India's Groundwater Crisis

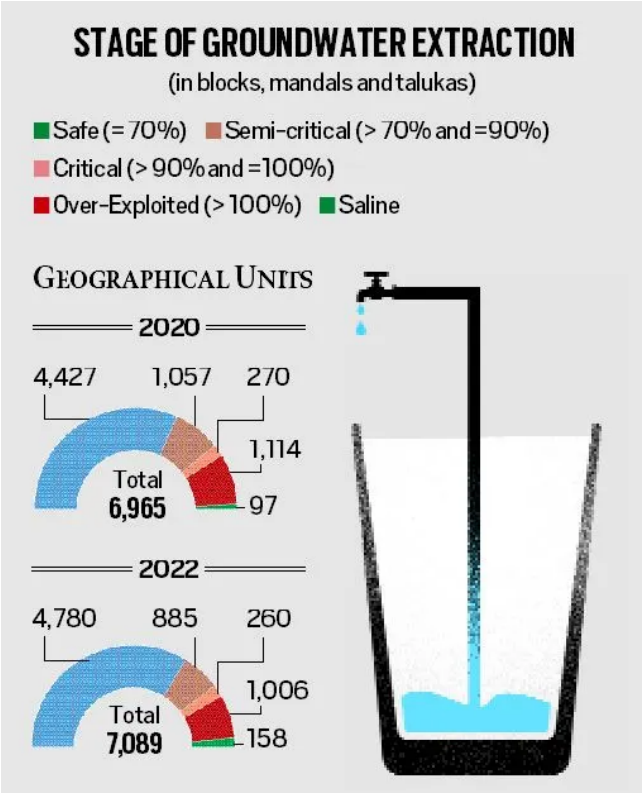
This editorial is based on "Make country's groundwater sustainable" which was published in The Hindustan Times on 10/01/2025. The article brings into picture the growing strain on India's groundwater due to increased irrigation for cultivation, worsened by population growth. Despite initiatives like the Atal Bhujal Yojana, urgent action is needed to address the looming water crisis.

For Prelims: Groundwater resources, Central Ground Water Authority, Central Ground Water Board, Subsidies for electricity, Jal Shakti Abhiyan, Atal Mission for Rejuvenation and Urban Transformation, Pradhan Mantri Krishi Sinchai Yojana, Mission Amrit Sarovar, Master Plan for Artificial Recharge to Groundwater, National Water Policy.

For Mains: Current Scenario of Groundwater Usage in India, Key Factors Responsible for Groundwater Shortage and Contamination.

India's agricultural prowess, particularly **in water-intensive crops like paddy**, comes at a severe cost to its **finite groundwater resources**. Between 2016 and 2024, while the country's population grew from **1.29 billion to 1.45 billion,** groundwater usage for irrigation jumped dramatically from **38%** to **52%**. Major paddy-producing states like Punjab, Haryana, and Rajasthan face a critical situation with most districts **over-exploiting their groundwater,** leading to issues of salinization and chemical contamination. While government initiatives like the **Atal Bhujal Yojana** have helped reduce unsustainable groundwater levels from 23% to 19% across districts, the looming population growth projections demand **urgent and scaled-up interventions for water security.**

What is the Current Scenario of Groundwater Usage in India?



- **Extraction and Availability:** India extracts nearly **25% of the world's groundwater**, making it the largest user globally.
  - **Annual groundwater extraction (2023)**: **241.34 bcm**.
  - **Overexploited units**: 736 assessment units (**11.23%**) show extraction exceeding replenishable recharge. (**Dynamic Groundwater Resource Assessment Report 2023)**
- **Dependency:** Groundwater is the backbone of India's water needs:
  - **62%** of irrigation needs are met through groundwater.
  - **85%** of rural water supply and **50%** of urban water supply depend on groundwater.

