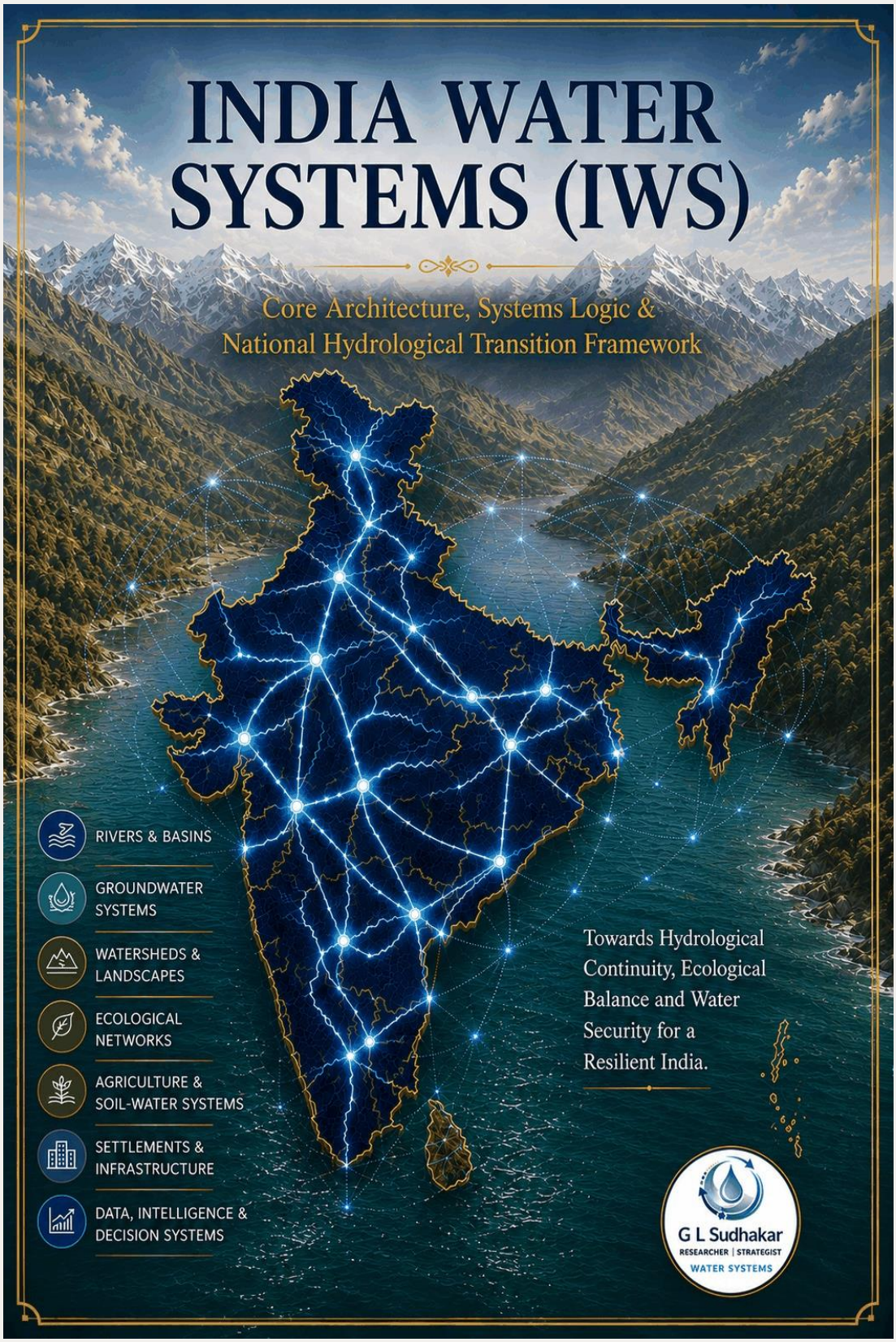

INDIA WATER SYSTEMS (IWS)
Core Architecture, Systems Logic & National Hydrological Transition Framework
RIVERS & BASINS
GROUNDWATER SYSTEMS
WATERSHEDS & LANDSCAPES
ECOLOGICAL NETWORKS
AGRICULTURE & SOIL-WATER SYSTEMS
SETTLEMENTS & INFRASTRUCTURE
DATA, INTELLIGENCE & DECISION SYSTEMS
Towards Hydrological Continuity, Ecological Balance and Water Security for a Resilient India.
G L Sudhakar
RESEARCHER | STRATEGIST
WATER SYSTEMS

INDIA — A WATER CIVILIZATION

The National Hydrological Foundation

India is not a single water system.

It is one of the world's most hydrologically diverse and territorially unequal water landscapes.

Across the subcontinent: water behaves differently, rain behaves differently, rivers behave differently, groundwater behaves differently, and civilizations evolved differently in response to these conditions.

In the Himalayas, water descends from glaciers and snow-fed river systems that sustain some of the largest floodplains on Earth. Across the Indo-Gangetic plains, sediment-rich rivers created agricultural civilizations dependent on seasonal inundation, alluvial groundwater, and monsoon variability. In Western India, scarcity shaped settlement behaviour, storage systems, stepwells, tanks, and drought-adapted cultures. In Peninsular India, hard-rock geology fundamentally altered how water could be stored, extracted, and sustained. Along the coasts, delta systems, estuaries, mangroves, saline intrusion, cyclones, and tidal interactions shaped ecological and agricultural systems differently again.

India's water systems are therefore not merely rivers, dams, groundwater, or rainfall. They are civilizational systems.

For thousands of years, settlements, agriculture, trade routes, governance systems, cropping patterns, cultural landscapes, and political power evolved around water availability and seasonal variability. Water determined where cities emerged, where civilizations survived, where agriculture expanded, and where conflict intensified.

The monsoon became more than climate. It became an organizing force of civilization. Even today, India remains one of the most monsoon-dependent large economies in the world. A delayed monsoon affects agriculture, groundwater recharge, hydropower, urban reservoirs, food inflation, migration, energy systems, and economic stability simultaneously.

Yet India's water systems are now entering a period of unprecedented stress convergence. The country faces simultaneous pressures from groundwater depletion, river fragmentation, declining storage systems, ecological degradation, urban expansion, wastewater stress, flood intensification, drought cycles, agricultural pressure, climate variability, coastal salinity intrusion, infrastructure fragmentation, institutional disconnect, and rising water demand. Many of these pressures no longer operate independently. They interact.

One of the defining characteristics of India's water challenge is territorial asymmetry. Water availability is not evenly distributed. Rainfall is highly unequal. Groundwater systems vary dramatically between alluvial basins, hard-rock regions, coastal aquifers, mountain systems, and arid landscapes. This territorial unevenness means that India cannot be understood through a single water narrative. Every region behaves differently.

India's water future will therefore not be determined only by new infrastructure, larger reservoirs, or deeper extraction. It will increasingly depend on system visibility, ecological recovery, groundwater stabilization, urban-water integration, watershed restoration, institutional coordination, and the ability to reconnect fragmented water systems.

The central challenge is no longer simply water availability. It is system response. Rainfall may remain similar in many regions. But if soil systems weaken, tanks disappear, wetlands shrink, rivers fragment, aquifers collapse, urban surfaces harden, or ecological buffers vanish, then the same rainfall no longer produces the same water outcome. This distinction is fundamental.

