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International Commission on Irrigation and Drainage (ICID)

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**Operational Paradigms for Water
Management in Irrigation:
Integrating Smart Applications,
Efficiency, and Adaptability**

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Operational Paradigms for Water Management in irrigation: Integrating Smart Applications, Efficiency and Adaptability

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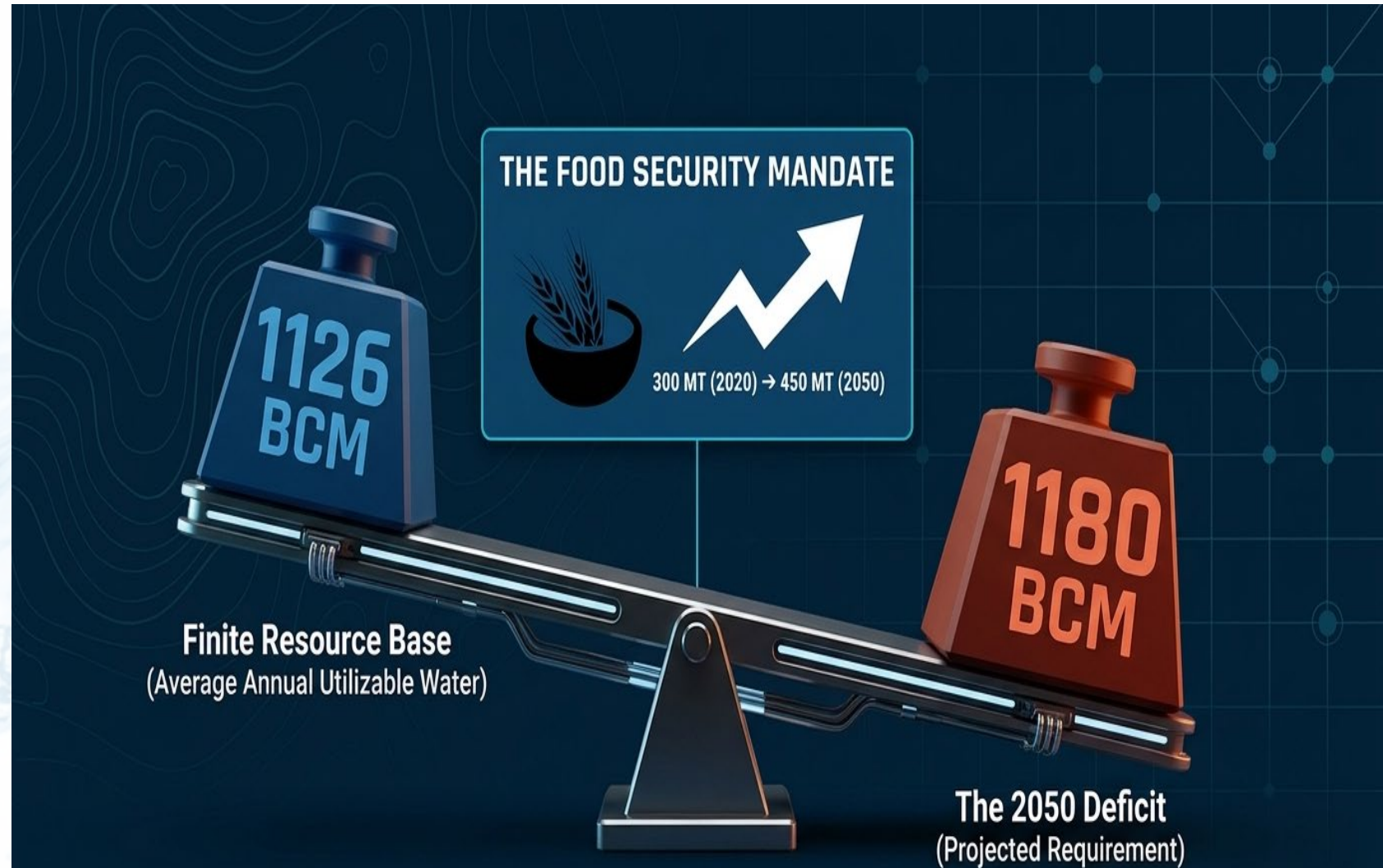
Food Security Mandate: The Mathematics of Survival

Target: Increase food grain production from 300 MT (2020) to 450 MT (2050)

The Deficit: Average annual utilizable water is 1126 BCM, while the 2050 requirement is 1180 BCM—a 54 BCM gap

Mission: This gap must be bridged through operational transformation rather than just capturing more rain

Annual Sewage Generation: 73K MLD
BCM: 26 BCM (50% converted also contribute to 13 BCM)



