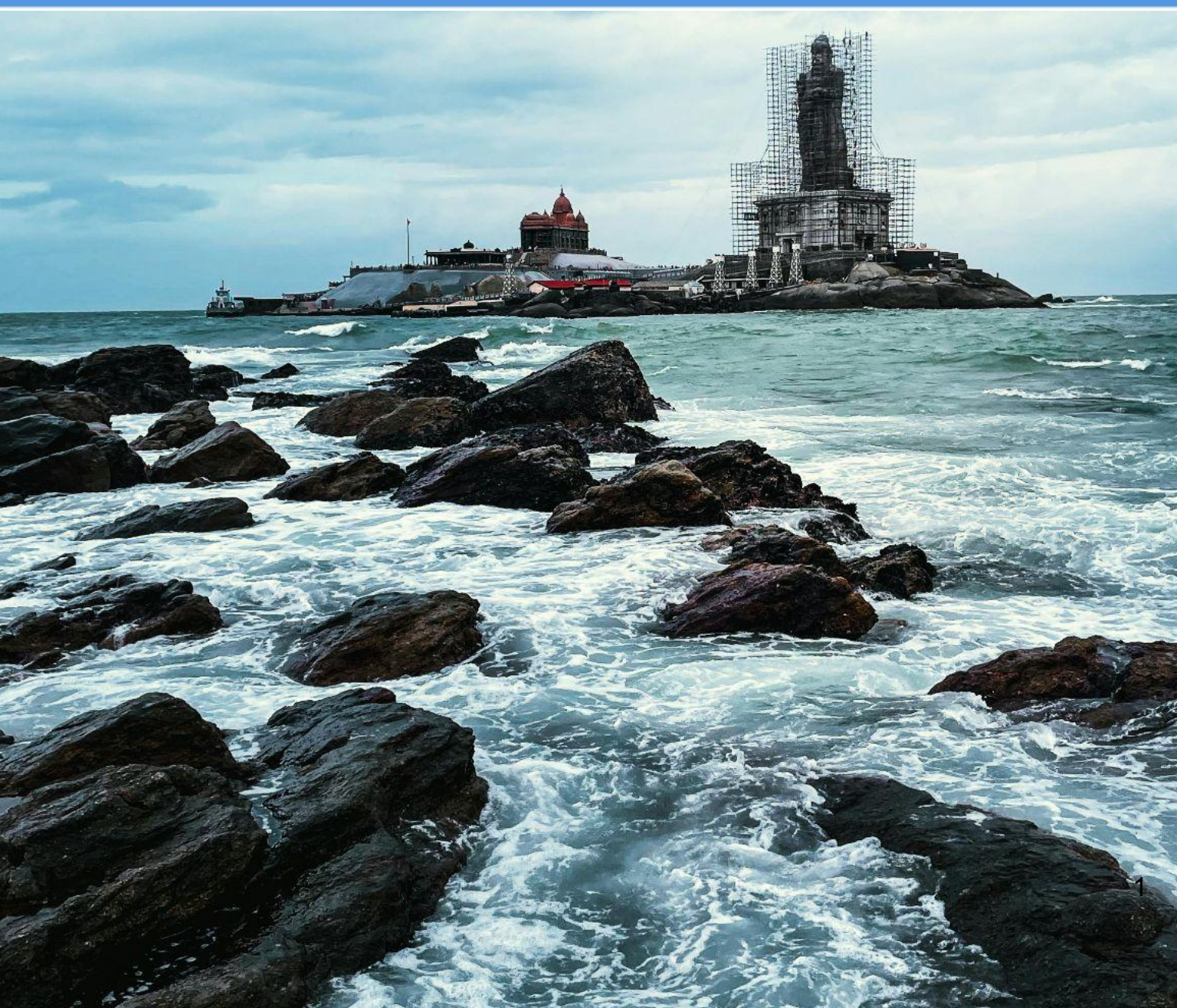


Final Report Strategic Document: Roadmap for Tamil Nadu's Water Future

By WELL Labs & AquaMAP | February 2026





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Foreword (to be added by TNSPC)

Preface

Tamil Nadu stands at a decisive historical threshold. As the state marches toward the ambitious milestone of becoming a \$1 trillion economy, it faces a fundamental paradox – its economic aspirations are rapidly outstripping its natural hydrological endowments. This report, commissioned to evaluate the state's water security future, moves beyond traditional engineering paradigms to propose a radical shift toward circular water intelligence. It recognises that water is not merely a utility but the primary lever for industrial growth, agricultural stability, and urban resilience.

As Tamil Nadu navigates the dual challenges of rapid urbanisation and climate-induced rainfall variability, the traditional reliance on monsoon-dependent surface storage is no longer sufficient. This document advocates for a shift toward circular water economies, leveraging advanced technologies like Managed Aquifer Recharge (MAR), indirect potable reuse of treated wastewater, and the reclamation of traditional surface water bodies. By integrating high-fidelity satellite data with localised field observations, this report moves beyond administrative statistics to provide a contextualised, insight-led understanding of the state's water accounts. It highlights that true water security lies in the technical optimisation of every drop, from the silted depths of the Mettur reservoir to the innovative decentralised recycling models pioneered by institutions like IIT Madras. This report is not just an assessment, it is a call to action for a coordinated, data-driven, and resilient water future for Tamil Nadu.

The initial scope of work is strategically woven into a five-chapter trajectory designed to transition Tamil Nadu toward hydrological resilience. The foundation is laid in Chapters 1 and 2 (Baseline Assessment), which provide a comprehensive study of the current water scenario and water balance by analysing surface, ground, and wastewater across varying regions to identify critical gaps in existing management practices. Building on this, Chapter 3 (Emerging Challenges) delivers a data-driven projection of future demands, assessing the intersecting pressures of intensive agriculture, rapid urbanisation, and industrial growth, while specifically addressing the degradation of the aquatic environment and water quality.

The transition to action occurs in Chapter 4 (Solutions and Best Practices), which catalogues global and national best practices (also detailed in Annexure B) suitable for adoption in Tamil Nadu. Finally, Chapter 5 (Roadmap) synthesises these elements into a phased implementation framework, outlining short, medium, and long-term strategies. This roadmap prioritises inter-departmental coordination and a dynamic planning framework, ensuring that infrastructure planning and community participation remain robust enough to achieve the State's \$1 trillion economic vision.

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Executive Summary

Tamil Nadu faces a fundamental development paradox. While the State aims for a \$1 trillion economy by 2030, its hydrological systems are approaching a hard ceiling of availability. Without a fundamental pivot from resource extraction to circular management, water scarcity will become a structural drag on economic stability.

Context: Reaching the Physical Limits

The State's economic stability is heavily leveraged against dwindling groundwater reserves, creating a hidden deficit in both hydrological and fiscal health. Physical access to water has improved, but the quality has sharply declined.

- **Structural Imbalance:** Tamil Nadu is hydrologically distinct from the rest of India, receiving ~50% of rainfall during the northeast monsoon (October–December). This creates a sharp geographic divide: reliable water storage is concentrated in the eastern alluvial plains, while the western hard-rock districts face inherent recharge limitations.
- **The Hard Ceiling of Supply:** Agriculture has expanded intensively through double and triple cropping, not because of surface water surplus, but over-extraction of groundwater. With 60% of irrigation now dependent on groundwater and 80% of blocks classified as over-exploited or critical, the current growth model is unsustainable.
- **The 'Invisible' Deficit:** Official irrigation statistics possibly underreport extraction. The energy sector reveals the true scale: agricultural energy demand hit 94,108 million units in 2022, confirming that farmers are pumping deeper to compensate for surface deficits. This has shifted the burden of water scarcity onto the state exchequer via escalating power subsidies.
- **Reversal of River Systems:** Extensive extraction has converted rivers from 'gaining streams' (fed by groundwater) to 'losing streams' (draining into depleted aquifers). Consequently, rivers that were once perennial are becoming seasonally dry channels, disconnected from their catchments.

Baseline Assessment: Infrastructure vs Reliability

This study moves beyond aggregate state-level averages to adopt a granular, district-level understanding of water supply and demand. While water supply metrics have improved, the water quality and reliability of the resource are degrading rapidly due to pollution and inefficient circularity.

- **District Water Accounting:** Primary water accounting shows a total water demand of 81.8 BCM (2/3rd of that is crop demand) against a sustainable supply of 34.7 BCM (~60% from groundwater). This high demand-supply gap is the reason 35 out of 38 districts face a water deficit.
- **Connectivity vs. Reliability:** Infrastructure coverage is impressive—98% of urban areas have piped water access. However, 'source reliability' is failing. In districts like Ramanathapuram, tap connectivity does not guarantee supply because local groundwater sources, which account for 64% of the coverage, are exhausted.
- **The Circularity Gap:** The state's circular water economy is nascent. Only ~20% of the generated wastewater is treated, and a mere 13% of that is reused. This represents a massive lost opportunity to drought-proof industrial corridors and urban hubs using reclaimed water.
- **Quality Crisis:** Untreated sewage has turned major urban rivers like the Cooum and Adyar into biologically dead zones with BOD levels up to 345 mg/L, which is over 100 times the safe limit. Simultaneously, 14.8% of water samples in districts like Dharmapuri exceed fluoride safety limits, presenting a public health hazard.

Emerging Challenges: The Mega-Urban Shift

Future demand is changing from historical patterns, driven by rapid urbanisation, high-tech industrial needs, and extreme climate volatility.

- **Urban Pressure:** By 2030, 60% of Tamil Nadu will be urbanised. While the urban population will grow by 22%, water demand will surge disproportionately by 33% by 2035, driven by increasingly water-intensive lifestyles.
- **Industrial Demands:** The economic pivot from textiles to electronics and data centres changes the type of water needed. The new economy requires ultra-purified water that current infrastructure cannot supply, necessitating advanced treatment systems.
- **Climate Volatility & 'Day Zero':** The State is entering a 'punctuated' monsoon phase, comprising intense rainfall bursts followed by extended dry spells. This increases the risk of 'Day Zero' events for cities and renders traditional crop calendars obsolete for Delta farmers.
- **The Groundwater Tipping Point:** Except for the Nilgiris, every district faces a structural deficit where extraction exceeds recharge. This is leading to increased seasonal drying of wells in large swathes of the state.

Solutions: Six Levers for Resilience

To secure the \$1 trillion vision, the State must operationalise a 'One Water' framework focused on demand management and circularity.

- **Secure Safe Access (Risk Management)**
 - Mandate water safety plans with robust contingency mechanisms.
 - Deploy AI-based monitoring at pumping stations to detect leaks and ensure last-mile delivery.
- **Enforce Water Balance (Circularity)**
 - Circular sanitation model, with special focus on increasing reuse of treated water
 - Overcome the current hurdles by prioritising underground drainage and STPs in Tier-2/3 cities with ring-fenced 10-year O&M budgets to prevent asset decay.
- **Build Climate Resilience (Buffers)**
 - Increase drought reserves by integrating larger reservoirs with smaller ones and by constructing safe injection wells to store surplus monsoon runoff in aquifers.
 - Implement nature-based watershed management to enhance retention and biodiversity.
- **Maximise Productivity (Agri-Efficiency)**
 - Transition to a direct benefit transfer (DBT) model that credits farmers for electricity saved, incentivising a shift to low-water crops.
 - Restrict subsidies in critical groundwater blocks exclusively to high-efficiency irrigation and low water intensity crops.
- **Modernise Governance (One Water)**
 - Establish a State Water Utilisation Committee with veto power over industrial/urban expansions in over-exploited blocks.
 - Transform the TiNAI platform into a hydrological Digital Twin, making data publicly available via Open APIs to drive innovation.
- **Restore Ecosystem Health (Sustainability)**
 - Enforce minimum environmental flows for rivers like the Cauvery to prevent saline intrusion and sustain delta ecosystems.
 - Systematically remove invasive species like Prosopis to restore natural water balances.

Actionable Recommendations and Roadmap

Short-Term (0–2 years)

As per the Water Resources Act of 2026, establish Tamil Nadu Water Resource Management Authority (TNWRMA).

Mandate Water Safety Planning (WSP) as a statutory risk-management strategy.

Develop a framework for economic incentive for farmers to adopt water-saving technologies.

Pilot IoT-based sensors in water supply systems to reduce the water loss, improve service delivery and ensure water quality.

Maintain a digital inventory of water bodies and mandate Integrated Reservoir Operation (IRO) that utilises AI-based forecasting

Medium-Term (3–5 years)

‘Circularity First’ mandate, which legally requires Urban Local Bodies (ULBs) and industrial estates to meet a substantial portion of their water demand through treated wastewater reuse.

Shift from ad-hoc grants to a dedicated, non-lapsable district water body fund specifically for operations and maintenance of water bodies.

Roll out the digital twin of river basins for real-time flood and drought simulation.

Scale tertiary treatment in industrial corridors and urban hubs for a drought-proof water source.

Launch the web-based Decision Support System using machine learning to predict inflow-outflow and reservoir losses.

Long-Term (6–10 years)

Fully integrate Water-Sensitive Urban Design (WSUD) into state building codes.

Enforce a total ban on riverine sand mining with a shift to 100% M-sand.

Implement a water credits system to encourage industrial stewardship of water resources.

Full restoration of the Thamirabarani and Palar riparian health.

State-wide real-time water accounting system accessible to the public, ensuring transparency in industrial, domestic, and agricultural allocations.

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List of Abbreviations

IWRM	Integrated Water Resources Management
LPCD	Litres per Capita per Day
CWC	Central Water Commission
CGWB	Central Ground Water Board
TWAD	Tamil Nadu Water Supply and Drainage
WRIS	Water Resources Information System
KII	Key Informant Interviews
CEEW	Council on Energy, Environment and Water
WEFE	Water-Energy-Food-Ecosystem
KPI	Key Performance Indicator
SCADA	Supervisory Control And Data Acquisition
TNAU	Tamil Nadu Agricultural University
USGS	United States Geological Survey
WRD	Water Resources Department
ISRO	Indian Space Research Organisation
NASA	National Aeronautics and Space Administration
LULC	Land Use Land Cover
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
IMD	India Meteorological Department
CWMI	Composite Water Management Index

List of Abbreviations

MCM	Million Cubic Metres
BCM	Billion Cubic Metres
MLD	Million Litres per Day
BIS	Bureau of Indian Standards
TNPCB	Tamil Nadu Pollution Control Board
TIDCO	Tamil Nadu Industrial Development Corporation Limited
SIPCOT	State Industries Promotion Corporation of Tamil Nadu
TN-IAM	Tamil Nadu Irrigated Agriculture Modernisation
RTFF	Real-Time Flood Forecast
SDSS	Spatial Decision Support System
TN-SMART	Tamil Nadu System for Multi-hazard Potential Impact Assessment and Emergency Response Tracking
TNSLURB	Tamil Nadu State Land Use Research Board
TWIC	Tamilnadu Water Investment Company
MAWS	Municipal Administration and Water Supply
IIHS	Indian Institute for Human Settlements
MIDS	Madras Institute of Development Studies
FPO	Farmer Producer Organisations
CETP	Common Effluent Treatment Plant
STP	Sewage Treatment Plant
ETP	Effluent Treatment Plants

List of Abbreviations

DRDA	District Rural Development Agency
CWSS	Combined Water Supply Scheme
CMA	Chennai Metropolitan Area
PWD	Public Works Department
ICT	Information and Communication Technology
DES	Department of Economics and Statistics
FHTC	Functional Household Tap Water Connection
CPCB	Central Pollution Control Board
JJM	Jal Jeevan Mission
NRSC	National Remote Sensing Centre
NHP	National Hydrology Project
GDP	Gross Domestic Product
BOD	Biochemical Oxygen Demand
TDS	Total Dissolved Solids
ZLD	Zero Liquid Discharge
WRI	World Resources Institute
GSDP	Gross State Domestic Product
GVA	Gross Value Added
SIDCO	Small Industries Development Corporation
TMC	Thousand Million Cubic Feet

List of Abbreviations

MAR	Managed Aquifer Recharge
CWSS	Combined Water Supply Scheme
NPK	Nitrogen, Phosphorus and Potassium
CAGR	Compound Annual Growth Rate
CWMA	Cauvery Water Management Authority
NRW	Non-Revenue Water
AMI	Advanced Metering Infrastructure
WSP	Water Safety Planning
SOPs	Standard Operating Procedures
ULB	Urban Local Body
IPR	Indirect Potable Reuse
UF	UltraFiltration
RO	Reverse Osmosis
AOP	Advanced Oxidation Processes
DEWATS	Decentralised Wastewater Treatment
UGD	UnderGround Drainage
O & M	Operation and Maintenance
TTUF	Tertiary Treatment UltraFiltration
SBR	Sequence Batch Reactor
DRIP	Dam Rehabilitation and Improvement Project

List of Abbreviations

ECR	East Coast Road
OMR	Old Mahabalipuram Road
VWBA	Volumetric Water Benefit Accounting
OMM	Odisha Millets Mission
WASSAN	Watershed Support Services and Activities Network
SGWD	State GroundWater Department
SWUC	State Water Utilisation Committee
WUA	Water Users Association
MWRRA	Maharashtra Water Resources Regulatory Authority
IoT	Internet of Things
KWRIS	Karnataka Water Resources Information System
APWRIMS	Andhra Pradesh Water Resources Information and Management Systems
IWRM	Integrated Water Resources Management
TNWRMA	Tamil Nadu Water Resource Management Authority
AMAs	Active Management Areas
E-flow	Environmental Flow
IWM	Integrated Water Management
WSUD	Water Sensitive Urban Drainage
TNIAMP	Tamil Nadu Irrigated Agriculture Modernization Project
PPIS	Project Performance Information System

List of Abbreviations

PforR	Program for Results
RTDAS	Real Time Data Acquisition System
C-FMS	Chennai Flood Management System
NOC	No Objection Certificate
ZBNF	Zero Budget Natural Farming
TNUSFIP	Tamil Nadu Urban Flagship Investment Program
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
IRMC	Integrated Reservoir Management Centre
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
DBT	Direct Benefit Transfer
SSDI	Subsurface Drip Irrigation
SMAM	Sub-Mission on Agricultural Mechanization
CAMPA	Compensatory Afforestation Fund
AH&D	Animal Husbandry and Dairying
DTA	Double / Triple / Annual
DIP	District Irrigation Profile
GLOBathy	Global Bathymetric

CHAPTER 1.

Introduction

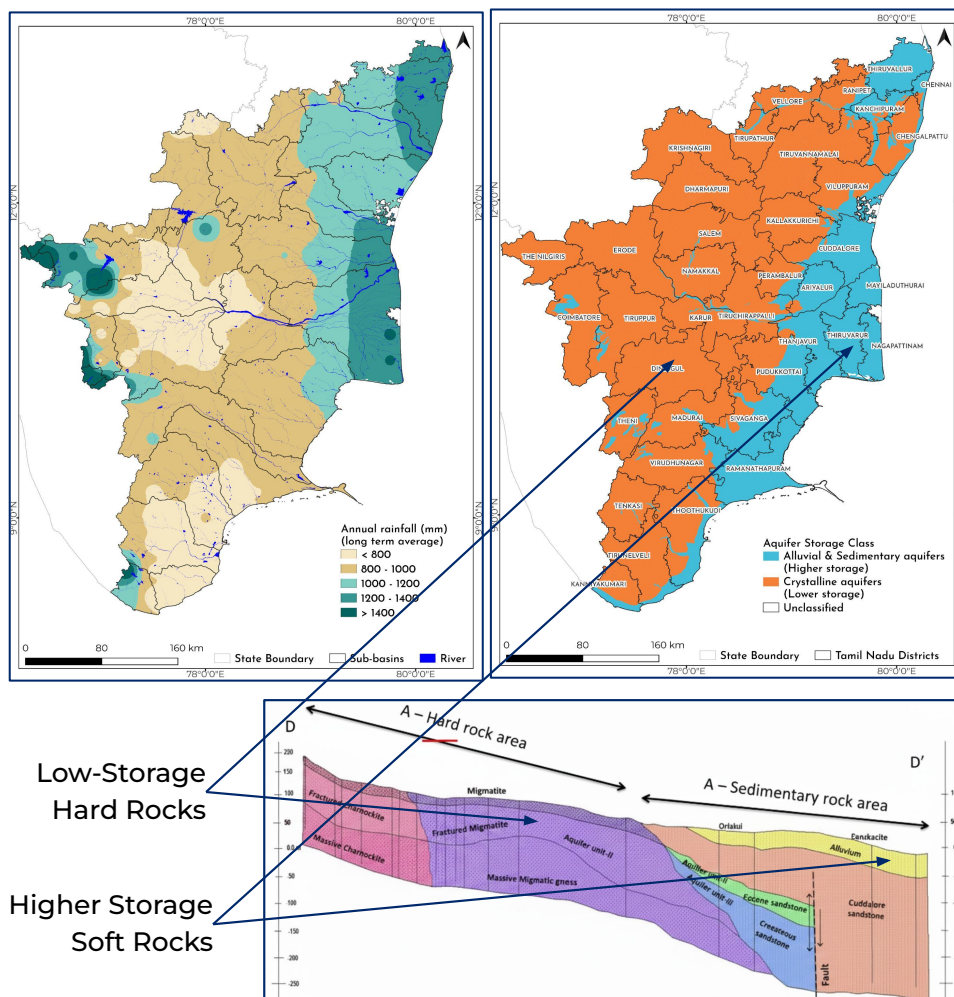
Dynamics of water availability and its movement across Tamil Nadu



Tamil Nadu's water is shaped by rainfall and geology.

Tamil Nadu's hydrological profile is defined by a distinct spatial imbalance in precipitation, primarily driven by its unique relationship with the northeast (NE) monsoon. Unlike much of India, which depends on the summer rains, Tamil Nadu receives approximately 50% of its annual rainfall from October to December. This creates a sharp geographic gradient, where the coastal and northern regions benefit from higher rainfall, while the southern and western districts often fall in rain shadow zones. This climatic variation means the State's water security is concentrated in a narrow seasonal window and specific geographic pockets, making the management of runoff during peak periods essential for economic stability.

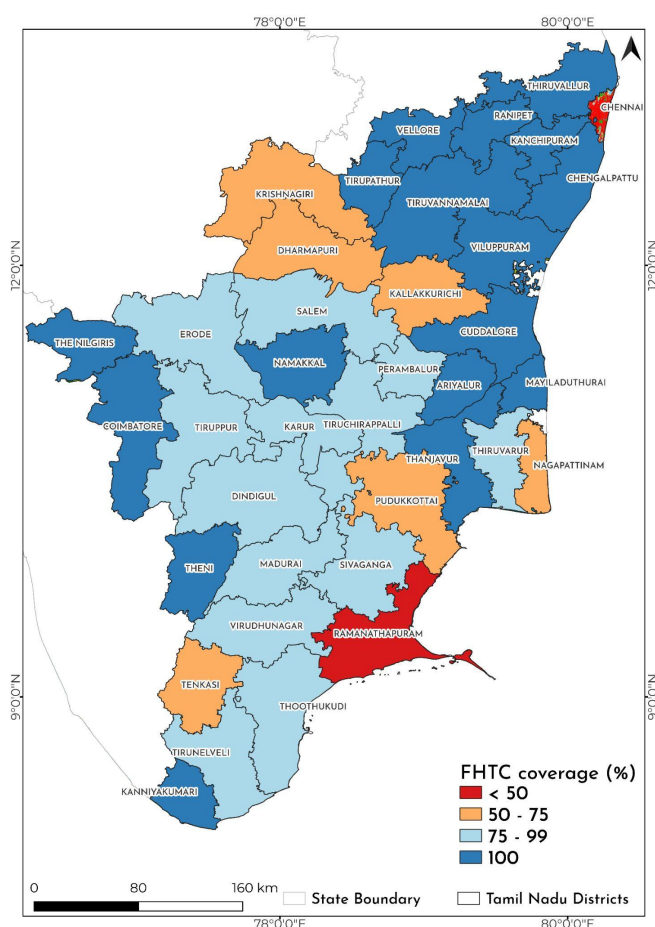
The State's underlying geology, which varies from east to west, further complicates water availability. Most of Tamil Nadu is composed of ancient crystalline hard rocks that offer limited storage and slow recharge rates, particularly in the western regions. The erosion of these highlands over millions of years has created deep alluvial deposits along the eastern coast. Consequently, the eastern plains serve as a superior hydrological 'bank', receiving higher rainfall and having greater aquifer storage capacity than its western counterpart. This natural advantage is bolstered by underground water inflows from the western highlands, effectively concentrating the State's most reliable water reserves in the east, while leaving the hard-rock western belt highly vulnerable to groundwater depletion.



Figures (clockwise): 1.1 Spatial distribution of average annual rainfall; 1.2 Spatial distribution of aquifer storage class; 1.3 Conceptual aquifer profile. Source: IMD, IndiaWRIS

Tamil Nadu has done well in improving tap water supply but intra-state differences remain.

Tamil Nadu has made commendable strides in expanding household tap water infrastructure, with Functional Household Tap Connections (FHTC) surging from a mere 17% prior to the Jal Jeevan Mission (JJM) to approximately 90% today. Yet, these impressive Statewide aggregate metrics mask significant intra-state disparities. As illustrated in the district-level mapping below, several regions, particularly coastal and northern districts like Tiruvallur, Kanchipuram, and Cuddalore, along with western hubs like Coimbatore and Theni, have successfully achieved the crucial benchmark of 100% coverage. However, stark regional inequities persist across the state. The southeastern district of Ramanathapuram remains critically underserved with less than 50% FHTC coverage, while the inland belt, including Krishnagiri, Dharmapuri, Tiruvannamalai, and Pudukkottai, still lags in the 50-75% bracket. This highlights an uneven infrastructure deployment that leaves specific geographical pockets highly vulnerable.



However, achieving high infrastructure coverage must not be conflated with actual water security, as physical access to a tap does not guarantee the delivery of water at an acceptable quality or quantity. Ground-level realities often contradict the optimistic picture suggested by the FHTC coverage statistics. Field visits consistently indicate that even in areas with high connection rates, the actual water supply is unreliable or of poor quality. This disconnect between infrastructure provision and reliable service delivery underscores an urgent need to shift focus from merely laying pipelines to ensuring comprehensive water services delivery through source sustainability and water safety plans.

Figure 1.4. District-wise percentage of households with Functional Household Tap Water Connection (FHTC).
Source: JIM 2026. WELL Labs

Tamil Nadu's economy is changing, but water demand is dominated by agriculture.

While Tamil Nadu's economic engine has fundamentally shifted away from its agrarian roots, its hydrological footprint remains tethered to the past. As shown in the sectoral GSDP breakdown, agriculture now contributes only 13% to the State's economy, vastly overshadowed by the services (54%) and industrial (33%) sectors. However, the water demand profile remains starkly disproportionate: agriculture still consumes 76% of the State's water resources, compared to just 20% for industry and 5% for domestic use. The land-use map further illustrates this tension, showing vast swaths of the State dedicated to double and triple cropping cycles in both kharif and rabi seasons. This misalignment creates a critical vulnerability as the State pursues a \$1 trillion economy driven by high-value manufacturing and services. The massive water lock-in by the relatively low GSDP-contributing agricultural sector limits the water available for future urban and industrial expansion.

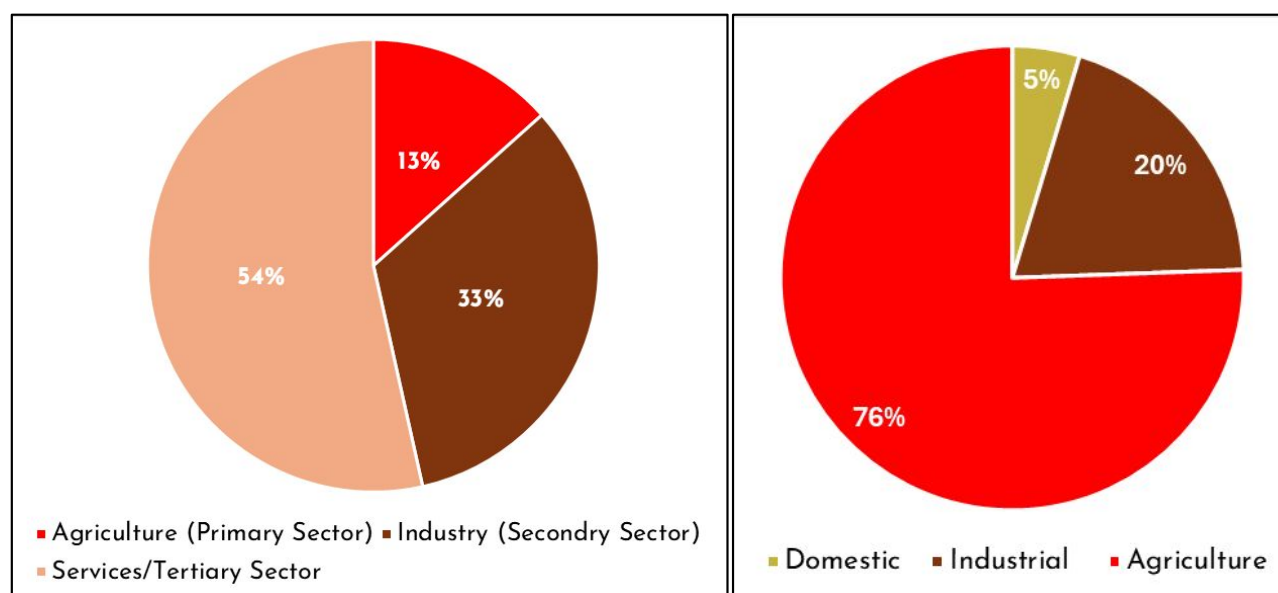


Figure 1.5 (left): Sectoral contribution to GDP. Figure 1.6 (right) Sectoral water demand. Source: WELL Labs, 2026. The graphs indicate that water demand is dominated by agriculture

The mapping of land use and land cover (LULC) is critical for water demand modeling, with the state average cropping intensity recorded at 129% as per the latest season and crop reports. While traditional land statistics from the Directorate of Economics and Statistics (DES) rely on manual revenue records that often lag behind real-time changes, we have utilized the National Remote Sensing Centre (NRSC) data due to its superior spatial and temporal accuracy. Discrepancies between NRSC and DES data—particularly in "Cropland" and "Barren Land"—frequently arise because remote sensing captures the actual biophysical state of the land (e.g., fallow lands or triple-cropping cycles) rather than its administrative classification. We chose NRSC data because its multi-temporal satellite imagery (at 1:50,000 and 1:250,000 scales) provides a dynamic view of seasonal crop progression and surface water spread, allowing for a more precise calculation of peak irrigation demand and the identification of "pit lake" storage potential in abandoned quarries that traditional records might overlook.