Rainfall is input. Water security is outcome.

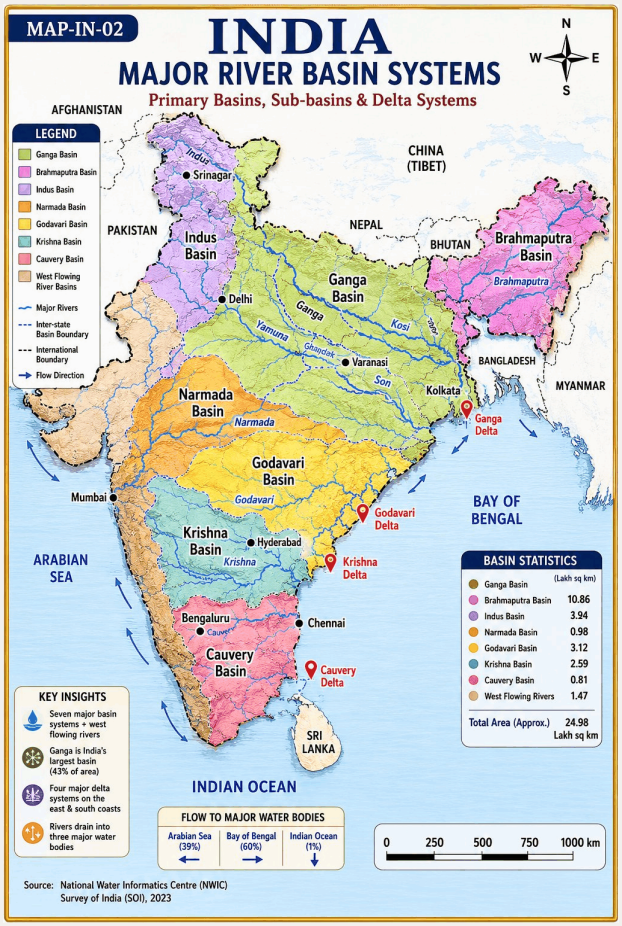
This national framing forms the foundation for understanding South India and, subsequently, Tamil Nadu — one of the most hydrologically stressed, historically engineered, and system-dependent water landscapes in India.



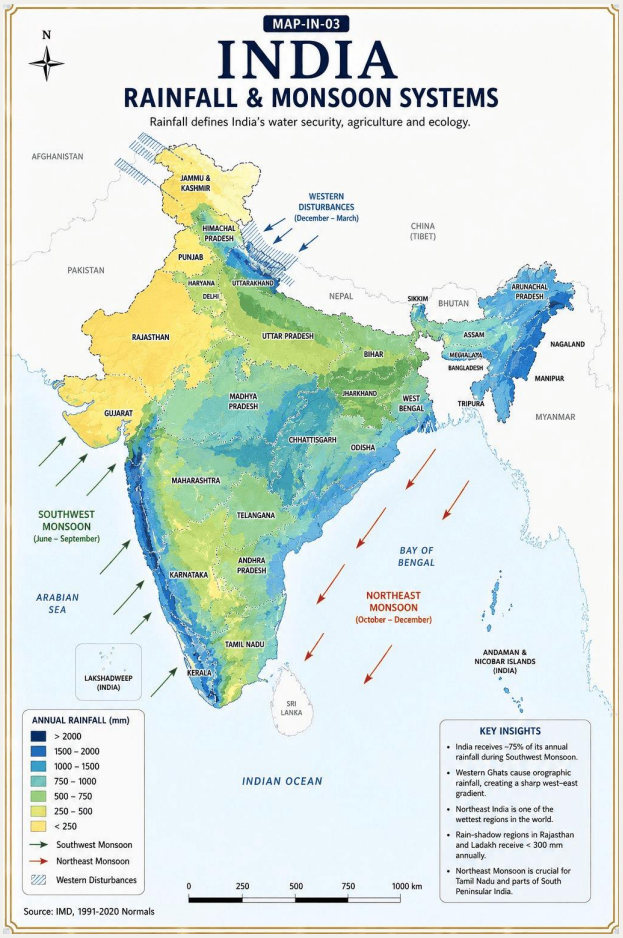
MAP-IN-01 | India Political Map — States & Union Territories | Source: Survey of India, 2023



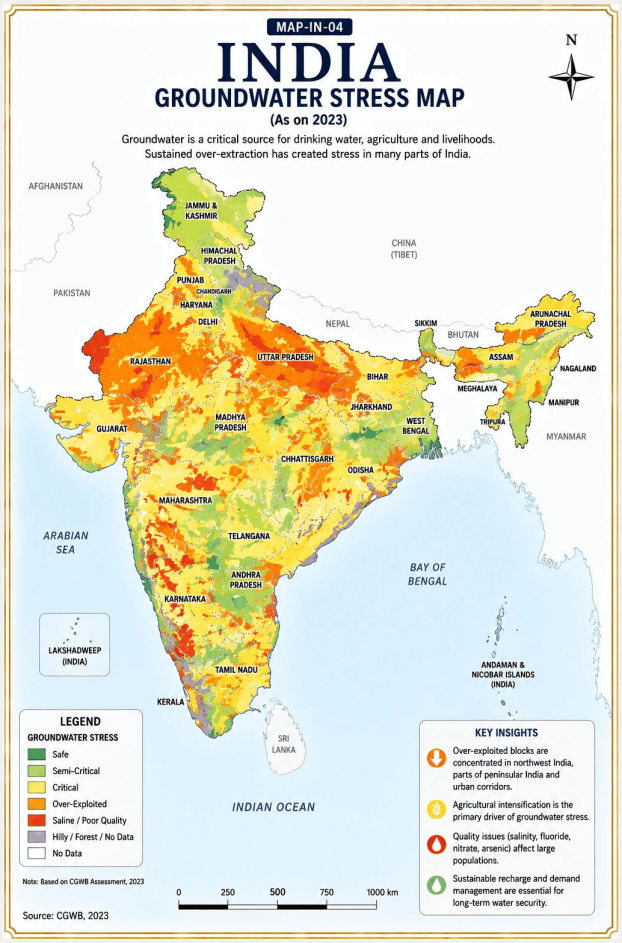
MAP-IN-06 | India Regional Map — Six Geographic Regions | Source: Survey of India, 2023



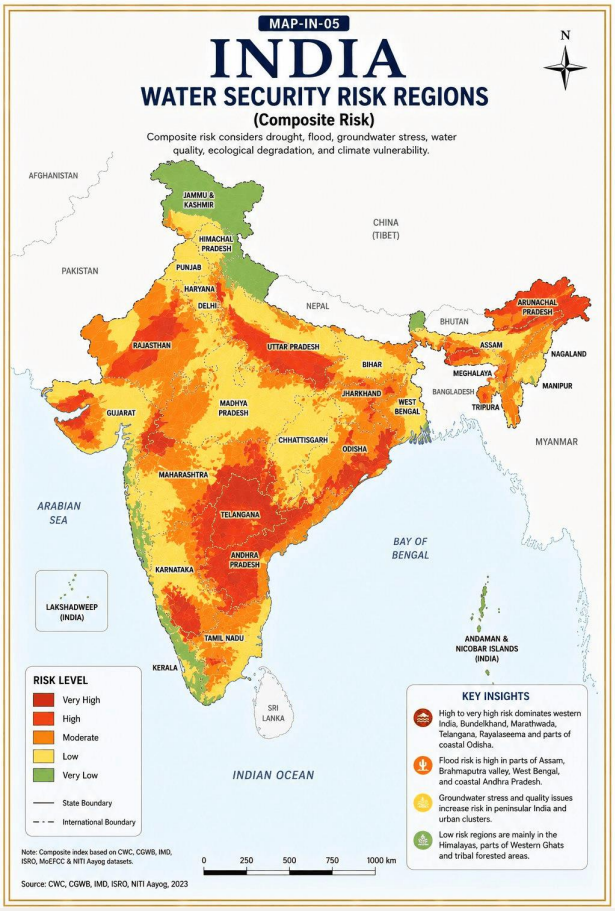
MAP-IN-02 | India Major River Basin Systems — Primary Basins, Sub-basins & Delta Systems | Source: NWIC; Survey of India, 2023