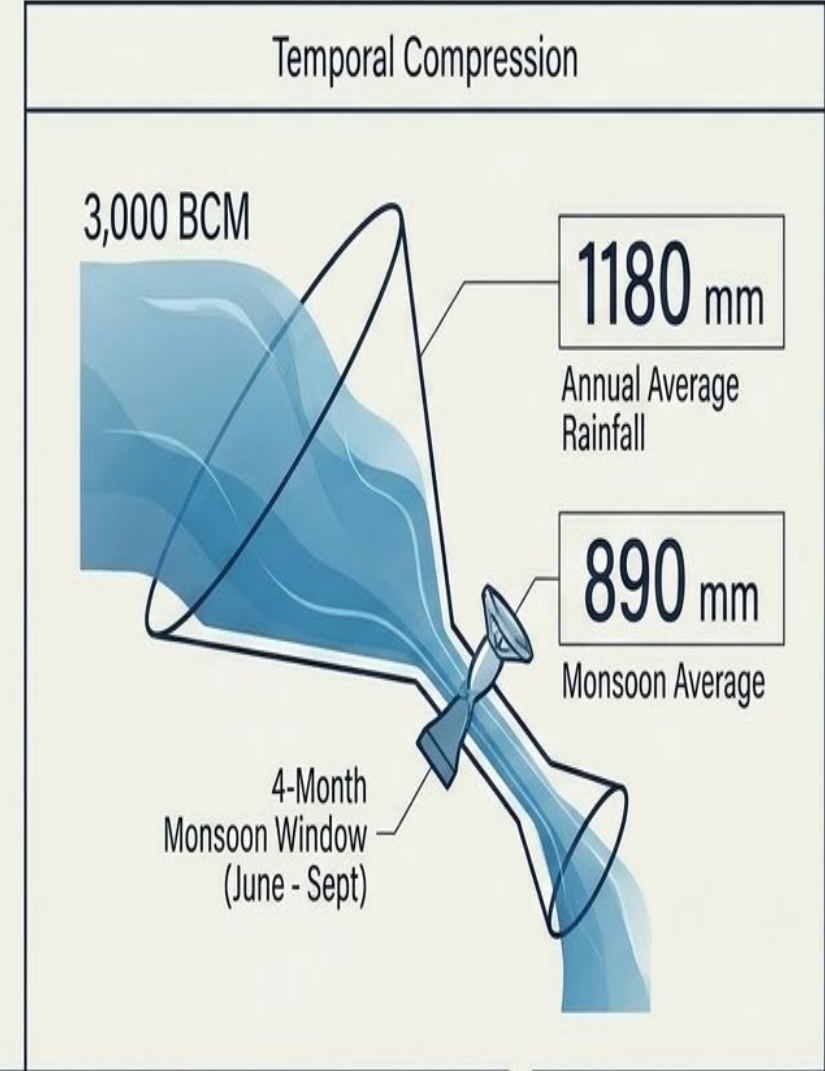
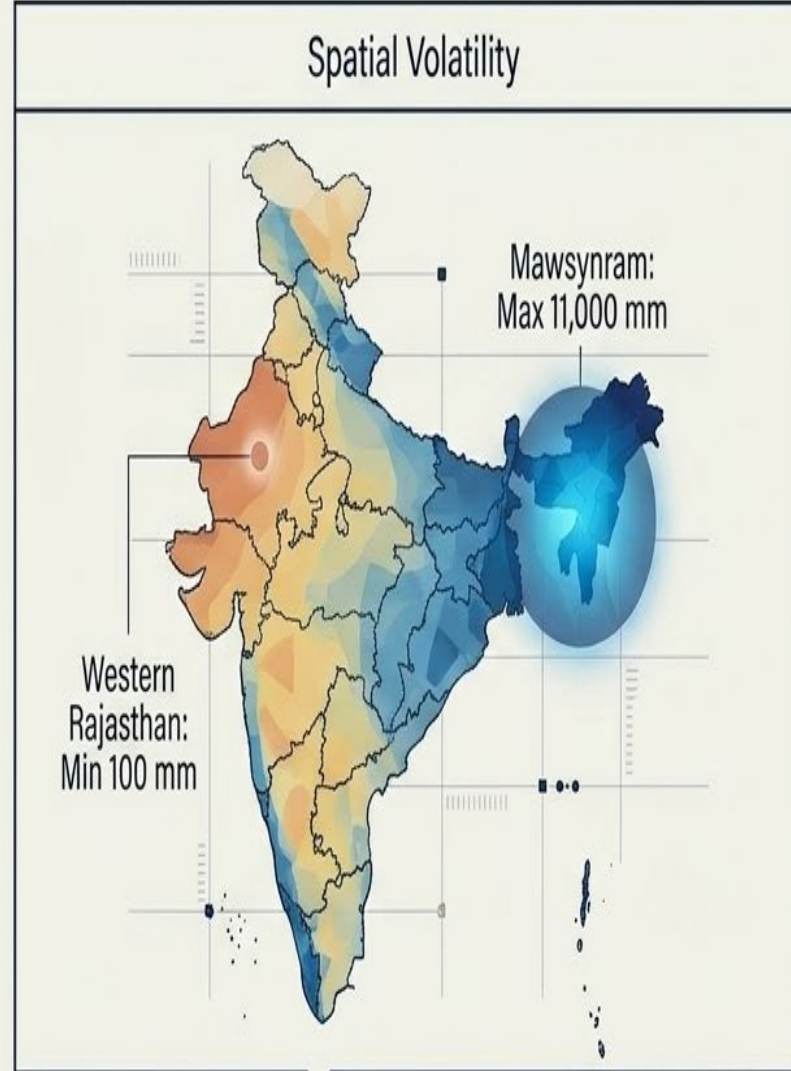
We cannot cross the 2050 threshold using current efficiency models.
The 54 BCM deficit must be bridged entirely through operational transformation.