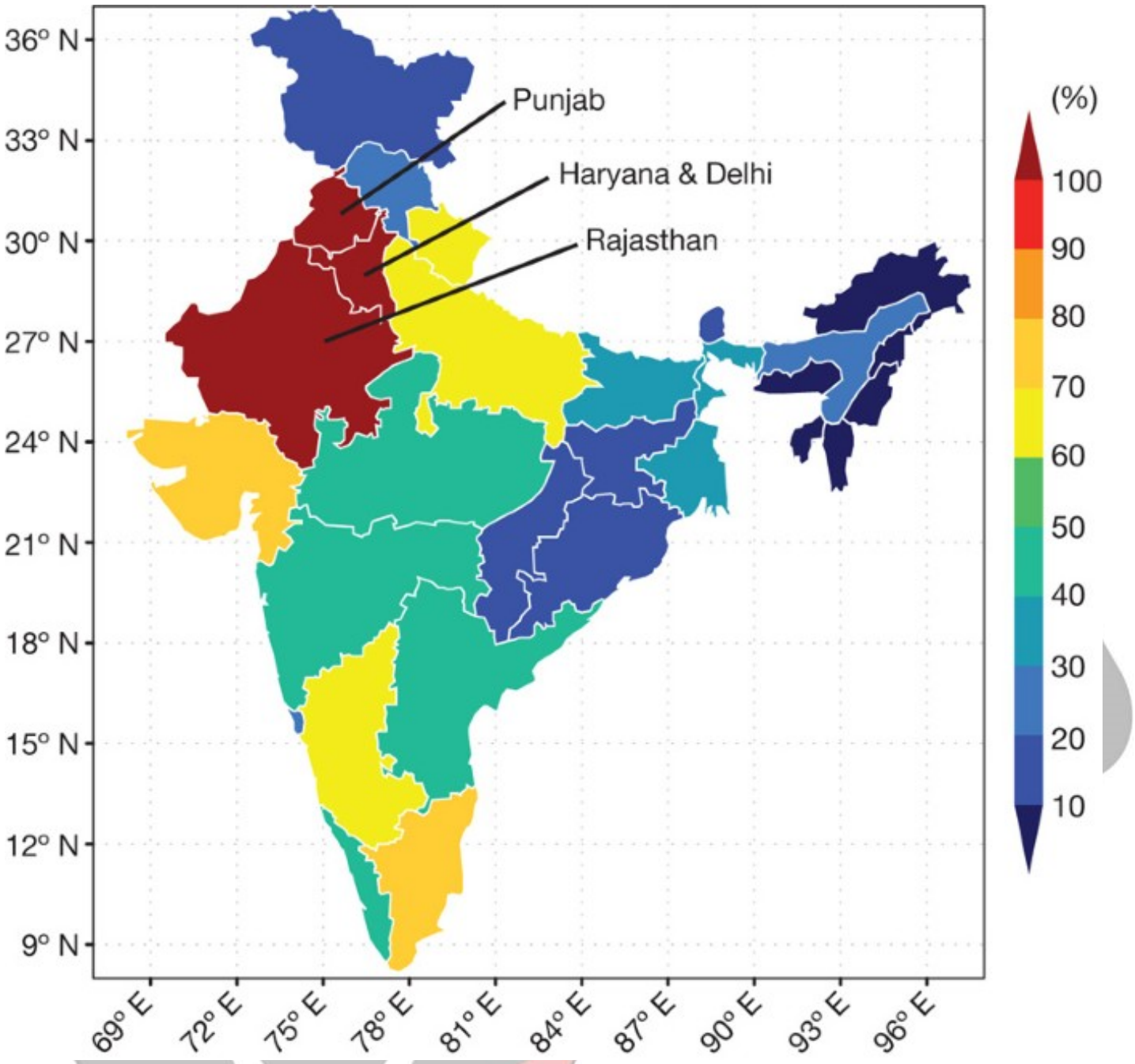
What is the Current Regulatory Framework for Groundwater Management in India?

- **Central-Level Regulation**
  - **Central Ground Water Authority (CGWA)**: Established in 1997 under the Environmental Protection Act, 1986.
    - Responsible for **issuing guidelines, granting permits, and regulating groundwater extraction** in notified areas.
    - Monitors overexploited zones and mandates rainwater harvesting in industries, housing, and urban projects.
  - **Central Ground Water Board (CGWB)**: Conducts groundwater assessments, mapping, and artificial recharge projects.
    - Implements the **Master Plan for Artificial Recharge to Groundwater (2020), aiming for 1.42 crore recharge structures.**
- **State-Level Regulation**
  - **State Groundwater Acts**: Several states, such as **Gujarat, Andhra Pradesh, Maharashtra, and Uttar Pradesh,** have enacted specific groundwater acts to regulate extraction and conservation.
    - These laws generally empower local authorities to monitor and manage groundwater.
  - **Model Groundwater Bill**: A 2017 framework for states to adopt sustainable groundwater practices, focusing on participatory and equitable use.