MAP-IN-03 | India Rainfall & Monsoon Systems | Source: IMD (1991-2020 Normals)



MAP-IN-04 | India Groundwater Stress Map (As on 2023) | Source: CGWB, 2023



MAP-IN-05 | India Water Security Risk Regions (Composite Risk) | Source: CWC; CGWB; IMD; ISRO; NITI Aayog, 2023

SOUTH INDIA — THE PENINSULAR WATER SYSTEM

Hard Rock, Seasonal Rivers & Tank Civilizations

South India is hydrologically distinct from much of the Indian subcontinent.

Unlike the northern plains that depend heavily on glacier-fed perennial river systems, Peninsular India evolved around seasonal rainfall, hard-rock geology, localized storage systems, and monsoon variability. This distinction shaped its rivers, its agriculture, its settlements, its political systems, and its civilizational water architecture.

The geography of South India is fundamentally defined by the Western Ghats, the Deccan Plateau, rain-shadow regions, east-flowing rivers, hard-rock aquifers, seasonal river systems, and extensive historical tank networks. These physical systems created a water landscape that depends less on continuous natural flow and more on capture, storage, distribution, reuse, and seasonal management.

The Western Ghats form one of the most important hydrological structures in India. Acting as both a climatic barrier and a water-generating system, the Ghats intercept monsoon winds and influence rainfall distribution across the peninsula. Regions along the western slopes receive intense rainfall and support dense river networks, forests, biodiversity systems, and ecological recharge zones. In contrast, large parts of the eastern rain-shadow regions receive substantially lower and more variable rainfall. This asymmetry shaped the development of some of the world's most sophisticated traditional water-storage civilizations.

South India's rivers are largely monsoon dependent. Unlike Himalayan systems, many peninsular rivers exhibit high seasonal variability, lower dry-season flows, and stronger dependence on rainfall timing and catchment health. The Cauvery, Krishna, Godavari, Pennar, Vaigai, Tamiraparani, and numerous smaller river systems collectively support agriculture, drinking water, industry, hydropower, urban systems, delta ecosystems, and interstate economies.

Groundwater behaves differently in South India compared to northern alluvial systems. Much of Peninsular India depends on hard-rock aquifers. These aquifers typically store less water, recharge more slowly, exhibit high local variability, and are highly dependent on soil condition, fracture systems, rainfall intensity, land use, and

watershed health. This makes groundwater systems in South India inherently more fragile under over-extraction, urbanization, surface sealing, deforestation, and declining recharge. In many regions, groundwater decline is not only a hydrogeological issue. It is a surface-system issue.

Historically, South India developed extensive decentralized storage systems to manage this variability. Tanks, eris, lakes, anicuts, temple ponds, village reservoirs, and interconnected water-distribution systems formed the backbone of water security across large parts of the peninsula. These systems performed multiple functions simultaneously: irrigation support, groundwater recharge, flood moderation, drought buffering, sediment management, ecological stabilization, local water storage, and

agricultural continuity. Water management was therefore not merely engineering. It was embedded into civilization itself.

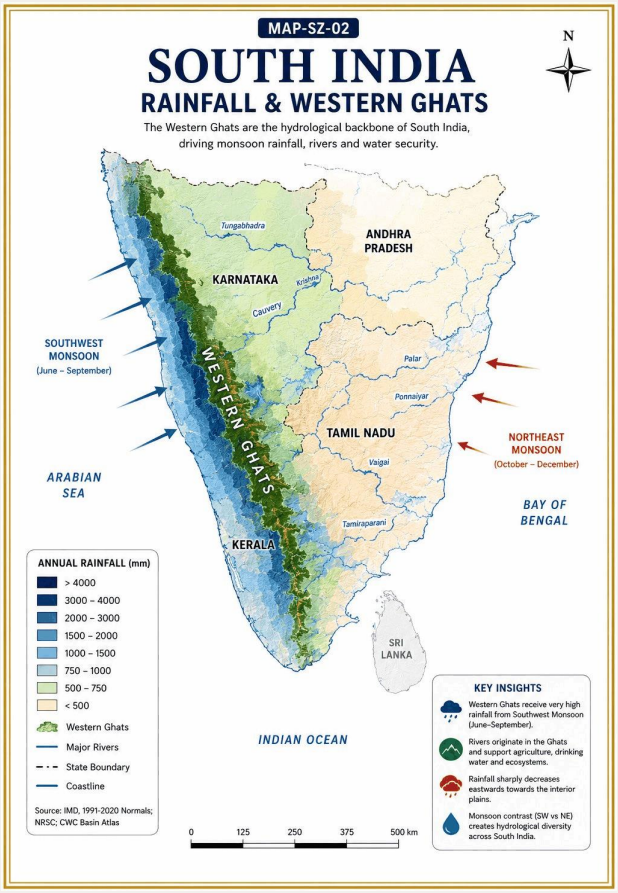
The Cauvery basin illustrates many of these tensions simultaneously. The river supports multiple states, major cities, industrial systems, agricultural economies, and ecologically sensitive delta systems. Yet the basin now faces variable rainfall, storage pressures, competing demands, seasonal uncertainty, and political conflict. This makes the Cauvery not merely a river system, but a territorial dependency system.

The future of South India's water systems will depend on system integration, watershed recovery, aquifer stabilization, urban-rural coordination, tank restoration, ecological buffering, groundwater visibility, wastewater management, and institutional continuity. The defining challenge is no longer simply water supply. It is whether territorial water systems remain capable of absorbing variability and sustaining long-term system response.