Climatic Baseline: Operating in Extremes

Spatial Volatility: Rainfall ranges from 100 mm (Rajasthan) to 11,000 mm (Mawsynram).

Temporal Compression: 3,000 BCM of water arrives in a compressed 4-month monsoon window.

Key Insight: India lacks the temporal and spatial mechanisms to capture water before it is lost.



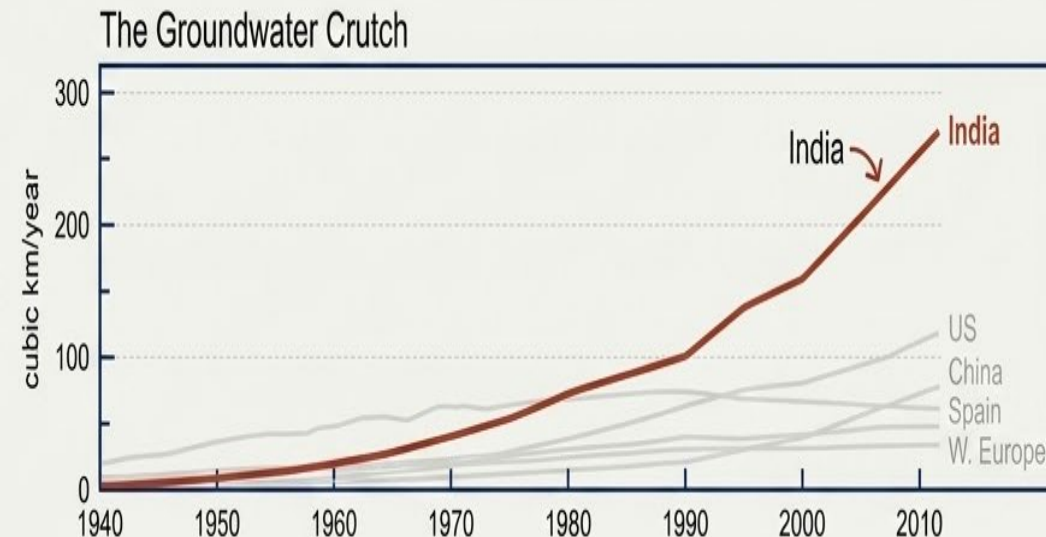
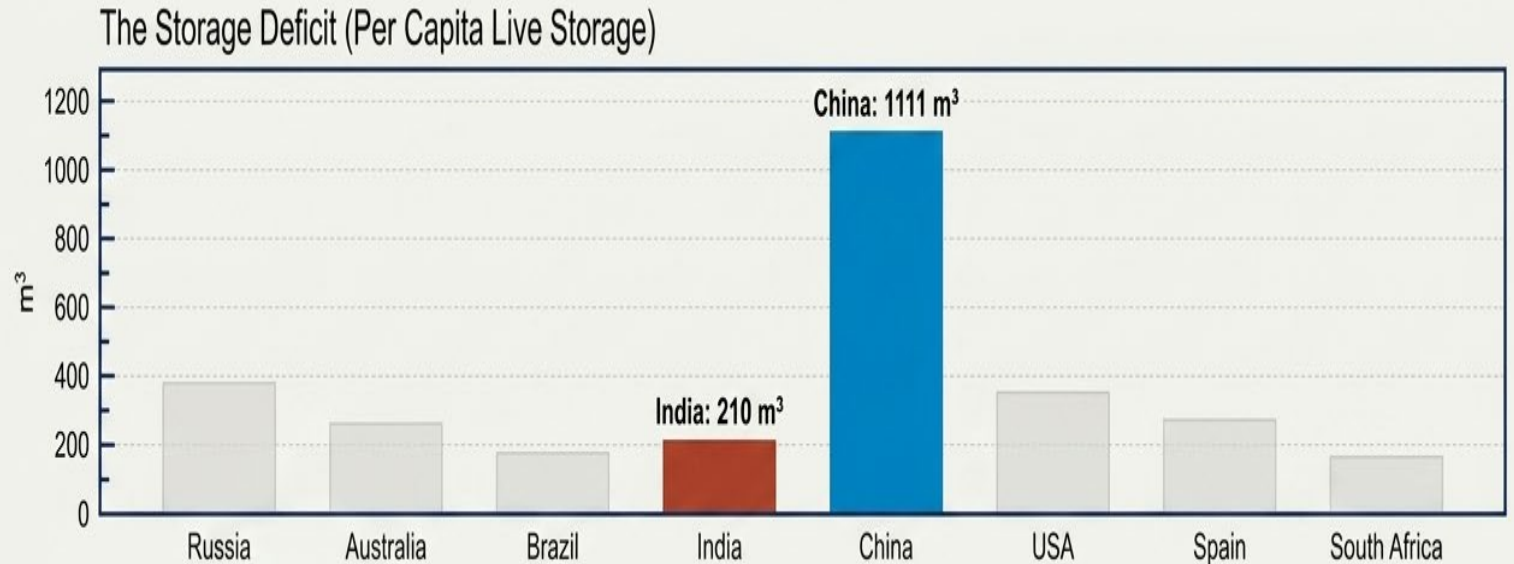
We do not lack water; we lack the temporal and spatial mechanisms to capture it before it is lost.

