Making Groundwater Sources Sustainable in the Desert Districts of Rajasthan

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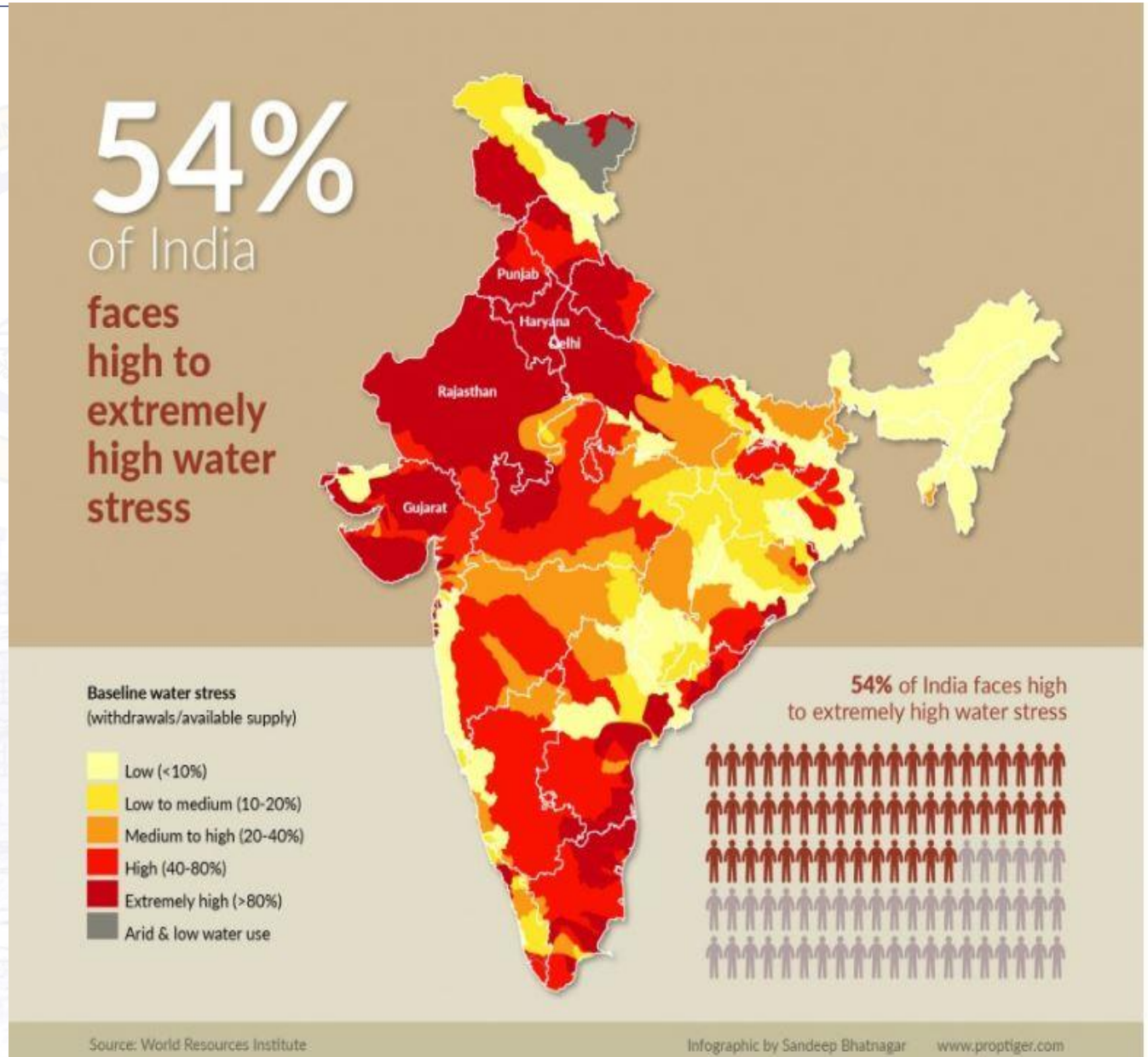
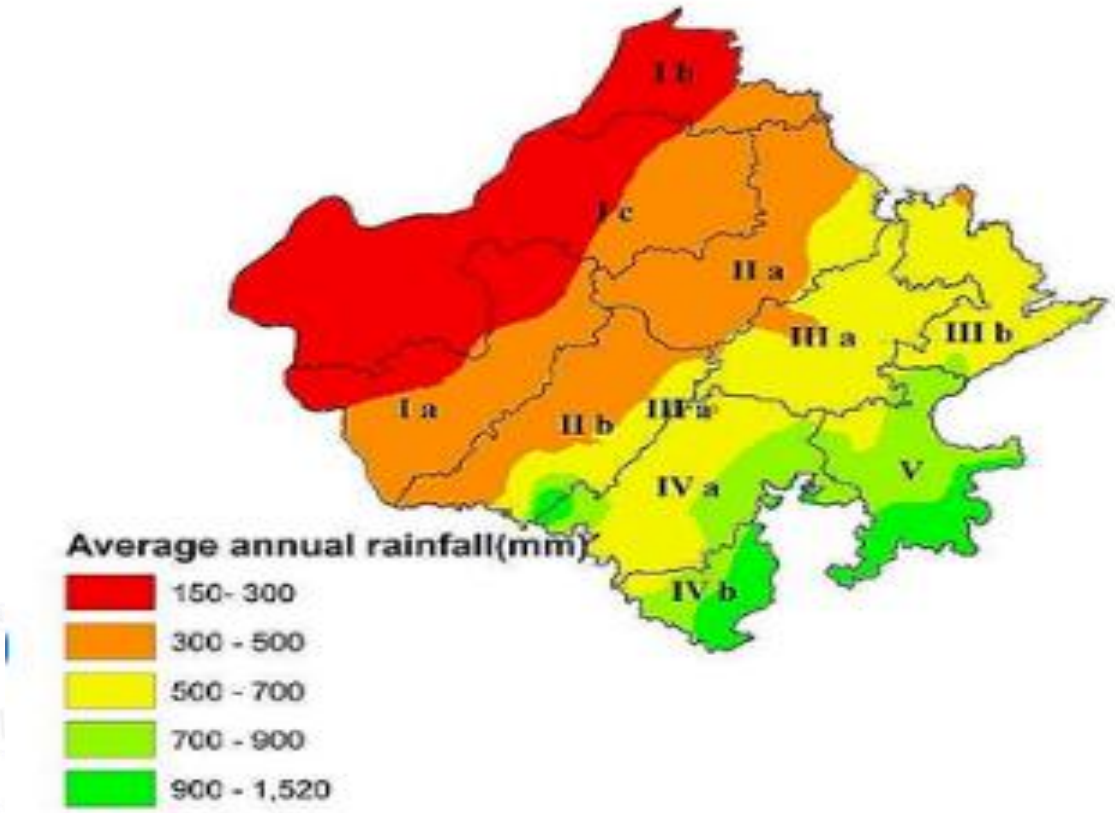