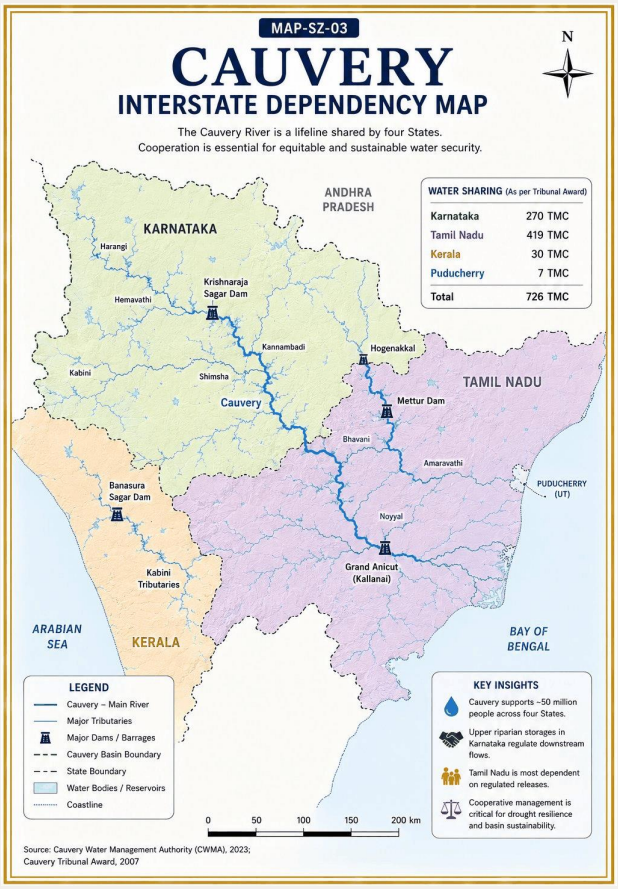
Tamil Nadu represents one of the most advanced and stressed expressions of this larger Peninsular water condition. Its dependence on seasonal rainfall, tank systems, hard-rock aquifers, river transfers, urban imports, and engineered water distribution systems makes it one of the most important territorial water systems to understand in contemporary India.



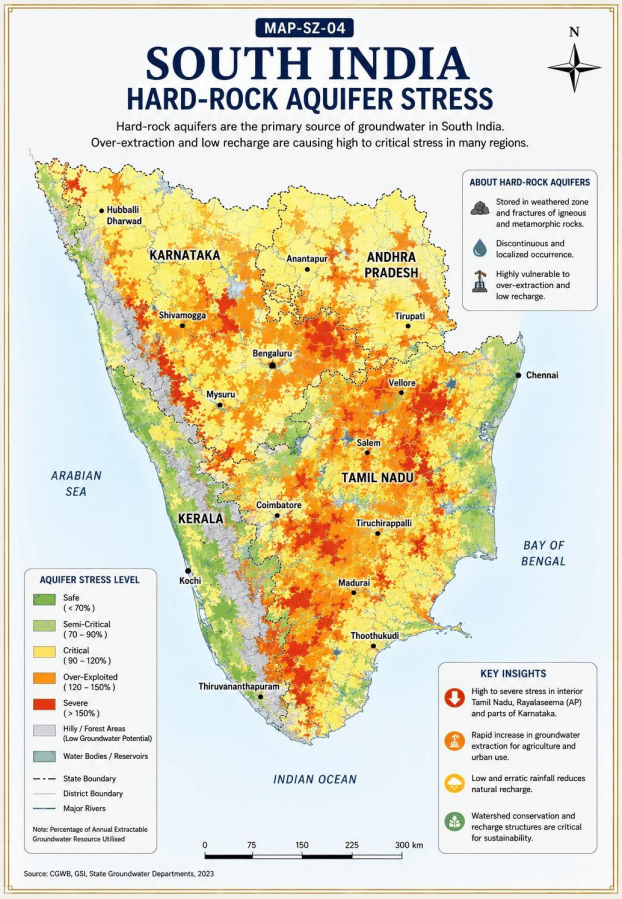
MAP-SZ-01 | South India Political Map — States & Union Territories | Source: Survey of India, 2023



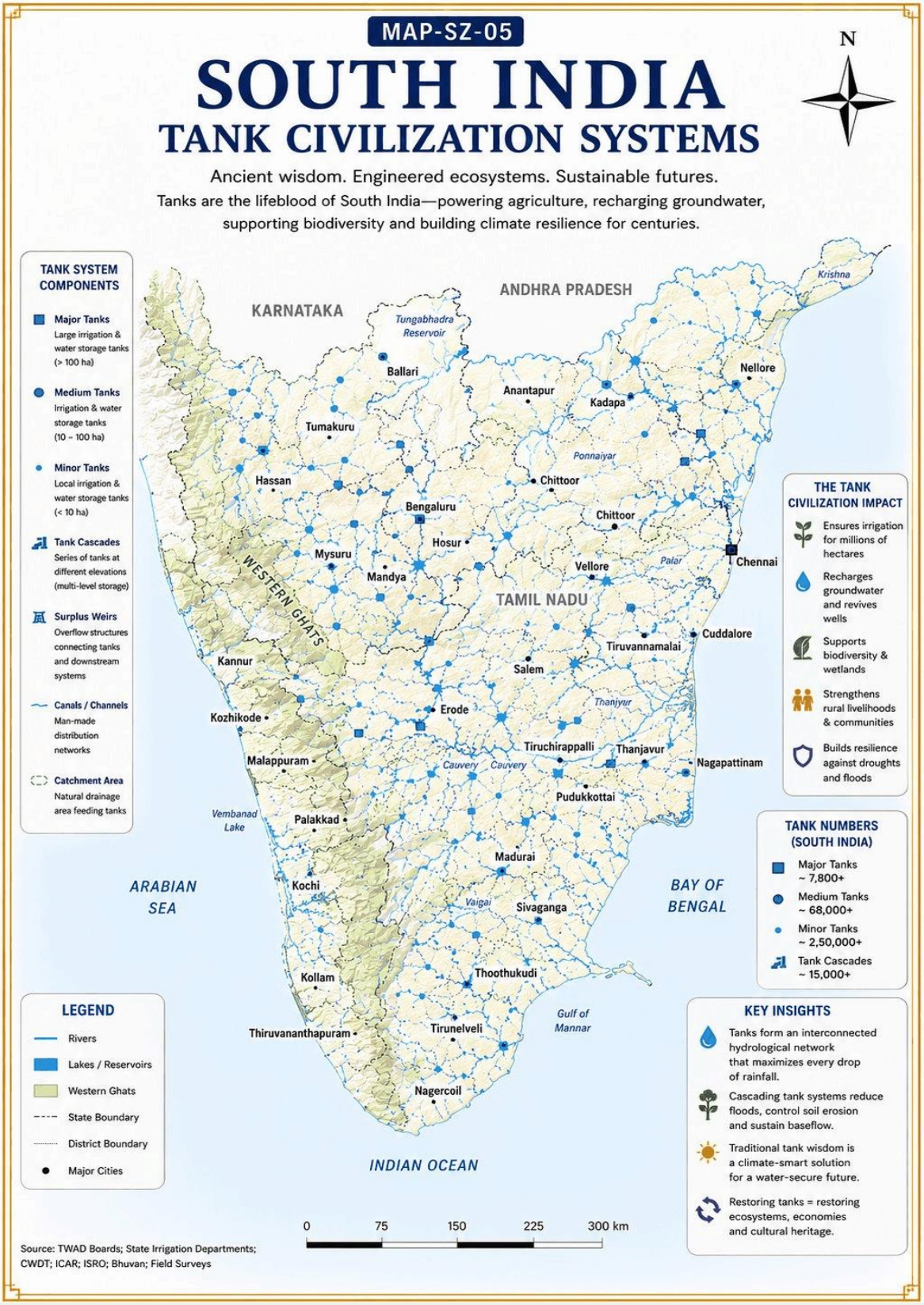
MAP-SZ-02 | South India Rainfall & Western Ghats | Source: IMD (1991-2020 Normals); NRSC; CWC Basin Atlas



MAP-SZ-03 | Cauvery Interstate Dependency Map | Source: Cauvery Water Management Authority, 2023; Cauvery Tribunal Award, 2007



MAP-SZ-04 | South India Hard-Rock Aquifer Stress | Source: CGWB; GSI; State Groundwater Departments, 2023



MAP-SZ-05 | South India Tank Civilization Systems | Source: TWAD Board; State Irrigation Departments; ICAR; ISRO; Bhuvan; Field Surveys

TAMIL NADU — A HYDRAULIC CIVILIZATION

The Tank Civilization Under System Stress

Tamil Nadu is not simply a water-stressed state.