Structural Gaps: Storage and Groundwater

Storage Deficit: India's per capita live storage is only 210 m³, significantly lower than China (1111 m³) or Russia.

Groundwater Crutch: India is the world's largest groundwater user in agriculture, with 25 million active wells.

Sustainability Crisis: 30.5% of units are over-exploited, critical, or semi-critical.



World's Largest User of Groundwater in Agriculture

25 Million Active Irrigation Wells

1 in 4 Cultivators Owns a Well
(Buffer against climate vagaries)

The Governance Gap: Transitioning to Scientific Allocation

Traditional

Reaction-based management, static historical quotas and administrative distribution.

Evidence-Based

Predictive modeling, dynamic allocation and adapting to rainfall variance.

Policy Mandate: Moving toward distribution dictated by localized soil matrices and crop types.

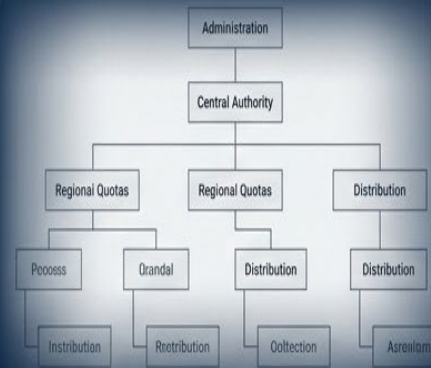
Governance:

management, static historical quotas and administrative distribution.

Science:

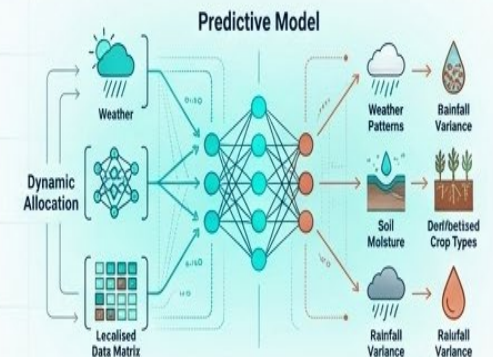
Predictive modeling, dynamic allocation and adapting to rainfall variance.

Traditional Governance



- Reaction-based infrastructure management
- Static historical quotas and boundaries
- Administrative distribution without soil or crop context

Evidence-Based Science



- Predictive modeling and dynamic allocation
- Distribution dictated by localized soil matrices and crop types
- Adapting to effective rainfall variance (100mm to 11,000mm)

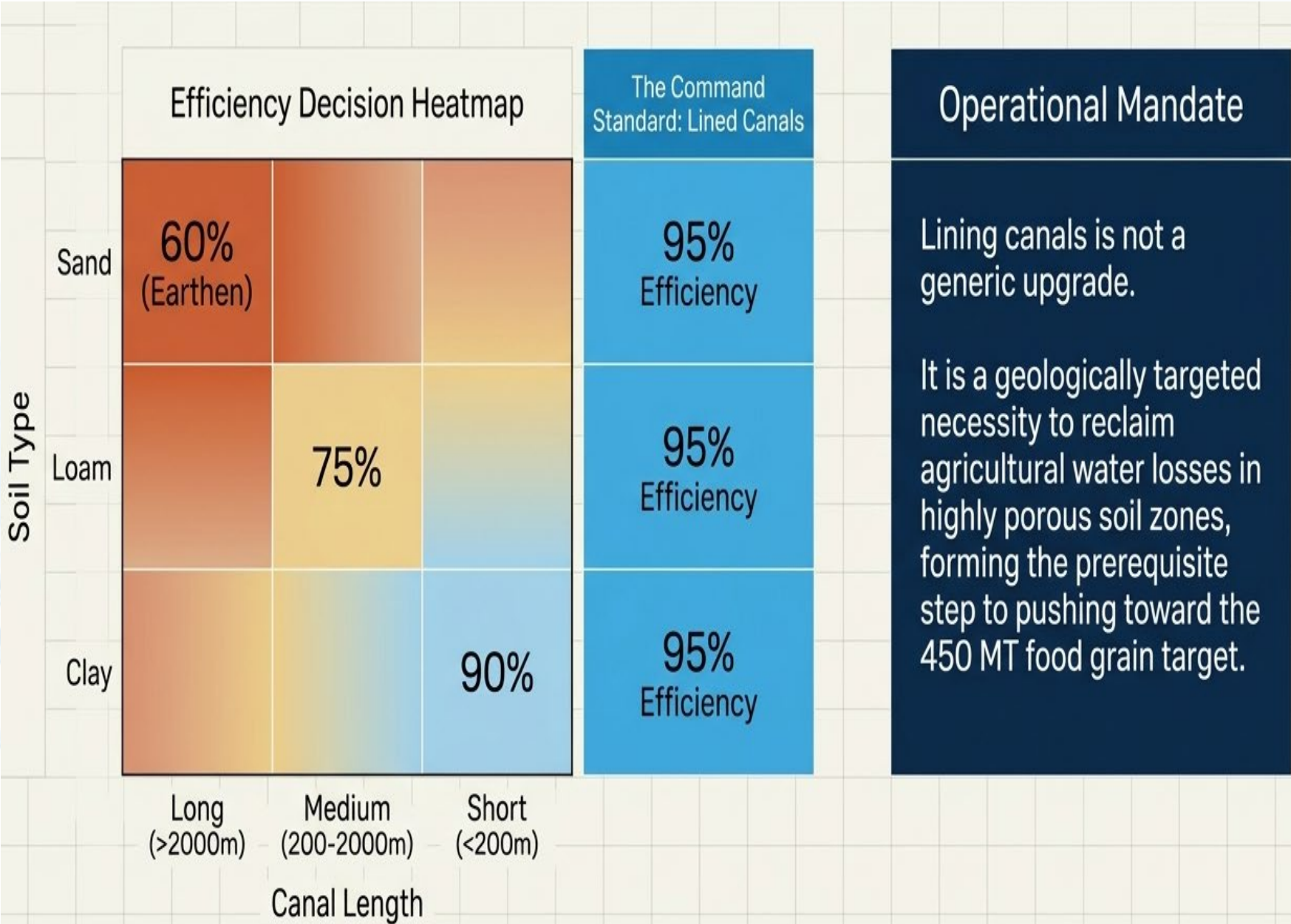
Critical Policy Mandate: Water tribunal awards must evolve to weigh and mandate efficiency matrices, not just absolute volume.