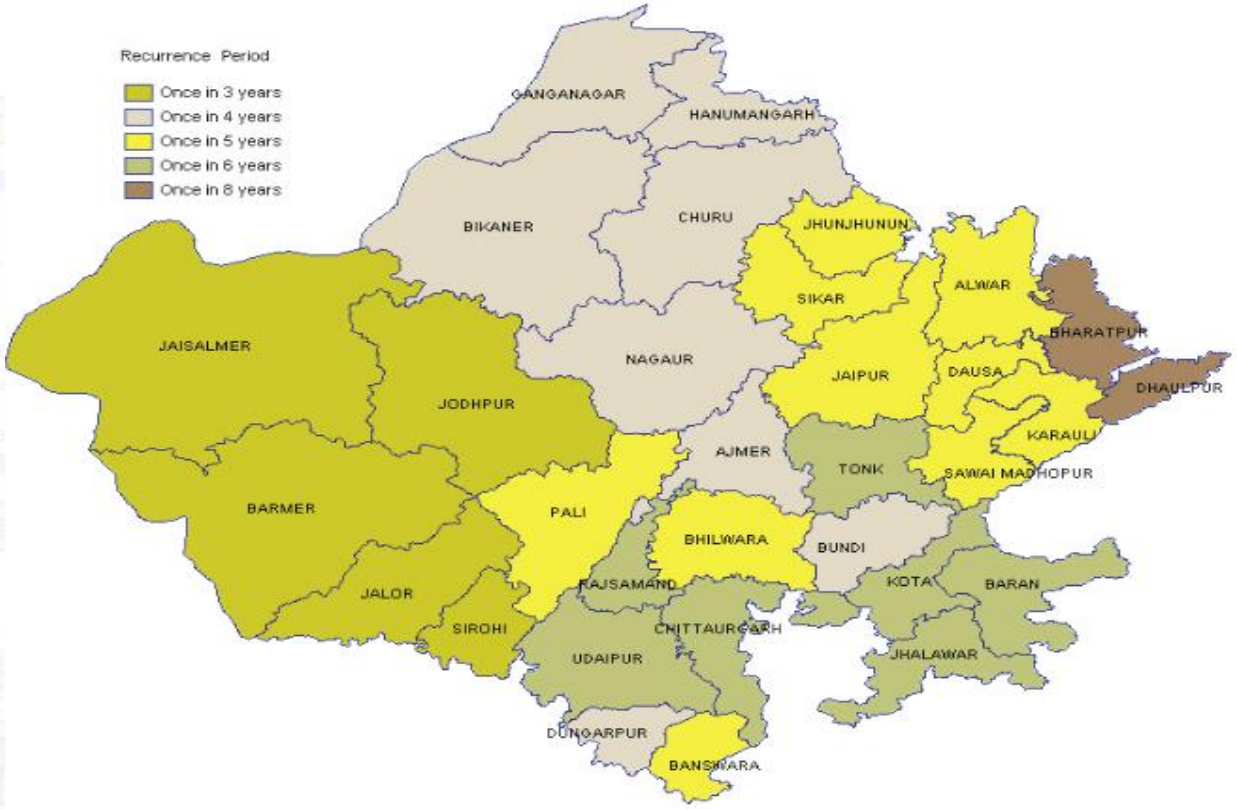
Why Groundwater Is Critical in Rajasthan