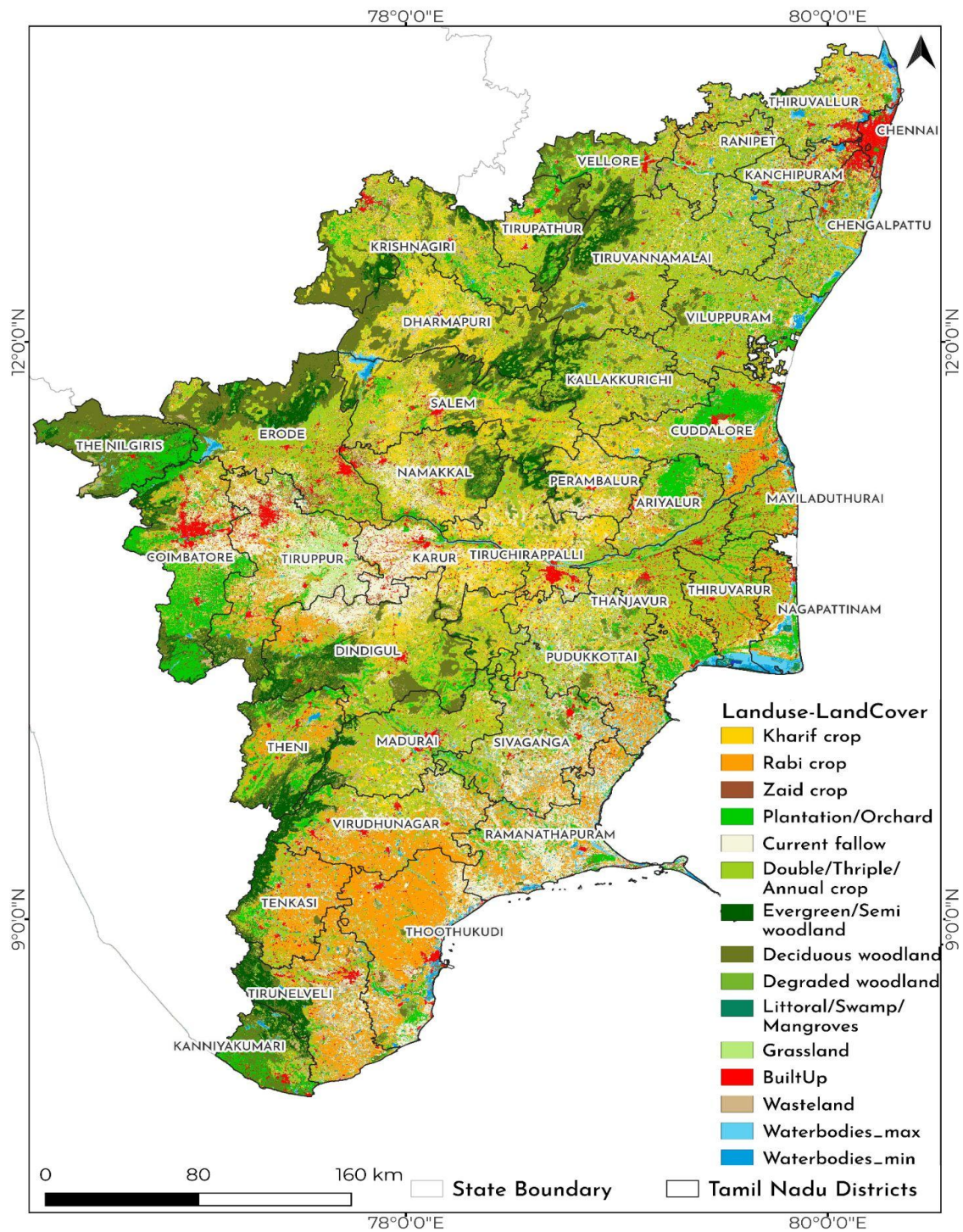


Figure 1.7 Spatial distribution of land use land cover. Source: NRSC 2023-24

Physical access to water has improved, but the quality has sharply declined.

Anthropogenic Contamination

Over the years, physical access to water has improved but its quality has sharply declined. The primary anthropogenic driver of declining water quality is the indiscriminate discharge of untreated domestic and industrial wastewater into water bodies.

Domestic discharge: Rapid urbanisation has significantly increased the volume of domestic wastewater generated across the State, intensifying pressure on already stressed rivers and tanks. Major urban rivers such as the Cooum, Adyar, and Noyyal have turned into biological dead zones. These rivers exhibit extremely high levels of biochemical oxygen demand (BOD), an indicator of the amount of dissolved oxygen required by aerobic microorganisms to decompose organic matter in water. Recorded concentrations reach as high as 345 mg/L, more than 100 times the safe limit of 3 mg/L for bathing, rendering the water a severe public health hazard. The Tamil Nadu Pollution Control Board (TNPCB) has identified untreated domestic sewage as the dominant source of pollution in the Noyyal river ([TNPCB,2025](#)).

Tamil Nadu state currently recycles ~ 17% of its sewage, with a large portion of treated water used for non-domestic purposes such as industrial cooling and urban greening. As of Jan 2026, the state generates 5499 MLD but only as a treatment capacity (including alternative technologies) of 3,395 MLD with another 615 MLD under construction but only about 1093 MLD (~17%) is being reused, primarily in Chennai city. A substantial amount of wastewater remains untreated or partially treated, often discharged into water bodies like the Cauvery, Buckingham Canal, and local drains.

Tamil Nadu State Pollution Control Board identifies 10 polluted stretches (CPCB Priority I-V).

Tamil Nadu has at least 10 heavily polluted river stretches, with the Cooum (Avadi to Sathya Nagar) and Adyar being the most contaminated, often exceeding safe biochemical oxygen demand (BOD) limits. Other severely polluted areas include the Thirumanimuthar and Vasishta rivers near Salem, and the Kaveri stretch from Mettur to Mayiladuthurai ([TNPCB, 2025](#)).



Figure 1.8: Chennai's Cooum River has been identified as the most polluted river stretch in the country based on CPCB filings.

Industrial discharge:

Over 54,000 industries operate in Tamil Nadu, with around 11,538 water-polluting industries generating over 2,835 MLD effluent. The filings by TNPCB suggest that all units are connected to Effluent Treatment plants (ETPs) or Common Effluent Treatment Plants (CETPs) with additional proposed plants and ongoing projects. However, details on the ETPs and CETPs are not being reported so it is difficult to judge the state of compliance. There remains a concern of compliance and industries illegally discharging into streams and abandoned borewells.

Industrial hubs therefore face a critical contamination crisis, where the sheer scale of production has outpaced historical environmental safeguards. In key manufacturing regions like Tiruppur, Ranipet, and Vellore, the risk of chemical pollution remains a persistent threat despite the implementation of Zero Liquid Discharge (ZLD) protocols. The 'legacy contamination' from decades of unregulated discharge has saturated the soil and local aquifers, creating a long-term environmental liability that continues to leach into the water cycle.

In the State's industrial clusters, particularly around Manali and Ennore, the footprint of petrochemical industries is evident through the presence of heavy metals and volatile organic compounds (VOCs) in local water bodies. Furthermore, the massive amounts of fly ash generated from thermal power plants – often stored in unlined ash ponds – leaches toxic elements like arsenic, mercury, and chromium into the soil and shallow aquifers. It is compounded by the discharge of untreated thermal effluents, which not only chemically alter the water but also causes thermal pollution, devastating local aquatic ecosystems and rendering surface water unusable for both domestic and agricultural purposes.

Climate induced risks: These risks are amplified by climate change. For instance, Cyclone Michaung hit Tamil Nadu in April 2023 with 110 km/h winds, causing heavy rains and flooding in Manali. A report by IIT Madras showed that excess water release from Poondi and Puzhal reservoirs (129 million cubic meters) caused flooding, leading to oil ingress from stormwater drains into Ennore Creek ([TNPCB, 2024](#)). Oil slicks were observed in Kosasthalaiyar River and along stormwater drains, spreading up to 11 km into Ennore Creek. The oil spill affected fishermen, boats, and local livelihoods, with oil reaching vessels and boats.

The State is also grappling with salinity. Along the 1,076 km coastline, particularly in the industrial and urban hubs of Minjur (North Chennai) and Cuddalore, excessive freshwater extraction has reversed the natural hydraulic gradient between aquifers and the sea. As groundwater levels fall below sea level, saline water is drawn inland, leading to permanent aquifer salinisation and rendering this critical resource unfit for drinking or industrial use. This vulnerability was starkly demonstrated in the aftermath of the 2004 tsunami. While typical storm surges penetrate only a few kilometres, field observations in Tirunelveli recorded saline intrusion extending as far as 20 km upland, likely facilitated by the region's unique estuarine conduits and fractured karst hydrogeology.

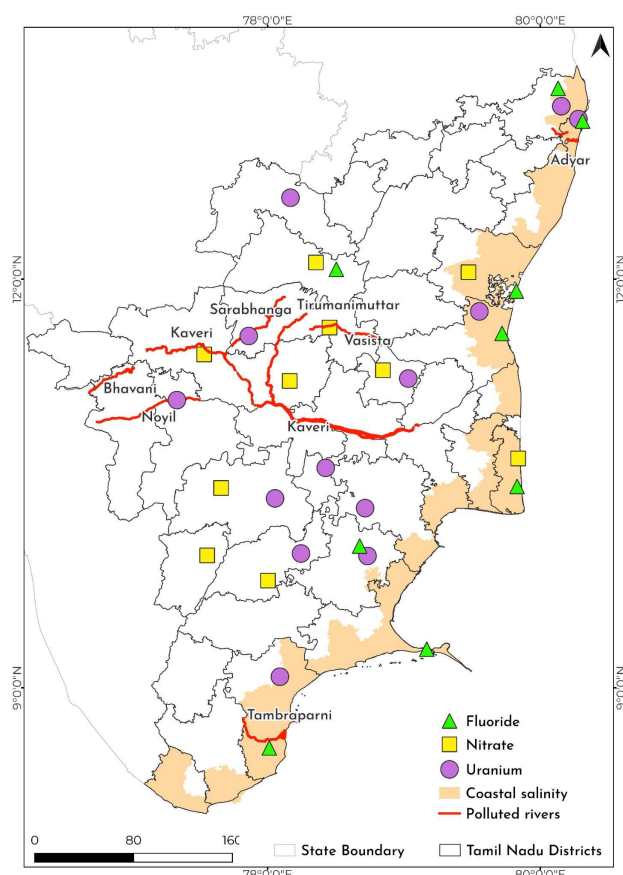


Figure 1.9: Water quality hotspots. Source: CGWB, WELL Labs 2026

Geogenic Contamination

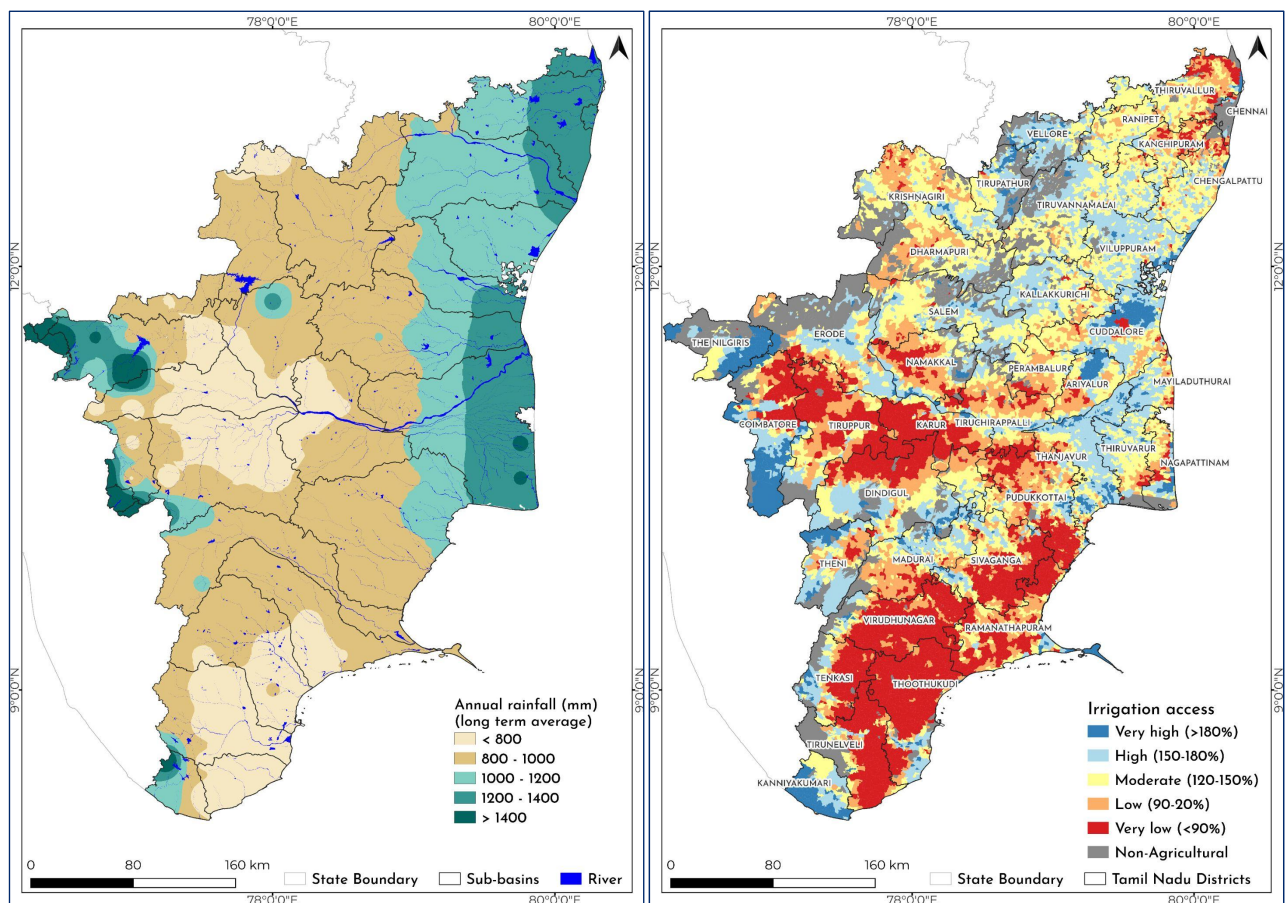
Geogenic contamination is a byproduct of the State's inherent geological makeup, where deep-seated minerals leach into the groundwater over millennia. This is most prevalent in the hard-rock terrains of the inland districts, where high concentrations of fluoride and salinity occur naturally as groundwater resides longer in mineral-rich aquifers. These 'natural' pollutants often exceed BIS standards, posing chronic health risks like skeletal fluorosis to rural communities that rely solely on deep borewells without adequate treatment. In districts such as Dharmapuri and Krishnagiri, approximately 14.8% of water samples exceed safe fluoride limits.

Simultaneously, uranium is emerging as a critical geogenic threat in the Kanchipuram and Tirunelveli regions, where declining water tables and alkaline soil conditions accelerate the mobilisation of natural radioactive minerals into the drinking water supply.

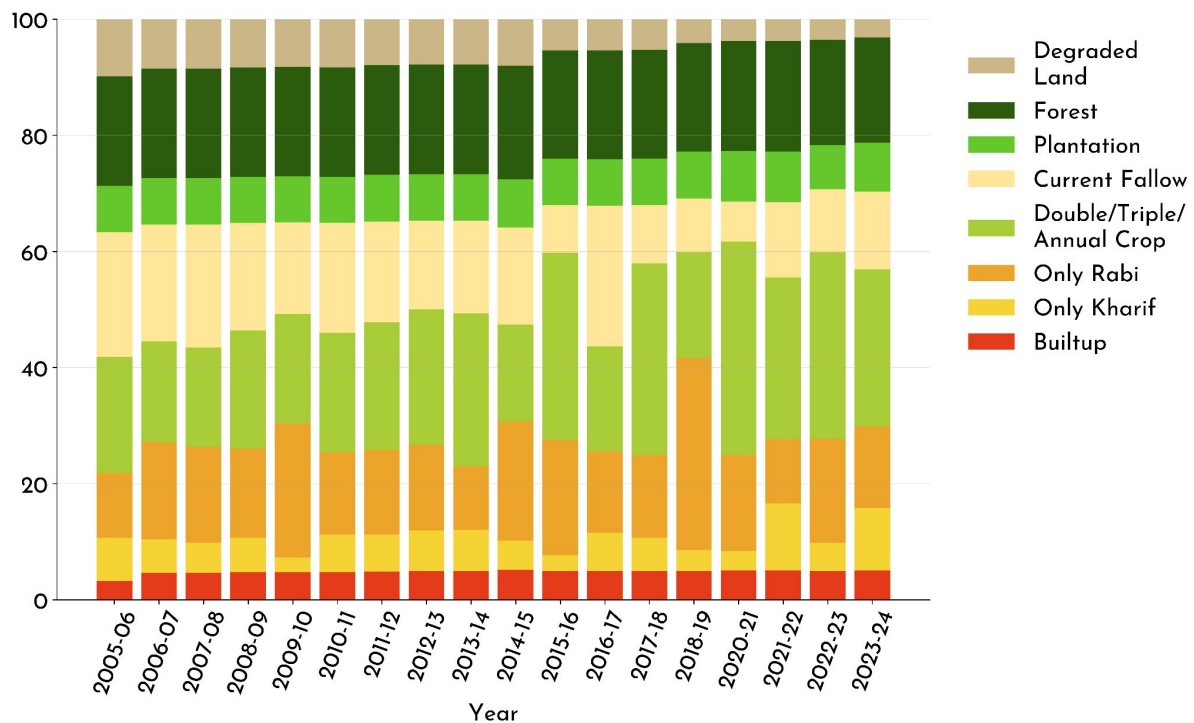
Beyond direct surface discharge, groundwater security is further compromised by the leaching of unlined solid waste disposal sites. In Tirupur, TNPCB monitoring has confirmed significant groundwater contamination in open wells situated near a solid waste disposal site, specifically one utilising an abandoned quarry. This illustrates how poorly managed domestic waste streams and unlined landfills facilitate the migration of pathogens and nitrates into vital subterranean reserves.

Cropping intensity is increasing even as the State nears the limits of its available water resources.

While Tamil Nadu has successfully increased its cropping intensity through technological adoption and enhanced irrigation access, it is now nearing the limits of its sustainable water availability. This trend is characterised by an expansion of cropping cycles, moving from single to double or even triple cropping in many pockets. This has maintained the agricultural output despite a shrinking net area sown. However, this intensification relies predominantly on depleting groundwater reserves rather than on surplus surface water. With nearly 80% of the State's blocks already categorised as over-exploited or critical, the current model of agricultural intensification is colliding with a hard ceiling of water availability. Without a shift toward water-neutral cropping patterns and high-efficiency precision irrigation, the State risks a systemic decoupling where the ambition for higher agricultural productivity is undermined by the physical exhaustion of its aquifers.

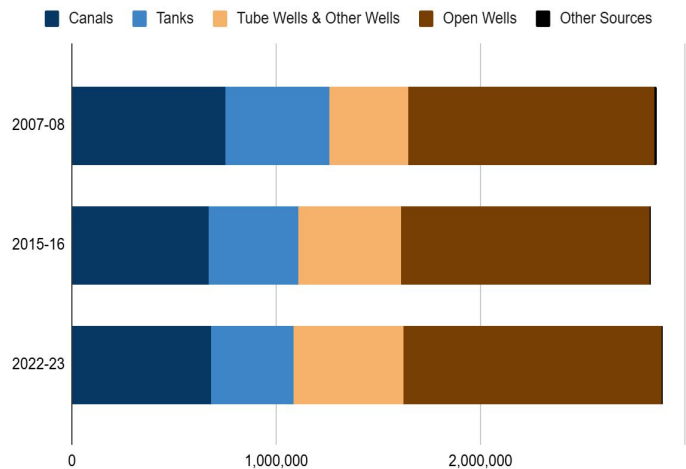


Note. These show that areas of low rainfall are similar to where farmers are not able to grow a second crop. Figure 1.1 (left): Spatial distribution of average annual rainfall (1950-2000). Figure 2.0 (right) Spatial distribution of cropping intensity (2005-06 to 2023-24). Source: IMD, WELL Labs 2026



Most of Tamil Nadu's irrigated farmlands now rely on groundwater, which supplies more than 60% of the State's irrigated area, marking a long term shift away from canals, tanks and other surface water sources. This transition is driven by the perceived reliability of irrigation using energised pump-sets. In comparison, canal systems and tanks bring with them seasonal uncertainty.

Groundwater extraction is widely under-accounted across many districts, as thousands of private wells operate without metering and numerous small scale withdrawals escape regulation. This creates a hidden deficit, where policy assumes a resource buffer that may already be depleted, heightening the risk of sudden aquifer collapse in water stressed regions.



Increasing groundwater use is leading to reduction in the flow of rivers

The extensive extraction of groundwater is fundamentally altering Tamil Nadu's river systems, causing a shift from gaining streams to losing streams. In a natural, pre-modern hydrological system, shallow groundwater levels remain high enough to discharge into riverbeds, maintaining base flow and ensuring rivers remain perennial even during dry seasons. However, as groundwater usage intensifies and the water table drops below the riverbed level, the direction of flow reverses. Instead of groundwater feeding the river, the river begins to drain into the depleted aquifer. This results in a scenario where streamflow decreases as one moves downstream, turning once-reliable perennial rivers into seasonally dry channels. Despite this physical reality, the management of surface and groundwater continues to operate in separate institutional silos, failing to account for the fact that every unit of groundwater extracted is often a unit of surface water lost.

This systematic decline of baseflow is increasingly evident across all hydrological signatures in the State. Data from major reservoirs, including Mettur and Bhavanisagar, reveal a consistent downward trend in dry season inflows (January-May), with particularly sharp reductions during dry years.

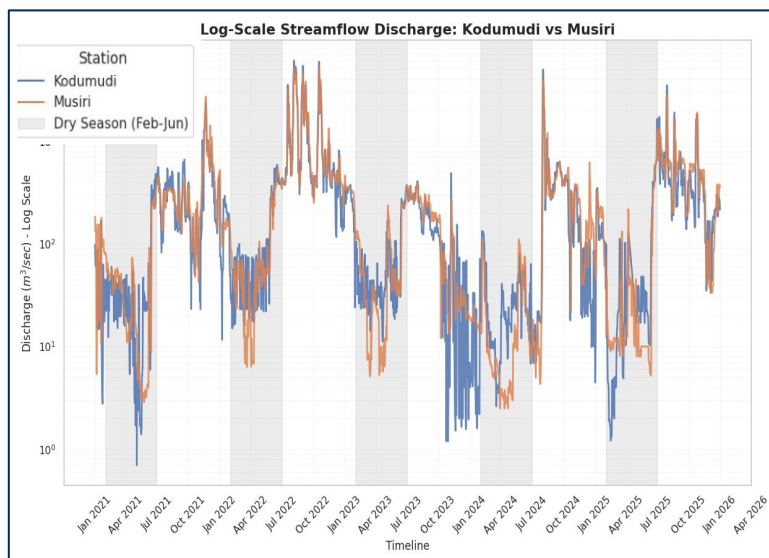
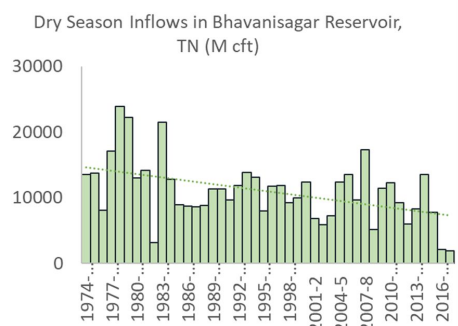
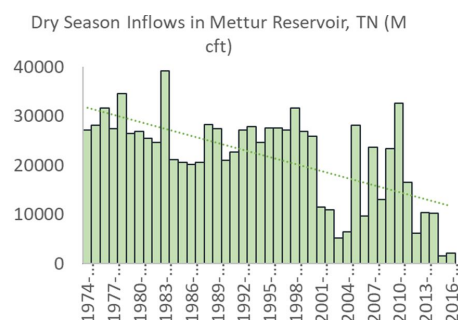
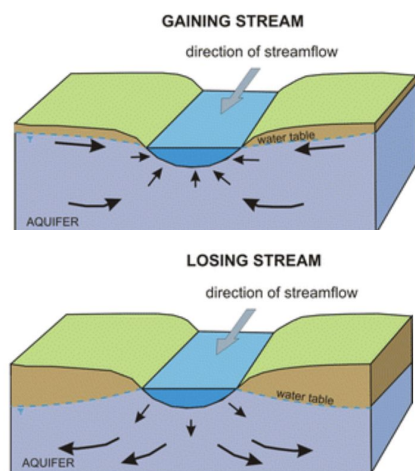


Figure 2.3 (above right): Long-term trends in dry season inflows to Mettur and Bhavanisagar reservoirs. Figure 2.4 (above): Streamflow discharge for Kodumudi and Musiri stations in Cauvery River. Source: National Hydrology Project (NHP)

Another such example can be seen in the Cauvery Delta. The downstream station at Musiri exhibits lower dry season flows compared to the upstream station at Kodumudi. This negative water balance confirms that the river is no longer being replenished by groundwater as it flows toward the coast, but is instead losing its volume to a depleted subsurface, effectively turning a vital life-line into a series of disconnected, dry stretches during the most critical months of the year.

Indiscriminate sand mining acts as a massive hydrological drain, fundamentally altering river morphology and stripping the landscape of its natural water storage capacity.

In a healthy river system, sand serves as a porous 'sponge' that slows down flow velocity, filters pollutants, and maintains the hydraulic pressure necessary to push water into adjacent aquifers. When this sand is removed beyond natural replenishment rates, it triggers channel incision – the vertical lowering of a riverbed that can disconnect the river from its floodplains and lower the surrounding water table. Furthermore, removal of the sand 'armour' increases the river's flow velocity, leading to aggressive bank erosion and reduced time for rainwater to infiltrate and recharge groundwater reserves.

A stark example of this impact is seen in the Palar river basin in northern Tamil Nadu. Studies and State measurements indicate that in parts of the Palar and Thamirabarani basins, the riverbeds have dropped by as much as 15 m (50 ft) over the past two decades due to aggressive mining. In the Palar specifically, this bed degradation has left once-prolific drinking water wells high and dry. Reports suggest that in riparian villages, groundwater, which was accessible at 20 ft, has plummeted to over 100 ft. This hydrological collapse has transformed the Palar into a 'dry' river for most of the year, where even significant rainfall fails to recharge the deep, emptied aquifers, directly threatening the water security of over 35 million people who depend on the Cauvery and Palar systems for their livelihoods. Although legal sand mining has been banned or restricted, illegal sand mining continues in many sites.



There are only a handful of empirical studies on the impacts of sand mining in the Indian context. Apart from the effects on biodiversity, one study showed that accelerated rate of sand mining led to the progressive incision of the riverbed, increasing the overall channel area, flow velocity, and conveyance capacity of the river. This likely led to rise in severity and frequency of floods downstream.

Figure 2.5: Sand being mined from the Cauvery River bed. Photo: P. Jeganathan/Wikimedia Commons

Over-extraction of groundwater has put a strain on drinking water supply, shifting the focus from expanding connectivity to ensuring source reliability.

Drinking water in Tamil Nadu is an intricate administrative relay where the Tamil Nadu Water Supply And Drainage (TWAD) Board designs massive regional grids and Rural Development and Panchayat Raj Department manages distribution at the village level. Yet, the Water Resources Department (WRD) remains the ultimate gatekeeper by controlling all river and dam withdrawals. On paper, this governance has achieved monumental success in infrastructure: piped water connectivity now reaches 88.37% of rural households and 98% of urban areas. Yet, for residents in districts like Ramanathapuram, Thoothukudi, and Dharmapuri, a tap in the house does not always mean water in the glass. The challenge has shifted from expanding connectivity to ensuring source reliability. Although pipes have reached the last mile, the water often stops short because local groundwater sources (accounting for 64% of the FHTC coverage) have been exhausted or contaminated.

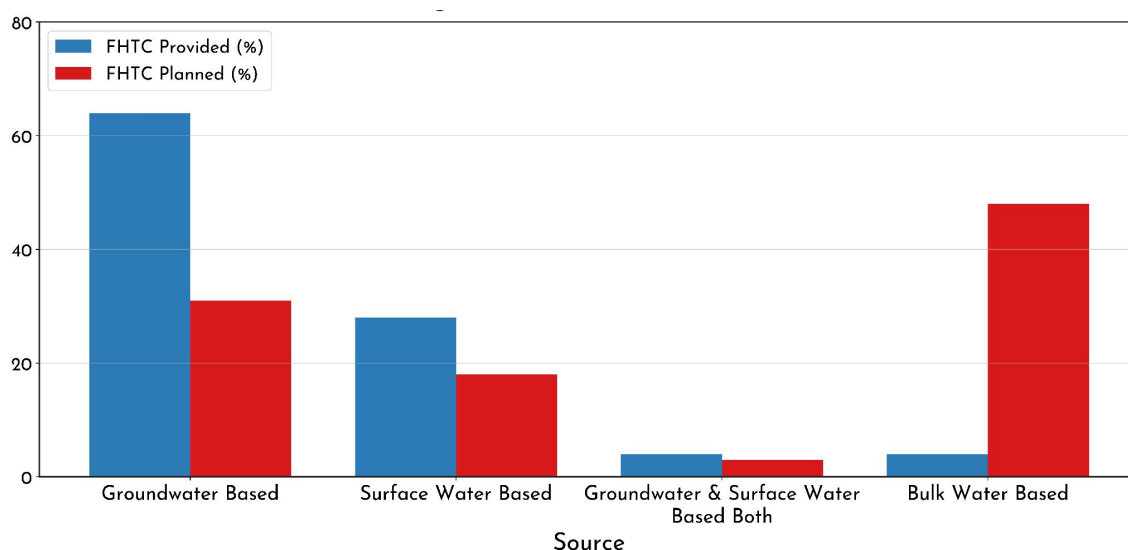


Figure 2.6: Comparison of the percentage of Functional Household Tap Connections (FHTC) provided and planned across different water sources. Source: JJM 2026

To address this slippage problem, the State is pivoting toward a bulk water strategy, replacing failing local borewells with large-scale Combined Water Supply Schemes (CWSS) that tap into stable surface rivers. This shift is designed to create a hydrological safety net that is immune to local well failures, but it requires professional management to succeed. The State is integrating modern mechanisms such as smart volumetric metering to track every litre and curb the losses often seen in unmonitored networks.

It means that many reservoirs are increasing water allocation from dams to urban water schemes, further decreasing the availability for agriculture.

Escalating fiscal drain from agricultural power subsidies necessitates demand-side groundwater management to ensure long-term economic and hydrological stability.

The increasing dependence on groundwater is vividly reflected in Tamil Nadu's escalating electricity subsidy figures, creating a stark data discrepancy with traditional irrigation reports. State irrigation statistics suggest a relatively modest increase in activity. However, with the reported net irrigated area approximately 13% lower than the actual irrigated area identified through high-resolution National Remote Sensing Centre (NRSC) satellite data, the energy sector tells a different story. The steady rise in agricultural energy demand, which constituted a significant share of the State's total electricity consumption of 94,108 million units in 2022, underscores the invisible expansion of groundwater pumping. This rising electricity consumption confirms that farmers are compensating for surface water deficits by tapping deeper into aquifers, effectively shifting the burden of water scarcity onto the State's power subsidies and fiscal reserves.

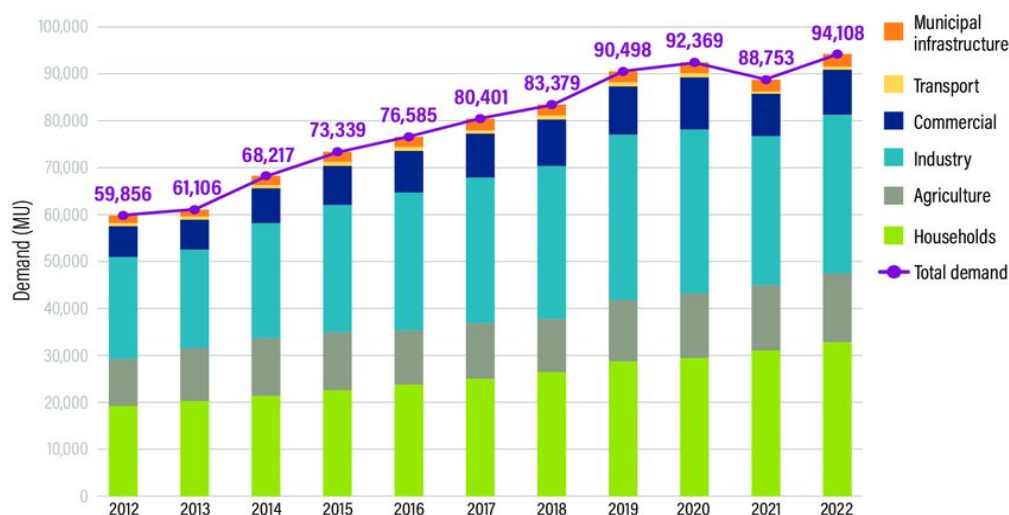


Figure 2.7: Sector-wise electricity demand (MU) from 2012 to 2022. Source: Sunderaraghavan et al., 2022

The steady rise in agricultural electricity consumption has exerted a disproportionate strain on the State exchequer, primarily due to rising electricity tariffs and the increasing cost of power procurement. While the volume of energy used for groundwater extraction has increased, the fiscal burden has grown even faster, making the agricultural power subsidy a significant recurring liability.