Evidence Based Distribution: The Efficiency Matrix

Operational Mandate: Lining canals is a geologically targeted necessity to reclaim agricultural water losses.

The Matrix: Short canals in clay soil reach 90% efficiency; long earthen canals drop to 60%.

Standard: Moving all systems toward a 95% command standard for lined canals.

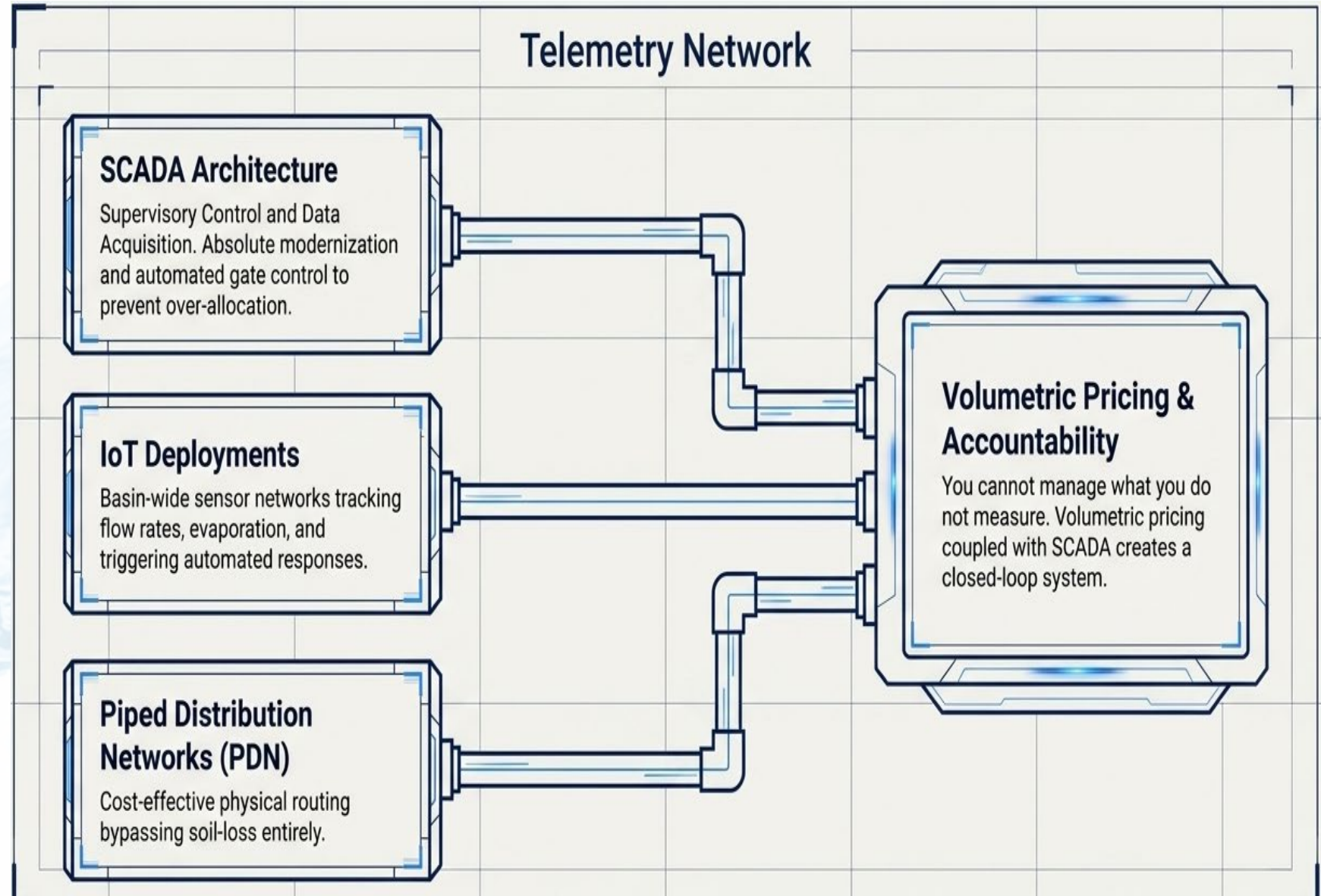


Upgrading the Grid: Telemetry, Automation and Volumetric Control