- Rajasthan is India's most water-stressed large state
- ~90% of drinking water and ~70–73% of irrigation depends on groundwater
- Surface water availability is extremely limited (≈1.16% of India's total)
- Thar Desert covers ~60–66% of the state → natural recharge is low
- Groundwater is the **lifeline for rural livelihoods and food security**



Desert Districts: Hydro-Climatic Reality



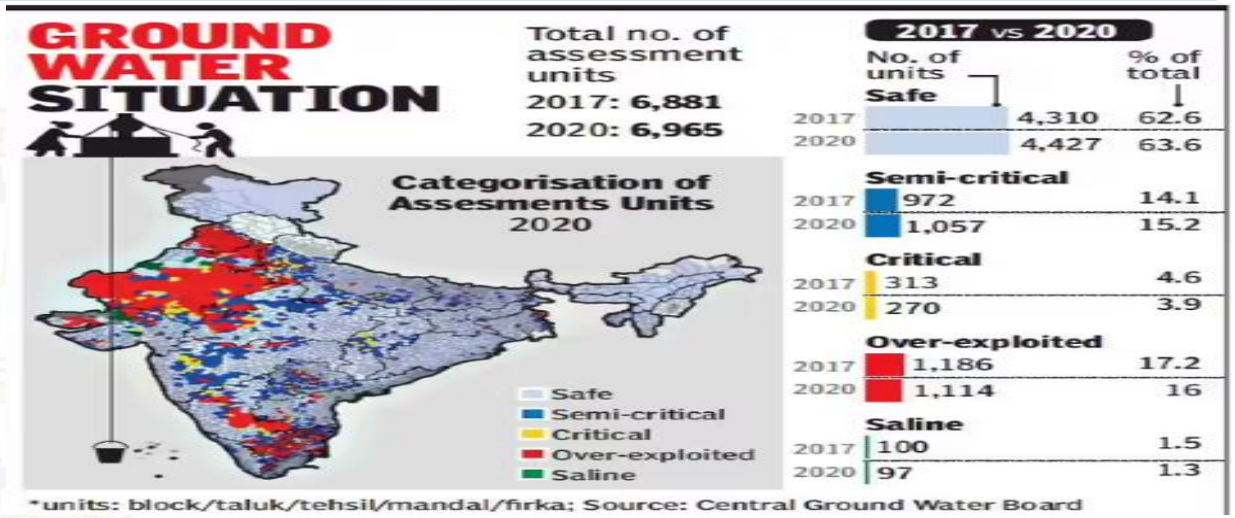


- Annual rainfall: 100–300 mm in western districts (Jaisalmer, Barmer, Bikaner, Churu)
- High evapotranspiration > rainfall

- Frequent droughts (≈1 in every 2–3 years historically)
- Sandy soils → high runoff, poor natural storage
- Climate variability increasing temperature & reducing recharge events

Current Groundwater Status (Alarming Trends)

- Annual groundwater draft > recharge
- Statewide draft ≈ 13 BCM vs recharge ≈ 10.4 BCM
- ~80% blocks are **over-exploited or critical**
- Water table decline: 1–3 m/year in many regions
- Safe blocks reduced drastically over last 3 decades
- **Salinity and fluoride threats:** Groundwater salinity exceeds permissible limits in over 50% of western Rajasthan blocks; fluoride levels are also alarmingly high

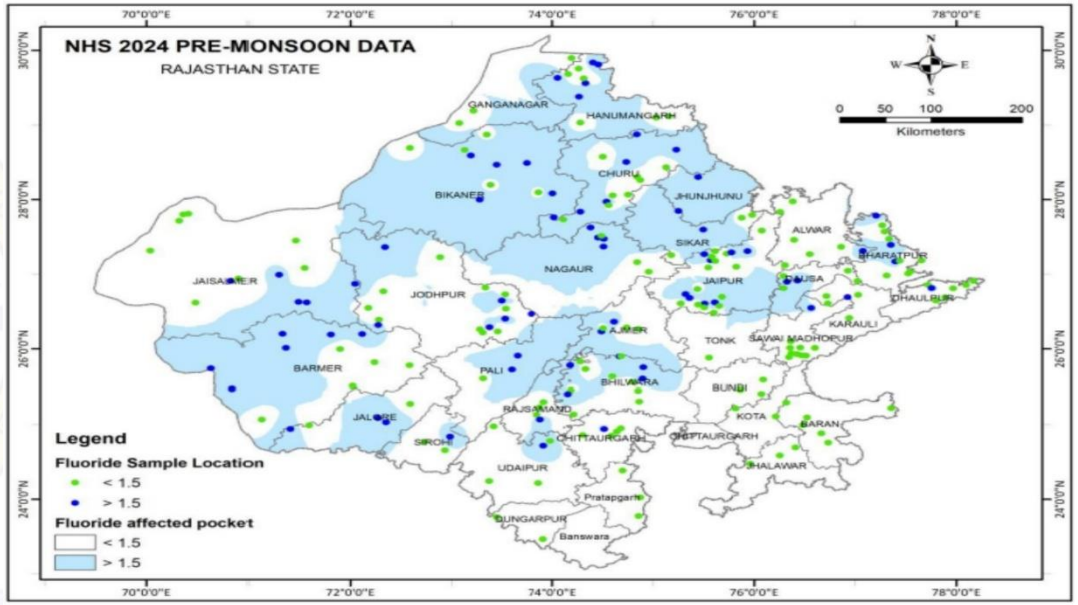


Category	Availability in BCM (as percentage of economically usable water) (1)	Usage in BCM (as percentage of economically usable water) (2)	Percentage used (2)/(1)
Internal surface water	21.71		5252
(a) Economically usable	16.05 (35.6)	11.29 (31.6)	70
(b) Economically non-usable	5.66		
Groundwater	11.36 (25.2)	11.77 (39.3)	104
Inter-state/external water	17.88 (39.2)	12.66 (35.4)	71
Total state water resources	50.96		70*
Total economically usable state water resources	**45.09 (100)**	**35.72 (100)**	**79**

