3. Groundwater Management in India - Environment

Recently, it has been highlighted that Population growth and development are straining groundwater, requiring sustainable management.

Concept and Key Features

Groundwater is freshwater stored below the Earth's surface in the pore spaces of soils and fractures of rocks; it acts as a natural buffer during droughts and seasonal rainfall variability. Aquifers are geological formations that store and transmit groundwater; their capacity depends on porosity, permeability, and recharge conditions. Groundwater sustains baseflow in rivers and streams during dry seasons, and maintains wetlands and ecological habitats. It is accessed through wells, tube wells, borewells, and can also emerge naturally through springs. Groundwater is often described as the dominant share of Earth's liquid freshwater, making it a core pillar of water security and climate resilience.

India's Groundwater Scenario

Groundwater is India's backbone resource for-

1. Irrigation (dominant source for agriculture in many States)
2. Rural drinking water
3. Urban and peri-urban supply, especially through private and municipal borewells

India's groundwater dependence has expanded due to-

1. Green Revolution cropping patterns
2. Expansion of irrigated area
3. Rising rural and urban demand
4. Growth of private tube wells driven by low entry costs

Monitoring and assessment-

1. India operates a large network of groundwater monitoring stations through the CGWB and allied agencies.
2. Groundwater levels are periodically monitored using observation wells to track trends and seasonal fluctuations.

Why Groundwater Management is Necessary

Over-extraction and Declining Water Tables

Intensive pumping—often unmetered and unregulated—has resulted in-

1. Falling groundwater levels in many hard-rock and alluvial regions
2. Drying of shallow wells and increased dependence on deeper borewells
3. Rising energy use for pumping, increasing cost burdens on farmers

Quality Degradation and Health Risks

Groundwater quality is affected by both **n**atural geogenic contamination and human-induced pollution-

1. **Arsenic** (notably in alluvial plains in some regions)
2. **Fluoride** (common in hard-rock regions)
3. **Nitrate** contamination (often linked to fertiliser use and poor sanitation)
4. Industrial effluents, mining leachates, and improper waste disposal

Consequences-

1. Chronic health impacts (skeletal fluorosis, arsenicosis, kidney-related impacts, etc.)
2. Higher treatment costs and reduced safe drinking water access

Drivers of Uncontrolled Abstraction

Structural drivers include-

1. Easy availability of drilling and pump technologies
2. Electricity subsidies and flat tariffs (where applicable), weakening conservation incentives
3. Fragmented legal control—groundwater often treated as attached to land rights
4. Weak enforcement capacity and inadequate local aquifer governance institutions

Climate Change and Hydrological Variability

Climate change influences groundwater through-

1. Higher evapotranspiration reducing effective recharge
2. More intense rainfall events increasing runoff but not necessarily recharge
3. Longer dry spells increasing reliance on groundwater

Groundwater is therefore both-

1. A climate adaptation asset, and
2. A risk amplifier if it is overdrawn during repeated drought years

Governance and Policy Context (India)

Integrated Water Resources Management (IWRM) Relevance

Groundwater cannot be managed in isolation because it is linked with-

1. Surface water flows
2. Watershed conditions
3. Land use, forests, and soil moisture
4. Urban drainage and wastewater systems

Effective management requires conjunctive use- Coordinated planning of surface water + groundwater to avoid over-dependence on aquifers

Key Initiatives and Programmes

Model Groundwater Bill

Provides a template for States to-

1. Regulate extraction
2. Protect drinking water sources
3. Promote sustainable use and recharge
4. Establish groundwater authorities and permit systems

Importance - Seeks to shift groundwater from purely private control toward regulated common-resource governance

Jal Shakti Abhiyan- Catch the Rain (JSA- CTR)

A national behavioural and infrastructure campaign focused on-

1. Rainwater harvesting
2. Restoration of water bodies
3. Watershed works and afforestation
4. Community participation and awareness

Strength- Promotes decentralised water conservation and local ownership of water assets