SCADA: Modernizing infrastructure with automated gate control to prevent over-allocation.

IoT Sensors: Tracking flow rates, evaporation and water quality (salinity/temperature) in real-time.

Volumetric Pricing: "Measure to Manage"—accurate volumetric measurement is the prerequisite for intelligent pricing of services.

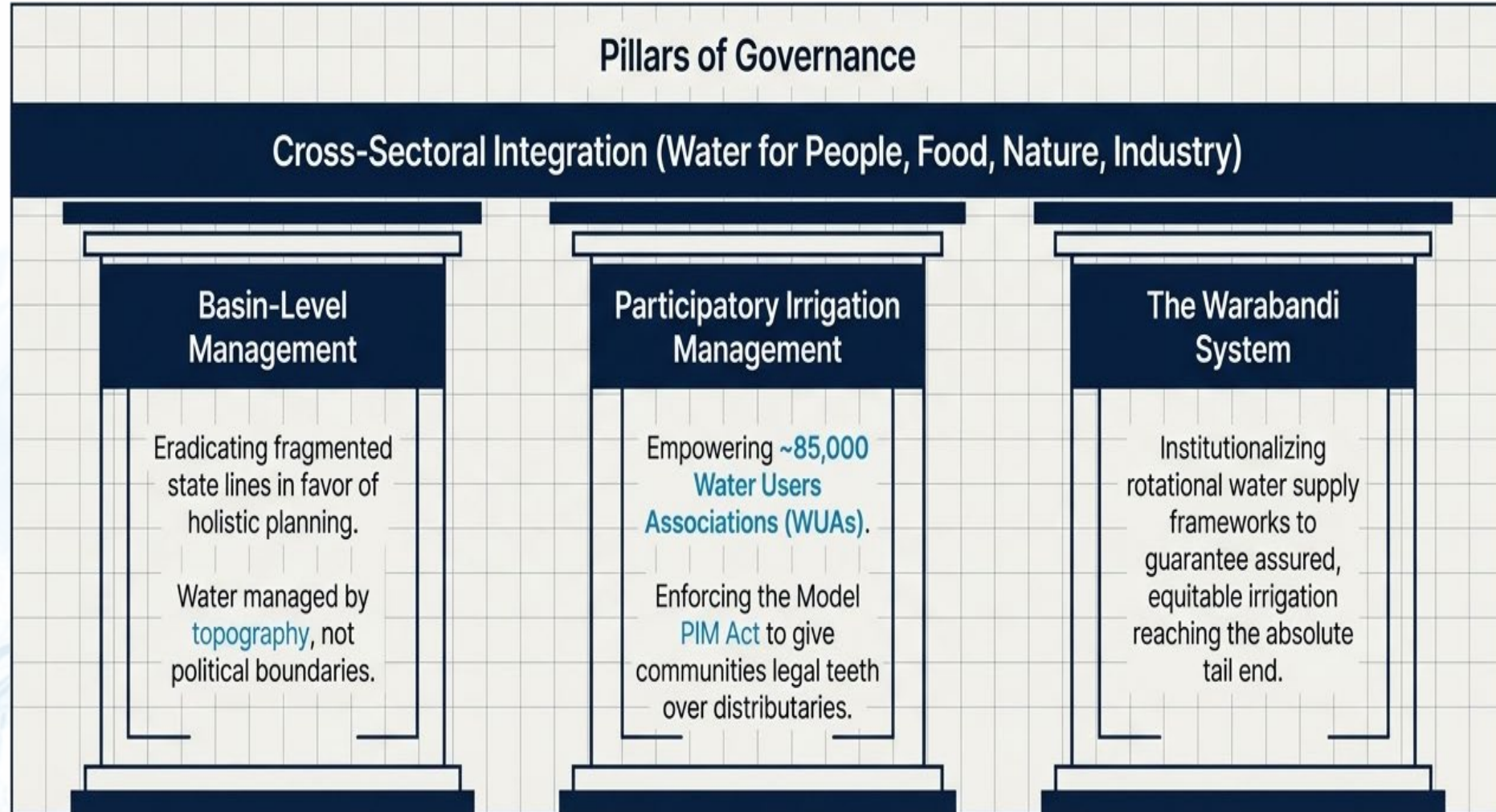


Institutional Pillars: Collaborative Frameworks

Basin Management:
Planning based on topography rather than political boundaries.