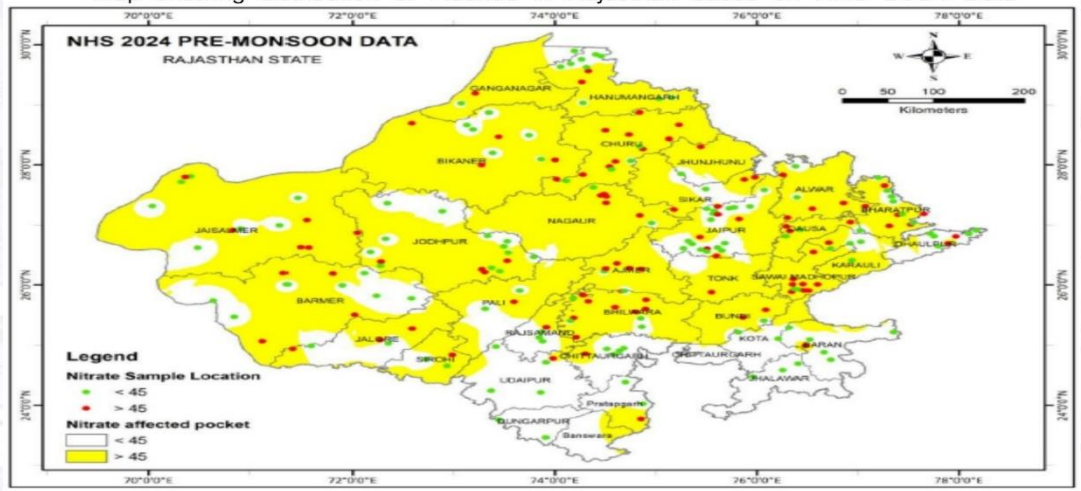
*Source: Planning Department (Government of Rajasthan) and Water Sector Performance (Reddy) * Total water usage as percentage of total state water resources*

Water Quality Crisis in Desert Aquifers

- High salinity (brackish water)
- Fluoride contamination (skeletal & dental fluorosis)
- Nitrate pollution (fertilizers)
- TDS often > 1000 mg/L
- Over 50% groundwater in Thar region unfit for drinking