Tamil Nadu Electricity Subsidy

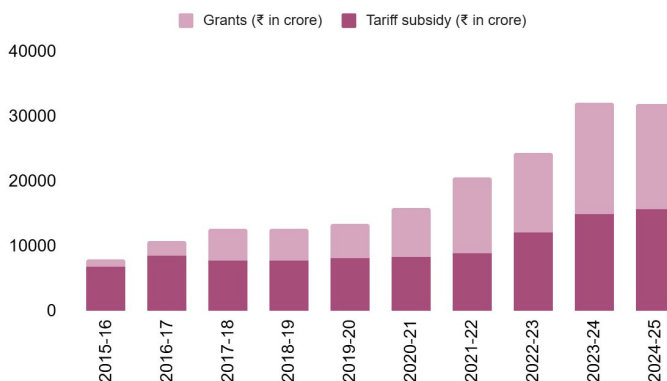


Figure 2.8: Trends in electricity subsidies in Tamil Nadu from 2015-16 to 2024-25. Source: The Hindu

This economic reality implies that strategic investments in groundwater management, particularly demand-side measures such as precision irrigation, crop diversification, and pump-set efficiency could prove highly cost-effective. By reducing the energy required to lift a unit of water, the State can achieve a double dividend of preserving critical aquifer reserves while simultaneously curbing the escalating fiscal drain on the power sector.

All these challenges are occurring in the context of increasing floods and droughts.

Tamil Nadu's water security challenges are increasingly defined by a high-volatility climate regime where both flood and drought risks are intensifying simultaneously across different geographies. Risk assessment mapping reveals a stark landscape of vulnerability, particularly in the northern and coastal belts. Riverine flood risk is notably high in districts such as Chennai, Kanchipuram, and parts of the Cauvery Delta, where dense drainage networks face being overwhelmed by high-intensity rainfall. Concurrently, coastal flood risk poses a systemic threat to the eastern seaboard, where 'Day Zero' urban water crises are often punctuated by catastrophic inundation.

While excess water causes localised devastation, the rest of the State remains highly susceptible to severe drought conditions, creating a paradox of 'unreliability of delivery'. Large swaths of the inland territory, especially in central and southern districts, are classified as having medium-high to high drought risk. Rising drought risks disproportionately impact rainfed farmers, who often lack the resilience to withstand the prolonged dry spells expected under climate change. Providing access to protective irrigation is a critical climate adaptation strategy to prevent crop failure and safeguard livelihoods.

This extreme variability shifts the crisis from a simple lack of resource to a systemic unreliability, where agricultural calendars and urban reservoir management are rendered obsolete by erratic monsoonal noise. Mitigating these impacts requires a radical transition toward resilience-first infrastructure that can both capture flash runoff through decentralised storage and maintain vital buffers to survive extended dry spells.

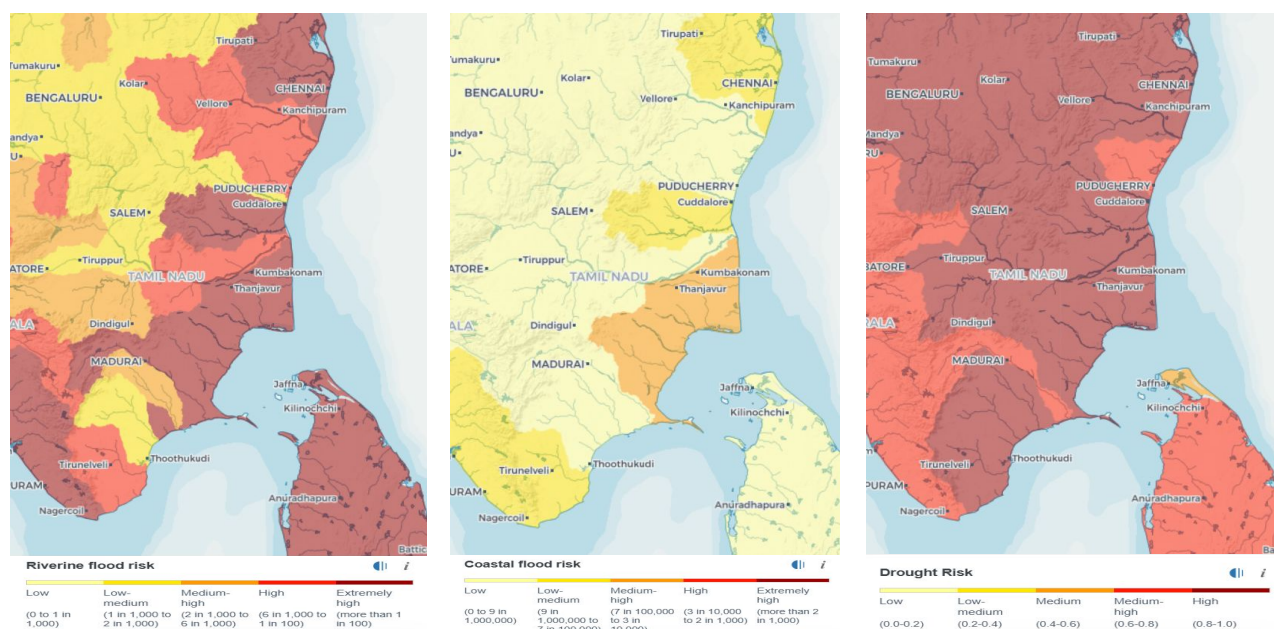
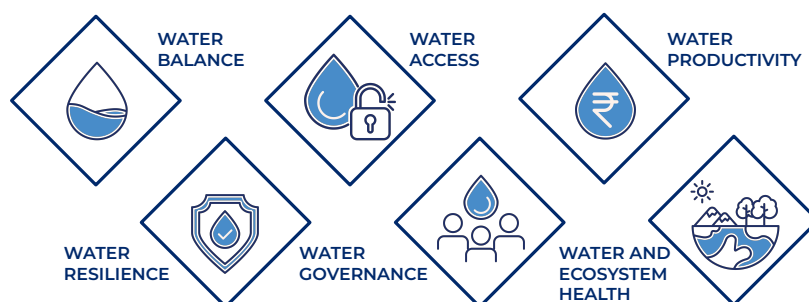


Figure 2.9: Aqueduct 4.0 Water Risk Atlas. Source: WRI 2023

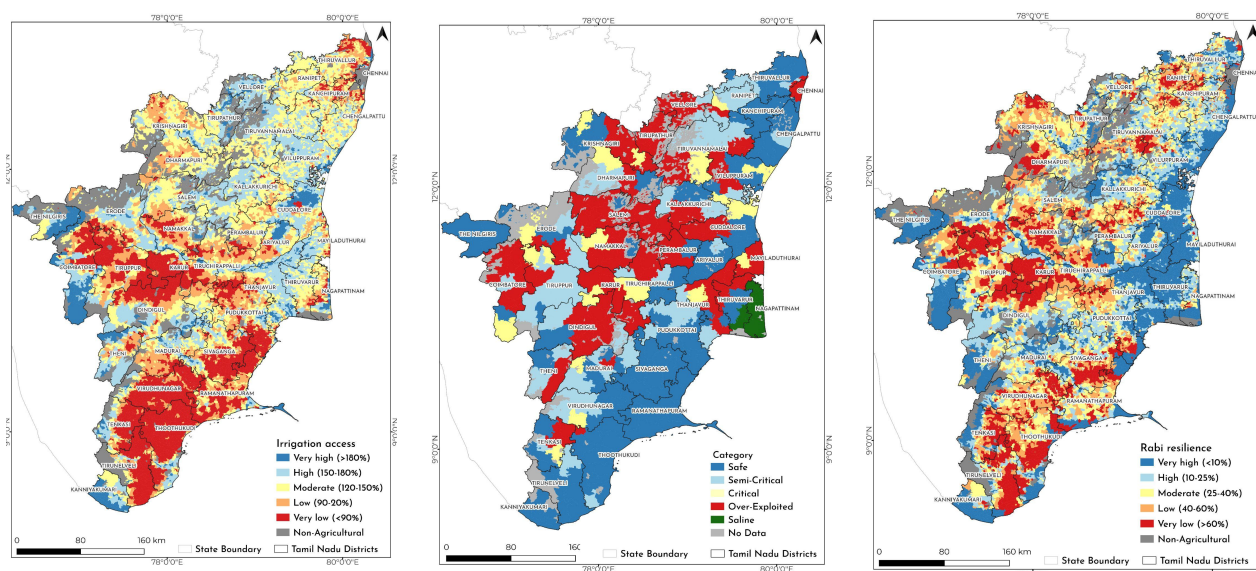
Water security can be assessed across multiple dimensions.

Assessing water security for the future requires a multi-dimensional framework that moves beyond simple volume metrics to evaluate the holistic health of the hydrological system. This involves measuring safe **water access** for all citizens and the **water balance** within specific basins to ensure extraction does not exceed recharge. It also necessitates improving **water use** productivity so that every drop generates maximum economic value, while strengthening infrastructure to withstand increasing climate variability and extreme weather events. Underpinning these technical goals is **water governance**, which provides the institutional and regulatory backbone for fair allocation, and **water and ecosystem health**, which ensure that the natural aquifers and rivers sustaining the economy remain uncontaminated and viable for future generations.



Dimensions of water security as referenced in this report

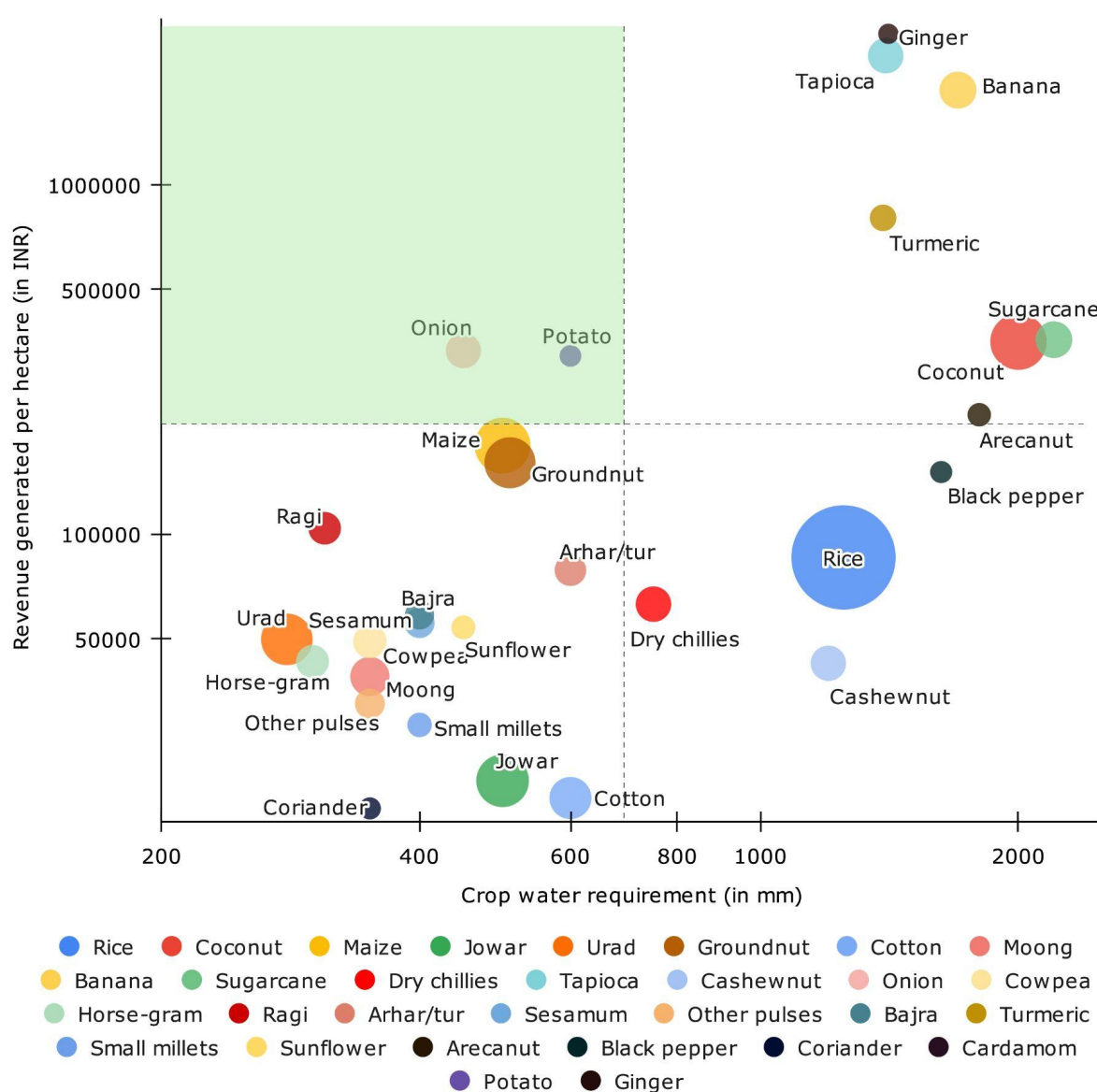
These dimensions are deeply interconnected through a feedback loop where water governance and ecosystem health dictate the physical limits of safe water access and water balance. Improving water use productivity (getting more value from less) is the primary driver for achieving climate resilience, as it reduces the overall system stress and creates the necessary buffer to absorb environmental shocks. These factors play out in different ways in different parts of the state. For instance, the southern districts of Ramanathapuram and Sivagangai show up as “safe” but they have very low access to irrigation and therefore are vulnerable to drought. This suggests perhaps that farmers have given up pumping GW because of high risk of failure. Similarly parts of Vellore, Dharmapuri and Krishnagiri have moderate irrigation access but groundwater is over-exploited and farmers are nonetheless vulnerable in dry years.



(Left to right) Figure 2.0: Spatial distribution of cropping intensity 2005-06 to 2023-24; Figure 3.0: Spatial distribution of groundwater extraction status for 2024-25; Figure 3.1: Spatial distribution of cropping resilience during rabi season 2005-06 to 2023-24. Source: CGWB, WELL Labs

Sustainable agricultural growth in Tamil Nadu requires a strategic pivot toward economic water productivity.

Water-intensive staples like paddy and sugarcane currently dominate the landscape but offer relatively low economic water productivity as illustrated in the figure below. In contrast, high-value horticultural crops such as vegetables (beans, tomato) and pulses (black gram) demonstrate significantly higher returns. A shift in cropping patterns is essential because agriculture consumes nearly 76% of the State's water resources, even as groundwater extraction exceeds 85% of annual recharge. Transitioning from low-value, high-water crops to climate-resilient, remunerative alternatives like maize, oilseeds, or drip-irrigated pulses can reduce the regional water footprint without compromising total agricultural production and farmer income. The detailed methodology for crop water productivity in the observed 30 crops is in Annexure C.III.



Water becomes a critical economic enabler for the ambitious goal of becoming a \$1 trillion economy by 2030.

To propel Tamil Nadu toward its goal of becoming a \$1 trillion economy by 2030, water must be reimagined as a strategic economic lever. The current model where agriculture consumes 76% of water but contributes only 13% to Gross State Domestic Product (GSDP) must evolve by **maximising Gross Value Added (GVA) per drop**. This involves a strategic shift from water-intensive, low-value staple crops to water-efficient, high-value horticulture. By decoupling agricultural growth from the current trend of exploiting the groundwater, the State can ensure that the primary sector contributes higher economic value without exhausting the finite hydrological reserves required for other growing sectors.

For the industrial sector, the focus must shift toward **de-risking industrial corridors** by institutionalising a circular water economy. Mandating the reuse of treated wastewater ensures that the manufacturing sector remains insulated from periodic droughts and seasonal shortages. This strategy not only drought-proofs industries but also strategically reserves precious freshwater for primary human consumption, reducing competition between citizens and corporations for a shared resource.

Climate-proofing urban growth centres is essential to prevent the economic paralysis caused by both water scarcity and urban flooding. Significant investments in 24x7 'drink from tap' systems will reduce the hidden costs of water storage and private procurement for urban households and businesses. Simultaneously, developing climate-resilient stormwater infrastructure is a prerequisite for ensuring that major cities avoid the flood-induced downtime and infrastructure damage that can cause significant setbacks to the State's GDP trajectory.

Securing natural capital through the protection of aquifers and the rejuvenation of water bodies is a fundamental prerequisite for sustained expansion. Currently, untreated contaminants and over-extraction act as economic drags, manifesting as rising treatment costs, healthcare expenditures, and aquifer productivity losses. Restoring these natural assets provides the resource reliability necessary for long-term fiscal stability, ensuring that the water foundation for the 2030 vision is both resilient and uncontaminated.

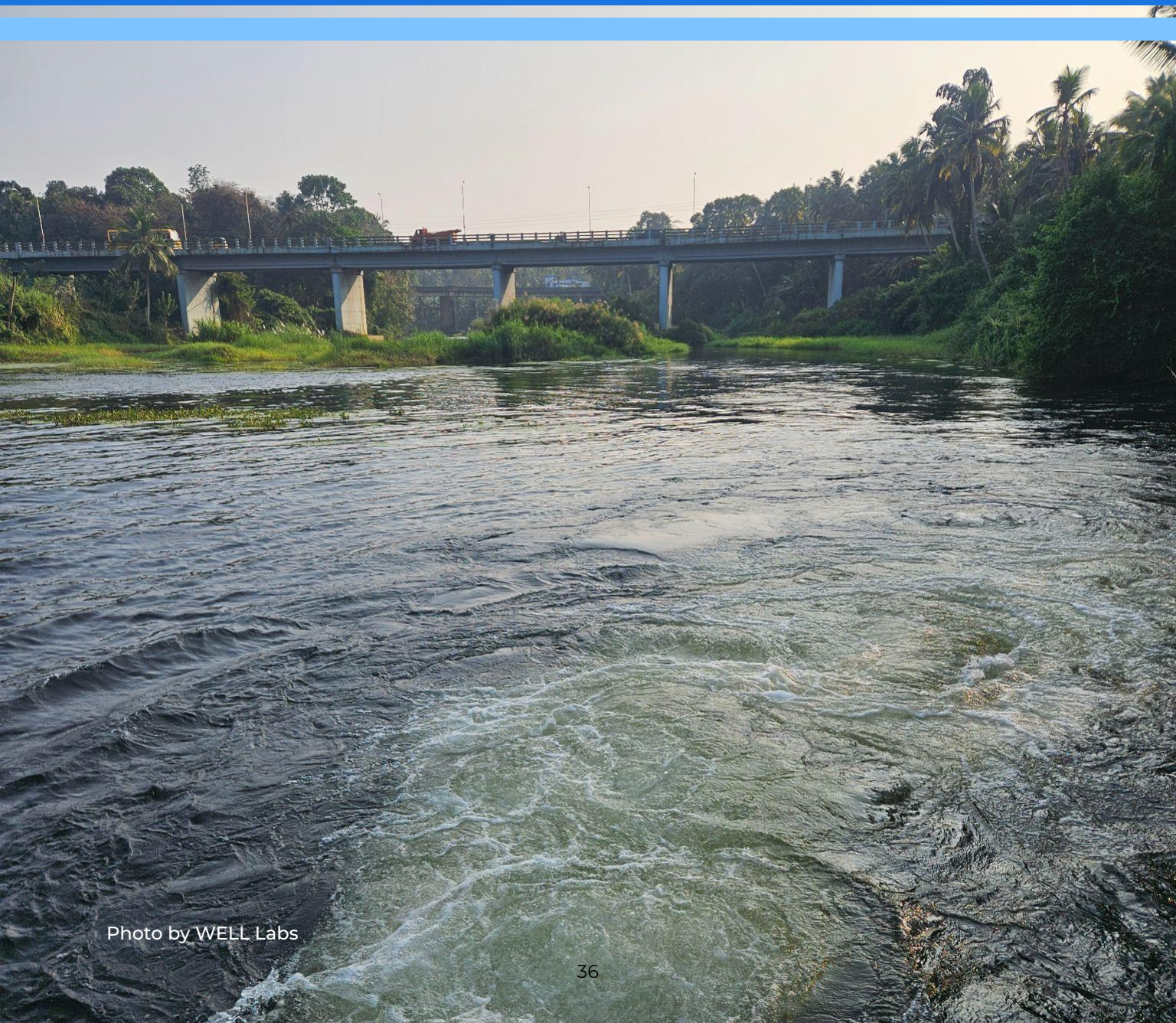
The **energy-water nexus must be untangled** to ensure that electricity policies do not inadvertently accelerate resource depletion. Efforts should be directed toward redesigning incentives so that they reward efficiency rather than encouraging excessive groundwater pumping. By aligning energy subsidies with water conservation goals, the State can turn a traditional fiscal burden into a driver for long-term water security.

Finally, the State must move toward **governing water as a unified resource**. While hydrological data clearly demonstrates that ground and surface water are deeply integrated, current governance remains fragmented across multiple departments. Establishing a synchronised, 'one-water' management protocol is critical to ensuring that planning is as integrated as the water cycle itself.

CHAPTER 2.

Baseline Assessment (2025 scenario)

Moving beyond aggregate State-level averages to the granular district-level understanding of supply, demand, and quality



District Water Account Framework

This study moves beyond aggregate state-level averages to adopt a granular, district-level understanding of water supply and demand. By doing this, we can identify specific ‘stress hotspots’ that are often masked by statewide statistics and implement highly targeted interventions. This localised approach ensures that this report’s recommendations on infrastructure and policy are tailored to the unique geological constraints and economic drivers of specific regions. A detailed methodology and underlying assumptions are provided in Annexure 1. A brief summary is presented below.

Water demand was estimated district-wise using a bottom-up approach by integrating agricultural, domestic (including livestock), and industrial water requirements.

Domestic demand was projected using Census-based population growth rates and BIS norms. Livestock demand was estimated using species-wise projections and standard coefficients (annualised in billion cubic metres). A standard geometric growth method was applied to project the domestic demand, assuming 55 litres per capita per day for rural populations and 135 litres per capita per day for urban populations.

Crop demand was computed using National Remote Sensing Centre (NRSC)’s land use land cover (LULC)-derived crop areas and Tamil Nadu Agricultural University (TNAU) crop water requirements, explicitly accounting for cropping intensity and multiple cropping to avoid double counting. Crop water demand was estimated for three years (2008–09, 2015–16, and 2022–23) under normal rainfall conditions. Crops were grouped into seven crop classes, and the percentage share of each crop class (as reported by season and crop reports) was applied to the total agricultural area derived from NRSC LULC.

Industrial demand was estimated using a water intensity coefficient, expressed in litres per rupee of Gross District Domestic Product for the industrial sector. The compound annual growth rate, derived from GDP growth between 2020–21 and 2022–23, was applied to project future GDP and corresponding water demand.

Water availability (supply) was estimated for surface water resources (storage and inter-state transfers), groundwater resource (annual extractable groundwater), and non-conventional water (wastewater reuse and desalination).

Storage capacity was estimated by multiplying satellite-derived water body surface area (from Joint Research Centre’s Global Surface Water data, post morphological cleaning and vectorisation) with mean depth values extracted from GLOBathy bathymetric data. To ensure the data is actionable for the water authorities, we set a minimum area threshold of 0.5 hectares. We overlaid the water body polygons on high-resolution bathymetric maps to calculate the storage volume.

Interstate supply was estimated by identifying major reservoirs receiving inflows from neighbouring states and quantifying Tamil Nadu’s allocated share. These volumes were then distributed across beneficiary districts based on irrigation command areas and drinking water project allocations.

Annual extractable groundwater resource estimates were adopted from the 2024 Dynamic Ground Water Resources of India assessments jointly conducted by the Central Ground Water Board (CGWB) and respective State Ground Water Departments.

Non-conventional water supply was estimated by accounting for treated wastewater generated from Sewage Treatment Plants (STPs) across districts. For Chennai, additional supply from operational desalination plants was incorporated based on installed treatment capacity.

Agriculture accounts for 2/3rd of the total water demand.

The highest **agricultural water demand** in Tamil Nadu is concentrated in the Cauvery Delta districts, specifically Thanjavur, Thiruvarur, and Nagapattinam, and the Palar basin districts like Vellore. These areas are characterised by:

- **Water-Intensive Cropping:** A heavy reliance on paddy and sugarcane, which consume significantly more water per hectare compared to other crops. Thanjavur alone, as the 'Rice Bowl' of Tamil Nadu, manages massive irrigation ayacuts* that require high seasonal water volumes.
- **Geographic Intensity:** High cropping intensity (often ranging from 113% to 150% as per season and crop report 2023-24) where multiple cycles of paddy are cultivated in a single year, placing a continuous load on surface canals and groundwater.
- **Irrigation Infrastructure:** The presence of extensive canal and tank systems in these command areas facilitates large-scale water diversion for agriculture.

Conversely, **industrial water demand** is predominantly clustered in the peri-urban belts surrounding major economic hubs, most notably Chennai, Tiruppur, Kancheepuram, and Coimbatore. These areas are characterised by:

- **Manufacturing Corridors:** Districts like Thiruvallur and Kancheepuram host major SIPCOT (State Industries Promotion Corporation of Tamil Nadu) and SIDCO (Small Industries Development Corporation) industrial estates (e.g., Gummidipoondi and Sriperumbudur) that support water-heavy sectors like automobile manufacturing, power plants, and electronics.
- **Textile and Chemical Hubs:** Coimbatore and Tirupur exhibit high demand due to concentrated textile processing and dyeing units, while the Noyyal and Bhavani river basins have historically seen intense competition between industrial and domestic use.
- **Urban Proximity:** As urban sprawl devours local storage, industries in these districts increasingly rely on groundwater extraction and, more recently, desalination and recycled wastewater to sustain growth in a water-scarce environment.

This creates a critical regional divide where the Delta faces surface-water stress due to canal dependency, while the industrial north and west face extreme groundwater depletion.

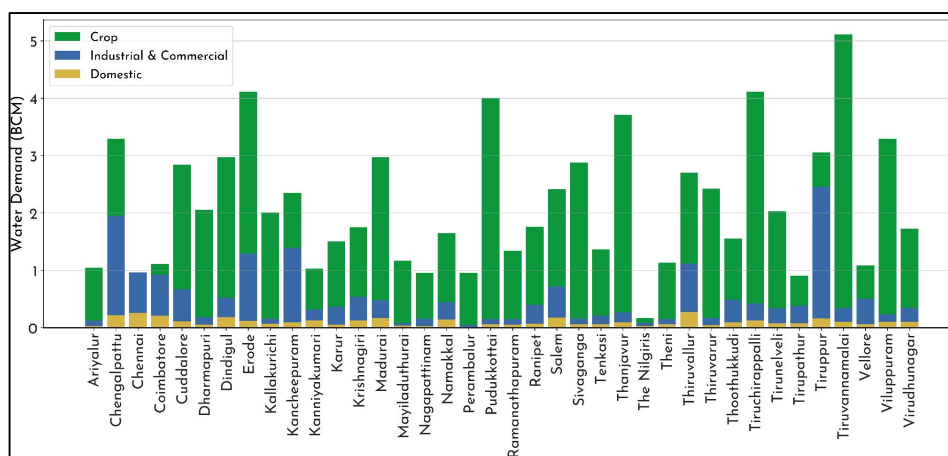


Figure 3.3: District-wise water demand (BCM) in Tamil Nadu. Source: WELL Labs 2026

*An ayacut is the designated command area of agricultural land entitled to receive irrigation water from a specific source, such as a canal, dam, or tank. The term is widely used in South India to refer to the registered command area under a particular irrigation project, whether served by gravity or lift systems.

~60% of the total water requirement is met through groundwater.

The spatial distribution of water supply sources in Tamil Nadu is dictated by a combination of geological features, political geography, and industrial necessity. While government agencies remain largely focused on surface water, a sizeable portion of the State's water needs are met by groundwater, as illustrated in the figure below.

Districts such as Pudukkottai, Viluppuram, and Cuddalore have significantly higher groundwater availability, primarily because they are situated over sedimentary and alluvial aquifers that possess superior recharge and storage capacities compared to the hard-rock terrains found in the western belt. In contrast, districts like Erode, Nagapattinam, and Thanjavur are characterised by higher interstate flow, a direct consequence of their location within the downstream command areas of major river basins. This is seen in the Cauvery Delta, which relies heavily on regulated releases from Karnataka via the Mettur system.

Chennai stands out with a uniquely high non-conventional flow, as seen in its significant reliance on desalination plants and tertiary treated wastewater. This diversification is a vital resilience strategy to insulate the city's massive domestic and industrial sectors from the perennial unreliability of monsoonal rainfall and local surface storage.

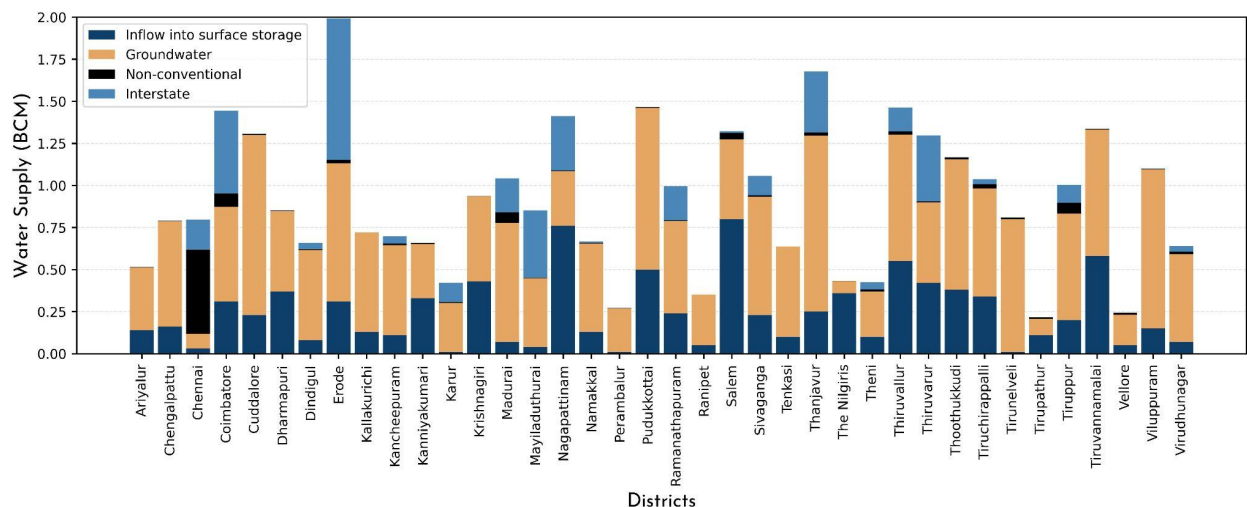


Figure 3.4: District-wise sources of water supply (BCM) in Tamil Nadu. Source: CGWB 2025, WELL Labs 2026

Only three districts (Coimbatore, The Nilgiris and Nagapattinam) seem to have a water surplus.