What are the Key Factors Responsible for Groundwater Shortage and

Contamination?

- **Water-Intensive Agriculture Practices:** India's agricultural practices prioritize **high-yield crops like paddy and sugarcane,** which are **water-intensive,** leading to excessive groundwater withdrawal.
    - **Subsidies for electricity and free water** in states like **Punjab and Haryana** encourage unregulated pumping.
    - As a result, groundwater extraction reached **241.34 bcm in 2023,** with **90% used for irrigation.** For example, **Haryana faces an annual water deficit of 14 billion cubic meters,** with total water demand reaching 35 billion cubic meters per year.
- **Population Growth and Urbanization:** Rising population and rapid urbanization have amplified groundwater demand for drinking water, sanitation, and industrial use.
    - Between 2016 and 2023, India's population increased from **1.29 billion to 1.45 billion,** and urban migration has stressed city aquifers.
    - Groundwater contributes roughly **45% to urban water consumption.** Major cities like **Bengaluru** now rely on tankers due to declining groundwater levels.
- **Climate Change and Erratic Rainfall:** Climate change exacerbates groundwater stress by reducing recharge rates due to erratic monsoons and increasing evaporation.
    - The southwest monsoon, **which contributes 60% of India's groundwater recharge**, has become unpredictable, with 2023 witnessing a cumulative rainfall shortfall of **5.6%** and over **200 districts experiencing deficient precipitation.**
    - For example, **Tamil Nadu's dependence on groundwater** has surged due to reduced monsoon rainfall, causing deeper aquifer exploitation.
- **Industrial Effluent Discharge:** Unregulated industrial discharges and untreated urban **wastewater contaminate groundwater** with heavy metals and chemicals like **lead, mercury, and chromium.**
    - For instance, **contaminated water in Kanpur's industrial areas**, particularly from tanneries, contain heavy metals like **chromium and mercury,** leading to widespread health issues.
- **Fertilizer and Pesticide Runoff:** Excessive use of **fertilizers** and pesticides has led to **nitrate and phosphate** seepage into groundwater.
    - Government's recent estimates suggest that consumption of chemical fertilizers has increased by around **16% between 2015-16 & 2020-21.**
    - Consequently, about **56% of India's districts have been found to have nitrates beyond the safe limit of 45 mg/L** in their groundwater.
- **Unsustainable Mining Activities: Mining operations,** especially in states like **Jharkhand and Chhattisgarh,** lead to heavy metal contamination and aquifer depletion.
    - Uranium and fluoride seepage from mines contaminates groundwater, posing severe health risks.
    - For instance, Uranium levels in groundwater exceeding the permissible limit have been detected in **Ballari, Kalaburagi, Kolar, Mandya, and Raichur in Karnataka**
        - Excessive **fluoride concentrations beyond permissible limits** are a significant concern in Rajasthan, Haryana, Karnataka, Andhra Pradesh, and Telangana.
- **Salinity from Coastal Intrusion:** Coastal regions face **saline water intrusion** into aquifers due to over-pumping and rising sea levels.
    - A recent CGWB report states that groundwater contamination in **Gujarat** due to salinity affects **28 out of 33 districts** (**85%**), impacting agriculture and drinking water availability.



What are the Key Government Initiatives in India for Groundwater Management?

- **Jal Shakti Abhiyan (JSA:** Launched in 2019 and now in its **5th phase ("Catch the Rain" 2024)**, the JSA focuses on rainwater harvesting and water conservation across rural and urban districts through the convergence of various schemes.
- **Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0:** This mission supports rainwater harvesting via stormwater drains and promotes groundwater recharge through 'Aquifer Management Plans.'
- **Atal Bhujal Yojana (2020):** This initiative targets water-stressed Gram Panchayats in 80 districts across 7 states, focusing on groundwater management.
- **Pradhan Mantri Krishi Sinchai Yojana (PMKSY):** The PMKSY aims to expand irrigation coverage and improve water use efficiency through components like Har Khet Ko Pani, Repair & Renovation of water bodies, and Surface Minor Irrigation schemes.
- **Bureau of Water Use Efficiency (BWUE):** Set up under the **National Water Mission** in 2022, the BWUE promote**s water use efficiency across sectors such as irrigation, drinking water supply,** power generation, and industries.
- **Mission Amrit Sarovar (2022):** This mission aims to create or **rejuvenate 75 Amrit**

Sarovars in every district to enhance water harvesting and conservation.