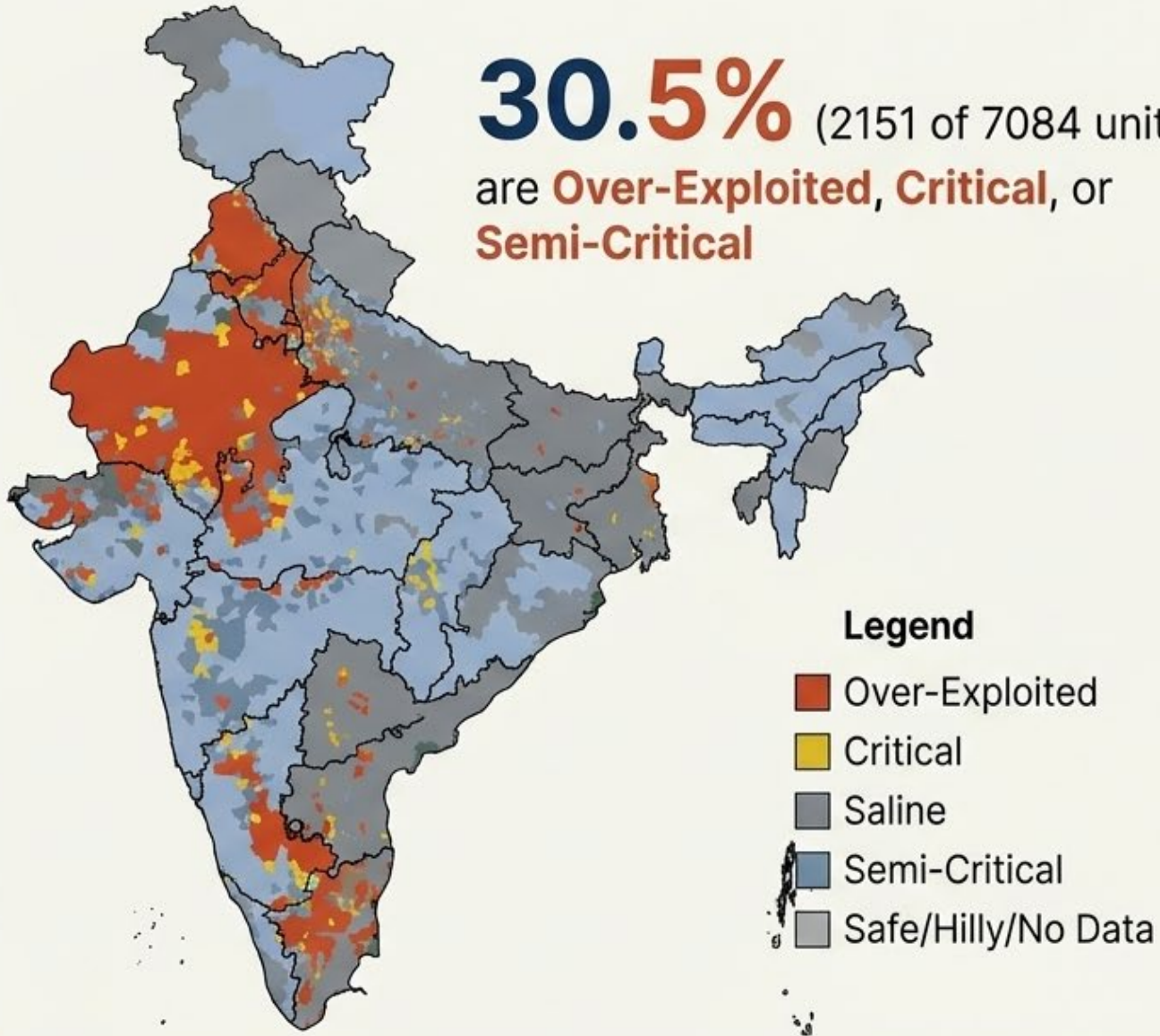
Participatory Management:
Empowering ~85,000 Water Users Associations (WUAs) through the Model PIM Act.

Equity (Warabandi):
Institutionalizing rotational water supply to ensure tail-end farmers receive their share.



Groundwater Command: Reversing the National Deficit

30.5% (2151 of 7084 units)
are **Over-Exploited**, **Critical**, or
Semi-Critical



Intervention HUD

NAQUIM Deployment

25 lakh sq. km mapped for precise, granular aquifer intelligence.

Artificial Recharge

Capturing surplus floodwater and initiating micro-level 'Catch the Rain' frameworks.

Community Control

Atal Bhujal Yojana: Leveraging District Implementation Partners to enforce hyper-local water budgeting.