The Tamil Nadu district-wise demand and supply data reveals a stark contrast between regions maintaining a hydrological surplus and those facing severe water deficits. The State's top-performing districts in terms of water balance are primarily The Nilgiris, Coimbatore, and Nagapattinam. They are among the few categorised as surplus (green) in the deficit-supply plot. In Nagapattinam district, the surplus is the result of significant interstate flows from the Cauvery systems. In The Nilgiris and Coimbatore, it is driven by high forest cover and lower comparative demand peaks.

Conversely, the worst-performing districts facing the most acute water deficits are Tiruvannamalai, Erode, and Tiruchirappalli, where the gap between total supply (blue markers) and demand (red bars) is most extreme. In Tiruvannamalai, the deficit is driven by a massive crop water demand exceeding 4.5 BCM, which far outstrips its available groundwater and surface storage. Similarly, Erode faces high demand from both intensive agriculture and a significant industrial sector, yet lacks the diverse non-conventional supply seen in urban centres like Chennai. These districts represent a perfect storm of high cropping intensity, water-guzzling crops like paddy and sugarcane, and a heavy reliance on a single, over-extracted groundwater resource. This imbalance underscores the urgent need for these regions to adopt Managed Aquifer Recharge (MAR) and crop-diversification strategies to prevent total hydrological exhaustion.

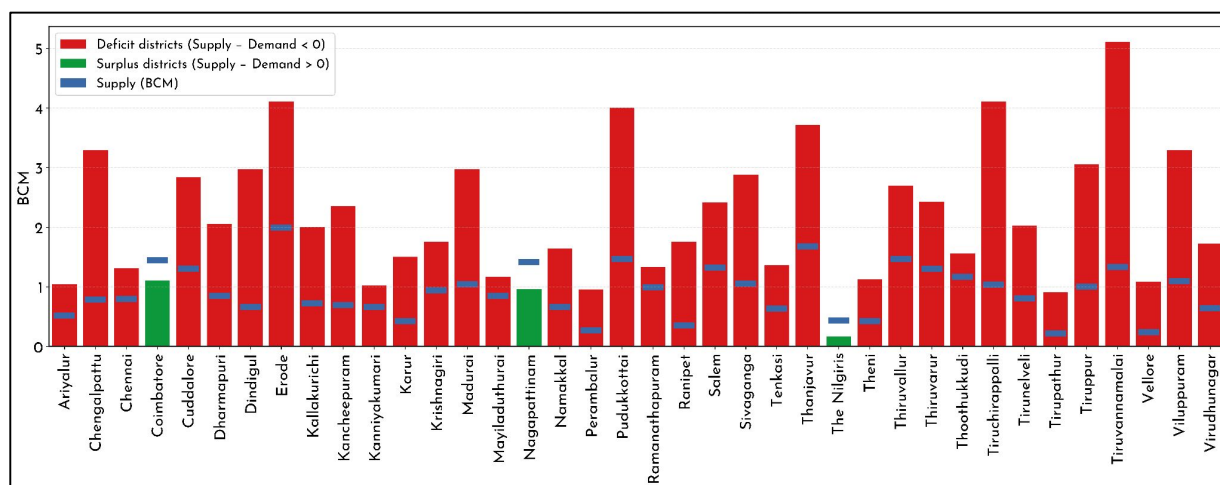


Figure 3.5: District-wise supply-demand deficit in Tamil Nadu (2025). Source: WELL Labs 2026

An important caveat:

These estimates were arrived at by assembling data from diverse sources. In most cases the data were collected using different methodologies for different purposes. We found considerable data inconsistencies. For instance industrial demand reported in district irrigation plans, simply did not match up to the number and types of industries in the Annual Industries survey. Ultimately, therefore this suggests an immediate need for **a serious cross-cutting data triangulation effort**.

Sankey diagrams of water balance

Sankey diagrams provide a powerful visual framework for water accounting by mapping the proportional flow from sources to end-users. However, due to granular data limitations across the state, we are presenting two distinct, for representative urban and agrarian geographies to ensure accuracy. In Kancheepuram, rainfall provides a significant supply of 2.575 BCM but, the surface water storage is alarmingly low at just 0.266 BCM, forcing the district to draw heavily from groundwater resource to meet the massive 1.650 BCM agricultural and 1.302 BCM industrial demands. Crucially, the diagram identifies a massive systemic leak – while domestic and industrial sectors generate substantial discharge, only a negligible 0.075 BCM of treated wastewater is recycled into the storage loop. This leaves nearly 0.9 BCM of untreated wastewater as the largest untapped source of water. Capturing and treating this volume would not only derisk Kancheepuram industrial clusters but also significantly alleviate the current over-extraction of the aquifer.

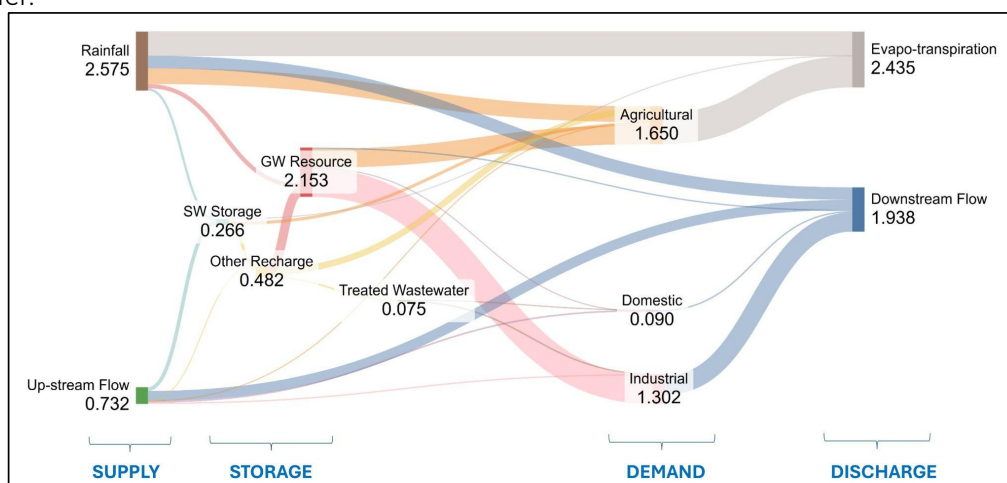


Figure 3.6: Water balance Sankey diagrams for Kancheepuram. Source: WELL Labs 2026

The Sankey diagram for Thiruvarur illustrates a significant hydrological imbalance, where a massive 1.960 BCM is lost as downstream flow rather than being retained for local use. While the district relies on a substantial 2.26 BCM for agricultural demand, the groundwater resource remains critically thin at just 0.532 BCM. To bridge this gap, Thiruvarur can implement Flood Managed Aquifer Recharge (Flood MAR). By scaling these MAR structures including check dams and percolation ponds, Thiruvarur can capture up to 79–92% of localised runoff, effectively converting a seasonal discharge loss into a permanent, drought-resilient water bank.

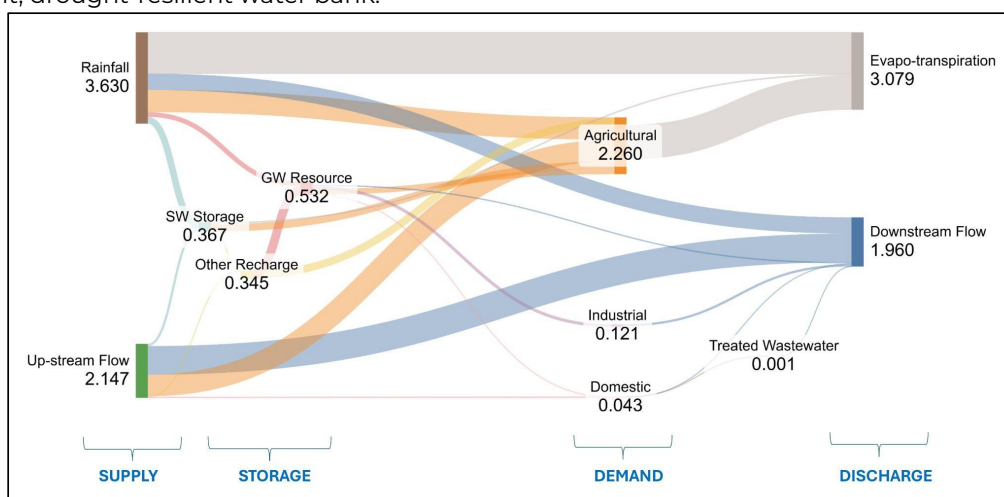


Figure 3.7: Water balance Sankey diagrams for Thiruvarur. Source: WELL Labs 2026

Upstream flow in most of the districts is characterised by inter-state water transfer.

Effective management of interstate water transfers is a cornerstone of Tamil Nadu's hydrological stability, as the State relies on external inflows to meet over half of its total demand in several key districts.

Cauvery River water sharing: The interstate sharing of Cauvery waters, governed by the Cauvery Water Disputes Tribunal and Supreme Court mandates to Tamil Nadu, Karnataka, Kerala, and Puducherry, has transitioned from a volatile political bargaining process into a more stabilised, bureaucratic framework overseen by the Cauvery Water Management Authority. While this authority has mitigated the historic lack of clear drought-year release protocols that previously triggered regional tensions, a significant and overlooked technical challenge remains in the siltation of the Mettur reservoir. Recent Central Water Commission studies indicate that Mettur is approximately 30% silted, yet the Tamil Nadu Water Resources Department (WRD) continues to utilise outdated storage capacity numbers. The data posted at the dam show that the bathymetric curves have not been updated since the dam was commissioned 90 years ago. This leads to a consistent overestimation of available water reserves for the Delta districts. Although the WRD has initiated studies into the technical and economic feasibility of desilting, there is an immediate requirement to correct official reservoir storage data to ensure that statewide water planning and management reflect the actual physical volume of the asset.

Krishna River water sharing: The Telugu Ganga project serves as a vital interstate lifeline for Chennai's drinking water supply. It originates from a 1983 agreement in which Andhra Pradesh committed to providing 12 TMC ft of Krishna River water annually, but its practical efficiency remains severely compromised. Since deliveries commenced in the mid-1990s, Tamil Nadu has received only about one-third of its entitled volume, which is approximately 112 TMC ft out of a due 340 TMC ft, primarily due to heavy transit losses in the hundreds of kilometres of open canals and unauthorised tapping of water en route. This shortfall is further exacerbated by Tamil Nadu's historical lack of adequate reservoir capacity to capture sudden large-scale releases, often resulting in precious freshwater flowing wastefully into the sea.

Transitioning to a pipeline delivery system offers a theoretical solution to eliminate evaporation and theft, but it requires significant interstate cooperation, which may not materialise. Instead, a more immediate opportunity lies in **Flood Managed Aquifer Recharge (Flood MAR)**. Numerical groundwater flow modeling indicates that diverting excess water from the Krishna river to the Araniyar-Kosathalaiyar basin well fields to the north could be transformative, with the potential to raise the groundwater table by 1–6 m by 2030 and push back seawater intrusion by nearly 1 km. This effectively turns transit surpluses into a secure subterranean pumping reserve.

The State has not fully realised the opportunity for Flood MAR with an explicit focus on recharging the peak flows. This requires a distinctly different approach to traditional MAR, which captures the low end of the hydrograph, and a greater coordination between ground and surface water agencies.

CHAPTER 3.

Emerging Challenges (2035 Outlook)

Structural shifts in demography, economy, and climate will render historical planning assumptions obsolete



Photo by WELL Labs

Agricultural water demand will likely stabilise at current levels.

Agricultural water demand in Tamil Nadu is expected to stabilise at current levels, acting as a fixed baseline in the State's hydrological budget. This stabilisation is primarily driven by a long-term structural shift: the net sown area has seen a gradual and consistent decline over the decades, dropping from 60.3 lakh hectares in 1975-76 to 47.6 lakh hectares in 2022-23. While irrigated area and cropping intensity saw an upward trajectory until approximately 2015, these metrics have more or less plateaued over the last decade. Notably, irrigated area has become highly variable between wet and dry years, signaling that the State has likely reached its maximum potential irrigable area under current climatic conditions.

Going forward, any localised intensification of agriculture is likely to be neutralised by the continued decrease in total sown area and incremental gains in water-use efficiency. While ongoing dam rehabilitation efforts and new storage projects may boost irrigated capacity in specific districts, these are viewed as measures to improve reliability rather than drivers of increased aggregate demand. Consequently, while agricultural water demand may vary across districts, historical trends suggest that the State's total agricultural water requirement will remain largely unchanged. This provides a critical opportunity to reallocate future water gains toward the State's growing industrial and urban sectors.

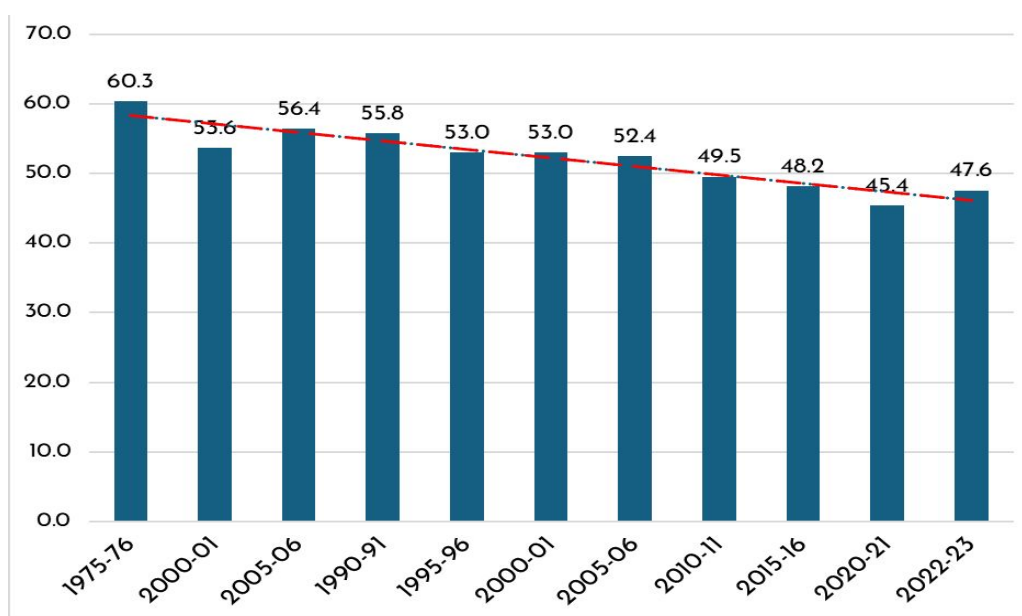


Figure 3.8: Trends in net area sown (lakh hectares). Source: TN Dept. Economics and Statistics (Season and Crop Report) 2024- 25

Tamil Nadu will become a 'mega-urban' state with high water demands.

Tamil Nadu is rapidly evolving into a 'mega-urban' state, with projections indicating that 60% of its population will reside in urban areas by 2030. This demographic shift is fundamentally altering the State's water profile. By 2035, the State's population is expected to grow by 22%, while the demand for water will surge by 33%. This gap highlights the inherently intensive consumption patterns in urban areas.

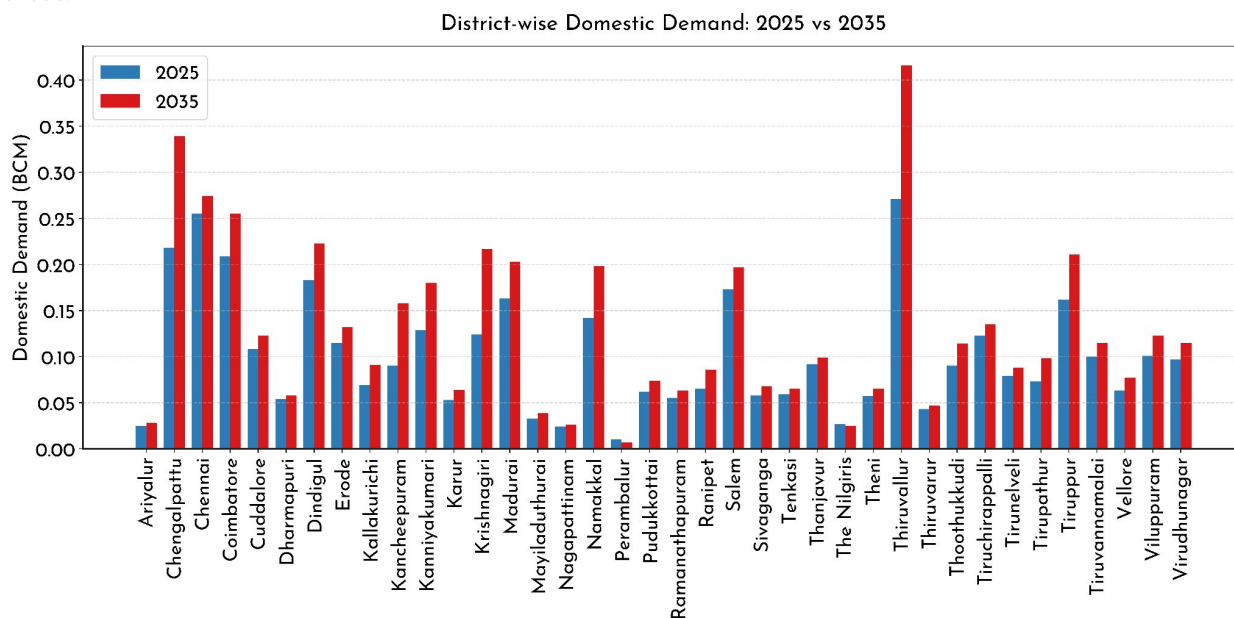


Figure 3.9: District-wise domestic demand (2025 vs 2035). Source: WELL Labs 2026

These figures are likely conservative estimates. Current planning often overlooks the floating population – the millions of daily commuters, seasonal workers, and tourists who utilise urban infrastructure. Tamil Nadu's water planning must move beyond static Census data and account for its massive floating population, which includes roughly 3.5 million migrant workers and over 140 million annual tourists. This demographic surge creates localised water stress peaks that can exceed a city's base capacity easily.

Water utilities should apply a floating multiplier to the water budgets of transit and tourism hubs like Chennai, Madurai, and Mahabalipuram to ensure that the infrastructure (particularly sewage treatment plants) can handle the surge in hydraulic load during peak seasons. For industrial clusters in districts like Tiruppur and Kancheepuram, water permits should mandate accounting for the on-site and off-site domestic needs of the transient workforce, preventing unregulated domestic waste.

Accounting for these users requires a data-bridge between the Department of Tourism, the Labour Department, and the agencies that supply water. By sharing seasonal occupancy data from hotels and migrant registration data from industrial units, the water authorities can preemptively allocate buffer volumes from the State's storage. This ensures that the water security of the local resident population is not compromised by the economic activity of the floating population, a balance essential for social and economic stability in a high-growth state.

Unplanned urbanisation and unchecked pollution will shrink the usable water faster than supply augmentation can expand it.

Unplanned urbanisation encroaches upon traditional tank systems and floodplains, replacing permeable blue infrastructure with concrete surfaces that prevent natural recharge and lead to a permanent loss of local surface water storage. For instance, rapid expansion of the urban footprint in Kancheepuram district has adversely affected its 'blue' infrastructure, with a staggering one-third reduction in surface water bodies. As concrete surfaces replace traditional tank systems and floodplains, the region's natural capacity for water storage and groundwater recharge has been critically compromised. This loss of surface water area not only reduces the local water inventory available for a growing population but also destroys the natural buffers that once protected the district from both seasonal droughts and urban flooding. By prioritising horizontal urban growth over the preservation of these historic water assets, the structural foundation of the region's hydrological resilience is being systematically dismantled.

Unchecked pollution acts as a hidden tax on the economy, shrinking the volume of usable water at a rate that outpaces our ability to expand supply through new infrastructure. Protecting freshwater ecosystems is, therefore, a vital economic priority. Once an aquifer or river is contaminated, the cost to remediate or replace it with alternative sources is staggering. Currently, shallow groundwater and local surface water remain the State's most cost-effective resources, offering the lowest and most predictable pricing for all users. In contrast, 'drought-proof' options like desalinated water, while highly reliable, have a much higher minimum cost because producing them requires large amounts of energy. Tertiary treated water with ultrafiltration promises a lower cost (Rs 20-30/KL) which can be adopted for indirect potable reuse promoting circularity.

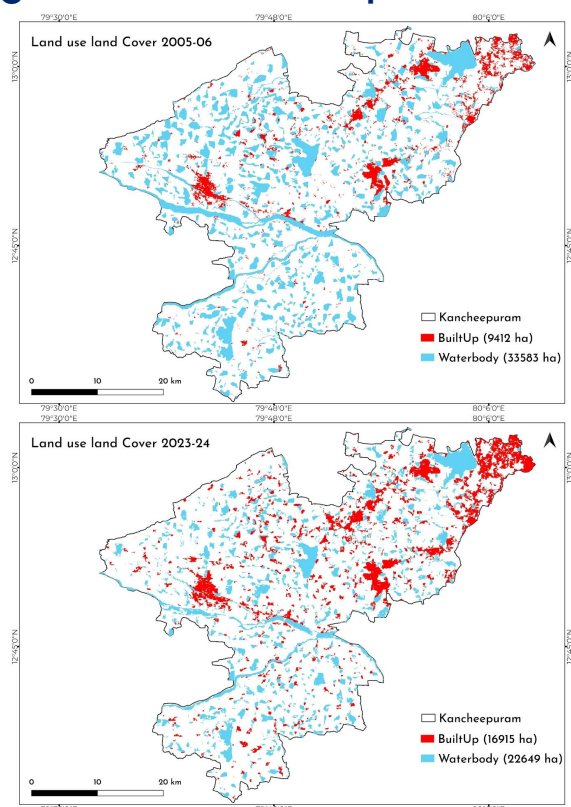


Figure 4.0: Change in the built-up and water spread area of Kancheepuram district. Source: NRSC 2005-06 to 2023-24

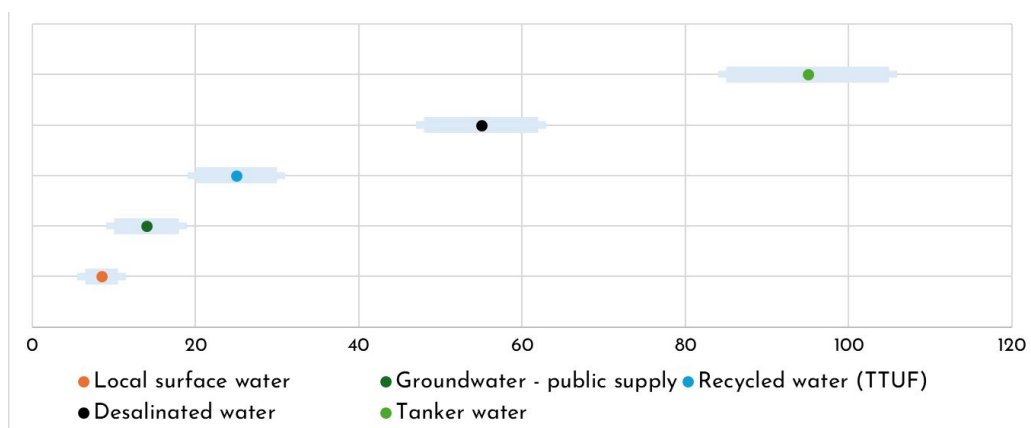


Figure 4.1: Cost (Rs/kL) distribution across diverse water supply schemes. Source: WELL Labs 2026

About 20% of total wastewater generated is treated and only 13% of that is reused.

Tamil Nadu's circular water economy is currently in its infancy, with only ~20% of total generated wastewater being treated and a mere 13% of that treated volume being reused. Chennai leads the way by recycling nearly 20% of its sewage through four tertiary treatment plants that supply around 500 industries in the Manali and Sriperumbudur industrial hubs. In addition, approximately 286 apartment-level decentralised STPs support non-potable reuse, although the statewide potential for recycling remains substantial. By scaling tertiary treatment of wastewater across other urban centres, sewage can be transformed from a liability to a reliable, drought-proof water source for industrial corridors. This transition not only secures manufacturing output during dry spells but also unlocks a treasure trove of nutrients. By integrating nitrogen, phosphorus, and potassium (NPK) recovery into treatment processes, the State can provide reclaimed water that reduces farmer dependency on expensive synthetic fertilisers

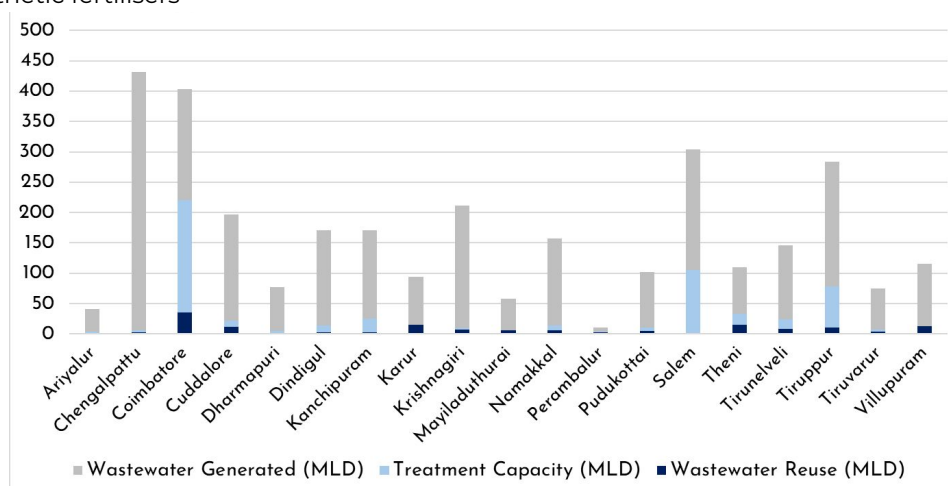


Figure 4.2: Wastewater generated and reuse (MLD) for different districts in Tamil Nadu. Note the untapped wastewater potential. Source: TNPCCB 2025

In areas where centralised sewer networks are missing, there is significant potential for in-situ and decentralised remediation of greywater. Capturing and treating water at the community level (at the source of generation) presents a high-impact opportunity to meet some portion of local non-potable demands, such as toilet flushing, landscaping, and per-urban agriculture. This decentralised approach reduces the burden on municipal infrastructure and lowers the energy costs associated with pumping water over long distances. By viewing every litre of greywater as a local asset rather than a disposal problem, the State can bridge the gap in urban water balance and build localised climate resilience.

Rural wastewater management also represents an untapped frontier for water augmentation, shifting the perspective from waste disposal to resource recovery. In the absence of massive centralised infrastructure, rural areas can leverage nature-based solutions such as constructed wetlands and phytoid systems* to treat domestic greywater and blackwater for local use. This treated water provides a consistent, weather-independent supply for community kitchen gardens, livestock, and groundwater recharge pits, effectively reducing the pressure on over-exploited village aquifers. By transforming waste into a localised agricultural and ecological assets, rural communities can build a circular economy that improves sanitation while creating a vital buffer against seasonal water shortages.

*A phytoid system is a nature-based wastewater treatment technology that uses plants, gravel, microbes, and natural filtration processes to clean sewage.

The economic shift from textiles to technology is transforming water demand from high volume consumption to the need for ultra high purity supply.

The State's economic pivot from traditional textiles to high-tech manufacturing and electronics represents a fundamental shift in its hydrological requirements. With an ambitious industrial Compound Annual Growth Rate (CAGR) of 18.6% needed to propel the economy from its current standing toward the \$1 trillion goal, the nature of water demand is evolving from high-volume bulk usage to a requirement for ultra-high purity water. Emerging electronics and IT corridors demand water that meets stringent technical specifications, as even microscopic impurities can disrupt advanced manufacturing processes. Consequently, future water security is no longer defined solely by quantity. The existing supply infrastructure, designed for conventional use, is currently unable to provide the ultra-pure water essential for these high-value sectors, making specialised treatment and dedicated quality-focused supply chains a critical economic necessity.

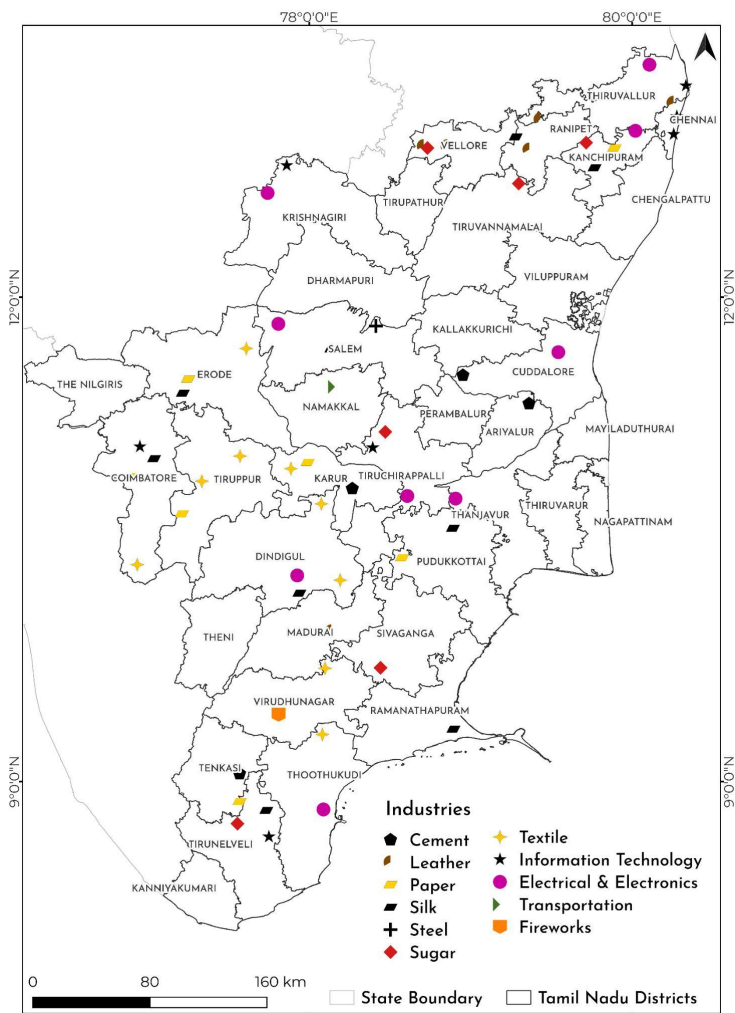


Figure 4.3: Spatial variation of different industries in Tamil Nadu. Source: WELL Labs 2026

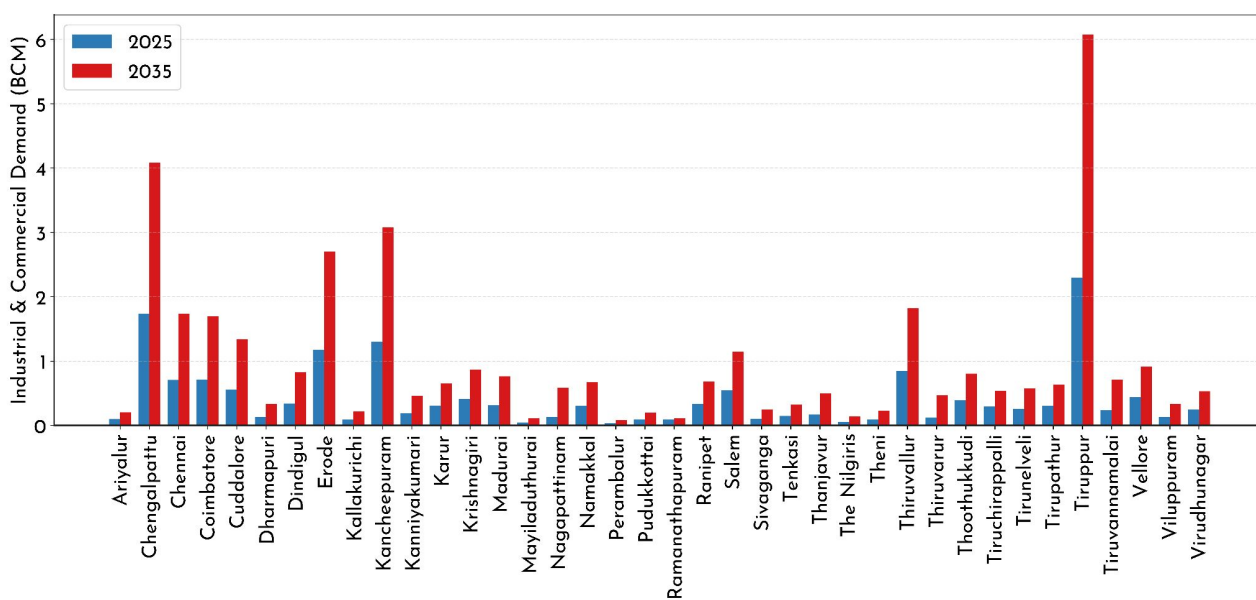


Figure 4.4: District-wise industrial and commercial demand (2025 vs 2035). Source: WELL Labs 2026

By 2035, the escalating industrial and urban water demands are projected to push the State to a groundwater tipping point.