- **National Aquifer Mapping (NAQUIM):** Completed by the **Central Ground Water Board (CGWB) for over 25 lakh sq. km,** this initiative supports groundwater recharge and conservation planning.
- **National Water Policy (2012):** Formulated by the Department of Water Resources, this policy advocates for rainwater harvesting, water conservation, and augmenting water availability through direct use of rainfall.
- **Watershed Development Component of PMKSY (WDC-PMKSY):** This component focuses on **rainfed and degraded lands,** integrating activities like soil conservation, rainwater harvesting, and livelihoods development.

What Measures can be Adopted for Effective Groundwater Management in India?

- **Promoting Water-Efficient Agriculture:** Adopting water-saving practices like **drip irrigation**, **micro-irrigation**, and **zero tillage** can significantly reduce groundwater extraction for agriculture.
    - Linking the **Pradhan Mantri Krishi Sinchai Yojana (PMKSY)** with the **Atal Bhujal Yojana** can ensure that efficient irrigation methods are adopted in critical groundwater-stressed regions.
- **Managed Aquifer Recharge (MAR) with Solar Desalination:** In regions with saline or contaminated aquifers, combine **Managed Aquifer Recharge (MAR)** with solar-powered desalination plants to enhance groundwater quality and quantity.
    - **Solar desalination removes excess salts** and contaminants before recharging aquifers.
    - For exampl**e, MAR coupled with desalination in Gujarat's Kutch region** could address both salinity intrusion and water scarcity, providing a sustainable solution for arid coastal areas.
- **Aquifer Mapping with AI and IoT:** Use **Artificial Intelligence (AI)** and **Internet of Things (IoT)** technologies to map aquifer health and predict recharge and extraction patterns.
    - Deploy IoT-enabled sensors to monitor water levels and quality in real time, integrated into a central AI-powered decision-making platform.
    - For instance, **Maharashtra can adopt this to monitor stressed aquifers in Vidarbha** and deploy corrective actions dynamically.
- **Biochar for Aquifer Recharge:** Introduce **biochar-based filtration systems** for aquifer recharge projects to enhance water quality and remove contaminants like heavy metals and nitrates.
    - **Biochar, derived from agricultural residues,** acts as a natural filter and reduces pollution during recharge.
    - This method can be tested in **Punjab's paddy fields** to mitigate nitrate contamination from fertilizer runoff.
- **Rainwater Harvesting and Aquifer Recharge:** Scaling up **rainwater harvesting** structures in urban and rural areas can help recharge aquifers.
    - Linking the **Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)** with groundwater recharge projects can mobilize community efforts.
    - For example, **Tamil Nadu's ancient extensive rainwater harvesting system can** be expanded throughout the country.
- **Crop Diversification:** Encouraging farmers to transition from water-intensive crops like paddy and sugarcane to less **water-intensive crops such as millets, pulses, and oilseeds can reduce groundwater stress.**
    - Linking the **National Food Security Mission (NFSM)** with state crop insurance schemes and **higher MSP on pulses and millet**s can incentivize farmers to adopt c**rop diversification.**
- **Revising Electricity Subsidies:** Reforming free or subsidized electricity policies that encourage unregulated pumping of groundwater is essential.
    - Introducing **metered electricity connections** and linking them with subsidies for efficient water usage can incentivize conservation.
    - For instance, **Gujarat's Jyotigram Yojana,** which introduced separate electricity feeders between agricultural and consumer usage, which can be expanded throughout the

country.