Initiative at State level:

Telangana: Mission Kakatiya

Participatory Management for Augmenting availability of Water

- Launched by the Telangana Government in 2015
- Aim to restore all silt-filled tanks and ponds (minor irrigation sources) for agricultural use
- Topography and rainfall pattern in Telangana make tank irrigation an ideal type of irrigation by storing and regulating water flow for agricultural use, particularly paddy cultivation.
- Census showed that 46,531 water bodies with about 5000 chain link tanks in State.
- Mission envisaged annual repair and rejuvenation of 9,300 minor irrigation through desilting, restoration of feeder channels, re-sectioning of irrigation channels, repairs to cross masonry and cross drainage structures, repairs of bunds etc.

Initiative at State level:

Telangana: Mission Kakatiya

Participatory Management for Augmenting availability of Water

- By 2018, about 17,859 water bodies restored and around 12.47 lakh acres of command area stabilized.
- Resulted in increased agricultural production, showing a record irrigation during the year 2016-17, irrigating an ayacut (the area served by an irrigation project) of around 16 lakhs acres through direct and indirect irrigation.
- Till 2022, around 8.25 TMC of storage capacity restored and 2,322 lakhs cubic meters of silt removed from 26,551 tanks, that saved Rs. 900 crore of public money.
- Mission is one of example towards addressing water security challenges

Initiative at State level:

Odisha: Pani Panchayats

Participatory Management for Augmenting availability of Water

- Backed by Pani Panchayats Act (2002), participatory irrigation management - Pani Panchayats in Odisha shows the way;
- As on 31st May 2018, altogether 30,033 Pani Panchayats have been programmed out of which 28,105 have been formed by conducting elections.
- Efficient coordination amongst Pani Panchayats under supervision of project committee coupled with adherence to rotational irrigation practice (beginning with the tail end of the command area)
- Decision of Project Committee and Pani Panchayats to restrict paddy cultivation during Rabi season also proved to be effective in maximizing output.
- Within one year, 36% more cultivation recorded in Sunei Medium Irrigation Project in Mayurbhanj district in Odisha in a drought-like situation in 2015-16 Kharif season
- Cultivation of only cash crops like oilseeds, pulses etc. yields better results

Initiative at State level:

Odisha: Pani Panchayats

Participatory Management for Augmenting availability of Water

- Through Asian Development Bank (ADB) assistance, 251 Pani Panchayats have been identified to strengthen activities in 6 Medium and 5 Major Irrigation projects.
- Assistance would include strengthening of Operation & Maintenance (O&M), Command Area Development (CAD), Agriculture Livelihood and Skill Development support activities.

Initiative at State level:

Rajasthan: Mukhyamantri Jal Swavalamban Abhiyan (MJSA)

Participatory Management for Augmenting availability of Water

- Launched on 27th January 2016.
- Led to average rise of 4.66 feet in water table in 21 non-desert districts of Rajasthan
- Adopted 'Four Waters Concept' and 'Ridge to Valley Technique' to maximize results
- Multi-phased water conservation scheme covered 12,042 villages in first three phases, created 3.90 lakh rain water harvesting structures and planted 148 lakh saplings across the State
- 56.13% reduction in water supply through tankers and 63.64% rejuvenation of defunct hand-pumps and an increase of 44,409 hectare of cropping area among other achievements

Initiative at State level:

Bihar: Jal-Jeevan-Haryali Abhiyan

Participatory Management for Augmenting availability of Water

- Envisaged countering challenges of water scarcity being faced by the State by constructing/reviving 1116 ponds, 59 weir/check dams and 592 ahars/pynes spanning 534 blocks in all 38 districts of Bihar.
- Total irrigation potential creation from this campaign expected to be 1,47,254 hectares.
- Ponds/talabs in rural areas with surface area up to 1 acre renovated by Panchayati Raj Department under Mahatma Gandhi National Rural Employment Scheme (MGNREGA) whereas Minor Water Resources Department (MWRD) tasked to revive ponds/talabs more than 1 acre in size.

Augmenting water by Reuse of Treated Waste Water

Policy Mandate

- National Framework on safe Use of Treated Water-Nov 2022 by DoWR,RD&GR.
- States promoting reuse of treated water by design and regulation
- Maharashtra WR Regulatory Authority conceptualised “No Fresh Water Zones” in areas where treated water is available.
- Haryana is also proposing reuse of treated water by construction of conveyance system from Gurgaon to Nuh.

Way Forward

Futuristic Demand-Based Awards: Tribunal awards must evolve to prioritize projected future demand rather than static historical quotas.

Efficiency-Centric Multipurpose Projects: Shift the focus of multipurpose projects from purely power-centric metrics to maximizing total water usage efficiency.

Mandated Efficiency Matrices: Policy should mandate efficiency targets (e.g., 90% conveyance) for all new water allocations.

Scaling Participatory Models: Institutionalize the success of Pani Panchayats and Mission Kakatiya nationwide to secure water security challenges

Wastewater Paradigm: Expand "No Fresh Water Zones" to industrial hubs to conserve fresh water for agriculture and domestic use



Thanks