With the sole exception of The Nilgiris, every district in Tamil Nadu faces a severe structural deficit where extraction rates far outpace natural recharge. This widening gap risks pushing the system from dynamic depletion, where aquifers can still recover during monsoon recharge, into static depletion, effectively mining fossil water that cannot be replenished within a human timescale. Without a radical shift toward circularity and Managed Aquifer Recharge, this tipping point risks collapsing the very subsurface reserves that currently act as the State's only insurance policy against climate volatility.

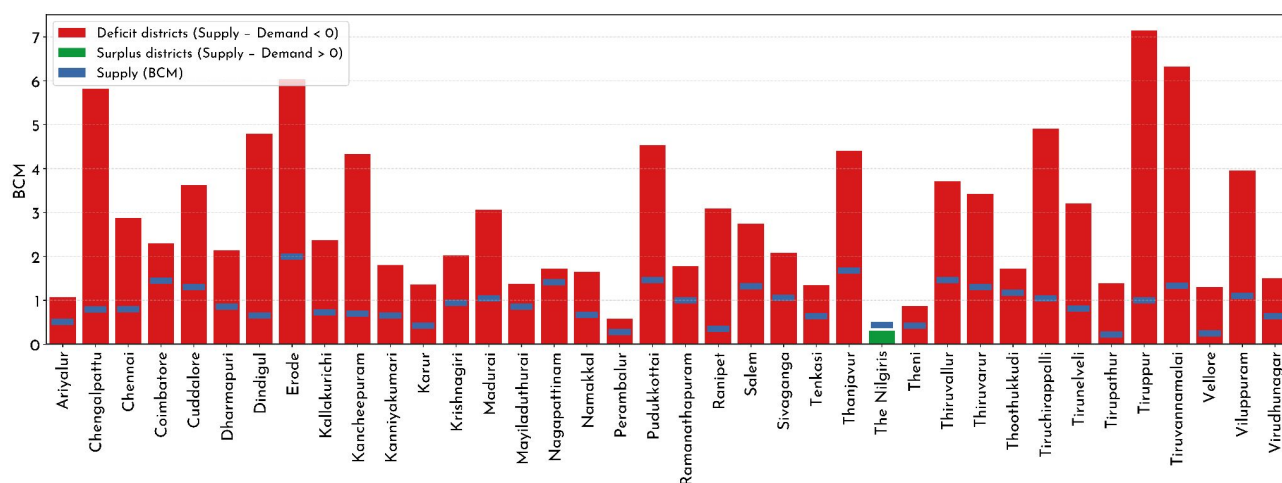


Figure 4.5: District-wise supply-demand deficit in Tamil Nadu (2035). Source: WELL Labs 2026

As water utilisation approaches 100% of available supply, the State's inherent resilience to climate shocks is rapidly eroding. The mapped rabi resilience data highlights a stark divide: while the Delta regions maintain higher resilience due to substantial groundwater reserves, the hard rock areas that depend on limited subsurface buffers experience a catastrophic reduction in cropping during drought years. These regions lack the hydrological insurance necessary to withstand extended dry periods, leading to a direct correlation between low groundwater availability and a collapse in agricultural output.

The 2016 drought remains a benchmark for this vulnerability, with communities vividly recounting severe crop losses and acute domestic water shortages. This collective memory underscores the urgent need to shift from seasonal planning to a long-term strategy that builds storage capacities capable of weathering consecutive bad years. Under the intensifying cycles of climate change, these multi-year buffers are no longer a luxury but a fundamental requirement for the State's socio-economic survival.

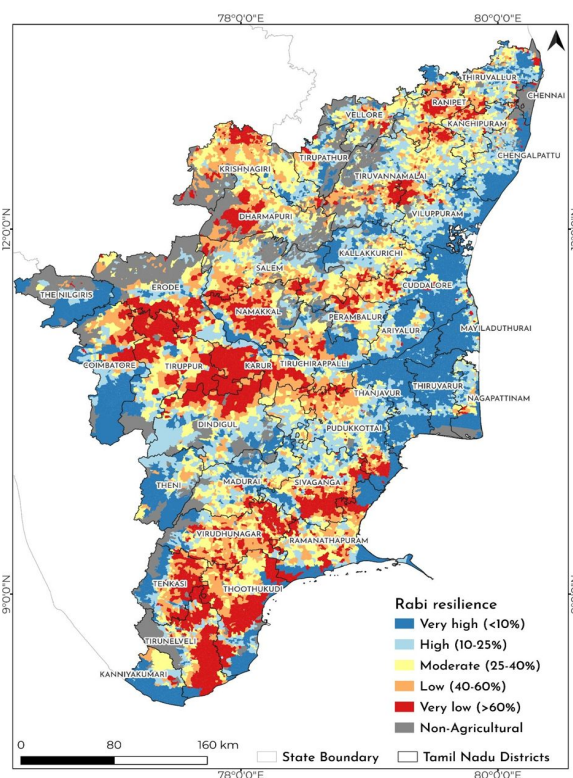


Figure 3.1: Spatial distribution of cropping resilience during rabi season 2005-06 to 2023-24. Source: WELL Labs 2026

11 districts are at 'High' to 'Very High' climate risk.

Based on the climate vulnerability mapping by the Council on Energy, Environment and Water (CEEW), eleven districts in Tamil Nadu are currently classified as facing 'High' or 'Very High' climate risk. This vulnerability is not determined by weather events alone but by the complex interplay of **exposure**, **sensitivity**, and **adaptive capacity**. Exposure reflects the frequency and intensity of specific hazards. For instance, interior districts like Dharmapuri and Krishnagiri face high drought exposure, whereas coastal belt is increasingly vulnerable to cyclones. Sensitivity determines the degree of impact, varying significantly between high forest cover areas like The Nilgiris, densely packed urban hubs like Chennai, and agricultural plains. Adaptive capacity serves as the State's shield against these risks. This capacity is built on socioeconomic foundations such as per capita income, literacy rates, and the density of healthcare and infrastructure.

Consequently, districts like The Nilgiris, Kanyakumari, Coimbatore, Dindigul, and Theni rank lower on the overall vulnerability scale despite facing significant climate events. Their robust adaptive capacity allows them to recover from shocks much more effectively than the highly sensitive agricultural belts in the eastern plains, which lack the same socioeconomic buffers.

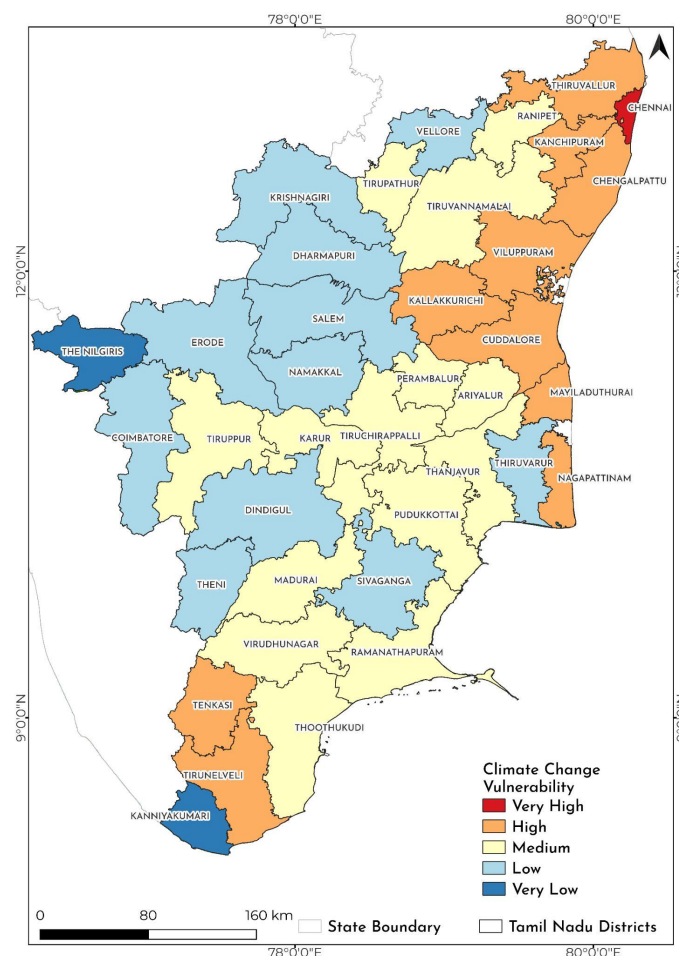


Figure 4.6: A district-level assessment of climate vulnerability. Source: 2021 Council on Energy, Environment and Water (CEEW)

A warmer world means more floods and droughts, and it needs more buffers for communities to be resilient.

Climate change is fundamentally altering the hydrological cycle. A warmer atmosphere holds more moisture, creating a dangerous paradox of prolonged dry spells interspersed with increasingly intense rainfall events. Historical analysis of rainfall in Tamil Nadu between 1951 and 2016 confirms these trends (Rajanpillai et al.). The data shows statistically significant increases in both the frequency and geographic spread of intense rainfall events. It also finds a rise in the area affected by drought and in the maximum severity of droughts, with these trends significant at the 90% confidence level. While modeling uncertainties remain, projections suggest that total northeast monsoon rainfall is likely to increase, driven by warmer sea surface temperatures. This modern shift mirrors the Medieval Warm Period (950 CE to 1250 CE), where a substantial increase in the northeast monsoon coincided with the Chola Empire's dominance and its development of sophisticated water infrastructure. While the most drastic impacts may manifest later in the century, the infrastructure designed between now and 2035 must be engineered for a 50-year lifespan and managed through dynamic, adaptive systems to ensure community resilience against these escalating extremes.

The future of Tamil Nadu's water security will be defined by a shift from predictable seasonal cycles to a high-volatility regime marked by more violent downpours and deeper droughts. While the total annual volume from the southwest and northeast monsoons remains difficult to project, scientific consensus confirms that a warming atmosphere will trigger a 'wet-gets-wetter' effect. This translates to higher rainfall intensity but greater 'noise' in seasonal reliability. The State is transitioning to a punctuated monsoon pattern, where steady, soaking rains are replaced by erratic swings between extreme floods and extended dry spells, making the timing of water arrival far more unpredictable than the total volume.

Extreme variability poses a systemic risk to the State's stakeholders, shifting the crisis from a simple lack of water to unreliable supply. This volatility increases the risk of 'Day Zero' scenarios in urban centres like Chennai, where reservoirs may run dry during droughts only to be overwhelmed by catastrophic flash floods. For Cauvery Delta farmers, traditional planting calendars for kuruvai and samba* crops are becoming obsolete as rain onsets no longer guarantee sustained moisture. Without a predefined distress-sharing formula by the Cauvery Water Management Authority (CWMA), these climatic swings will inevitably trigger recurrent socio-political conflicts over dwindling resources during deficit years.

Mitigating these impacts requires a radical transition toward resilience-first infrastructure and automated, data-driven water governance. Existing systems must be retrofitted to handle high-intensity bursts through decentralised harvesting and river restoration to capture flash runoff before it reaches the sea. To survive extended droughts, the State must prioritise groundwater recharge and maintain significant 'dead storage' buffers in major reservoirs. Crucially, the CWMA must adopt a mathematical distress-sharing formula that replaces manual political negotiations with a climate-responsive system, securing Tamil Nadu's water future against drought.

*Kuruvai and samba are regional paddy seasons in Tamil Nadu that roughly align with the kharif cycle but are adapted to the State's irrigation systems and the northeast monsoon.

CHAPTER 4.

Solutions: Best Practices, Policy Levers and Integrated Governance

Tamil Nadu's path to 2035 requires a shift from 'crisis management' to 'asset management'



Proposed Solutions Roadmap: Focusing on Key Levers to Improve Six Core Outcomes

To secure Tamil Nadu's hydrological and economic future, the proposed solutions roadmap focuses on mobilising specific policy and technical levers to achieve six interconnected outcomes. To ensure safe **water access**, the State must implement comprehensive water safety plans combined with technology-led loss reduction and source sustainability. Achieving a stable **water balance** will require a transition toward water circularity and the strategic capping of extraction rates. **Climate resilience** will be bolstered by expanding storage capacities both above and below ground, while **water productivity** in the agricultural sector can be enhanced through the integration of technology, modern markets, and optimised electricity use. Finally, the roadmap emphasises **water governance** through data-driven inter-departmental coordination, alongside a commitment to **water & ecosystem health** achieved via circular water economies and nature-based solutions.

Desired Outcomes	Proposed Lever	Description/Examples/Best Practices
Safe Water Access	• Water Safety Plans • Technology-led loss reduction • Source sustainability	• Last-mile infrastructure and reliable service delivery within ULBs, panchayats and TWAD • AI-based leakage detection • Institutional implementation of water safety plans • Giving higher priority to drinking water for source sustainability
Water Balance	• Water circularity • Capping water extraction	• Scaling the reuse of treated wastewater to meet urban and industrial demand • Reducing pollution • Easing competition for freshwater • Focus on all three aspects: Increase STP capacity, pipe infrastructure, institutional reuse of treated wastewater
Climate resilience	Water storage, both above and below ground	• Subsurface storage through Managed Aquifer Recharge (MAR) • Scientific desilting of water bodies • Tank filling schemes connected to larger reservoirs to augment capacity
Water Productivity	Agriculture water productivity by tech, markets, electricity	• Shifting toward high-value, micro-irrigation-based horticulture to reduce total consumption while increasing farmer income • Incentivisation through innovative finance
Water Governance	Water data-led inter-departmental coordination	Establishing easy access to consistent, cross-agency data layers to ensure coordinated and informed decision-making.
Water & Ecosystem Health	• Water circularity • Nature-based solutions	• Treatment of anthropogenic contaminants • Restoring natural watersheds, riparian buffers, and wetlands to enhance the State's biological capacity to filter and retain water

Key levers of the roadmap for the six outcomes.

OUTCOME: Safe Water Access



Problem:

There are repeated instances of cross-contamination of supplied water with nearby wastewater

Lever:

Focus on water safety to ensure safe access

While piped infrastructure coverage is statistically high, estimated at 88.37% in rural areas and 98% in urban centres, the actual availability of reliable, safe, and affordable water remains a critical challenge.

In urban centres like Chennai and Madurai, intermittent supply creates a vacuum or negative pressure in the distribution network once the supply stops. This vacuum effectively sucks in sewage and contaminants from surrounding soil through cracks in aging pipes, re-contaminating treated water before it reaches the consumer.

Further, the prevailing **intermittent supply model**, where water flows for only 1–2 hours every few days, inherently **favours affluent households** with large storage sumps and high-powered pumps, leaving tail-end users in slums and peripheral areas with almost zero pressure. This performance gap is **exacerbated by non-revenue water (NRW) losses** of ~20%, where treated water is lost to leaks and illegal tapping before it even reaches the consumer. This forced scarcity creates a lucrative but unregulated private tanker market, where the poor often pay five times the public rate for lower-quality water. Tamil Nadu should **transition to 24/7 pressurised supply**, as benchmarked by the Drink From Tap Mission in Puri, Odisha and global standards in Singapore. This must be paired with **advanced metering infrastructure (AMI)** to track every litre in real-time, allowing utilities **to pinpoint leaks and ensure that tail-end pressure** is maintained across all socioeconomic strata. This should be paired with smart quality surveillance benchmarked against Israel, where manual random sampling is replaced by **real-time IoT sensors that monitor residual chlorine and turbidity**. These sensors trigger instant alerts for contamination events, allowing utilities to isolate specific pipe sections immediately rather than issuing boil water advisories.

To secure the long-term integrity of the State's drinking water, Tamil Nadu must **mandate Water Safety Planning (WSP) as a statutory risk-management strategy**. Unlike traditional 'end-of-pipe' testing, WSP utilises a comprehensive 'catchment-to-consumer' approach, ensuring safety through continuous monitoring and the proactive prevention of contamination at every stage, from the source and treatment plant to the distribution network and the final household tap. By legally codifying safety protocols and building capacity within ULBs, the State can shift from reactive crisis management to systemic preventative management.

To move beyond fragmented water management, Tamil Nadu must **replace ad-hoc inter-agency communication with statutory standard operating procedures (SOPs)** that mandate synchronised action across key entities, including the TNPCB, TWAD Board, CMWSSB, and local municipalities. Such a governance framework would ensure that a breach in water quality standards reported by any single department automatically triggers a mandatory, time-bound joint investigation involving all relevant stakeholders. By codifying these response protocols, the state can eliminate bureaucratic delays and ensure that industrial or domestic contamination events are addressed in a timely manner.

OUTCOME: Safe Water Access



Problem:

Some last-mile users still have inadequate water in summers

Lever:

Focus on source sustainability and diversification

The State's distribution network suffers from severe physical and operational bottlenecks that lead to inequitable water sharing, including high non-revenue water losses, persistent tail-end supply deficits, and systemic contamination risks. When the water table drops in such area during dry spells, both the private borewells and the public piped supply, which often draw from the same source, fail simultaneously. This **dependency is particularly acute in rain-shadow and inland districts where surface water buffers are minimal**, leaving the most vulnerable populations without any hydrological safety net.

Future water security hinges on shifting the focus toward **source sustainability**, ensuring that every supply point is managed for long-term viability rather than immediate extraction. This requires a rigorous emphasis on the resilience of primary sources alongside the strategic development of secondary and tertiary buffers that can be activated during extreme drought events. By **diversifying the water portfolio to include a mix of surface storage, managed groundwater recharge, and decentralised local assets**, the State can avoid over-reliance on any single, vulnerable system.

Given the dearth of traditional sources of drinking water, there is also a need to diversify sources. Harnessing **water stored in abandoned quarry pits offers a high-potential alternative for augmenting drinking water supplies**, effectively transforming these excavations into 'pit lakes' that capture significant volumes of rainfall and groundwater inflow. To transition this from an incidental accumulation to a reliable resource, a rigorous hydrogeological investigation is mandatory to assess storage capacity, seasonal recharge rates, and connectivity with local aquifers to ensure both physical and qualitative sustainability. In the Indian context, water quality must be strictly analysed against BIS IS 10500 standards for physicochemical and microbiological parameters; any deviations necessitate a treatment spectrum ranging from conventional sedimentation to advanced membrane filtration.

Given the geographic variability of these sites, modular or mobile treatment units provide a flexible, cost-effective solution for on-site processing without the need for permanent, fixed infrastructure. Successful precedents, such as the utilisation of treated mine water from Neyveli lignite operations for domestic and irrigation use, prove that with proper regulatory oversight and treatment, these industrial by-products can be integrated into the municipal water network to alleviate seasonal deficits.

OUTCOME: Safe Water Access



Problem:

Water availability issues coupled with water pollution reduces the net freshwater availability

Lever:

Focus on alternative water sources like used water

Treated wastewater provides a climate-resilient and dependable alternative for water resource augmentation, offering a constant supply that remains independent of volatile rainfall patterns. The application of this resource is governed by the 'fit-for-purpose' principle, where treatment levels are dictated by the intended end-use. For instance, indirect potable reuse (IPR) and the recharge of deep, confined aquifers require advanced multi-barrier treatment trains including ultrafiltration (UF), reverse osmosis (RO), and advanced oxidation processes (AOP) to prevent irreversible aquifer contamination. Conversely, for non-potable applications like construction industry curing or dust suppression, secondary treatment followed by disinfection is typically sufficient, while industrial cooling and boiler processes often necessitate tertiary treatment, with RO to prevent scaling and corrosion.

Chennai has pioneered the integration of treated wastewater into its water grid, utilizing a "fit-for-purpose" model where tertiary-treated water is supplied to industrial clusters in Manali and Sriperumbudur to preserve freshwater for domestic use. International precedents, such as the Orange County Groundwater Replenishment System in the USA and reuse strategies in Windhoek, Namibia, demonstrate that integrating treated municipal wastewater into surface reservoirs or aquifers not only enhances perennial water availability but also secures 'pumping reserves' for high-growth sectors.

Operating as a near-zero discharge campus since 2017, **IIT Madras treats 4 MLD of wastewater through a sophisticated SBR and ultrafiltration-ozonation system to potable standards**, utilizing a dual-piping system for flushing, cooling, and horticulture. The centerpiece of this circular economy is a rejuvenated campus lake augmented by both treated effluent via a "reverse lake bank filtration" process and harvested monsoon runoff, creating a resilient buffer that sustained the campus during Chennai's 2019 drought. This decentralized model has not only reduced external water procurement costs by up to ₹3 crores annually but has also served as the blueprint for CMWSSB's successful 10 MLD tertiary treatment pilots, paving the way for expanded indirect potable reuse across the city.

Another example is Devanahalli, a small town about 40 km to the north of Bengaluru, which exploded into an industrial hub after the international airport. **Through an indirect potable water reuse project, the town now gets 0.64 MLD of potable drinking water per day**, adhering to BIS-10500 drinking water standards. The town, with about 45,000 residents, heavily relied on deep borewells for its water needs. The project was done in collaboration with Boson Whitewater, a water utility company that converts STP-treated water into potable water, and Biome Environmental Trust. Treated water from a sewage treatment plant (STP) is pumped into Bagalur Lake, mixed with rainwater, and further directed to Devanahalli's Sihineeru Lake. The water is filtered through the earth (Managed Aquifer Recharge) and later extracted via borewells for a final, ultrafiltration treatment before supplying it to the town.

OUTCOME: Water Balance



Problem:

As a rapidly urbanising and industrialising state, degrading water quality may fast erode the availability of the freshwater

Lever:

Create incentives for water circularity as it is an effective mechanism to reduce demand and not deplete clean freshwater

The **lack of comprehensive sewerage coverage in peri-urban zones leads to the silent seepage of septage into shallow aquifers**, further compromising local water security. To address the rising sanitation challenge, the State must establish a clear roadmap for providing adequate sewage treatment plant (STP) capacity across all Tier 2 and Tier 3 cities. Currently, a significant bottleneck in effective waste management is the persistent lack of underground drainage (UGD) networks and low rates of household connectivity. To overcome this, the State should prioritise the incentivisation of household connections alongside the physical rollout of sewer lines. Without this last-mile integration, even the most advanced treatment facilities will remain underutilised, allowing domestic sewage to continue polluting local water bodies.

Tamil Nadu must rigorously **enforce the septage management protocol by mandating GPS tracking for all private ‘honeysucker’ (sewage vacuum) trucks**. This policy lever prevents the rampant illegal dumping of raw septage into lakes and stormwater drains, ensuring that waste is transported only to designated treatment facilities. In rural areas, in-situ facilities like twin-pit latrines often fail due to design failure, high water tables or rocky terrain, leading to direct fecal contamination of shallow aquifers. In urban and peri-urban hubs, the lack of integrated land use planning for sewage treatment plants (STPs) and dump sites often located in ecologically sensitive lowlands results in legacy pollution where leachate and untreated overflow permanently contaminate water bodies intended for urban supply.

The State must **transition to a circular sanitation model, where treated greywater and blackwater are actively repurposed to reclaim usable water**. For new urban developments, the implementation of dual-pipeline systems – one for potable water and another for treated recycled water – can reduce freshwater demand for flushing and landscaping by up to 40%. In rural settings, benchmarking against decentralised wastewater treatment (DEWATS) allows communities to treat greywater through nature-based filters and use it for targeted groundwater recharge or kitchen gardens, preventing the pooling of stagnant water and the subsequent leaching of nitrates into the water table.

This policy should be anchored by a dedicated sanitation O&M fund, sourced from a percentage of property taxes or water cess, to end the build-neglect-rebuild cycle. By legally linking land use approvals to the availability of sewage infrastructure and ensuring that **every STP has a 10-year ring-fenced O&M budget**, the State can ensure that the sanitation value chain remains functional. When ULBs are cash strapped, the State must consider **tendering for resource recovery plants instead of STPs**. This will enable new business models that allow operators to diversify revenue streams to finance operations and maintenance, including the sale of treated wastewater, on site horticulture within STP premises, bulk water sales, and carbon credits.

Best Practice: Indirect Potable Reuse

One approach to circularity is indirect potable reuse. An excellent example is the Nesapakkam tertiary treatment ultrafiltration plant (TTUF) set up by the Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB). Chennai's Nesapakkam plant converts raw sewage to potable drinking water.

The TTUF is designed to handle 10 million litres of sewage daily and was set up using a capital of ₹28 crore on a site area of 6,500 sq m. Raw sewage treated up to the secondary stage is first put through a Sequence Batch Reactor (SBR) process, where the water is treated through biological processes and filtration to remove the majority of physical and bacterial loads. Next, it undergoes tertiary treatment, such as ultrafiltration, to remove the finer physical and chemical contaminants, and ozonation to disinfect the water. Finally, the treated wastewater is passed through an activated carbon filter before it is sent to Porur Lake, the primary source of drinking water for about one lakh residents, through a surface pipeline network.

The operation and maintenance cost to treat one kilolitre of sewage at the TTUF works out to ₹18, while residents currently pay an average of ₹80 per kilolitre to buy water supplied by tankers, which goes up to ₹150 per kilolitre in the summer. Switching to tertiary treated wastewater would be an economic alternative to freshwater in water scarce regions.

A key feature of this project is the effort at open communication and awareness among stakeholders which ensured sustained success. Regular meetings between the area's residents and CMWSSB ensured that all concerns and possible risks associated with reusing treated wastewater were discussed and addressed upfront. People were reassured further by the usage of fish ponds within the treatment plant as a quality control check before the water was released into the lake as fish are extremely sensitive to any chemicals or effluents present in the water.

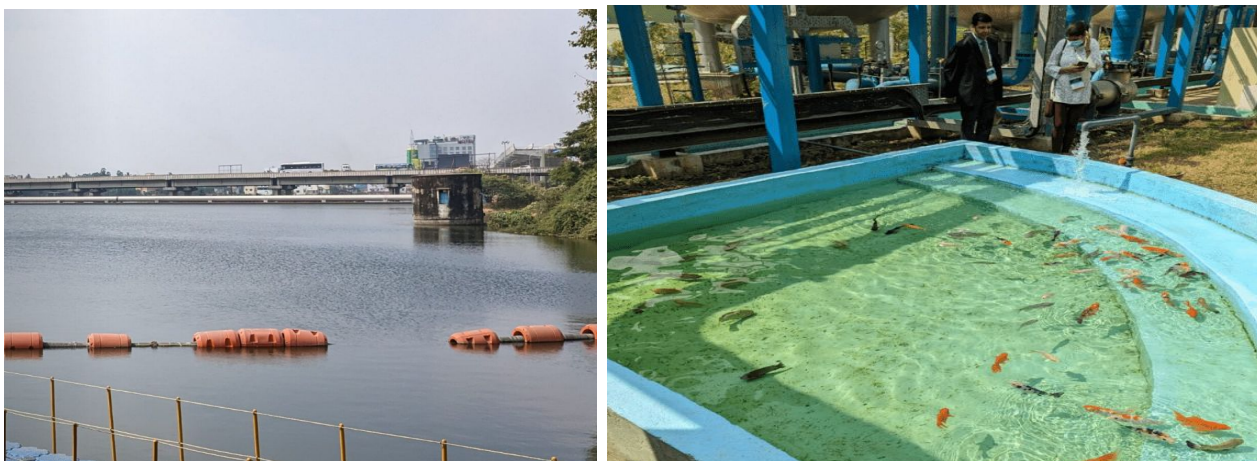


Figure 4.7 (left): Treated wastewater in Porur Lake. Figure 4.6 (right): A fish pond to check water quality.
Photo credit: Shashank Palur

OUTCOME: Water Balance



Problem:

The lack of systematic monitoring of industrial water consumption remains a critical structural barrier to effective water management in Tamil Nadu

Lever:

Mandatory industrial water audit and public data disclosure

To secure Tamil Nadu's path toward a \$1 trillion economy, industries must transition from a supply-side mindset to a water-efficiency paradigm. Currently, many units in major industrial clusters like Tirupur (textiles) and Ranipet (leather) view water as a low-cost input, often neglecting the systemic inefficiencies that lead to massive invisible losses. A **mandatory industrial water audit** is the essential first step to change this. These audits go beyond simple consumption metrics; they map every litre of water throughout the plant, identifying leakage points in cooling towers, boiler feed systems, and process lines that current basic metering misses. By exposing these inefficiencies, an audit can transform water from an overlooked utility into a manageable economic asset.

To ensure these audits translate into long-term behavioural change, the State must implement a real-time monitoring framework. This means moving away from manual logging and toward IoT-enabled smart flow meters installed at every major point of use. When factory managers can visualise their real-time water data on a centralised dashboard, they can instantly identify operational anomalies and benchmark their performance against industry-specific Gross Value Added per cubic metre standards. To further curtail excessive use, Tamil Nadu should introduce a **water tariff tier system where industries exceeding their sustainable allocation pay a premium**. Ultimately, the State should standardise the disclosure of water balances for large scale industrial units, using Sankey diagrams to transparently map inflows, consumption, reuse, and discharge.

While current Zero Liquid Discharge (ZLD) mandates in Tamil Nadu have successfully targeted high-volume industrial process water, the **management of domestic wastewater within industrial premises remains a critical regulatory blind spot**. In most industrial clusters, domestic sewage generated from canteens, washrooms, and staff quarters is often treated in isolation through basic septic tanks that are not held to the same rigorous recycle-reuse standards as the process water systems. This fragmentation leads to a significant loss of greywater that could otherwise be recovered. To bridge this gap, State should mandate industries to co-treat domestic sewage with process effluents.

To secure the State's trajectory towards a \$1 trillion economy, the proposed industrial water audit must be complemented by **a policy of public data disclosure and strengthened through a robust inter-departmental coordination framework**. Making audited water data public through an annual water footprint report for each industrial unit would drive corporate accountability, allowing investors and local communities to benchmark a facility's efficiency against global best practices. This transparency should be facilitated by a unified digital water portal, where real-time data from IoT-enabled smart meters is shared across the industries department, the TNPCB, and the WRD. Such coordination ensures that industrial expansion permits are granted based on actual hydrological carrying capacity rather than theoretical quotas, enabling the State to proactively manage local water stress while incentivising the reuse of treated domestic wastewater within industrial processes.

OUTCOME: Climate Resilience



Problem:

As climate becomes, more variable, increasing storage becomes urgent

Lever (Supply side):

Future water security will not come from better management of existing assets and decentralised surface storage

The future of Tamil Nadu's water security lies not in the pursuit of massive new storage projects that are increasingly hindered by high maintenance costs, ecological disruption, and a 25–40% loss in capacity due to siltation, but in the sophisticated management of existing assets. A prime example is the Mettur Dam system, where the focus must shift to data-driven water release protocols. By integrating real-time inflow forecasting with downstream demand modeling, the State can optimise 'just-in-time' releases, minimising the risk of both spillway wastage and tail-end scarcity. Simultaneously, the State must accelerate the retrofitting and rehabilitation of aging structures through programmes like Dam Rehabilitation and Improvement Project (DRIP). This includes deploying advanced geo-membranes to minimise seepage and structural reinforcements to ensure that 100-year-old masonry can withstand high-intensity cloudburst events triggered by climate change.

