efforts have emerged to address the challenges associated with groundwater governance, reflecting a growing awareness of the need for coordinated action.

- **Integrated Water Resource Management (IWRM):** IWRM, emphasizing coordinated development of water and land resources, operates on four key principles: viewing water as finite and vulnerable, adopting a participatory approach, recognizing the important role of women, and treating water as an economic good.
- **United Nations Millennium Ecosystem Assessment, 2001:** Launched in 2001, this international initiative broadens the definition of ecosystem services, recognizing the interconnectedness of food, water, climate, and various other aspects. It responds to changing environmental conditions on a global scale.
- **Climate Change Adoption and Groundwater Governance in East Anglia, UK:** Implementing IWRM principles, this initiative manages groundwater through environmental agencies. It involves local stakeholders in policy-making, enforces licensing, and implements measures such as efficient irrigation techniques and winter water harvesting.
- **Internationally Shared Aquifers Resources Management Program:** Organized by UNESCO, this program raises awareness about

the management of shared aquifers, promoting cooperation and sustainable use on an international scale.

- New Water Sustainability Act, 2016 (British Columbia):** This act licenses non-domestic groundwater use, introducing fees and rentals. It shifts from free extraction practices, even during drought conditions, ensuring responsible use of groundwater resources.
- World Bank's EWS 'Too Big to Fail: The Paradox of Groundwater Governance':** The World Bank explores the challenges and opportunities in groundwater governance, aiming to understand and address issues in developing countries. Acts like the Edwards Aquifer Authority Act in Texas and Tanzania's Water Resource Management Act are other examples.

Global water depletion

While groundwater is relatively safe in many countries, over-exploitation is increasing, particularly in India. A significant portion of Indian regions reports 75 to 100% groundwater development, emphasizing the need for urgent attention to sustainably manage this vital resource.

Groundwater governance in India

India has become the world's largest user of groundwater, witnessing a tenfold increase in extraction from 1950 to 2013. With more than 20 million new wells annually, India consumes 230 cubic kilometers of groundwater each year, constituting over a quarter of the global total. Since 1990, Indian states have recognized the groundwater crisis as a serious concern.

It is evident from Table 1 that annual replenishable groundwater, net groundwater availability is almost same over the years but annual groundwater draft for irrigation, domestic and industrial purpose is increasing which makes stage of groundwater development to increase from 58 to 63% from 2004 to 2017.

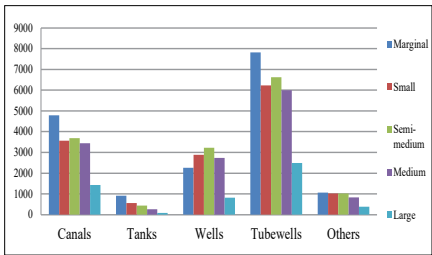
Table 1. Ground water resources assessment (2004 to 2017)

Ground water resources assessment	2004	2009	2011	2013	2017
Annual Replenishable Ground Water Resources	433 bcm	431 bcm	433 bcm	447 bcm	432 bcm
Net Annual Ground Water Availability	399 bcm	396 bcm	398 bcm	411 bcm	393 bcm
Annual Ground Water Draft for Irrigation, Domestic & Industrial uses	231 bcm	243 bcm	245 bcm	253 bcm	249 bcm
Stage of Ground Water Development	58%	61%	62%	62 %	63%

Source: CGWB 2020

Groundwater development and utilization

India's groundwater story is a tale of development, utilization, and challenges. The adoption of bore wells led to increased irrigated areas, transforming the agricultural landscape (63.63% of cultivated area is irrigated by tube wells and wells). However, this growth comes at a cost, with areas like Punjab and Haryana experiencing a rapid decline in water tables.



Area irrigated by different sources of irrigation. Note : Figures in '000 Hectare.
Source: Agricultural Statistics at a Glance 2022

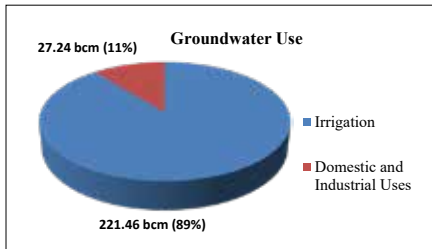
Socio-economic impact of groundwater use

The socio-economic impact of groundwater use is extensive. The green revolution, fueled by groundwater irrigation and technological advancements like tube wells, led to increased agricultural productivity. This, in turn, contributed to food security, poverty alleviation, and economic growth.

- Green Revolution and Technological Advancements:** The introduction of high-yielding varieties, chemical fertilizers, and pesticides, coupled with the use of tube wells for groundwater extraction, marked the beginning of the green revolution in India. This period witnessed a substantial increase in agricultural production and played a pivotal

role in transforming India into a food-sufficient nation.