It is a hydraulic civilization undergoing systemic transition.

For over 1,500 years, the people of the southern peninsula designed, built, maintained, and governed one of the most sophisticated decentralized water systems in human history — a system that fed millions, recharged aquifers, sustained rivers, and built social institutions around the shared management of rainfall.

The tank — the eeri or oorani — was not merely a storage pond. It was the structural unit of the Tamil water system. A tank captured rainfall runoff from its catchment, held it through the dry season, provided drinking water, supported fisheries and livestock, recharged the groundwater table beneath it, and transferred surplus to the next tank downstream through a carefully engineered cascade.

Tamil Nadu's 38 districts span dramatically different water realities. The Cauvery Delta in the northeast is one of the most intensively irrigated agricultural regions in Asia. The hard-rock uplands of Coimbatore and Erode sit on aquifers already at critical extraction levels. The southern dry belt of Ramanathapuram receives below 600 mm of annual rainfall. The coastal corridors face salinity intrusion and cyclone exposure.

The Nilgiris in the southwest hold Tamil Nadu's most critical forest water towers.

Today, the Tamil Nadu water system faces its most serious structural challenge in recorded history. Not because rainfall has fundamentally changed. But because the systems that converted rainfall into water security have been progressively dismantled.

Of the 39,532 tanks documented at independence, fewer than 27,281 remain functional. Of the approximately 65,000 ooranis that once served village drinking water across the dry belt, fewer than 35,000 remain. Wells and borewells now irrigate 62.8% of the net irrigated area (2022-23). Chennai depends on desalination for 14% of its supply. The Cauvery delivers approximately 290 TMC against a legal allocation

of 404.25 TMC.

The Atlas documents not merely this decline, but the systems that drove it, the systems that still function, and the pathways through which recovery remains possible.

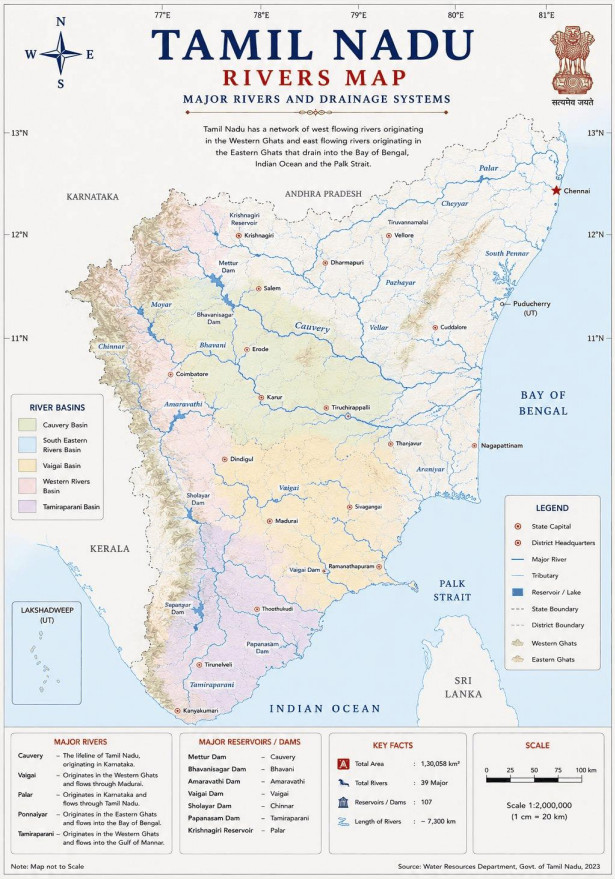
Tamil Nadu is not a lost cause. It is a recoverable system — if the decision to recover it is made.



TN-TRANSITION | Tamil Nadu — Atmospheric & Territorial Systems Synthesis | Source: TWAD Board; WRD TN; Remote Sensing; IMD; CGWB; Forest Survey of India; Census of India; Field Surveys



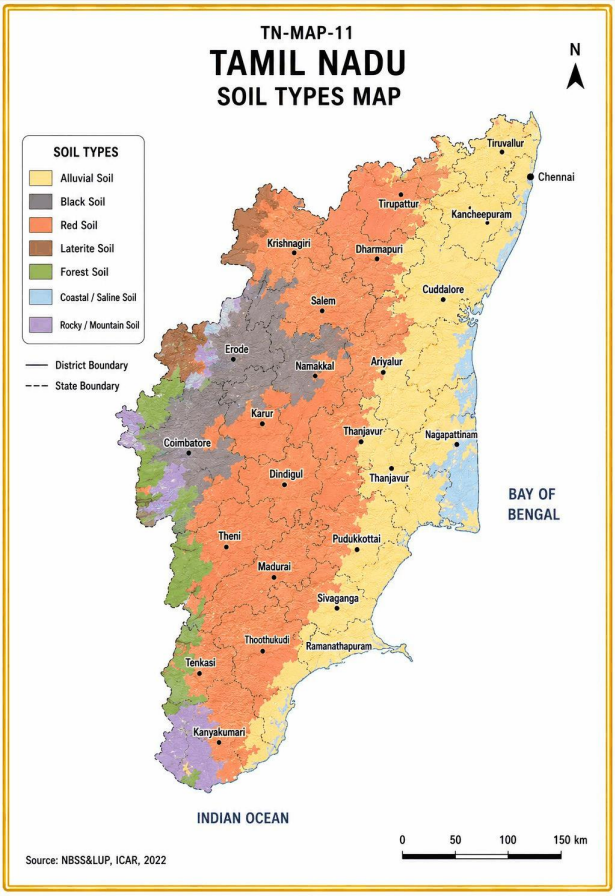
MAP-TN-01 | Tamil Nadu District Map — 38 Administrative Districts | Source: Survey of India, 2023



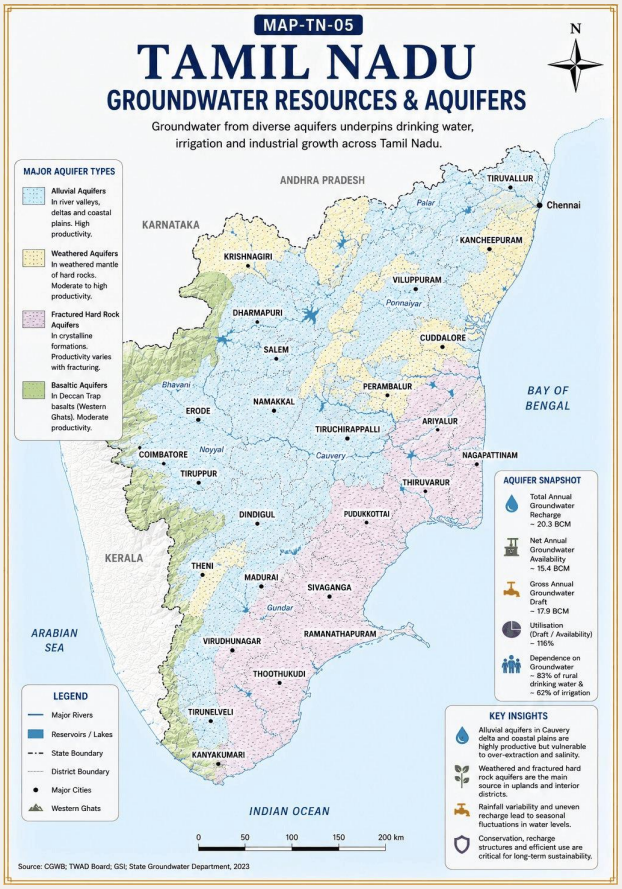
MAP-TN-02 | Tamil Nadu Rivers Map — Major Rivers and Drainage Systems | Source: Water Resources Department, Govt. of Tamil Nadu, 2023