Complementing this large-scale optimisation is a shift toward decentralised blue-green* infrastructure. While individual check dams, barrages, and farm ponds may seem small, their aggregate impact on local water stress is immediate and transformative. In the Upper Vaigai basin, for instance, check dams have been shown to increase local groundwater recharge rates by up to 47%, effectively turning ephemeral rivers into year-round base flow contributors. Furthermore, creation of large underground reservoirs beneath urban public spaces can capture monsoon runoff, effectively mitigating floods while securing vital pumping reserves for lean periods.

Best Practice: Distributed Surface Storage

To address the burgeoning water needs of Chennai's southern IT corridor and peri-urban settlements, the Tamil Nadu government has launched the **Mamallan Reservoir project** (also known as the Kovalam sub-basin reservoir). Located between Kelambakkam and Mahabalipuram, this ₹471-crore project is designed as Chennai's sixth major reservoir, spanning over 4,300 acres of coastal wetlands and salt pans. By tapping into the surplus flows of 69 upstream irrigation tanks that would otherwise drain into the sea, the reservoir aims to store 1.655 TMC (thousand million cubic feet) of freshwater, potentially supplying 170 MLD (million litres per day) to the fast-growing Old Mahabalipuram Road (OMR) and East Coast Road (ECR) regions. While the project is a vital effort in surface water augmentation, it represents a massive shift in local land use, converting dynamic coastal marshes into a permanent freshwater lake.

*Blue-green infrastructure is a strategic, nature-based planning approach that integrates aquatic (blue) and vegetation (green) systems into urban design to manage water sustainably, reduce heat, and enhance ecological and social resilience.

OUTCOME: Climate Resilience



Problem:

The groundwater crisis in Tamil Nadu is characterised by a 'low-storage, high-extraction' trap

Lever (Supply side):

Construct injection wells in the right places to replenish deeper aquifers, especially in coastal zones to protect groundwater

Over 73% of Tamil Nadu is underlain by crystalline hardrock formations where water is stored only in shallow fractures and weathered zones rather than deep, porous aquifers. These formations have a low 'specific yield', meaning the State lacks a deep hydrological buffer. Even moderate pumping in districts like Dharmapuri and Krishnagiri leads to rapid water table decline and seasonal well failure. This structural constraint forces agriculture and rural supply into a volatile, hand-to-mouth relationship with the annual monsoon. The State must transition from passive check dams to **active water banking, injecting surplus monsoon runoff directly into deep fractured zones using injection wells.**

In coastal hubs like North Chennai (Minjur) and Nagapattinam, intensive pumping has reversed the natural hydraulic gradient, allowing a saline wedge to intrude up inland. This qualitative crisis permanently contaminates freshwater assets, rendering them unusable for decades. Hardrock and coastal aquifers have limited natural flushing capacity. Once seawater enters these fracture networks, it stays there permanently, ruining vital freshwater sources for a long time. Tamil Nadu should implement injection barriers as seen in California's coastal basins to halt the saline front. This practice involves pumping highly treated recycled water into **specialised coastal wells to create a freshwater 'wall' or pressure ridge.** This artificial barrier physically **blocks seawater from moving inland**, reclaiming salinised zones over time and providing a high-value use for urban wastewater.

Best Practice: Managed Aquifer Recharge

The **Thisayanvilai 'Miracle Well' project in Tirunelveli stands as a premier best practice** for Managed Aquifer Recharge in fractured karst geography. The issue originated in the Ayankulam village, where farmers faced a crippling paradox: chronic drought and saline intrusion from the coast, followed by seasonal flash floods that drained wastefully into the sea. Upon discovering a local open well that could absorb staggering volumes of floodwater – up to 2,500 litres per second – without overflowing, Dr Venkatraman Srinivasan from IIT Madras proposed a scientific Rapid Recharge Technology. This initiative, adopted by the Tirunelveli District Administration as part of the broader Tamirabarani-Karumeniyar-Nambiyar River Interlinking Project, leverages the region's unique subterranean limestone caverns and calcareous deposits to store massive volumes of water underground.

Technically, the project involves sinking specialised injection wells equipped with advanced silt catchers to protect the deep aquifer from contamination while facilitating high-speed recharge. The expected outcome is the creation of a 'hydraulic mound' – a pressurised freshwater barrier that pushes back seawater intrusion and stabilises the water table for a 10–15 km radius. By converting a flood hazard into a localised water bank, this model provides a resilient, cost-effective blueprint for securing agricultural livelihoods in Tamil Nadu's coastal and arid belts.

OUTCOME: Climate Resilience



Problem:

Industrial extraction will actively compete with rural drinking water and agriculture as Tamil Nadu develops, leading to conflict

Lever (Supply side):

Encourage industries to undertake water replenishment projects

Tamil Nadu's industrial corridors are trapped in a quantity crisis where massive industrial pumping competes directly with rural domestic needs, leading to the rapid desaturation of fractured rock aquifers. Concentrated extraction in water-intensive industrial leads to a permanent drop in water tables. This depletion is worsened by the lack of local recharge infrastructure. To overcome this, industries must move from being passive consumers to active water stewards by implementing Managed Aquifer Recharge (MAR) within their factory footprints and local catchments, and investing in outside-the-fence replenishment projects, perhaps through an active water credits system. Many companies have already made commitments to be water positive by 2030 through water replenishment targets. Here, a company invests in or supports water replenishment projects beyond its own operational boundaries, restoring a volume of water equivalent to a defined portion of its direct, supply chain or indirect water use. This creates a clear, standardised global metric that companies can track and report against. Water replenishment (unlike carbon credits) is a relatively nascent area; standards are evolving and there is a limited supply of eligible projects. Niti Aayog's guidelines, however, on water positivity offer companies an initial framework. If Tamil Nadu engages seriously, it can leverage this additional source of funds.

Best Practice: Water Stewardship by Industry

The Volumetric Water Benefit Accounting (VWBA) framework is a standardised, science-based methodology used by corporations to quantify and communicate the benefits of their water stewardship activities in a consistent way using a common metric. It consists of six core principles:

- **Standardisation:** A unified method for companies to assess benefits across diverse geographies and project types (e.g., land restoration vs. irrigation efficiency).
- **Understand Local Context:** Identify shared water challenges (availability, quality, or access) in the specific catchment.
- **Evaluate Projects and Partners:** Vet activities against eligibility criteria to ensure they can generate credible benefits.
- **Quantify Benefits:** Select appropriate indicators and scientifically defensible methods to calculate the volume of water produced or saved.
- **Plan and Agree:** Align with partners on implementation timelines, costs, and how benefits will be attributed.
- **Implement and Track:** Execute the project and document performance over time.
- **Communicate Claims:** Prepare transparent public disclosures based on the calculated results.

Many multinationals like Microsoft, Nestle, Google, Apple, Meta, and Coca Cola, as well as Indian companies like Tata Group companies, have announced their intention to become water positive by 2030.

OUTCOME: Climate Resilience



Problem:

The groundwater crisis in Tamil Nadu is characterised by a 'low-storage, high-extraction' trap.

Lever (Demand side):

Cap extraction to keep aquifers in balance and explore savings from electricity efficiency

The groundwater crisis in Tamil Nadu is characterised by a 'low-storage, high-extraction' trap. Unlike the deep alluvial aquifers of northern India, Tamil Nadu's hydrology is dominated by crystalline hardrock formations that possess limited natural storage capacity and are highly sensitive to climate variability.

The State must move away from treating groundwater as an unregulated landowner right and **adopt the Public Trust Doctrine (as per the Model Bill 2016)**. Legally, **redefining groundwater as a shared community resource allows the state to regulate extraction based on the collective health of the saline-freshwater interface**, enabling the enforcement of no-pumping zones in sensitive coastal corridors.

The State should **designate 'Critical Blocks' as Active Management Areas (AMAs)**, similar to models used in Arizona, **where groundwater extraction is strictly capped**. In these zones, new large-scale developments or industrial permits are blocked unless the proponent can assure 100 years of water supply through certified recharge or wastewater recycling, ensuring extraction stays within the aquifer's carrying capacity.

The provision of free, unmetered electricity for agriculture has removed the economic feedback loop that would otherwise signal water scarcity to users. With the marginal cost of pumping effectively at zero, there is a structural incentive to pump until wells are dry, leading to a tragedy of the Commons. This **policy paradox, combined with the lack of a modern legal framework since the repeal of the Tamil Nadu Groundwater (Development and Management) Act, 2003, prevents any meaningful regulation of extraction volumes**.

The State should implement smart metering for agricultural pumps to establish baseline consumption data. By linking this to **solar-powered micro-irrigation**, farmers can be incentivised to **sell surplus electricity back to the grid rather than using it to pump excess water**. This transforms electricity from an entitlement to over-pump into a financial asset for conservation, reintroducing a scarcity signal without increasing the farmer's cost of living.

Instead of open-ended free power, the State should pivot to a **Direct Benefit Transfer-based 'electricity pivot' model**. Farmers would be credited a cash incentive for every unit of electricity saved relative to a standard crop water budget. This creates a direct financial reward for groundwater conservation, **aligning the farmer's economic interest with the long-term sustainability of the aquifer**. This transforms electricity from a simple entitlement into a tangible financial asset, providing a powerful economic incentive for farmers to adopt water-saving technologies and view groundwater as a finite resource rather than an infinite tap.

OUTCOME: Climate Resilience



Problem:

Degradation and siltation of traditional cascading tanks undermine their water storage capacity as the State's primary buffer against climate variability

Lever:

Maintain and restore existing water storage

The management of water bodies (comprising over 40,000 traditional tanks and several large reservoirs) in Tamil Nadu is currently in a state of systemic decline, undermining the State's primary buffer against climate variability. The **Kudimaramathu scheme**, while originally a practical and culturally-rooted solution for communal water management, has **seen its effectiveness decline sharply due to systemic implementation gaps**. A primary driver of this failure is haphazard desilting, which often prioritises immediate volume removal over the hydrological integrity of the tank bed. Furthermore, the systematic neglect of feeder channels means that even when tanks are desilted, the pathways for inflow remain blocked or encroached upon, preventing the tanks from filling up during monsoons. Coupled with insufficient funding for long-term operations and maintenance (O&M), these traditional assets are transitioning from vital community lifebloods into neglected infrastructure that fails to provide the necessary buffer against climate variability.

To maximise storage potential across the landscape, the State should commission a **feasibility study for an integrated tank-filling scheme** modeled after successful regional precedents. One such model is Andhra Pradesh's Handri-Neeva Project, where a network of tanks and aquifers functions as a physical extension of large reservoirs, allowing for distributed storage that recharges the water table while mitigating overflow. Similarly, Karnataka's Hebbal-Nagawara (HN) Valley scheme demonstrates the potential for water circularity by utilising treated wastewater to fill cascading tank systems, providing a reliable secondary source for drought-prone regions. By adopting this integrated approach, Tamil Nadu can move beyond isolated reservoir management toward a hub and spoke system where decentralised tanks act as vital buffers, maximising the capture of monsoonal surplus and treated flows for long-term resilience. The State should also **mandate Integrated Reservoir Operation (IRO)** that utilises AI-based forecasting to synchronise releases across the basin. By **balancing flood control with storage maximisation based on real-time catchment data**, the State can optimise the remaining capacity of its reservoirs. This must be supported by a policy that treats catchment restoration as a core part of reservoir infrastructure, funding reforestation as a water-security investment.

The Water Resource Department should **maintain a mandatory digital inventory of water bodies, where real-time health, storage levels, and encroachment data are publicly accessible**. This transparency ensures that funding is allocated based on hydrological impact rather than administrative boundaries, reclaiming the State's latent storage capacity for the 2035 vision. The State should **shift from ad-hoc grants to a dedicated, non-lapsable district water body fund specifically for operations and maintenance (O&M)**. Sourced from water cess or a portion of property taxes, this fund would provide the consistent financing required to move beyond infrastructure-heavy interventions and focus on the continuous upkeep of feeder networks, ensuring that tanks remain perennial assets rather than decaying after a single government scheme.

OUTCOME: Climate Resilience



Problem:

Under an erratic climate, rainfed farmers are vulnerable to facing repeated crop loss

Lever:

Provide protective irrigation for rainfed farmers through relevant means so that crops can survive more dry days

In the drought-prone drylands of districts like Sivagangai and Ramanathapuram, rainfed farmers face acute vulnerability as erratic rainfall threatens them with repeated crop loss. As Tamil Nadu's economy transitions toward industrialisation, the state must ensure that any shift away from agriculture is a choice made with dignity rather than a forced exit driven by climate distress. To safeguard these livelihoods, the state should institutionalise "protective irrigation"—the provision of minimal, life-saving water during critical growth stages when monsoons fail. This can be operationalised through a portfolio of interventions, including community farm ponds, soil mulching, and innovative groundwater pooling. In extreme dry spells, emergency measures like mobile water tankers or irrigated nutritional gardens can provide essential water buffers. By guaranteeing this baseline irrigation, the state can transform rainfed farming into a resilient livelihood, preserving the socio-economic fabric of dryland regions.

Best Practice: Groundwater Collectivisation for Protective Irrigation for Rainfed Farmers

The Groundwater Collectivisation programme, pioneered by WASSAN in the semi-arid regions of Andhra Pradesh and Telangana, offers a transformative model for equitable climate adaptation. By pooling individual borewells into a common grid, the programme provides "protective irrigation" to smallholder farmers who previously lacked water access, enabling them to survive the increasing dry spells triggered by climate change. This social and technical arrangement effectively de-links land ownership from water access, ensuring that even non-borewell owners can safeguard their crops during critical growth stages. To ensure long-term sustainability, the collective promotes a shift toward reduced borewell drilling, water-efficient crops, and micro-irrigation, reducing the groundwater footprint and stabilising incomes.

Best Practice: Odisha Millets Mission

The Odisha Millets Mission (OMM) serves as a benchmark for climate adaptation by revitalising the cultivation of traditional, hardy grains that are naturally tolerant to intensifying heat waves and droughts. By promoting these water-efficient crops, the mission provides a critical safety net for smallholder farmers who lack the resources to withstand erratic rainfall in rainfed regions. Beyond field resilience, OMM utilises an integrated value chain approach that links community-managed processing units with guaranteed state procurement and inclusion in public nutrition schemes. This comprehensive framework significantly reduces market risks and increases farmer incomes by transitioning from a vulnerable monocrop system to a diversified, high-value agricultural model.

OUTCOME:
Water Use
Productivity



Problem:

Water intensive crops are grown and irrigated inefficiently because of absence of incentives

Lever:

Improve agricultural productivity by incentivising low water use and high value crops

Agriculture is the biggest user of water in the state. While the amount of water available is limited, there is an aspiration across stakeholders to increase farmer income. The two outcomes of sustainability and farmer income need not be exclusive. The right indicator to follow for this is the income per unit of water used (Rs./m³).

To enable this, subsidies should slowly shift exclusively towards low water intensity crops and high-efficiency irrigation systems. This is especially important for groundwater overexploited areas. This localised approach ensures that state funds are not inadvertently subsidising the depletion of stressed aquifers but are instead steering the agricultural landscape toward a more sustainable and hydrologically balanced future.

While existing frameworks like Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) and Irrigated Agriculture Modernisation and Water-Bodies Restoration and Management (IAMWARM) support general drip irrigation, they currently lack specific mandates or training programmes for subsurface drip (SSDI) and advanced fertigation scheduling. Policy recommendations suggest a move toward crop-specific micro-irrigation designs to improve the adoption.

In canal command areas, water use efficiency needs to be looked at in a holistic manner. It is especially difficult in canal command areas dominated by extensive paddy cultivation, as an individual farmer cannot move away from paddy if everyone around them is doing flood-irrigated paddy. **The seepage has to be prevented by better control of water to enable them to move towards other high-value crops.** This means the state should look at irrigation modernisation, including pipe-to-the-field and conjunctive use of groundwater and surface water.

Beyond water use though, there is a need to drive a transition, to high value, low water using crops. The Mission for Integrated Development of Horticulture (MIDH) provides one framework for this, but its current guidelines prioritise the creation of water resources rather than the efficiency of their use. Shifting the policy focus **from resource creation to extraction management** is essential to ensuring that cultivation remains viable.

Importantly, the Water Resources Department must work with the Agriculture Department to ensure that the **entire ecosystem is geared towards cropping pattern shifts**, starting from crop input ecosystems, mechanisation of labour through crop-specific innovations, going beyond paddy and sugarcane as well as assured market linkages and financing for low-water using crops.

OUTCOME: Water Governance



Problem:

Siloed work across departments may result in sub-optimal coordination and efficiency

Lever:

Improve governance for water resource management

One water approach

For decades, water management is split across functional silos, often leaving the State Groundwater Department (SGWD) sidelined as a technical advisory body rather than a regulatory authority. This **fragmentation has led to conflicting investments where surface water releases were decoupled from aquifer recharge needs**. To address this, the SGWD needs to be elevated to a central role within the State Water Utilization Committee (SWUC), ensuring that groundwater health is no longer an invisible variable but a primary determinant in the State's integrated command structure.

The State need to adopt an Integrated Water Resources Management (IWRM) framework through SWUC. This body **serves as the hydrological custodian of the State, with the power to set volumetric quotas and regulate abstraction**. By moving toward a basin-scale management model, the SWUC ensures that upstream decisions on reservoir storage are synchronised with the SGWD's real-time data on aquifer carrying capacity and coastal saline interface movements.

A landmark policy of the SWUC should be a **'circularity first' mandate**, which legally requires Urban Local Bodies (ULBs) and industrial estates to meet a substantial portion of their water demand through treated wastewater reuse. This strategic pivot **preserves high-quality freshwater exclusively for rural water supply, agriculture, and unserved areas** (particularly regions without perennial river systems or those facing severe salinity). By forcing cities and industries into a circular loop, the State ensures that freshwater is protected as a public trust for the most vulnerable and hydrologically disadvantaged populations.

A new Water Allocation Act is also needed to empower the SWUC **to act as the ultimate clearinghouse for all multi-sectoral water allocations**. With the SGWD as a core member, this committee will hold the **statutory power to veto industrial or urban expansions in over-exploited blocks**. Furthermore, the committee will oversee the implementation of volumetric tariffs for commercial users, with revenue ring-fenced for the State water fund to finance precision-recharge and water conservation projects.

Best Practice: Water Governance

Maharashtra pioneered a **robust regulatory framework through the Maharashtra Water Resources Regulatory Authority (MWRRA)**. Maharashtra transitioned toward a system of water entitlements and volumetric metering for bulk water users and water user associations (WUAs). A critical component of their success is the use of IoT-based smart metering and the 'solarisation of feeders', which ensures farmers receive reliable daytime power with data on actual consumption. For Tamil Nadu, a phased adoption is suggested: start by installing smart meters at the feeder level to provide transparent data on energy-water usage, followed by a 'reward for saving' scheme. Instead of removing subsidies, the State could offer direct financial incentives to farmers who consume less than a predetermined baseline of electricity and water, effectively turning conservation into a new source of farm income

OUTCOME: Water Governance



Problem:

MGNREGA and watershed funds are spent sub-optimally

Lever:

Improve water governance by the use of digital tools which can empower the panchayats to understand water systems better, capture water data, and improve decentralised decision-making

The use of digital tools and capacity building of frontline functionaries in panchayats can significantly improve their ability to spend water conservation money appropriately. Current water management practices often suffer from a fundamental lack of technical rigor, leading to misdiagnosis, inappropriate siting, and outcomes that are assumed rather than measured. To rectify this, the state should prioritise the democratisation of hydrological sciences by providing intuitive digital tools and standardised playbooks to relevant Panchayat functionaries, effectively transforming them into "community hydrologists". This capacity-building shift ensures that substantial public funds, such as those allocated through MGNREGA and the Finance Commission, are transitioned from generic, inventory-based infrastructure spending to science-led, locally relevant interventions.

Improved problem diagnosis—the decentralised governance system should assess what the precise water problems and root causes are in their area. Before any implementation begins, Panchayats must move beyond "one-size-fits-all" solutions to identify the specific hydrological stressors unique to their geography. By utilising digital tools to rapidly assess critical dimensions such as water balance, cropping intensity, and soil health, local bodies can determine if their deficit stems from inadequate storage capacity, sub-optimal management of existing tanks, or high-velocity runoff leading to land degradation. Such a targeted approach ensures that the root cause of water insecurity is addressed rather than just the symptoms.

Better solutions design and site selection: modern digital tools can help in better selection of tools based on the objective and constraints of the location. Modern digital tools and GIS-based site suitability workflows can allow local stakeholders to simulate water flow and design better. They can ensure that groundwater recharge structures are actually built in locations that are naturally suited to groundwater recharge. This scientific rigour directly informs local infrastructure upgrades, ensuring that activities like the desilting of tanks, the restoration of supply channels, and the expansion of storage capacity are targeted specifically where they will yield the highest recharge and longevity.

The digital tools must be complemented with community-led continuous monitoring of water levels through simple methodologies like [the use of staff gauges](#). Digital tools alone are insufficient without a field-based "feedback loop"; therefore, the state must initiate low-cost participatory monitoring, such as installing staff gauges in all village tanks and larger Water Resources Department bodies. This data collection provides granular, ground-level tracking of rainfall, river flow, and catchment health that complements the high-level modelling done by the water resources department. By feeding staff gauge readings into digital platforms, local governance can accurately estimate seasonal inflows, outflows, and storage losses, creating a comprehensive water accounting system.

OUTCOME: Water Governance



Problem:

Siloed work across departments may result in sub-optimal coordination and efficiency

Lever:

Improve governance of water resources through common data sharing platforms

Open integrated data platforms

While Tamil Nadu has made significant strides with the launch of TiNAI (Tamil Nadu Land Use Information System) to visualise development and land-use patterns, the State's water management remains trapped in a static data environment. Current platforms effectively map where water bodies are (spatial extent) but fail to capture how much water is in them in real-time (volumetric dynamism). This disconnect means that **while land-use planning is becoming AI-driven, water allocation decisions such as releasing reservoir flows or permitting new borewells are still based on outdated, manual gauge readings that are often kept within departmental silos.**

The State must **expand the TiNAI platform from a land-use visualiser into a dynamic hydrological digital twin** to bridge this gap. Benchmarking against Taiwan's Water Resources Agency, which integrates real-time telemetry with land-use maps to manage flood and drought risks simultaneously, Tamil Nadu should layer live IoT data (from river gauges, aquifer sensors, and STPs) directly onto the TiNAI interface. This transition **turns the platform from a retrospective planning tool into a live operational dashboard**, allowing officials to see not just the location of a tank, but real-time storage, inflow rate, and evaporation loss.

The reform requires a **statutory shift from 'need to know' to 'right to data.'** The State should mandate that all non-sensitive hydrological data be published via Open APIs on the TiNAI portal. By **making this data machine-readable and publicly accessible, the government can crowdsource innovation**, allowing agri-tech startups and researchers to build precision irrigation apps and local water budgets, effectively democratising water management.

Best Practice: Open Water Data Platforms

India has developed robust government-led repositories alongside community-driven initiatives to address its water management challenges. India-WRIS (Water Resources Information System) – a single-window public portal by the Ministry of Jal Shakti – acts as a central repository for nationwide water resources data, including rainfall, river levels, discharge, and reservoir storage. Similarly, KWRIS (Karnataka Water Resources Information System) and APWRIMS (Andhra Pradesh Water Resources Information and Management System) are state-level, web-enabled open data platforms designed to provide near real-time, comprehensive, and spatial data to facilitate Integrated Water Resources Management (IWRM). They serve as authoritative 'single-window' sources for water-related data to support decision-making, planning, and monitoring for government, researchers, and the public.

States are increasingly making these platforms available and accessible via API to both other agencies and increasingly the general public.

OUTCOME: Water and Ecosystem Health



Problem:

Water is essential for other species, and water scarcity may lead to loss of biodiversity, which is detrimental to all in the long run

Lever:

Nature based solutions restore and protect ecosystems and create a virtuous cycle that strengthens water management for people

Implementing a **‘sponge strategy’ for the Western Ghats** is essential to securing the State’s primary ‘water towers’, where restored forest ecosystems act as natural infrastructure to regulate hydrological flows. By **enhancing watershed management through the restoration of native vegetation and the protection of riparian buffers**, these highlands can capture and hold significantly more rainwater, releasing it slowly into downstream river systems throughout the year. This approach creates a virtuous cycle – improved forest health increases the soil’s infiltration capacity and moisture retention, which in turn sustains more robust biodiversity habitats. As the ecosystem recovers, it further stabilises the climate and water cycles, transforming the Western Ghats from a source of rapid runoff into a resilient, self-sustaining reservoir that serves both the environment and the State’s growing water needs. A list of relevant NbS is attached as Annexure F.

A significant portion of Tamil Nadu’s surface water and storage capacity is effectively locked by the **rapid spread of invasive species**. These invasives do **not just reduce water quantity, they physically colonise storage infrastructure, making mechanical desiltation more expensive and destroying the local biodiversity essential for rural livelihoods**.

The State must address **nutrient-driven weeds through constructed wetlands at entry points to filter nitrates and phosphates**, while simultaneously implementing a **systematic prosopis eradication and replacement programme** (mechanical uprooting followed by the immediate planting of native, soil-binding species). To stop the influx of nutrients that fuels aquatic weeds, the State must **mandate decentralised sewage treatment plants (STPs) for all upstream urban clusters**, enforcing a zero-discharge policy into traditional tank systems. Additionally, the State should **introduce invasive-free performance standards for all Kudimaramathu and Water Resource Department projects**, where the successful removal and long-term suppression of prosopis and hyacinth are mandatory for project completion and fund release, ensuring that water bodies are managed as healthy ecosystems rather than just concrete basins.

To safeguard the long-term health of Tamil Nadu’s riverine ecosystems, the State must implement formal environmental flow **(e-flow) mandates coupled with nature-sensitive dam management**. This requires **commissioning river-specific studies for critical basins like the Cauvery and Vaigai to determine the precise volume and timing of water releases needed to sustain a functional delta**. Beyond supporting aquatic biodiversity, maintaining these minimum flows provides a vital hydraulic barrier against saline water intrusion, protecting coastal aquifers and agricultural lands from permanent salt contamination. By transitioning from a model of total water capture to one of ‘managed ecological pulse’, the State can ensure that its river systems continue to provide essential ecosystem services while remaining resilient.

CHAPTER 5.

Actionable Recommendations and Roadmap

Short-term, medium-term, and long term strategies



Photo by WELL Labs

Phased Roadmap

This phased roadmap synthesises the solutions landscape into a strategic blueprint designed to transition Tamil Nadu from a state with a water crisis to a water-secure economic powerhouse by 2035 and beyond.

Medium-Term
(3–5 years) &
Long-Term
(6–10 years)

Short-Term (0–2 years): Stabilise current extraction, bridge the JJM data gap, and initiate unified governance.

Governance

As per the [Water Resources Act of 2026](#), establish a Tamil Nadu Water Resource Management Authority (TNWRMA) to unify the Water Resources Department, TWAD Board, and Agriculture Department

Implement strict regulations on borewell diameter and pump horsepower based on firka-level groundwater status.

Designate 'Critical Blocks' as Active Management Areas (AMAs).

Mandate Water Safety Planning (WSP) as a statutory risk-management strategy.

Develop a framework for economic incentive for farmers to adopt water-saving technologies.

Technology Adoption

Pilot IoT-based smart meters at the electricity feeder level in over-exploited districts.

Launch a Reward for Saving scheme for farmers.

Implement AI-based technology at pumping stations to detect and reduce losses.

Pilot IoT-based sensors in water supply systems to reduce the water loss, improve service delivery and ensure water quality.

Maintain a digital inventory of water bodies and mandate Integrated Reservoir Operation (IRO) that utilises AI-based forecasting

Infrastructure Planning

Complete the desilting of 40,000+ tanks (Mission Kakatiya model).

Data Use

Expand the network of automatic rain gauges to every firka.

Map geogenic and anthropogenic pollutant hotspots (fluoride, arsenic, petrochemicals) for targeted treatment.

Community Participation

Revive water user associations (WUAs) to manage local tank systems and oversee the maintenance of community rainwater harvesting structures.

Encourage industrial stewardship of water resources by facilitating water replenishment projects.

**Short-Term
(0–2 years)**

Medium-Term (3–5 years): Decouple economic growth from water consumption through circularity and resilience.

**Long-Term
(6–10 years)**

Governance

'Circularity First' mandate, which legally requires Urban Local Bodies (ULBs) and industrial estates to meet a substantial portion of their water demand through treated wastewater reuse.

Mandate Integrated Water Management (IWM) for industries, requiring ZLD to cover both process and domestic wastewater.

Implement environmental flow (E-flow) mandates for the Cauvery and Vaigai basins.

Shift from ad-hoc grants to a dedicated, non-lapsable district water body fund specifically for operations and maintenance of water bodies.

Technology Adoption

Scale up solar agriculture feeders Statewide to ensure daytime power and controlled irrigation.

Roll out the digital twin of river basins for real-time flood and drought simulation.

Infrastructure Planning

Construct sponge parks in all major municipal corporations (Chennai, Madurai, Coimbatore).

Transition from 'grey' drains to 'green' bioswales and 'blue' corridors. Scale tertiary treatment in industrial corridors and urban hubs for a drought-proof water source.

Establish adequate STPs in all Tier 2 and Tier 3 cities exploring new "circular economy business models"

Conduct pilots for lake/pond rejuvenation and filling it with tertiary treated wastewater and indirect potable reuse of treated water

Data Use

Launch the web-based Decision Support System using machine learning to predict inflow-outflow and reservoir losses.

Community Participation

Introduce water literacy in schools and incentivise apartment complexes to install greywater recycling systems for landscaping.

Short-Term
(0–2 years) &
Medium-Term
(3–5 years)

Long-Term (6-10 years): Achieve water-neutrality
and total climate-proofing.

Governance

Fully integrate Water-Sensitive Urban Design (WSUD) into state building codes (Israel model).

Enforce a total ban on riverine sand mining with a shift to 100% M-sand.

Implement a water credits system to encourage industrial stewardship of water resources.

Technology Adoption

Implement autonomous, sensor-driven irrigation networks in all major command areas to maximise GVA per drop.

Infrastructure Planning

Completion of deep tunnel drainage systems in coastal cities to mitigate 1-in-100-year floods.

Full restoration of the Thamirabarani and Palar riparian health.

Data Use

State-wide real-time water accounting system accessible to the public, ensuring transparency in industrial, domestic, and agricultural allocations.

Community Participation

Transition to community-led aquifer management where villages monitor and regulate their own groundwater extraction limits.

Inter-departmental coordination can be governed by TNWRMA

The cornerstone of this framework is the Tamil Nadu Water Resources Management Authority (TNWRMA), established under the landmark Water Resources Act of 2026. Chaired by the Chief Secretary, this apex body centralises the decision-making formerly scattered across the Water Resources Department (WRD), TWAD Board, and CMWSSB. By including the Secretaries of Finance, Agriculture, and Industries as permanent members, the **TNWRMA ensures that water allocation is treated as a core economic budget rather than an engineering afterthought**. This high-level oversight is critical for resolving historical water-use conflicts between the sprawling industrial corridors of Sriperumbudur and the traditional agricultural ayacuts of the Palar basin.