Map showing distribution of Fluoride in Rajasthan based on NHS 2024 Data

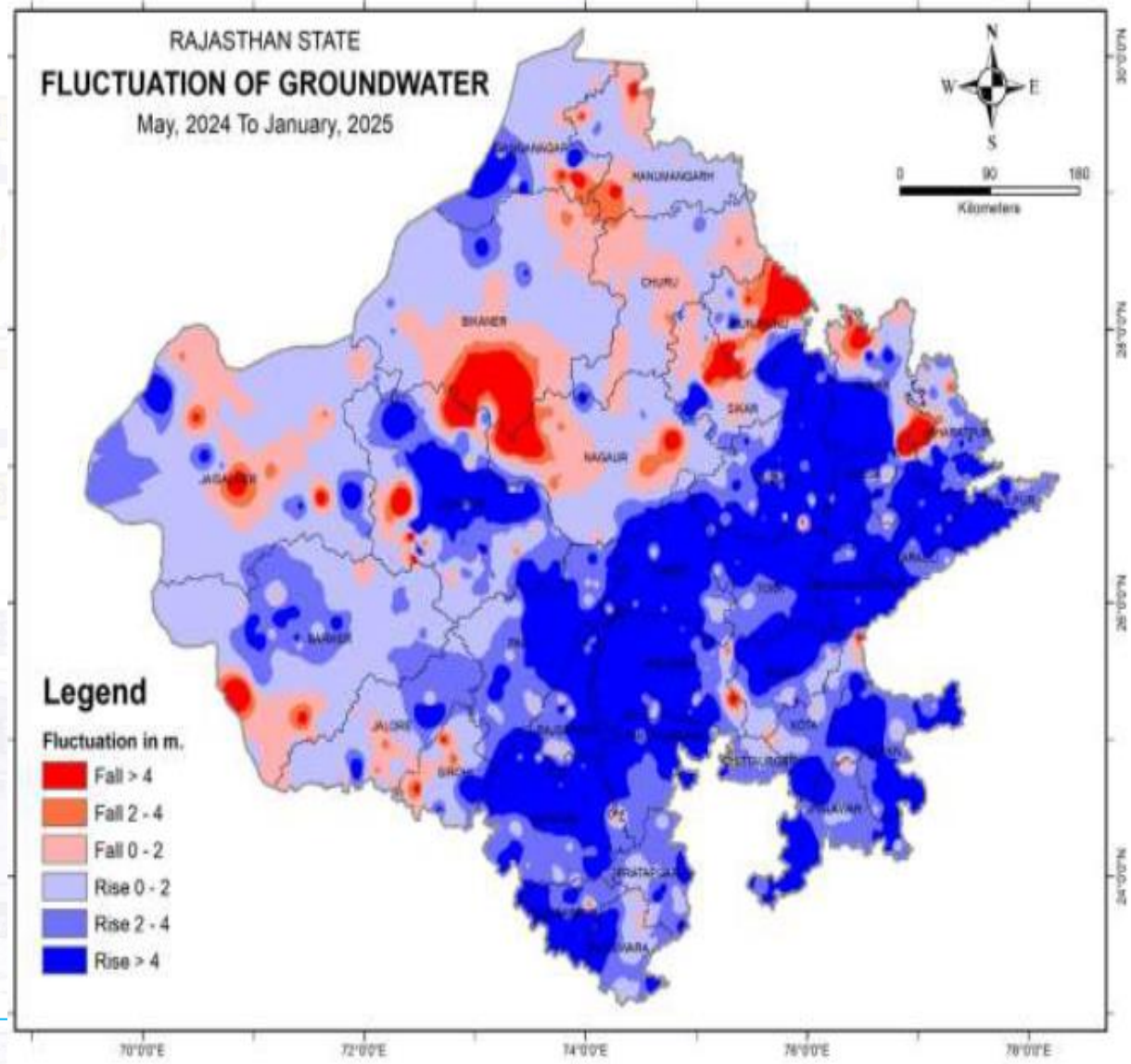


Map showing distribution of Nitrate in Rajasthan based on NHS 2024 Data

Source: Central Ground Water Board (2024), Ministry of Jal Shakti, Govt. of India.

Groundwater Quantity Crisis in Desert Aquifers

- 10 out of 12 desert districts show long-term groundwater decline (>5–10 m in many blocks).
- Barmer, Jodhpur, Jalore, Nagaur, Jhunjhunu & Sikar are already over-exploited zones.
- Rajasthan extracts 17.05 BCM/year but recharges only 11.37 BCM → chronic deficit.
- Water table depth reaches 100–140 m in parts of Jodhpur & Jaisalmer.
- Jhunjhunu district alone lost 27 m groundwater in 36 years; projected to reach 82 m depth by 2050.
- 63% of monitoring stations show declining levels in the last decade.
- 50% of drinking water and 60% of irrigation depend on these declining aquifers.