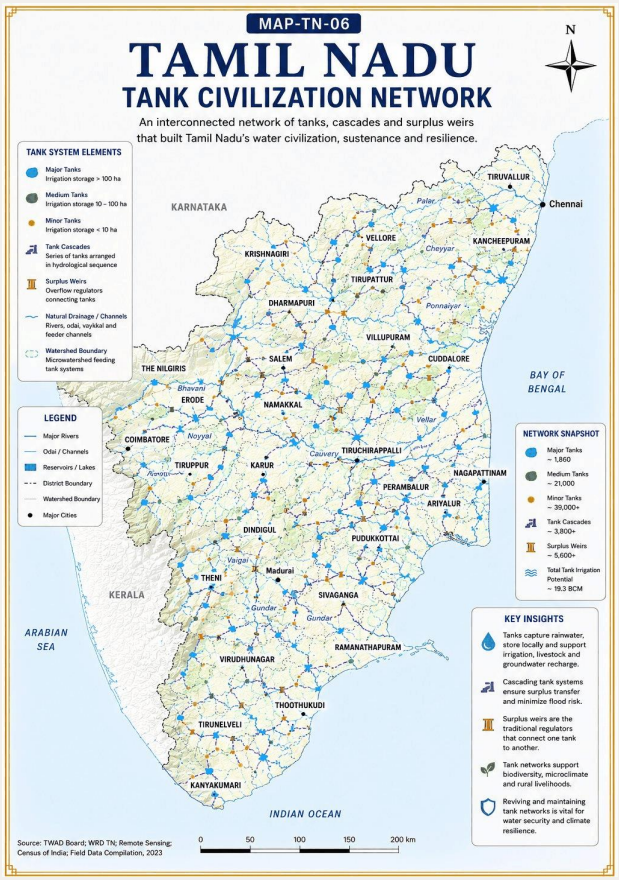
MAP-TN-03 | Tamil Nadu Political Map — Districts and Major Cities | Source: Survey of India, 2023



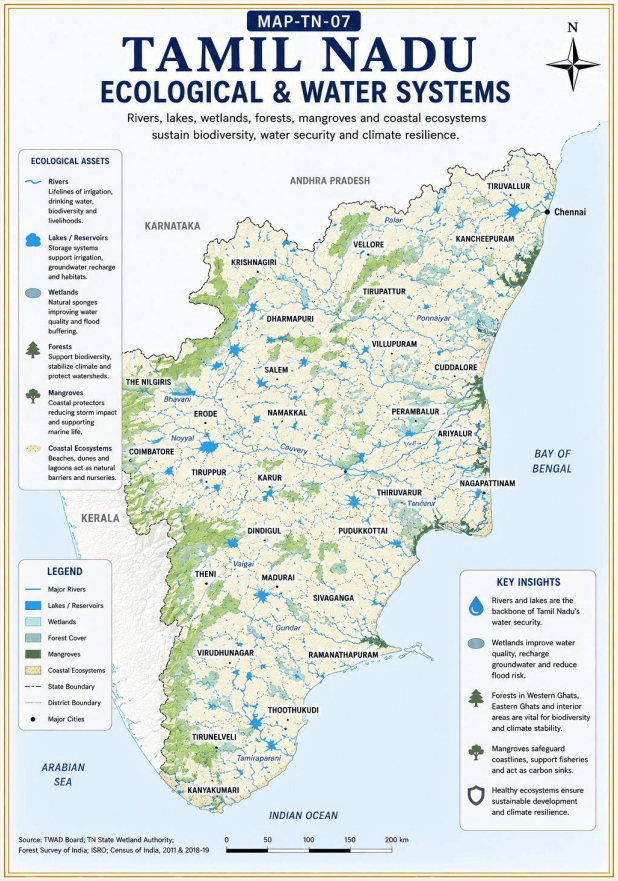
TN-MAP-11 | Tamil Nadu Soil Types Map | Source: NBSS&LUP, ICAR, 2022



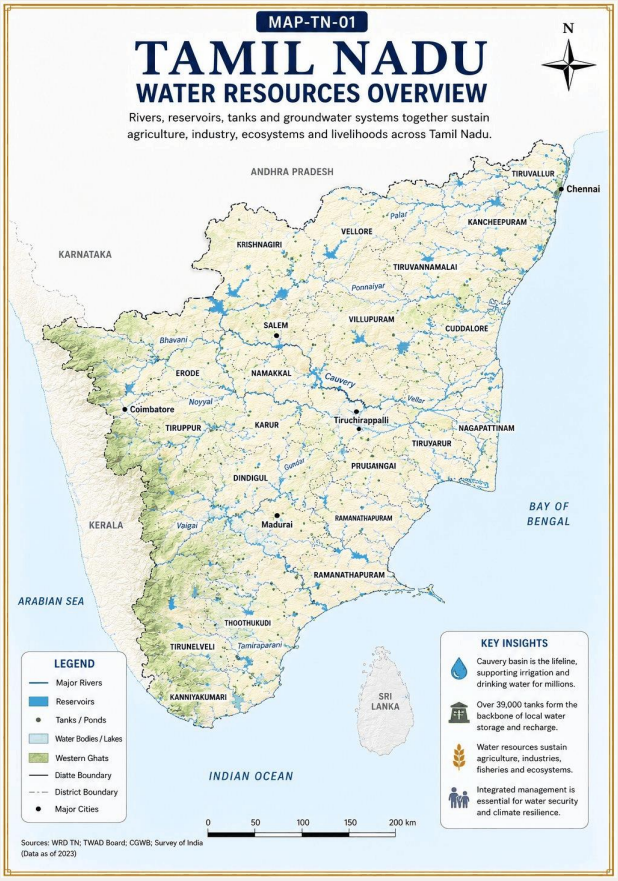
MAP-TN-05 (NEW) | Tamil Nadu Groundwater Resources & Aquifers | Source: CGWB; TWAD Board; GSI; State Groundwater Department, 2023