Vertical integration is achieved through **district water resources committees, chaired by District Collectors**. These committees serve as the tactical layer, translating state policy into local action. They **bridge the gap between the WRD's primary channel maintenance and the Rural Development Department's check dam projects**. A successful precedent for this is the Kudimaramathu* spirit, now modernised through these committees to ensure that local water bodies are not just desilted but are hydrogeologically linked to the broader basin drainage network. This prevents islands of excellence where one village's recharge structure inadvertently blocks another's downstream flow.

The larger framework targets the **energy-water-agriculture nexus through a formal convergence cell between the Agriculture Engineering Department and TANGEDCO**. This cell is tasked with implementing the solar agriculture feeders programme, ensuring that electricity subsidies are leveraged to promote micro-irrigation. By coordinating the timing of power supply with real-time soil moisture data, the State can prevent the wasteful flood irrigation that currently depletes the Cauvery Delta's shallow aquifers. This follows the best practice of the Maharashtra Water Resources Regulatory Authority (MWRRA), which uses inter-departmental data to set volumetric water entitlements for different sectors.

Finally, industrial coordination is mandated through a **Circular Economy Portal jointly managed by the TNPCB and SIPCOT**. This platform **tracks the water footprint of every industrial unit** in clusters like Ennore and Manali. Under this framework, the permission for a new industrial borewell is strictly contingent on the unit's commitment to treat and reuse 100% of its domestic and process wastewater (total ZLD). This integrated permitting process eliminates the regulatory blind spots that previously left segments of industrial wastewater unregulated, ensuring that every drop of water used in the manufacturing sector is accounted for and reintegrated into the production cycle.

**Kudimaramathu is a centuries-old, community-driven water management tradition in Tamil Nadu, based on the principle of collective, voluntary participation in the maintenance of local water bodies.*

Monitoring, Evaluation and Dynamic Planning

Monitoring and evaluation (M&E) in Tamil Nadu is transitioning to a Theory of Change model, as pioneered by the Tamil Nadu Irrigated Agriculture Modernization Project (TNIAMP). Instead of merely tracking inputs (e.g., kilometres of lined canals), the **new Project Performance Information System (PPIS) measures impact-level outcomes such as the increase in Gross Value Added per drop and the reduction in groundwater gap areas.** This results-based monitoring uses a digital dashboard that integrates satellite imagery with ground-level sensor data to verify whether a desilted tank has actually improved the local water table or if the gains were lost to unauthorised extraction.

A key pillar of the roadmap is dynamical planning, which can **utilise the Program-for-Results (PforR) financing instrument under the World Bank-supported Tamil Nadu Climate Resilient Urban Development Program.** Unlike static five-year plans, dynamical planning allows for mid-course corrections based on real-time climate signals. If the real-time data acquisition system (RTDAS) detects a three-year trend of declining northeast monsoon intensity in the southern districts, the State's investment strategy can automatically pivot funding from surface water projects to deep aquifer recharge and drought-resistant horticultural subsidies, ensuring the economy remains resilient to shifting weather patterns. Dynamical planning is also required because of uncertainties in our predictions for future LULC changes and urbanization.

Technological best practice should be represented by the **development of digital twins* for the major river basins (Cauvery, Vaigai, and Thamirabarani).** These hydraulic models are fed by ultrasonic water level recorders and automated rain gauges to simulate 'what-if' scenarios for the upcoming season. For instance, before the monsoon hits, the Chennai Flood Management System (C-FMS) can predict street-level inundation and reservoir overflow paths, allowing the State to preemptively release water or activate Sponge City detentions. This **shift from forecasting to predictive simulation** is modeled after The Netherlands' Digital Delta, ensuring that water management is proactive rather than reactive.

The final layer of the M&E framework involves citizen-science and community monitoring. Every water user association **(WUA) should be equipped with 'single window information centres' where farmers can access their village's water budget.** By demystifying hydrological data into simple surplus/deficit wall writings, the State can foster community accountability. If a village's groundwater usage exceeds its recharge budget, the dynamical planning framework triggers localised recharge incentives or crop-diversification programmes. This ensures that the State's \$1 trillion economy goal is built on a foundation of transparent, localised, and scientifically validated water security.

**A digital twin is a data-driven virtual model of a real-world system, such as a river basin, that integrates real-time data and simulations to monitor conditions, test management scenarios, and support better decision-making.*

Track Progress on the Key Outcomes

A strategic roadmap is only as effective as the mechanism used to monitor its progress. The path to 2035 must be anchored by a rigorous, data-driven tracking framework. This study suggests that the key indicators for the six identified outcomes, ranging from water circularity indices to groundwater recharge rates, be tracked on a mandatory annual basis to ensure the State remains on trajectory. This live roadmap will allow for mid-course corrections, enabling agencies to transition from static five-year plans to a dynamic management system that responds to real-time hydrological shifts. By institutionalising this annual performance audit, Tamil Nadu can transform its \$1 trillion economic vision from a series of aspirational goals to a measurable, accountable reality where every drop is accounted for in the drive toward long-term resilience.

Outcome Category	Recommended Indicator
Safe Water Access	% of rural and urban households with safe and adequate water, no downtime % farmers with access to at least protective irrigation
Climate Resilience	Total water storage capacity (m ³)
Water Productivity	Average Rs/m ³ for crops
Water Balance - Circularity	% of wastewater treated, % of treated water reused
Water Balance - Streamflow	% of rivers with stable dry season flow
Water Balance - Groundwater	In alluvial aquifers: % blocks with long term pre-monsoon groundwater levels stable In hard rock aquifers: % blocks with no seasonal drying
Water Governance	Number of open data sets made available and used
Water Ecosystems	% of water bodies that are not eutrophic or silted

Proposed Studies to Strengthen Tamil Nadu's Water Future

1. **More detailed water balance study** – The current study was based on secondary data and was completed in 3 months. The state should initiate and complete a detailed water balance study in the next two years for the entire state, followed by district water balance studies. This should be the starting point for water resources projects in the following 8 years. These studies should be based not only on available secondary data but also on targeted primary data collection where it is crucial.
2. **Groundwater recharge estimation** – The water balance suggests that our estimates of groundwater recharge are highly underestimated. The literature suggests recharge numbers vary by a factor of five. This cannot be resolved without better studies.
3. **Groundwater sub-flow estimation** – There is also a possibility that subsurface inflows from upstream are not properly estimated. There is some indication of the existence of a 'Cauvery Delta Water Machine' – the notion that pumping in the Delta optimises water storage by capturing monsoon runoff and using subsurface storage so the massive annual monsoon flows can be used throughout the year.
4. **Industrial demand** - There is a lot of data on industries. But industrial water demand based on self-reported extraction data is probably severely underestimated. There is a need for a comprehensive survey of industrial water use.
5. **Flood risk** - The state needs its own flood risk map. At the moment only national-level maps are readily available in the public domain.
6. **Digital twin** – Ideally there should be a single water model for the state, a digital twin of water flows in the state that is completely open source and open data and is constantly improved based on the best available data. This digital twin can form the basis of assessment and coordination of all water-related departments. E.g., the state of Arizona in the US has a digital twin, and any new NOCs given to groundwater extractors are given after the assessment of additional impact based on this groundwater model, and the model continues to improve based on the usage.
7. **Specific Study** - The long-term success of the Mamallan project hinges on a rigorous, multi-dimensional study of its hydrological impact. While the reservoir is expected to act as a freshwater cushion that recharges neighbouring aquifers and provides a physical barrier against seawater intrusion, its actual efficacy remains a subject of technical scrutiny. A detailed study is required to evaluate the recharge-draft balance – if extraction in the surrounding 13 lakh population catchment exceeds the reservoir's annual recharge potential, the benefit to the water table could be neutralised. Ensuring this project lives up to its promise requires moving beyond infrastructure and implementing a real-time monitoring network to track how much of this stored water actually reaches the deep aquifers versus being lost to evaporation or runoff.

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Annexure A

List of Nature Based Systems (NbS)

Wastewater Management

Suitable NbS

1. [Constructed Wetlands \(Phytoid systems\)](#): Using aquatic plants like Cyperus to treat domestic wastewater in decentralized clusters, significantly reducing the load on centralized grids
2. [Rain Gardens](#): It filters out sediment and other pollutants (like animal waste, brake dust, oils and automotive chemicals) by capturing the first flush of rain, which tends to contain the highest concentration of pollutants, reducing the silting process for the wastewater
3. [Wastewater Ponds](#): The ponds can be used individually, or linked in a series for improved treatment. There are anaerobic, facultative and aerobic (maturation) ponds, with different treatment and design characteristics. High nutrient removal efficiency, flexibility for different flows, and provide ecological support. They enable water reuse, improve water quality, and reduce environmental impact

Water Recharge

Suitable NbS

1. [Bioswales and Rain Gardens](#): Vegetated channels along highways and urban roads that slow down runoff, filter pollutants, and encourage infiltration. They mitigate pollution as the plants naturally filters water before it runs into nearby stormwater systems
2. [Rainwater Harvesting](#): Capturing rainwater runoff which falls over building terraces and paved area and recharge it into groundwater aquifers. This process is accomplished using various structural methods, including recharge wells with desilting ponds, soakaways, recharge trenches, and abandoned borewells
3. [Permeable Pavements](#): Allows infiltration into the ground, minimizing runoff. Provides a sustainable alternative to traditional capture, treatment, and discharge. Filters pollutants before they reach groundwater. Encourages infiltration, potentially replenishing groundwater
4. [Green Roofs](#): Absorbs rainwater by water buffering in the plants, substrate and drainage layer. The delay in the discharge of rainwater to the sewage system, purifies the rainwater, and water also evaporates through the plants. This helps to stabilise the groundwater level, reduces the peak load on the sewage system and reduces the risk of flooding

List of Nature Based Systems (NbS)

Water Use

Suitable NbS

1. [Zero-Budget Natural Farming](#): An agricultural practice that reduces direct costs for farmers by encouraging the use of natural inputs, such as cow dung and cow urine, while requiring less tilling and completely rejecting the use of inorganic fertilizers, pesticides, and herbicides. ZBNF processes require 50%–60% less water and electricity compared to conventional farming practices for all the selected crops. Significant water savings for paddy crop (3500 KL for ZBNF versus 1400 KL for conventional per acre).

Augmentation of Surface Water Bodies

Suitable NbS

1. [Urban "Blue Corridors"](#): Rejuvenating interconnected tank systems (the 13-tank network in Tirunelveli) focuses on restoring their structural integrity to optimize their dual role as flood carriers and storage basins. By desilting supply channels and repairing dilapidated sluices and surplus weirs, the project ensures efficient water conveyance and improved storage capacity. These interventions effectively transform the tanks into a robust network that mitigates downstream flooding while securing irrigation water for the ayacut

Water and Ecosystem Health

Suitable NbS

1. [Mangrove & Riparian Buffers](#): Restoring natural riverbanks and coastal mangroves (Pichavaram) to reduce flow velocity and protect against storm surges. These restored bio-shields act as a critical physical shield against extreme weather events. The mechanical resistance effectively reduces flow velocity and dissipates the destructive energy of storm surges and tidal waves.

Annexure B

Catalogue of Best Practices and Policies

1. Safe Water Access

SL No	Solutions	Standard Measures
1	WSP as a statutory risk-management strategy uses catchment-to-consume approach	The TN Water Resources Act 2026 mandates "catchment-to-consumer" risk management as a statutory requirement
		Australian Drinking Water Guidelines mandate Water Safety Plans (WSPs) as a statutory framework for preventative risk management
2	Replace ad-hoc communication with statutory SOPs	CMWSSB has implemented digital Service Level Benchmarks (SLB) and statutory SOPs for water quality alerts
		JJM provides standardized communication protocols for water quality alerts and community "right to know" updates
3	Source Sustainability	Mandatory Rainwater Harvesting (RWH) since 2003 in Tamil Nadu
4	Technology-led reduction of water losses	Coimbatore's 24x7 water supply project using SCADA and IoT sensors to track Non-Revenue Water (NRW)
		The Hubli-Dharwad 24x7 Water Project used automated pressure management and GIS mapping to reduce Non-Revenue Water (NRW)
		Drink from Tap Mission - Puri where 24*7 water supply with active leakage control coupled with telescopic tariff that ensured equitable distribution and longevity of distribution lines
5	Lake rejuvenation	Reverse Lake Bank Filtration (Managed Aquifer Recharge) for IIT Madras campus lake

2. Water Balance

SL No	Solutions	Standard Measures
1	Roadmap to establish adequate STP capacity in all Tier 2 and Tier 3 cities	TN Urban Flagship Investment Program (TNUSFIP) targets 100% STP coverage in 135 ULBs
		AMRUT 2.0 provides a national roadmap for 100% sewage coverage in all 4,700+ urban local bodies
2	Prioritization of underground drainage and household connection incentivisation	AMRUT 2.0 includes financial incentives for cities that achieve high household tap and sewer connection ratios

3	Nature-based solutions for better management of village ponds	Mission Amrit Sarovar aims at developing and rejuvenating 75 water bodies in each district of India using natural filtration
4	STPs with 10-year ring-fenced O&M budget	Hybrid Annuity Model (HAM) for Namami Gange projects (e.g., Mathura) ensures 15-year ring-fenced O&M

3. Climate Resilience

SL No	Solutions	Standard Measures
1	Injection wells - Stores surplus monsoon runoff	Large-scale injection wells in the Araniyar-Kosasthalaiyar basin to store monsoon surplus
2	Freshwater wall or pressure ridge to avoid seawater intrusion	Hydraulic barriers at Minjur and Nemmeli (Chennai) using recharge wells to block seawater intrusion Orange County (California) uses a " Seawater Intrusion Barrier " by injecting highly treated recycled water to block ocean salt
3	Encourage industries to undertake water replenishment projects	CGWA mandates that "Over-exploited" industries recharge 200% of the water they extract
4	Designate Critical Blocks as Active Management Areas (AMAs)	Arizona's (USA) AMAs , which restrict groundwater pumping based on safe-yield goals
5	Savings from electricity efficiency as incentives to reduce groundwater use for farmers	"Pani Bachao, Paise Kamao" (Punjab) – Farmers get DBT for every unit of electricity saved via reduced pumping
6	Improvement in Kudimaramathu Scheme	Mission Kakatiya restored 46,000+ tanks through massive community participation in desilting
7	Pond/Tank Filling scheme	Mettur-Sarabanga lift irrigation scheme to fill 100 surplus tanks in dry regions; Andhra Pradesh's Handri-Neeva Project The K.C. Valley Project treats Bengaluru's wastewater to tertiary standards to fill lakes in drought-prone Kolar.
8	Mandate Integrated Reservoir Operation (IRO) that utilizes AI-based forecasting	The Integrated Reservoir Management Centre (IRMC) in Chennai uses AI-ML for the Poondi/Puzhal dam system K-water uses AI-based "Smart Dam Management" to predict inflow and optimize releases during extreme weather
9	Shift from ad-hoc grants to a dedicated, non-lapsable district water body fund	The Nature Conservancy (Quito, Ecuador) established water funds where downstream users pay for upstream conservation

10	Water-Efficient Crop varieties with tolerance to heat waves	Odisha Millet Mission promotes water-efficient crops, which are naturally tolerant to intense heat waves along with safety net for smallholder farmers to withstand erratic rainfall in rainfed regions
11	Protective irrigation by borewell grid pooling and delinking water and land ownership	Groundwater Collectivisation is a transformative model which de-links land ownership from water access, ensuring that non-borewell owners can safeguard their crops during critical growth stages

3. Water Use Productivity

SL No	Solutions	Standard Measures
1	"Reward for savings" system powered by Direct Benefit Transfer (DBT) to encourage low-water intensity crops	Micro-irrigation DBT under PMKSY (Per Drop More Crop) – widely used in TN PM-KUSUM (Component C) rewards farmers for selling surplus solar power to the grid instead of over-pumping
2	Push to low-water intensity crops is accompanied by adequate support for labour-saving and crop inputs	Integrated Farm Management (IFM) schemes providing power tillers and weeders to drip-irrigated farms Sub-Mission on Agricultural Mechanization (SMAM) provides subsidies for automated fertigation and weeding tools
3	Economic incentive for farmers to adopt water-saving technologies	Jal Sanjeevani - offers higher financial assistance for sensor-based irrigation
4	Subsidies should shift exclusively toward low-water-intensity crops and high-efficiency irrigation systems	Haryana- Mera Pani, Meri Virasat pays farmers ₹7,000/acre to switch from water-guzzling paddy to maize or pulses
5	Per-hectare incentives for sub-surface drip irrigation (SSDI)	Israel offers massive R&D and installation subsidies for Subsurface Drip Irrigation (SSDI) to minimize evaporation

3. Water Governance

SL No	Solutions	Standard Measures
1	State water utilization committee to act as the ultimate clearinghouse for all multi-sectoral water allocations	The TN Water Resources Management Authority (TNWRMA) acts as the ultimate clearinghouse The Maharashtra Water Resources Regulatory Authority (MWRRA) acts as an independent body to allocate water across sectors

2	Statutory shift from "Need to Know" to "Right to Data."	The National Data Sharing and Accessibility Policy (NDSAP) provides a framework for making hydrological data open and accessible
3	Expand the TiNAI platform from a land-use visualizer into a dynamic hydrological digital twin	European Space Agency DTE Hydrology Platform - A new digital twin earth Aarhus Water created a digital twin of their city's water system to simulate flood impacts and energy use in real-time
4	Circularity First mandate for Urban Local Bodies (ULBs) and Industrial Estates	SIPCOT industrial parks are mandated to use Tertiary Treated Water (TTW) from urban STPs The National Policy on Safe Reuse of Treated Water (2022) mandates thermal power plants to use treated sewage within a 50km radius
5	Implement a one-water management protocol to shift from fragmented departmental planning	Singapore's PUB manages the entire water cycle (rainfall, sewers, and desalination) as one system

3. Water and Ecosystem Health

SL No	Solutions	Standard Measures
1	Sponge strategy for Western Ghats forests	Shola-grassland restoration in the Nilgiris (TN/Kerala) to act as a natural sponge for river origins The Sponge City Program (Wuhan/Shenzhen) uses permeable pavements and rain gardens to absorb 70% of rainwater
2	Integrated Invasive Species Management	2025-2026 drive to eradicate <i>Senna spectabilis</i> from forest divisions CAMPA (Compensatory Afforestation Fund) guidelines prioritize the removal of invasives to restore native catchment biodiversity
3	Nature based wastewater treatment	Constructed Wetlands (using Typha/Phragmites) for low-cost rural sewage treatment Constructed Wetlands in the EU use Phragmites (reeds) to treat municipal wastewater without chemicals or electricity
4	Environmental flow mandates and nature sensitive dam management	IRMC's 3R Principle (Retention, Regulation, Release) to maintain river health downstream of dams The Ganga E-Flows Notification (2018) mandated minimum flow levels for the River Ganga to protect aquatic life

Annexure C

Detailed Methodology for Demand and Supply Estimation

Methodologies for water demand and supply estimation for various uses are as follows:

C.I. Water Demand Estimation

C.I.1. Domestic Water Demand

Water demand for urban and rural population, as well as livestock demand for two reference years, i.e., 2025 and 2035 estimated using census-based population growth rates and BIS norms, and species-wise projections and standard coefficients (annualised in the BCM) respectively. Livestocks considered include Cattle, Buffaloes, Sheep, Goats, Horses and ponies, Donkeys and mules, Camels, Pigs, and Poultry.

Data and standardized norms: Baseline population collected by Census 2001 and 2011, along with District Statistical Handbooks for boundary reconciliation and validation. Livestock population baseline collected from Department of Animal Husbandry and Dairying (AH&D) for 2012 and 2019 rounds. Water demand standards used from IS 1172:1993 (Reaffirmed 2002): Code of Basic Requirements for Water Supply, Drainage and Sanitation, and [Synopsis of District irrigation Plans \(2016-2023\)](#)

Population Growth Rate Estimation: District-wise annual population growth rates were calculated using Census 2001 and 2011 data following the geometric growth method as follows

$$r = (P_{2011}/P_{2001})^{1/10} - 1$$

For livestock categories, CAGR was estimated as:

$$r = (P_{2019}/P_{2012})^{1/7} - 1$$

Where:

- R = annual growth rate
- P_{2011} , P_{2001} = Census population
- P_{2019} , P_{2012} = Livestock census population

Population Projections: Using Census 2011 as the base year, population projections were carried out using the geometric method:

$$P_{\text{future}} = P_{\text{base}} * (1+r)^t$$

where:

- P_{base} = population in base year
- r = annual growth rate
- n = number of years from base year

Estimation of Net Domestic Water Demand: Per Capita water demand norms for rural and urban are taken as 55 and 135 lpcd respectively from IS 1172:1993. For integration with water accounting frameworks, daily demand (MLD) is converted to annual volumes in hectare-meters per year (ha m/year -MLD×36.5)

$$\text{Domestic Demand - (MLD)} = \{(P_{\text{rural}} \times 55) + (P_{\text{urban}} \times 135)\} / 1,000,000$$

Where: MLD = Million Litres per Day (daily demand at point of use)

$$\text{Livestock Demand - Population} \times \text{LPCD} / 1,000,000$$

Livestock	Water demand (LPCD)
Cattle	70
Buffaloes	70
Sheep	7.5
Goats	7.5
Horses and ponies	45
Donkeys and mules	35
Camels	50
Pigs	9
Poultry	23 LPCD per 100 birds

C.I.2. Crop Water Demand

Crop water demand is computed using NRSC LULC-derived crop areas and TNAU crop water requirements, explicitly accounting for cropping intensity and multiple cropping to avoid double counting. The steps involved are as follows.

STEP 1 - District wise LULC area extraction

Types of Crop Classes Included	
Agriculture Class	LULC
2	Kharif
3	Rabi
4	Zaid
5	Double/triple/annual (DTA)
7	Plantation

The classes of crops included are then recategorised as follows:

Class	Combination
Total kharif	Kharif + (DTA)
Total rabi	Rabi + (DTA)
Total summer	Zaid + (DTA)
Plantation	Plantation

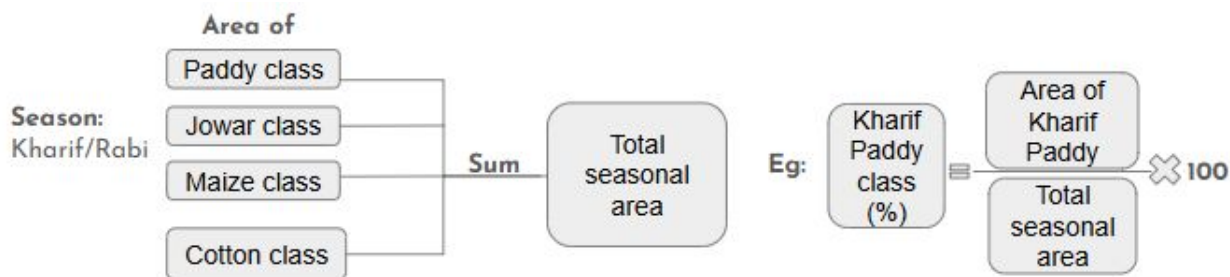
STEP 2 - Selection of 3 normal rainfall years

- Calculation of district wise mean rainfall value for Agricultural year (July - June) for all the years of existing LULC data.
- Calculation of deviation of rainfall from its Long period average.

STEP 3 - Identification and categorization of crops grown in each district and calculating percentage of total crop area using state season and crop [report](#) from [2008 to 2009](#) of the state and Department of Agriculture and Farmers Welfare, [GoI](#).

For calculation of percentage of crops:

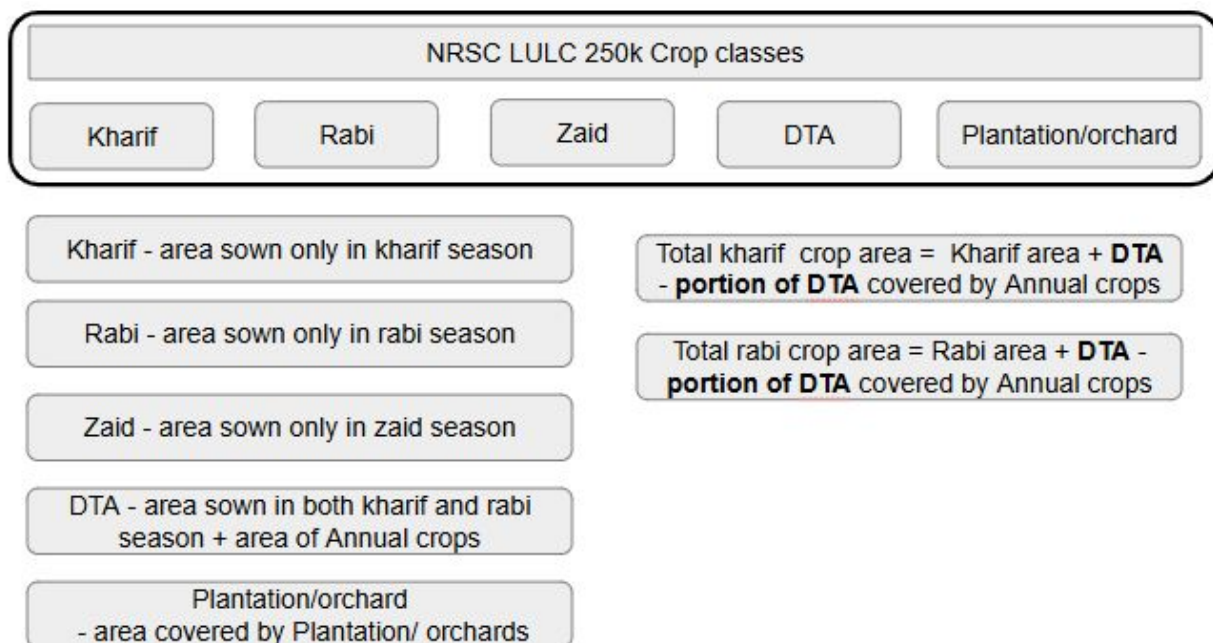
(Kharif or Rabi) Crop class % = Seasonal crop class area / Total seasonal area * 100



Categorize crops into 7 different classes based on similarity in crop duration period and crop water requirement. The 7 different classes will have Kc/ETo value same as that of representative crop of that group.

The Classification is as follows:

- Annual class: (Sugar cane of Sugarcane class) + Vegetables
- Plantation class : (Coconut, Arecanut, Tamarind etc) + (Banana, Grapes etc of Sugarcane class)



Calculation of portion of DTA covered by annual crops: Portion of DTA covered by annual crops = $\frac{\text{Total annual crop area}}{[\text{Total annual crop area} + \text{Sum of Max (Kharif,Rabi crop classes)}]}$

STEP 4: Estimation of monthly crop water requirement

Considering [TNAU](#) total crop water requirement (CWR) and monthly crop coefficient (Kc) values.

Monthly CWR = $(\text{Monthly Kc}/\text{Total Kc}) \times \text{total CWR for a crop}$

STEP 5: Crop area wrt NRSC crop area

The percentage of each crop class to calculate crop area is used, with respect to NRSC crop area for each crop class.

STEP 6: Total agricultural water requirement - $\text{Sum}(\text{Crop area} \times \text{monthly crop ET}_y)$ **C.I.3. Industrial and Commercial Water Demand**

The estimation of industrial water demand for this study followed an iterative process, testing multiple analytical frameworks to ensure regional accuracy. Initial attempts leveraged bottom-up approaches, including extrapolating 2016 District Irrigation Profile (DIP) data, analyzing production volumes from District Industrial Profiles, and deriving demand from workforce statistics. However, these methods consistently yielded significant underestimations. DIP data was found to be outdated and disconnected from recent industrial surges, while production and workforce data failed to capture invisible water use in auxiliary processes and the high water footprint of informal MSME clusters.

To address these gaps, the study transitioned to a top-down economic approach, linking industrial output measured via Secondary Sector Gross District Domestic Product (GDDP) to resource consumption through Water Intensity factors. By categorizing all 38 districts into a 4-Tier Intensity Scale, we were able to calibrate demand based on the actual "water-per-rupee" footprint of each district's specific economic mix (e.g., textiles vs. electronics). This GDDP-based model proved most robust, as it accounts for total economic value added, thereby encompassing the full spectrum of formal and informal water requirements that earlier bottom-up methodologies failed to register.

Category	Intensity (L / ₹1)	Sector Mix Context	Districts
Critical Hub	3	Massive wet-process manufacturing	Erode
High Impact	2	Heavy Industry + high infra growth	Cuddalore, Kanchipuram, Karur, Ranipet, Thoothukudi, Tirupathur, Tiruppur, Vellore,
Moderate	1.2	Mixed MSME, Cement, and Housing	Ariyalur, Chengalpattu, Dindigul, Nagapattinam, Namakkal, Salem, Perambalur, Ramanathapuram, Tiruchirapalli, Tirunelveli
Standard	0.8	General manufacturing & Urban construction	Chennai, Coimbatore, Dharmapuri, Kallakurichi, Kanyakumari, Krishnagiri, Madurai, Mayiladuthurai, Pudukkottai, Sivagangai, Tenkasi, Thanjavur, The Nilgiris, Theni, Thiruvallur, Thiruvavur, Villupuram Thiruvannamalai, Virudhnagar

Estimated District-wise Water Demand for 2025

Sl. No.	Districts	Domestic	Industrial	Crop	Total Demand
1	Ariyalur	0.025	0.098	0.92	1.043
2	Chengalpattu	0.218	1.732	1.34	3.290
3	Chennai	0.255	0.707	0	0.962
4	Coimbatore	0.209	0.709	0.19	1.108
5	Cuddalore	0.108	0.561	2.17	2.839
6	Dharmapuri	0.054	0.129	1.87	2.053
7	Dindigul	0.183	0.339	2.45	2.972
8	Erode	0.115	1.174	2.82	4.109
9	Kallakurichi	0.069	0.089	1.85	2.008
10	Kancheepuram	0.090	1.302	0.96	2.352
11	Kanyakumari	0.129	0.186	0.71	1.025
12	Karur	0.053	0.31	1.14	1.503
13	Krishnagiri	0.124	0.409	1.22	1.753
14	Madurai	0.163	0.317	2.49	2.970
15	Mayiladuthurai	0.033	0.047	1.09	1.170
16	Nagapattinam	0.024	0.134	0.8	0.958
17	Namakkal	0.142	0.305	1.2	1.647
18	Perambalur	0.010	0.037	0.91	0.957
19	Pudukkottai	0.062	0.091	3.85	4.003
20	Ramanathapuram	0.055	0.092	1.19	1.337
21	Ranipet	0.065	0.332	1.36	1.757
22	Salem	0.173	0.544	1.7	2.417
23	Sivaganga	0.058	0.1	2.72	2.878
24	Tenkasi	0.059	0.147	1.16	1.366
25	Thanjavur	0.092	0.171	3.45	3.713
26	The Nilgiris	0.027	0.057	0.08	0.164
27	Theni	0.057	0.094	0.98	1.131
28	Thiruvallur	0.271	0.848	1.58	2.699
29	Thiruvarur	0.043	0.121	2.26	2.424
30	Thoothukudi	0.090	0.396	1.07	1.556
31	Tiruchirappalli	0.123	0.297	3.69	4.110
32	Tirunelveli	0.079	0.26	1.69	2.029
33	Tirupathur	0.073	0.304	0.53	0.907
34	Tiruppur	0.162	2.295	0.6	3.057
35	Tiruvannamalai	0.100	0.239	4.77	5.109
36	Vellore	0.063	0.441	0.58	1.084
37	Viluppuram	0.101	0.134	3.06	3.295
38	Virudhunagar	0.097	0.246	1.38	1.723
	Total =	3.854	15.794	61.83	81.478

Note: All values are in BCM (Billion Cubic Meters)

Estimated District-wise Water Demand for 2035

Sl. No.	Districts	Domestic	Industrial	Crop	Total Demand
1	Ariyalur	0.028	0.204	0.84	1.072
2	Chengalpattu	0.339	4.084	1.39	5.813
3	Chennai	0.274	1.734	0	2.008
4	Coimbatore	0.255	1.699	0.35	2.304
5	Cuddalore	0.123	1.34	2.16	3.623
6	Dharmapuri	0.058	0.336	1.75	2.144
7	Dindigul	0.223	0.826	3.74	4.789
8	Erode	0.132	2.704	3.2	6.036
9	Kallakurichi	0.091	0.221	2.06	2.372
10	Kancheepuram	0.158	3.081	1.09	4.329
11	Kanyakumari	0.180	0.46	1.16	1.800
12	Karur	0.064	0.655	0.64	1.359
13	Krishnagiri	0.217	0.87	0.93	2.017
14	Madurai	0.203	0.765	2.1	3.068
15	Mayiladuthurai	0.039	0.113	1.22	1.372
16	Nagapattinam	0.026	0.588	1.11	1.724
17	Namakkal	0.198	0.676	0.77	1.644
18	Perambalur	0.007	0.08	0.49	0.577
19	Pudukkottai	0.074	0.196	4.26	4.530
20	Ramanathapuram	0.063	0.111	1.61	1.784
21	Ranipet	0.086	0.682	2.32	3.088
22	Salem	0.197	1.142	1.41	2.749
23	Sivaganga	0.068	0.248	1.77	2.086
24	Tenkasi	0.065	0.321	0.96	1.346
25	Thanjavur	0.099	0.503	3.8	4.402
26	The Nilgiris	0.025	0.139	0.14	0.304
27	Theni	0.065	0.225	0.58	0.870
28	Thiruvallur	0.416	1.823	1.47	3.709
29	Thiruvarur	0.047	0.469	2.91	3.426
30	Thoothukudi	0.114	0.803	0.81	1.727
31	Tiruchirappalli	0.135	0.534	4.24	4.909
32	Tirunelveli	0.088	0.573	2.55	3.211
33	Tirupathur	0.098	0.633	0.66	1.391
34	Tiruppur	0.211	6.076	0.86	7.147
35	Tiruvannamalai	0.115	0.712	5.49	6.317
36	Vellore	0.077	0.912	0.32	1.309
37	Viluppuram	0.123	0.336	3.49	3.949
38	Virudhunagar	0.115	0.532	0.85	1.497
	Total =	4.896	37.406	65.5	107.802

Note. All values are in BCM (Billion Cubic Meters)

C.II.1. Water Source Mapping and Supply Quantification

The analysis follows a four-stage process using Google Earth Engine (GEE) to identify, vectorise, and measure the volumetric potential of water bodies across Tamil Nadu's districts for satellite-based mapping of water resources through the following steps

STEP 1: Establishing the "Permanent" Water Baseline

Instead of looking at a single satellite image (which might be affected by a specific rain event or cloud cover), the JRC Global Surface Water (GSW) dataset is used.