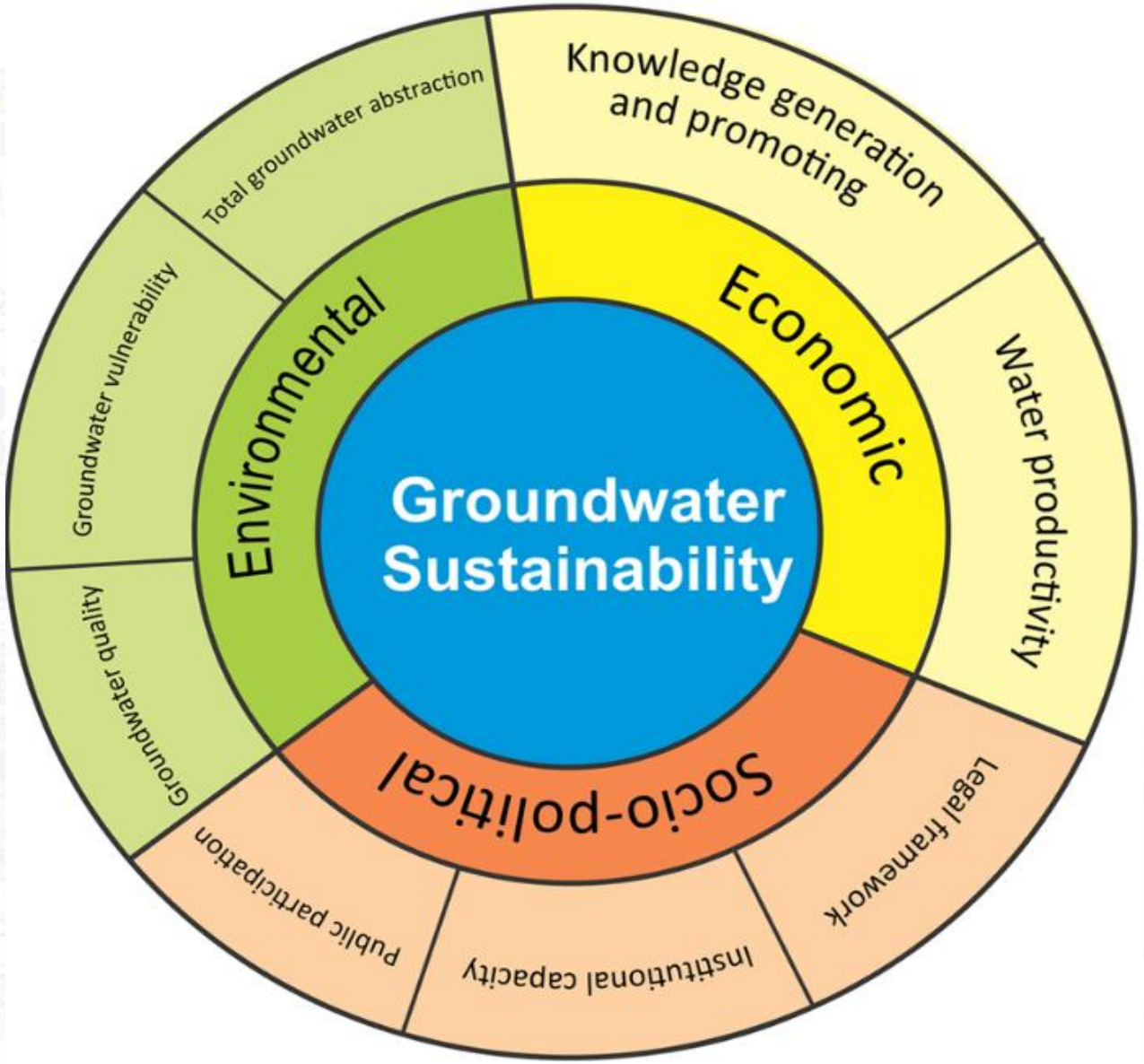


Source: CGWB (2024–2025); Singh & Kumar (2015); Goyal et al. (2025)

What Does "Groundwater Sustainability" Mean?

- Balance between:
  - Recharge ≥ Extraction
  - Quantity + Quality protection
  - Ecosystem health
  - Inter-generational equity
- Requires integrated management:
  - Technical + institutional + social

Groundwater Sustainability Index studies show **western Rajasthan in "high stress" category**



Pillars of Sustainable Groundwater Management

1. Recharge enhancement
2. Demand management
3. Water quality protection
4. Governance & regulation
5. Community participation
6. Technology & monitoring

Integrated Sustainability Framework (Recommended)

- **Recharge infrastructure:** Combines traditional systems like Baodis, Khadins and Taankas with scientific interventions like recharge shafts and percolation tanks.
- **Demand-side interventions:** Reduces irrigation load through crop diversification and precision irrigation; urban demand via rooftop harvesting.
- **Water quality protection:** Addresses salinity and fluoride with groundwater zoning, safe aquifer targeting, and community monitoring.
- **Data and monitoring systems:** Integrates CGWB wells, satellite datasets (e.g., GRACE), and GIS mapping for zonal planning and early warnings.
- **Institutional and legal framework:** Grounded in the 2024 Groundwater Bill with village-level budgeting, regulatory authorities, and participatory governance.