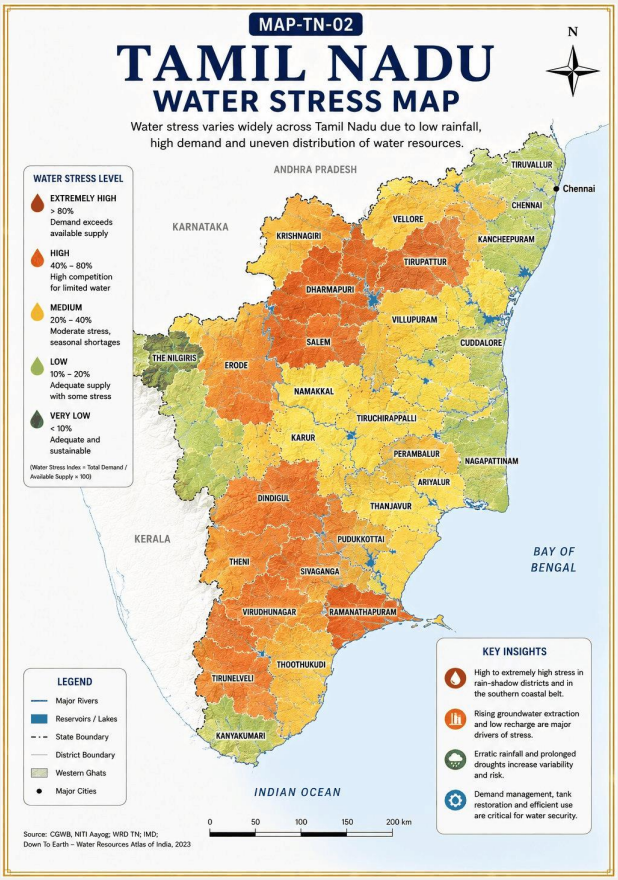
MAP-TN-06 (NEW) | Tamil Nadu Tank Civilization Network | Source: TWAD Board; WRD TN; Remote Sensing; Census of India; Field Data Compilation, 2023



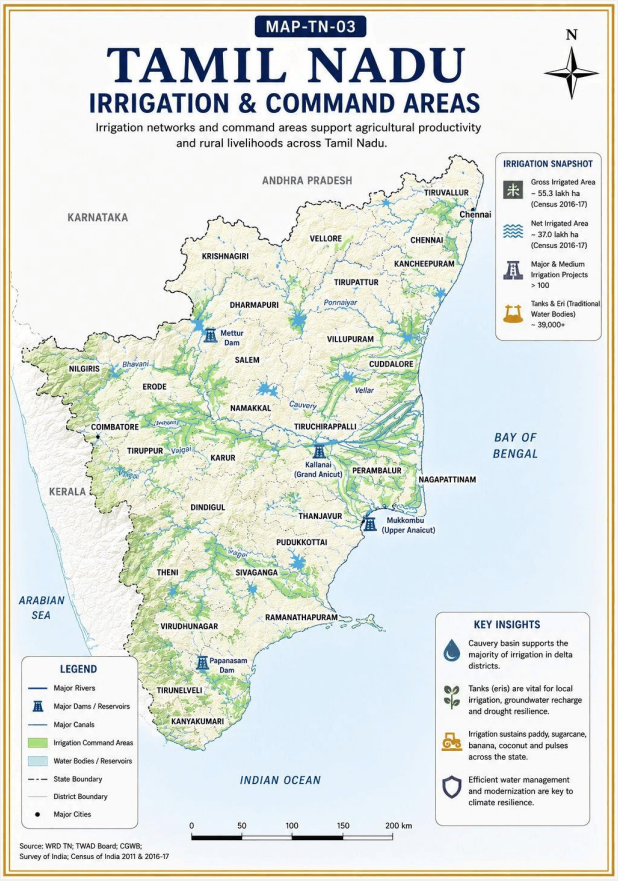
MAP-TN-07 (NEW) | Tamil Nadu Ecological & Water Systems | Source: TWAD Board; TN State Wetland Authority; Forest Survey of India; ISRO; Census of India, 2018-19



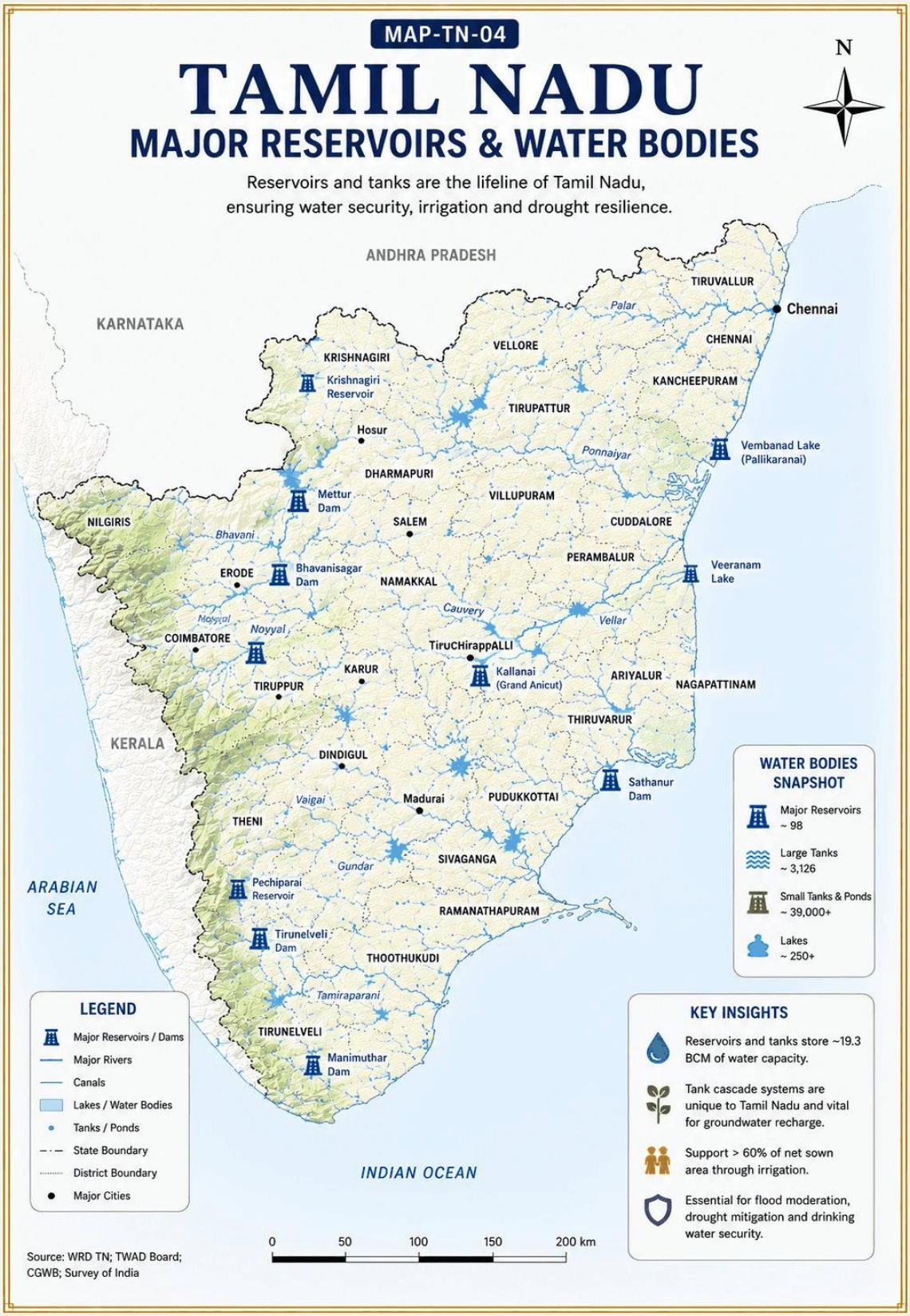
MAP-TN-04 | Tamil Nadu Water Resources Overview | Source: WRD TN; TWAD Board; CGWB; Survey of India, 2023



MAP-TN-05 | Tamil Nadu Water Stress Map | Source: CGWB; NITI Aayog; WRD TN; IMD; Down To Earth, 2023



MAP-TN-06 | Tamil Nadu Irrigation & Command Areas | Source: WRD TN; TWAD Board; CGWB; Survey of India; Census of India 2011 & 2016-17



MAP-TN-07 | Tamil Nadu Major Reservoirs & Water Bodies | Source: WRD TN; TWAD Board; CGWB; Survey of India

THE TERRITORIAL RECKONING

From Immersion to Interpretation

The territorial journey through India, South India, and Tamil Nadu reveals a single recurring pattern.