- Long-term Observation: Dataset analyzes over 38 years of Landsat satellite imagery.
- Occurrence Filtering: A 30% occurrence threshold is applied which allows only pixels classified as "water" if satellite sensors detected water in that exact location for at least 30% of all observations over the last several decades. This helps us ignore temporary puddles or monsoon-only flooding while capturing persistent tanks and reservoirs.

STEP 2: Morphological Cleaning & Noise Removal

Raw satellite data discontinuity (single pixels of water) or tiny gaps within a lake.

- Focal Filtering: Mathematical morphology (max/min filters) to smooth the edges of water bodies and fill tiny holes are used
- Size Constraints: To ensure the data is actionable for the Water Board, we set a Minimum Area Threshold of 0.5 hectares. Anything smaller than this is removed, ensuring the final list focuses on significant irrigation tanks, ponds, and reservoirs rather than smaller false water bodies.

STEP 3: Vectorization and Geometric Profiling

The grid-based satellite data is converted into GIS Polygons. For every identified water body, we calculate:

- Exact Surface Area: Measured in square meters (m^2), hectares (ha), and square kilometers (km^2).
- Geographic Centroids: Precise Latitude and Longitude coordinates are assigned to the center of each water body to enable field teams to locate them via GPS.
- Area Categorization: We bin the water bodies into five classes (from Class A: <10ha to Class E: >1000ha) to help prioritize large-scale storage management versus smaller community ponds.

STEP 4: Integrating Depth and Volumetric Modeling (GLOBathy)

To move beyond surface area and understand storage capacity, the GLOBathy (Global Bathymetric) dataset is integrated

- Depth Sampling: Overlay the water body polygons on high-resolution bathymetric maps.
- Statistical Breakdown: For every tank, the system extracts the Mean Depth and Maximum Depth. By multiplying the surface area by the mean depth, the Water Storage Potential of each district's infrastructure is estimated

STEP 5: Using mean depth for data gaps

- In each class of lake, a mean depth was further calculated and used for the lakes without any data captured. This was repeated for all the classes in each district.
- Further, the area was multiplied by the mean depth, and volume was estimated for each water body and the total storage has been calculated.

Limitations of the methodology: The framework has temporal latency, as the foundational JRC dataset establishes a climatological baseline terminating in 2021, rendering it outdated for capturing contemporary morphological alterations like recent illegal encroachments or state-sponsored desilting interventions. Furthermore, spatial resolution constraints reduces the model's localized efficacy. Landsats' 30-meter pixel threshold obscures narrow, traditional distributaries and micro-irrigation channels, which underrepresents the region's complex hydrological connectivity.

The GLOBathy model exhibits bathymetric inaccuracies in low-relief topography. By relying on topographical heuristics rather than empirical sonar soundings, it miscalculates true volumetric capacity in flat deltaic zones. This attributes shallow profiles to deeply excavated reservoirs. Also, this structural flaw is exacerbated by threshold arbitrariness, where stringent water-occurrence parameters inadvertently filter out critical water bodies. Such parameters generate systemic false positives by temporarily inundated paddy fields with permanent aquatic ecosystems. Persistent monsoonal cloud cover creates substantial data vacuums during peak inundation periods. The obstructions of *Eichhornia* (Water Hyacinth) infestations, are misclassified by sensors as terrestrial vegetation, blurring substantial underlying water volumes.

C.II.2. Groundwater Extraction and Treated Wastewater supply

Annual extractable groundwater resource estimates were adopted from the 2024 [Dynamic Ground Water Resources](#) of India assessments, which were jointly conducted by the Central Ground Water Board (CGWB) and the respective State Ground Water Departments.

Treated wastewater supply is estimated by accounting for treated wastewater generated from Sewage Treatment Plants (STPs) across districts. For Chennai, additional supply from operational desalination plants and the treated wastewater supply estimation was incorporated based on installed treatment capacity and CMWSSB official data interviews.

C.II.3. Inter-State Water transfer supply

For estimating interstate water transfers, major reservoirs in Tamil Nadu that received inflows from neighbouring states were considered, including Mettur, Poondi, Aliyar, Bhavanisagar, and Mullaperiyar. The interstate supply was estimated by identifying these reservoirs and quantifying Tamil Nadu's allocated share of inflows. The estimated volumes were then distributed across beneficiary districts based on the extent of irrigation command areas and allocations made for significant drinking water projects.

C.III. Crop Economic Water Productivity

The source for crop-wise yield and area under cultivation was sourced from [DES](#). As the latest data available in the DES database is up till 2022-23, projected yield for 2024-25 was calculated and used for this analysis. Crop water requirement is sourced from [TNAU](#) where available to be as relevant to TN as possible; the rest come from wider literature. District-wise crop-wise prices for 2024-25 are sourced from [Agmarket](#) where available, and for the rest either MSP or market prices for 2024-25 were used.

Due to a lack of adequate seasonal yield & price data, simple averages of district-level values were used to arrive at state-level yield and price estimates for each crop. The revenue generated per hectare is calculated by multiplying the state-level average projected yield for each crop (in tonnes/ha) with the average price (in INR/tonne). The size of the bubbles is determined by the total area under cultivation for each crop (in hectares)

Estimated District-wise Water Supply for 2025

Sl. No.	Districts	Inflow into Storage	GW	Non_Convventional	Runoff	Interstate
1	Ariyalur	0.126	0.373	0.002	0.461367857	
2	Chengalpattu	0.053	0.628	0.002	0.767258032	
3	Chennai	0.048	0.089	0.500	0.157957305	0.1785
4	Coimbatore	0.120	0.563	0.080	0.27270504	0.4918
5	Cuddalore	0.097	1.069	0.008	1.03040328	
6	Dharmapuri	0.017	0.479	0.002	0.280119587	
7	Dindigul	0.041	0.536	0.005	0.390104839	0.0384
8	Erode	0.063	0.822	0.020	0.187269394	0.8417
9	Kallakurichi	0.115	0.590	0.001	0.638340705	
10	Kancheepuram	0.266	0.535	0.009	0.542635048	0.0444
11	Kanyakumari	0.215	0.323	0.006	0.112940852	
12	Karur	0.024	0.292	0.005	0.223252823	0.1143
13	Krishnagiri	0.095	0.505	0.003	0.28981474	
14	Madurai	0.142	0.708	0.062	0.323769529	0.2029
15	Mayiladuthurai	0.060	0.409	0.002	0.807221897	0.4006
16	Nagapattinam	0.794	0.324	0.005	0.834121916	0.3225
17	Namakkal	0.156	0.524	0.005	0.163134729	0.0077
18	Perambalur	0.011	0.260	0.002	0.31499989	
19	Pudukkottai	0.492	0.962	0.004	0.594263559	
20	Ramanathapuram	0.215	0.549	0.003	0.507933743	0.2036
21	Ranipet	0.048	0.301		0.390570474	
22	Salem	0.805	0.475	0.037	0.31718147	0.011
23	Sivaganga	0.223	0.704	0.007	0.447368335	0.1157
24	Tenkasi	0.114	0.537		0.788537976	
25	Thanjavur	0.289	1.046	0.019	0.268073599	0.3629
26	The Nilgiris	0.364	0.072	0.002	0.159417299	
27	Theni	0.000	0.270	0.012	0.190809515	0.0419
28	Thiruvallur	0.497	0.752	0.018	0.34374713	0.1432
29	Thiruvarur	0.409	0.480	0.005	0.645041842	0.3934
30	Thoothukudi	0.929	0.775	0.012	0.432472082	
31	Tiruchirappalli	0.150	0.642	0.026	0.364437166	0.0306
32	Tirunelveli	0.520	0.790	0.009	0.161899572	
33	Tirupathur	0.011	0.097	0.010	0.788348515	
34	Tiruppur	0.176	0.634	0.064	0.863740715	0.1064
35	Tiruvannamalai	0.202	0.752	0.003	0.547187318	
36	Vellore	0.009	0.182	0.011	0.222323167	
37	Viluppuram	0.153	0.945	0.005	0.929295433	
38	Virudhunagar	0.054	0.522	0.013	0.400501813	0.0343
	Total =	8.106	20.518	0.976	17.16056819	4.0858

Note. All values are in BCM (Billion Cubic Meters)

Annexure D

Key Informant Interviews for Roadmap

Expert	Challenges	Opportunities
Mr Ashok Natarajan <i>(Former CEO, TWIC)</i>	• Rainwater harvesting structures are poorly maintained and storage strategies are nonexistent, forcing reliance on water tankers • Many projects remain stuck in the planning phase with unimplemented budgets, leading to asset deterioration • Inconsistent supply from Metro Water and inefficient pumping operations forces industries/commercials/residences to disconnect from central grid • Inadequate maintenance and operational management of supply infrastructure, is leading to rapid structural and water loss • Inefficiencies in sewage treatment plants across the state and its lengthy execution timeline hinder the ability to reuse water effectively	• Treatment & reuse of used water can be explored in Agriculture to reduce extraction of freshwater • Increase the implementation of hybrid water management which will combine government funding with private investment that enhances O&M • Adopting integrated water supply with Stormwater harvesting can boost urban water resilience • Regulatory body office to be established which oversee water allocation, extraction and management efficiency • Integration of ICT for real-time monitoring and forecasting alongside exploration in small bore technology can help upgrade physical infrastructure and improve pollution mitigation

Expert	Challenges	Opportunities
Mrs Rangalakshmi Raj <i>(Executive Director – MS Swaminathan Research Foundation)</i>	•Shift from community-managed tanks to government control has diminished local ownership and participation •Restoration of larger tanks is severely hampered by encroachment, invasive species, and insufficient funding (specifically, within the <i>Kudimaramuthu</i> scheme) •Agriculture consumes the majority of available water but, use efficiency remains critically low •Detrimental shift observed in cropping patterns towards high water-demanding crops like banana and coconut •Water pollution from industrial centers, such as Tiruppur, has degraded water quality to the point of reducing agricultural land and forcing changes in crop production	•Utilizing schemes like MGNREGA to renovate smaller tanks presents a pathway to secure water specifically for domestic and livestock needs •Promoting projects like small millet cultivation in semi-arid areas (e.g., Kolli Hills) provides a model for reducing agricultural water demand •Ongoing efforts in wetland restoration and the proper demarcation of catchment areas to be increased which can effectively reverse degradation and improve groundwater recharge •Improve resilience by deepening the analysis of behavioral factors affecting irrigation adoption and enhancing data collection

Expert	Challenges	Opportunities
Mr Rajesh Rangarajan <i>(Head – ANVESHAN: Centre of Excellence in WaSH & Waste Management)</i>	• Severe contamination of Cooum and Adyar rivers, alongside industrial pollution in hubs like Coimbatore and Tirupur (from tanning), critically limits the availability of safe water • Shift from comprehensive Master Plans to infrastructure-driven City Development Plans (under JNNURM) led to fragmented development neglecting holistic water resilience • Dual threat from sea-level rise and increased urbanisation severely stresses water resources • Current STPs have significant limitations, failing to treat wastewater effectively for reuse • Disconnect in governance (involving TWAD, CMWSSB, PWD) results in mismanagement and a lack of effective national policy aligned initiatives	• Additional to centralized systems, decentralized water treatment facilities offers a significant opportunity to improve local management and resilience • Introducing water pricing mechanisms can serve as a powerful economic instrument to regulate demand and fund conservation efforts • Leveraging innovations in water quality monitoring can provide the real-time data necessary to manage contamination and improve supply reliability • Establishing robust regulatory frameworks specifically for groundwater usage can balance the extraction ratio • Shift the governance paradigm to prioritize water conservation over pure infrastructure expansion, utilizing available data for better decision-making

Expert	Challenges	Opportunities
Mr Vivekanandan (Retd. Chief Engineer TWAD Board)	•Water management is severely hampered by a lack of basin-level planning; responsibilities split across WRD, TWAD, and local bodies leads to siloed projects failing from lack of connectivity and need •Behaviour among farmers and rural residents that land ownership gives right to extract groundwater, leads to over-extraction •Increased water supply (via JJM) has led to a surge in wastewater generation, without proper treatment networks leading to pollution •Despite bulk supply efforts, rural supply suffers from poor monitoring and unauthorized tapping, with losses reaching 20–25% causing inequity •Tanks under ULBs gets encroached & block link channels and distributaries which disconnects the system, causing tanks to dry up	•Massive opportunity exists to reduce freshwater dependence by expanding recycling capacity to 6000 MLD •Empowering the PWD/WRD to act as a Basin Manager, offering central approval for all water projects (including for local bodies) would fix the disconnected drainage and storage systems •Only 20% of industrial demand requires high-grade (TTRO) water. Incentivising industries to set-up DSTPs can save money and water •Flow sensors and online water quality monitoring for STPs and industries can help detect leakages, enforce regulations, and have a data-driven safe withdrawal limit for aquifers •Desiltation of tanks and ponds offers high-impact, lower-cost method to immediately boost local groundwater recharge and storage

Expert	Challenges	Opportunities
Mr M R Jaishankar (CMWSSB)	•Supply in Chennai relies on surface water for 60% but lacks adequate reservoir capacity to store excess water •Desalination is unviable long-term due to high power consumption, environmental concerns, and exorbitant operational costs (₹43–65/m³) •City relies heavily on groundwater extraction, but has poor monitoring, inadequate mapping, and a lack of regulation on extraction •Long-distance water transfers (ex. Palar basin) to be discouraged due low reliability (~30%), synchronization issues with monsoons, and growing demand in the source regions •Current water tariffs do not cover operational costs, and high NRW combined with the high cost of treatment and transmission	•Circular economy by integrating treated wastewater into the main distribution system could enable a 24×7 water supply •Porur Lake project demonstrates a proven model for indirect potable reuse replication that is climate-resilient •Decentralized water and sewage systems offers superior climate resilience, allowing for closer control, better monitoring of quality, and reduced dependence on centralized infrastructure •Bank Filtration (Europe Model) which involves filling rejuvenated ponds with rainwater or treated wastewater, allows natural soil filtration to purify the water before it is extracted than deep injection well •Graded or telescopic tariff system for high-consumption users pay more while slums can remain subsidized

Expert	Challenges	Opportunities
Ch. Raja (WWF)	• Translating basin-wise water budgets to district-wise water budgets • The state relies on groundwater for 60–70% of its water needs, yet the entire resource is governed by a single government order (G.O. 142) rather than a comprehensive legal act • Unregulated agricultural exploitation accounts for 70–80% of total groundwater extraction, and the complete absence of pricing eliminates any financial incentive for demand management • Rapid urban sprawl routinely bypasses extraction norms, with commercial water tankers in fast-developing corridors like OMR/ECR ignoring the 600-meter spacing rule to illegally cluster borewells just 5 to 20 meters apart • Water resource governance is severely hindered by siloed institutional expertise, resulting in surface water and groundwater being managed in complete isolation; in practice	• Valley areas in Coimbatore (which receives bimodal rainfall of 600mm) retain shallow water levels, offering specific zones of water security • Introducing a stepped pricing model provides a pathway to establish water's economic value, scaling from nominal rates of 5 to 10 paise per 1,000 liters up to ₹1 to ₹3+ for daily extractions of 25 to 200+ units • Forming a unified Regulatory Authority creates the legislative leverage needed to curb illegal extraction • Structuring formal distress-year protocols allows for systematic deficit management by capping domestic supply at a 50–70 LPCD baseline and strategically utilizing the dead storage of 83 state reservoirs

Annexure E

Field Visit - Tiruppur 20th - 21st January, 2026

Representatives	Documents	Key Observations
- Mr Manish S. Narnare IAS (<i>Tiruppur collector</i>) -Mr. Narayanan (<i>AE, statistical department</i>) - Mr. Shanmugaraj (<i>Fellow SPC, Tirupur</i>) -Mr. Narendran (<i>AEE – WRD</i>) -Mrs. Selvirani (<i>EE - TWAD – board</i>) -Mrs. Lavanya (<i>AE - TNPCB- flying SQUAD</i>)	•Tiruppur District Profile with CWSS data from TWAD Board • Recent TDS measurement for 12 monitoring stations in Noyyal River from TNPCB Flying squad • District G-Return data for Fasli Year - 2024-25 from Dept. of Economics and Statistics	•Notable agricultural shift from cotton to dryland crops like maize, primarily driven by water availability and changing conditions seen •PAP canal system operates with water only released once every two years to zones receiving it, highlighting a significant irrigation deficit •New dam proposed (Nallar/Anaimalaiyar), with existing domestic pipelines aging, that requires upgradation •current water supply and STP planning exclude the floating population which creates a gap in future water demand •TWAD Board faces a revenue deficit, with production costs (Rs. 18) exceeding supply costs (Rs. 14), alongside the challenge of high industrial tariffs in New Tiruppur Area Development Corporation Limited (NTACL) driving industries to more groundwater usage •Small industries are suspected of releasing untreated waste during night hours, and drone monitoring was suggested for better enforcement •Electroplating industries in Coimbatore contribute significantly to high TDS levels (starting at 1000 TDS) before the river even enters Tiruppur, further increasing to another 400 – 600



Figure 4.9: District officials meeting with the honorable Collector of Tiruppur. Source: WELL Labs, 2026



Figure 5.0: A visit to the sewage treatment plant at Tiruppur. Source: WELL Labs, 2026

Field Visit - Kanyakumari

22nd - 23rd January, 2026

Representatives	Documents	Key Observations
- Mrs. Jasmine Sheeba (AE/TWAD) - Mrs. Ananthi (AEE/TWAD) - Mr. Gerald Paul (AE/TNPCB) - Mr. Solomon Suresh (AEE/WRD)	• Technical profile of Prakkani Check Dam working as a tail end regulator from WRD • Details of CWSS from TWAD Board • Details of Kodayar Irrigation System from WRD • District G-Return data for Fasli Year - 2015-16 and 2024-25 from Dept. of Economics and Statistics	• The region demonstrates successful water planning with 5 connected reservoirs, allowing for 60–70% canal irrigation coverage for major crops like coconut, banana, and paddy • Pallaiyar River is heavily polluted due to domestic sewage discharge, and the current infrastructure—one STP with 19 MLD capacity—proving insufficient to handle the load • Groundwater is generally safe, found at depths as shallow as 2m; Rajakanmangal region is identified as semi-critical • In Tirunelveli border villages, water supply is critically low, providing only 25–35 LPCD, against the norm of 55 LPCD, with a frequency of twice a week • In Border villages, municipal water is rendered unsafe with high TDS borewell water (caused by geogenic factors and low rainfall). It is mixed with river water in sumps before distribution. This further increases burden and cost of water with reliance on private tankers • In coastal areas, high TDS levels have made household RO systems a necessity; Water ATMs in the area to bridge the cost are suffering from maintenance issues

Field Visit - Kanyakumari

22nd - 23rd January, 2026

Representatives	Documents	Key Observations
		•The use of high-HP motors by some households, with municipal connections, depletes pressure and reduces supply for neighbors and tail-end areas in coastal villages •Sharp contrast seen in villages without direct access to rivers, ponds, or tanks to face high water scarcity, unlike the canal-irrigated zones •Encroachment of tanks observed in visited areas for land conversion to construction •In Tirunelveli villages, cropping is mostly flowers, vegetables and coconut plantations



Figure 5.1: District officials meeting at DRDA Kanyakumari. Source: WELL Labs, 2026



Figure 5.2: Site visit with officials in Kanyakumari. Source: WELL Labs, 2026

Field Visit - Kancheepuram

28th - 29th January, 2026

Representatives	Documents	Key Observations
- Tmt. K Aarthy (<i>Project Director, DRDA</i>) - <i>Secretary, District Panchayat & District Planning Office</i> - Officials from TWAD Board, WRD, and Irrigation Dept.	• Details of CWSS from TWAD Board • Flow diagram of CWSS to Salavakkam & 6 other habitations from TWAD Board • District groundwater profile from WRD	• With CMA expansion 22 village panchayats will move to municipal corporation. When a Panchayat becomes an urban ward, it loses the benefits of being rural without immediately gaining the infrastructure of a city. They fall into a governance limbo especially for water and sanitation. • Greywater management is strictly needed in peri-urban areas like Padappai towards Chennai • There are 380 tanks irrigation 24,720 ha of area. Desilting of these tanks is done only through large projects by world bank. Farmers can collect silt from the tank if there is a G.O and tehsildar approves. Field channels are maintained by WUAs. • There are 2 CETPs - 1 each for electroplating industries and silk dyeing industries. • No significant drop in groundwater table is observed in recent years. • Farmers have shifted from paddy to groundnut as the 3rd crop • Non-revenue water is controlled under 20% • MGNREGS was the single largest scheme for water conservation • Sand-mining has altered the flow in Palar river and reduced groundwater recharge • There is a 14.3 MLD waste stabilization pond and a 36 MLD STP is under construction.



Figure 5.3: District officials meeting at Kancheepuram. Source: WELL Labs, 2026



Figure 5.4: Eutrophication of a lake in Kancheepuram. Source: WELL Labs, 2026

Field Visit - Thiruvavarur

28th - 29th January, 2026

Representatives	Documents	Key Observations
-Mr V. Mohanachandran, IAS (District Collector) -Mr T. Santhanam (District Planning officer) - Mr T. Ashok Kumar (Block Fellow, FBDD-DPO) -Mrs M. Geetha (Statistical Inspector) -Mr Ramesh Babu (AD - Panchayat) - Mr S.Manikavel (AEE - WRD) -Mr T. Vinoth (AE - WRD) -Mr K. Kannadasan (AEE - TWAD) -Mr B. Dhayazhasamy (AE - TWAD) -Mr C. Arulmudhan (Deputy Hydrologist, TWAD) -Mr K. Ramalingam (Asst. Hydrologist, TWAD) -Mr S. Kathir K (Jr. Water Analyst)	• Details of CWSS for Village Panchayats from TWAD Board • Water Charger - Assessments Gap for Tamil Nadu • District G-Return data for Fasli Year 2024-25 from Dept. of Economics and Statistics	•Single collection well is working at 24hrs beyond its design capacity (18hrs) with a defunct second indicating infrastructure strain •Out of 7 blocks, 3 blocks of the districts are facing water scarcity during non-rainy months •Ground water consumption quality reduces beyond 3 to 4 meters with salinity intrusion observed, 10m from the coastline at 2m depth •Udayamandal area has been proposed for a new storage structure fed by rainwater, for use in irrigation and drinking purposes •26 tanks spread across the districts under the maintenance of WRD are currently running low on storage due to siltation, 90% of canals are unlined, to be desilted •Green manure on agriculture fields has been recommended by the department to farmers to reduce the EC of water •Drip irrigation preferred in fields to save water and labor costs •Cultivation of pulses has decreased due to salinity issues, and labor shortages has pushed farmers to shift to paddy •TDS difference of 1000 seen between borewell water and agriculture field water; TDS levels in canal waters approx.12 km from the coastline were found to be more than 1800

Field Visit - Thiruvarur

28th - 29th January, 2026

Representatives	Documents	Key Observations
- Mrs Hema Hepzebah (Deputy Director of Agriculture) -Mr J. Sudharsan (AE - TNPCB) -Mrs V. Renuga (Agriculture Officer) -Mrs S. Bhuvaneshwari (Asst. - DPO)		·Water tax collection at 46% to be improved with Rs 600/0 per HH (2024-25) ·With 75% of UGD coverage in Mannargudi municipality of the district is under expansion to other parts. HH sewage is cited to pollute canals and ponds ·Dedicated groundwater monitoring well is absent in the district with issues of legacy waste ·Tail-end regulators effectiveness to reduce saltwater intrusion to be verified with field studies apart from their efficient use for flood water control from landward and seaward side ·Water plan for distribution during peak drought periods of May and June yet to be clearly laid out ·Farmers report drilling for water up to depth of 420 feet with hard Rock layer found at 120-foot mark ·Water storage structures are proposed as a viable option for agriculture fields and drinking water purposes to store water year-round



Figure 5.5: District officials meeting with the honorable Collector of Thiruvavur. Source: WELL Labs, 2026



Figure 5.6: Site visit to meet farmers at a coastal stretch in Thiruvavur. Source: WELL Labs, 2026

Annexure F

Roundtable discussion I - Water Quality 28th January, 2026

Attendees: Prof. R. Saravanan (Director, CWR, Anna University), Dr. Senthilkumar (Senior Scientist CGWB), Mr. Gopal (CWA, TWAD Board), Ms. Subha (DCE O&M, TWAD Board), Dr. Vanitha Murugaiyan (DEE Manali, TNPCB), Er. T. Manimehalai (DEE Chennai, TNPCB), Mr.Chandrasekhar (AOL), Mr. Rajkumar (Hand in Hand), Mr. Selvaraj (NRM, Hand in Hand), Ms.Indumathi Eeswaramoorthy (Real Tech GPS), Dr. Chandrika

Discussion Points	Insights
Ø Do the STPs across the state have required capacity and treatment efficiency? Ø How is monitoring taken up for polluting industries? Ø How does land use planning affect the water use? Ø What are remedial measures taken to improve water quality?	• Fish species like Tilapia in ponds is seen as a biological indicator, for water quality loss depicting its deterioration • Lake and tank rejuvenation under SBM 3.0 should not be done in isolation but with entire interconnected chain of tanks • Strict monitoring is required to ensure that bad quality water does not enter rainwater harvesting pits, and borewell recharge in industrial zones must be managed carefully to prevent effluent mixing • Planning strategies need to shift from an infrastructure-centric approach to an environment-centric one, where land use is strictly categorized based on climate, terrain, and water availability • Rural strategies should focus on incentivizing behavioral change and ensuring greywater is tested before reuse, whereas urban strategies should focus on penalization and implementing dual piping systems • Dedicated State Water Quality Cell spanning TNPCB, TWAD Board, and CGWB is urgently needed to coordinate monitoring and enforcement efforts



Figure 5.7: Water quantity roundtable session at IIT Madras. Source: WELL Labs, 2026



Figure 5.8: Water quantity roundtable with TWAD, CGWB, TNPCB and academic scholars. Source: WELL Labs, 2026

Roundtable discussion II - Water Quantity

28th January, 2026

Attendees: Mr. Janakarajan Srinivasan (MIDS), Mr. E. Nandakumar (ICCW), Dr. Senthilkumar (Senior Scientist, CGWB), Mr. K. Vivekanandan (Retd. Twad Board), Prof. Elango L (IIT Madras), Prof. Ashwin Mahalingam (IIT Madras), Prof. Sudhir Chella Rajan (IIT Madras), Prof. Balaji Narasimhan (IIT Madras), Ms. Indumathi Eeswaramoorthy (Real Tech GPS), Ms. Sujatha Srinivasan (IFMR), Dr. Sakthivel (Director, Stone Hands), Prof. Kurian Joseph (IIT Madras)

Discussion Points	Insights
Ø Does Tamil Nadu have adequate domestic water supply in rural and urban areas? How can we move beyond building infrastructure to ensuring a reliable, climate-resilient water supply by 2035?	· Tamil Nadu faces acute water scarcity with a per capita availability of only 800 cubic meters, significantly lower than the national average of 1,400 cubic meters · With an urbanization of 48.56%, rapid development has drastically increased surface runoff preventing natural water infiltration and exacerbating local shortages · The state's geological makeup, characterized by hard rock aquifers, makes natural groundwater recharge difficult while simultaneously increasing surface runoff
Ø How are the surface water and groundwater availability changing across the districts at present? What strategic shifts are needed to ensure long-term availability?	· There is a widening gap between groundwater consumption and recharge rates, threatening the sustainability of the resource · Tamil Nadu possesses the highest number of micro-waterbodies in the country, offering a massive, decentralized opportunity for water conservation if properly managed
Ø How are the farmers faring in terms of current water availability? How can we help farmers transition toward higher economic productivity per drop of water?	· To improve water security, the yield of the state's 17 major catchments and sub-catchments must be improved through integrated basin-level management strategies · Current sanitation projects often construct STP treatment plants before laying pipelines, a sequence that should be reversed to ensure design performance

Roundtable discussion II - Water Quantity

28th January, 2026

Discussion Points	Insights
Ø As Tamil Nadu grows, how can industries adopt circular water systems and reuse strategies to meet their needs without competing for freshwater? Ø What are the critical gaps in our current water data, and how do we build a high-quality, accessible system to support better planning?	· The Tirupur Municipal Corporation is pioneering a circular economy model by planning to supply 65 MLD of treated water for agricultural irrigation via a central pipeline network · In Chennai, the practice of connecting sewers is shifting from local road networks to direct toilet pipeline connections to accommodate the varying sizes and locations of septic tanks across diverse land parcels · The restoration of the OMR lake stands as a successful model for reviving urban water bodies and should be replicated across other districts



Figure 5.9: Water quality roundtable discussion with ICCW, IFMR, CGWB and MIDS at IIT Madras. Source: WELL Labs, 2026



Figure 6.0: Water quality roundtable discussion with ICCW, IFMR, CGWB and MIDS at IIT Madras. Source: WELL Labs, 2026



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