- Impact on Livelihoods:** The reliance on groundwater for agriculture has not only boosted food production but has also become a significant source of livelihood for millions of farmers. It has contributed to poverty alleviation and improved the economic well-being of rural communities.
- Tube Well Revolution:** The widespread adoption of tube wells, especially in the post-green revolution era, further intensified groundwater use. Tube wells offered farmers greater control over water resources, allowing them to irrigate their fields based on their cropping patterns and water requirements.



Source: CGWB 2020

Challenges in groundwater governance

- Over-Extraction:** One of the most significant challenges in groundwater governance is the issue of over-extraction. The increasing demand for water, especially in agriculture, has led to the depletion of groundwater levels in various regions. The unrestricted drilling of borewells exacerbates this problem.
- Pollution:** Groundwater pollution is another pressing concern. Agricultural runoff, industrial discharges, and

untreated sewage can contaminate groundwater, making it unfit for consumption. The lack of proper sanitation facilities in many areas further contributes to groundwater pollution.

- **Lack of Sustainable Practices:** The absence of sustainable groundwater management practices poses a threat to the long-term availability of this resource. Unregulated extraction, inadequate recharge mechanisms, and the lack of awareness about water conservation contribute to unsustainable practices.
- **Legal Ambiguity:** The legal framework governing groundwater in India is complex and often ambiguous. The absence of a comprehensive and uniform law across states leads to inconsistencies in implementation and enforcement. This legal ambiguity contributes to challenges in addressing issues like over-extraction and pollution.
- **Energy Subsidies and Over-Extraction:** Energy subsidies for agriculture, including electricity for pumping groundwater, have inadvertently contributed to over-extraction. The low cost of energy encourages farmers to pump more water than necessary, leading to the depletion of groundwater levels.
- **Conflicts over Water Rights:** The Plachimada case in Kerala exemplifies the conflicts arising from the extraction of groundwater. The clash between landowners' rights to extract groundwater and the community's authority to regulate private extraction underscores the need for reevaluating existing legal frameworks.
- **Lack of Enforcement:** Even with existing laws and regulations, the lack of effective enforcement mechanisms hampers groundwater governance. Weak implementation allows for continued over-extraction,

pollution, and unsustainable practices.

- **Ambiguity in Water Rights:** The ambiguity in water rights, especially in areas where groundwater is considered private property, creates challenges in defining responsibilities and regulating usage. Clear delineation of water rights is essential for sustainable and equitable groundwater management.
- **Impact of Climate Change:** Climate change poses additional challenges to groundwater management. Changes in precipitation patterns, increased temperatures, and extreme weather events can affect groundwater recharge and availability, necessitating adaptive strategies.

Initiatives and legislative framework

- **National Water Policy:** India's National Water Policy outlines principles for the sustainable development and management of water resources. It emphasizes the need for equitable distribution, efficient use, and the integration of traditional water systems.
- **Indian Easement Act, 1882:** The Indian Easement Act provides guidelines on the right to groundwater. However, its applicability and effectiveness in addressing contemporary challenges remain subjects of debate.
- **Water (Prevention and Control of Pollution) Act, 1974:** The Water (Prevention and Control of Pollution) Act addresses water pollution, including contamination of groundwater. Despite its existence, challenges persist in enforcing regulations to prevent groundwater pollution.
- **National Project on Aquifer Management (NAQUIM):** NAQUIM is an initiative aimed at identifying, mapping, and formulating management plans for aquifers in India. This project seeks to enhance sustainable groundwater use by

understanding and managing aquifer dynamics.

- **Karnataka Groundwater Act:** The Karnataka Groundwater Act is an example of state-level legislation that aims to regulate and control the development and management of groundwater. The act empowers the Karnataka Groundwater Authority to grant permits and regulate groundwater extraction.
- **Jyotigram Scheme in Gujarat:** The Jyotigram Scheme in Gujarat focuses on restructuring electricity subsidies for agriculture to promote more sustainable groundwater use. By providing power during specific hours and charging higher rates for excessive use, the scheme aims to encourage judicious use of groundwater.
- **National Mission for Clean Ganga (NMCG):** NMCG, an initiative under the Ministry of Jal Shakti, focuses on cleaning and rejuvenating the Ganga River. While not exclusively groundwater-oriented, the mission indirectly addresses water quality issues, including groundwater pollution.

Despite the existence of legislation and regulatory bodies, challenges persist in the effective implementation of groundwater governance. Enforcement, monitoring, and addressing issues related to over-extraction remain areas that require improvement. Achieving sustainable groundwater management necessitates coordinated efforts from various stakeholders, including farmers, local communities, government agencies, and non-governmental organizations. Collaborative initiatives can enhance awareness and ensure the success of regulatory measures. The governance of groundwater, a critical and finite resource, demands immediate attention and concerted efforts from policymakers, communities, and stakeholders.

*Corresponding author email:
yamunanarayan97@gmail.com