- **Strengthening Groundwater Monitoring:** Improving monitoring networks with real-time groundwater-level sensors can provide actionable data for policymakers.
    - Integrating **India's Water Resources Information System (WRIS)** with local groundwater monitoring can ensure better decision-making.
    - For example, **Telangana's Mission Kakatiya** combines local data insights to track aquifer health and aims to restore the minor irrigation tanks and lakes.
- **Urban Water Management:** Promoting urban wastewater recycling for **non-potable uses**, such as industrial cooling and irrigation, can reduce groundwater dependency in cities.
    - Integrating the **AMRUT 2.0 (Atal Mission for Rejuvenation and Urban Transformation)** with **wastewater recycling policies** can ensure sustainable urban water use.
    - For instance, Bangalore Water Supply and Sewerage Board (BWSSB) aims to **recycle 1 crore MLD of sewage to reduce pressure on the Cauvery by 50%,** marking a significant step in the right direction
- **Incentivizing Private Sector Participation:** Encouraging corporate social responsibility (CSR) investments in groundwater recharge projects can mobilize additional resources.
    - Linking CSR with schemes like the **Atal Bhujal Yojana** can attract funding for community-level interventions.
- **Climate-Resilient Strategies:** Preparing for erratic monsoons with groundwater banking and adaptive recharge systems is crucial to mitigate climate risks.
    - Linking climate-resilient agriculture practices under the **National Adaptation Fund for Climate Change (NAFCC)** with **groundwater recharge projects** can strengthen resilience.
- **Phytoremediation for Contaminated Aquifers:** Adopt **phytoremediation**, a plant-based method, to clean up contaminated groundwater.
    - Select plants like **water hyacinth or vetiver** that absorb heavy metals and chemicals through their roots.
    - Deploying this method in heavily contaminated areas like **Kanpur**, affected by tannery effluents, can improve groundwater quality effectively.
- **Community Awareness and Participation:** Educating communities about **sustainable groundwater practices** through campaigns and training programs can empower them to adopt conservation measures.
    - Linking **Jal Shakti Abhiyan** with **local self-help groups (SHGs) and NGOs can amplify outreach.**

What India Can Learn from Other Countries for Groundwater Management?

- **Regulated Groundwater Extraction (California, USA):** California's **Sustainable Groundwater Management Act (SGMA)** enforces local plans for sustainable aquifer use with real-time monitoring.
    - India can empower **Panchayati Raj Institutions** to develop region-specific groundwater plans and enforce extraction limits.
- **Precision Irrigation (Israel):** Israel's **drip irrigation** and soil moisture monitoring save water while increasing crop yields.
    - India can integrate precision irrigation into **PMKSY**, especially in water-stressed states like Punjab and Haryana.
- **Water Trading (Australia):** Australia's **water markets** enable buying and selling of water rights within sustainable limits.
    - India can pilot water trading systems in overexploited regions like Rajasthan to promote efficient water allocation.

Conclusion:

India's groundwater crisis, exacerbated by **excessive use for irrigation, population growth, and contamination**, demands immediate and sustained action. While initiatives like the Atal Bhujal Yojana

and the Jal Shakti Abhiyan show promise, further strengthening of groundwater management frameworks, **adoption of water-efficient agricultural practices, and innovative solutions like aquifer mapping and biochar filtration are essential.**

Drishti Mains Question:

"India, as the largest consumer of groundwater, faces challenges related to overexploitation and contamination". Suggest sustainable solutions for effective groundwater management.

UPSC Civil Services Examination, Previous Year Question:

Prelims:

Q. Which of the following can be found as pollutants in the drinking water in some parts of India? (2013)

1. Arsenic
2. Sorbitol
3. Fluoride
4. Formaldehyde
5. Uranium

Select the correct answer using the codes given below.

a) 1 and 3 only

b) 2, 4 and 5 only

c) 1, 3 and 5 only

d) 1, 2, 3, 4 and 5

Ans: C

Q. Which one of the following ancient towns is well known for its elaborate system of water harvesting and management by building a series of dams and channelizing water into connected reservoirs? (2021)

(a) Dholavira

(b) Kalibangan

(c) Rakhigarhi

(d) Ropar

Ans: (a)

Q. With reference to 'Water Credit', consider the following statements: (2021)

1. It puts microfinance tools to work in the water and sanitation sector.
2. It is a global initiative launched under the aegis of the World Health Organization and the World Bank.
3. It aims to enable the poor people to meet their water needs without depending on subsidies.

Which of the statements given above are correct?

(a) 1 and 2 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

Ans: (c)

Mains

Q.1 What are the salient features of the Jal Shakti Abhiyan launched by the Government of India for water conservation and water security? **(2020)**

Q.2 Suggest measures to improve water storage and irrigation system to make its judicious use under the depleting scenario. **(2020)**