Recharge Solutions for Desert Districts Traditional + modern blend

- Johads, tankas, kunds, khadins (traditional systems)
- Check dams & anicuts
- Percolation tanks
- Recharge shafts in sandy aquifers
- Rooftop rainwater harvesting (urban + rural)
- Managed Aquifer Recharge (MAR)

Traditional systems revived successfully in the Thar region

Demand Management: Agriculture & Urban Water

- **Agriculture: Major groundwater consumer:** Over 90% of groundwater use is for irrigation. Jaipur district has all 15 blocks classified as over-exploited.
- **Urban impacts on recharge:** Urban expansion reduces infiltration due to paving; rooftop harvesting helps retain stormwater.
- **Crop diversification:** Switching from water-intensive crops (e.g., wheat) to millets and pulses reduces irrigation demand.
- **Precision irrigation technologies:** Drip and sprinkler systems enhance water-use efficiency by 30–50% and reduce non-beneficial evaporation losses.
- **Policy incentives:** Government schemes promote adoption of water-saving devices through subsidies and capacity-building.

Demand Management: Agriculture First

- Shift from flood irrigation → drip & sprinkler
- Irrigation scheduling using soil moisture
- Crop diversification:
  - Bajra, moth bean, guar, moong
- Micro-irrigation incentives
- Promote “more crop per drop”

Urban & Industrial Water Management

- Mandatory rooftop harvesting
- Wastewater reuse for industry
- Leakage reduction in supply networks
- Artificial recharge through stormwater drains
- Water-efficient building codes

Government Initiatives Supporting Recharge

- **Mukhya Mantri Jal Swavlamban Abhiyan (MJSA 2.0)**
  - ₹11,200 crore budget
  - 5 lakh water harvesting structures by 2030
- Jal Jeevan Mission – source sustainability
- Canal support (Indira Gandhi Canal, PKC link project)

Governance & Policy: Legal & Institutional Reforms (2024 Breakthrough)

Rajasthan Groundwater Conservation & Management Authority Act, 2024

- Establishes state groundwater authority
- Registration of wells
- Regulation of the extraction and monitoring of recharge
- Usage categories (domestic, industrial (recharge policy similar to carbon credit), irrigation)
- Pricing & monitoring provisions
- Aquifer protection zones

*Industrial water reuse and recharge policy similar to carbon credit

Way Forward (Policy Roadmap)

- District-wise aquifer management plans
- Crop-water alignment policy
- Universal rainwater harvesting
- Strict well registration
- Incentives/counter subsidy for recharge
- Integration with climate adaptation plans
- Continuous scientific monitoring

Key Takeaways

- **Groundwater stress is structural:** Desert districts in Rajasthan face chronic groundwater imbalance due to climate, geology, and usage patterns—not just short-term scarcity.
- **Local solutions are key:** Traditional systems like Khadins and Taankas offer cost-effective, community-driven recharge and conservation.
- **Demand control and governance:** Crop pattern change, irrigation tech, and regulation through the 2024 Bill form the demand-side response.
- **Data science and monitoring:** GIS zoning, CGWB wells, and satellite datasets enable early warning, water budgeting, and better planning.
- **Policy + Community = Sustainability:** Success requires a synergy of legal frameworks, scientific tools, and empowered local participation.

Conclusion

- Groundwater sustainability in desert Rajasthan is **not optional**
- **it is existential**
- Science + policy + community action must converge
- Traditional wisdom + modern technology is the winning model
- 2024 groundwater law is a historic opportunity
- Next decade will decide water security or water crisis

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Thank you for listening

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Questions?