Jal Sanchay Jan Bhagidari (JSJB)

A participatory push under JSA to improve recharge through-

1. Rooftop harvesting and community structures
2. Recharge pits/shafts
3. Borewell recharge and aquifer recharge measures

4. Illustrates "people + infrastructure + science" approach to groundwater recharge

NAQUIM and NAQUIM 2.0

NAQUIM (2012–2023)-

1. Aquifer characterisation and mapping
2. Data generation on availability and quality
3. Aquifer-wise management plans

NAQUIM 2.0 (2023–present)-

1. Higher-resolution datasets
2. More granular planning support (up to local levels)
3. Focus on stressed/vulnerable zones

Significance - Enables aquifer-based management, not just administrative-district-based measures

Master Plan for Artificial Recharge to Groundwater (2020)

Focus-

1. Terrain- and aquifer-specific recharge structures
2. Differentiated strategies for rural, urban, coastal, hilly regions

Examples of recharge interventions (generic categories)-

1. Check dams, percolation tanks, recharge ponds
2. Recharge shafts, trenches, injection wells
3. Rooftop harvesting linked to recharge
4. "Artificial recharge" is effective only when matched with hydrogeology, land availability, and maintenance capacity

Atal Bhujal Yojana (Atal Jal)

Emphasises-

1. Community-led groundwater budgeting and planning
2. Demand-side management and crop-water alignment
3. Incentive-based outcomes and institution building

Focus geography - Water-stressed blocks in selected States

Significance - Moves beyond supply augmentation toward behavioural and institutional reform

Mission Amrit Sarovar

Supports creation/rejuvenation of ponds as local water assets that can-

1. Improve surface storage
2. Support recharge (where hydrogeology permits)
3. Strengthen local drought resilience
4. Aligns with climate adaptation, watershed development, and rural livelihoods

Key Challenges

Scientific and Technical Constraints

Recharge is not always feasible everywhere-

1. Hard-rock terrains have limited storage; recharge may be slow and localised
2. Coastal aquifers risk saline intrusion if over-pumped
3. Urban recharge faces contamination risk if stormwater is polluted

Institutional and Regulatory Challenges

Fragmented governance across departments- Water supply, irrigation, rural development, urban local bodies, pollution control boards

Weak enforcement- Difficulty in regulating millions of private wells

Data gaps- Need for real-time monitoring in critical aquifers and peri-urban areas

Political Economy Constraints

Cropping patterns and MSP-incentives sometimes encourage water-intensive cultivation in water-stressed regions. Power subsidies reduce marginal cost of pumping, weakening demand discipline (context-specific across States)

Way Forward- A Stronger Groundwater Strategy

Aquifer-Based Governance

Shift from "administrative boundary management" to aquifer boundary management-

1. Aquifer-specific extraction limits
2. Community groundwater budgeting (water accounts at village/GP level)

Demand Management as Core

Promote "more crop per drop" with region-appropriate choices-

1. Micro-irrigation + agronomy + crop diversification
2. Water-smart procurement and incentives

Combine with-

3. Metering/pricing reforms where feasible
4. Energy-water nexus reforms (smart feeders, separation of agricultural feeders, etc.)

Protect Quality and Recharge Safely

Strong pollution control and source protection-

1. Prevent industrial effluent seepage
2. Improve sanitation to reduce nitrate contamination

Ensure recharge structures are paired with- Silt management, maintenance, and water quality safeguards

Conjunctive Use and Drought Preparedness

Use surface water when available and conserve groundwater as a strategic reserve

Build drought plans around-

1. Prioritisation of drinking water
2. Local storage + recharge + demand restrictions during drought phases

Equity and Rights-Based Approach

Ensure basic drinking water security for vulnerable communities first. Provide compensation/transition support where livelihood shifts are necessary in over-exploited blocks

Source- https-//www.pib.gov.in/PressNoteDetails.aspx?NoteId=157038&ModuleId=3&reg=3&lang=1