Systems that were once integrated have become fragmented. Systems that were once visible have become invisible. Systems that were once self-sustaining now depend on extraction, import, and emergency intervention.

This is not the story of nature failing. It is the story of system disconnection.

Tamil Nadu's groundwater extraction now takes 73.5% of the annual extractable resource, and 392 of 1,202 assessment units are over-exploited. Rainfall has not collapsed. The surface water systems that once recharged the aquifers were allowed to decay. Chennai faces simultaneous flood risk and water scarcity — not because of weather extremes, but because the lakes and wetlands that buffered both conditions were encroached. Ramanathapuram's villages pay Rs. 820 per month for tanker water — not because the rains failed, but because the 46% of ooranis that provided free water were allowed to disappear.

The Atlas that follows does not treat these as separate problems requiring separate solutions.

It treats them as symptoms of a single territorial disconnection — between rainfall and aquifer, between forest and river, between tank and groundwater, between governance and system reality.

The disconnection is reversible. The evidence is in the document that follows.

Thanjavur's 840-tank restoration programme returned +0.58m of groundwater across 156 monitored wells. Chennai's treated wastewater reuse grew 2,233% in two decades. Tiruppur's ZLD programme proved that industrial river pollution can be reversed with the right enforcement architecture.

Recovery is not a theory. It is a documented, measured, replicable outcome.

The Atlas now enters its analytical phase. The territorial foundation has been established. The systems intelligence begins.

FM | FRONT MATTER

India Water Systems Atlas | Tamil Nadu Volume

Document Attributes

Document Title	India Water Systems Atlas — Tamil Nadu Volume
Series	India Water Systems Atlas (IWSA)
Volume Reference	TN-001 | Master Reference State Volume
Version	1.1 Abridged Edition | September 2026
Author	G.L. Sudhakar | OPXL Consulting | Akhsheya Group
To Reference Date	To window 2024 to 2026. Re-based to Tamil Nadu Schemia V1.77 (19 September 2026)
Status	Active — Master Reference. Governs all subsequent state volumes.
Amendment Authority	G.L. Sudhakar only — no amendments without explicit authorization
Distribution	Open — For all Atlas builders, contributors, and collaborators
Export Format	DOCX (primary) | PDF via Microsoft Word (distribution)

REVISION 1.1 | SCHEMIA V1.77 RECONCILIATION

This revision re-bases the Tamil Nadu volume on the Tamil Nadu Schemia V1.77 (single master, 19 September 2026). Where the Schemia holds a sourced value, the Atlas now carries that value. Where the Schemia holds no counterpart, the Atlas value is kept and marked with a double dagger. Where only the current value could be reconciled, the row carries a section mark, its earlier periods keep a double dagger and its projection is withdrawn until re-based.

Four findings change the reading of the volume. Statewide groundwater stage is 73.5% (CGWB 2025), not 80% or more, and it has held near 74% since 2022. Over-exploitation is counted in 1,202 firkas, of which 392 are over-exploited, and the earlier count of 105 blocks has no source. The tank loss is 31% of the Independence count, not 40% to 60%, and it built up over decades. Groundwater stress peaks in the Western Corridor (C2), not the Southern Dry Belt (C3).

The full volume carries Appendix A (every changed figure with its Schemia reference) and Appendix C (the marked rows the Schemia cannot yet verify). Appendix B, kept here, lists conflicts that need the author's decision. Each cluster chapter opens with two district evidence panels built from the Schemia.

ABRIDGED EDITION | FOR THE LIVE ATLAS

This edition keeps all 52 maps, the statewide reading, the district register, the Chennai chapter and the closing synthesis. Each cluster chapter is cut to its Schemia evidence panels, its lead domain where space allowed and its Priority Response Table. Maps are set two to a page to hold the page count. Appendix D lists what was left out and where it sits in the full volume.

Marks and figures are unchanged from the full volume. The full volume remains the master reference and page numbers here are this edition's own.

Disclaimer & Technical Limitation

This Atlas volume is an intelligence document built on published primary data from national and state agencies. All data is sourced from CGWB, CWC, IMD, FSI, NRSC, TWAD Board, Tamil Nadu State Departments, and other verified primary agencies. Data presented at T-20, T-10, T-5, and T0 is drawn from published reports and carries Grade A confidence unless otherwise noted. T+5 projections carry Grade D confidence and represent directional scenarios — not forecasts.

No data in this document has been fabricated or interpolated without explicit notation. Where data gaps exist, they are identified and noted. The Atlas does not claim to be exhaustive. It claims to be honest, evidence-led, and structurally complete.

Confidence Framework

Grade	Standard	Application
A	Published and verified from primary national agencies. No interpolation.	T-20, T-10, T-5, T0 values
B	State agency data, cross-referenced. Minor interpolation where noted.	Secondary domain data
C	Estimated from partial data, field reports, or academic sources. Explicitly noted.	Gaps in district-level data
D	Directional projection only. Two scenarios always shown. Never a forecast.	All T+5 [PRJ] values — mandatory label
Source Row	Every data table must carry a source row. Agency + publication + year.	All tables — no exceptions

Version Governance

Version	1.1
Release Date	Revision 1.1, September 2026 (original release May 2026)
To Lock	Opened for Revision 1.1 on the author's instruction, to re-base the volume on Schemia V1.77. Values without a Schemia counterpart keep their May 2026 basis and are marked.
Next Review	May 2027 — Annual Architecture Review Cycle
Amendment Authority	G.L. Sudhakar only
Data Spine	Tamil Nadu Schemia V1.77 (single master, 129 sheets, 19 September 2026)
Supersedes	All previous session-level discussions and informal decisions

Primary Data Sources

Agency	Data Domain	Reference Period
Central Ground Water Board (CGWB)	Groundwater stage, depth, overexploited blocks, recharge	T-20 to To
Central Water Commission (CWC)	River flows, Cauvery allocations, reservoir storage, dam data	T-20 to To
India Meteorological Department (IMD)	Rainfall, drought, climate variability, monsoon data	T-20 to To
TWAD Board (Tamil Nadu)	Tank data, rural water supply, scheme functionality, irrigation	T-20 to To
Forest Survey of India (FSI)	Forest cover, catchment condition, ecosystem data	Biennial T-20 to To
NRSC / ISRO	Remote sensing, land use change, waterbody mapping, wetland loss	T-20 to To
Tamil Nadu Pollution Control Board (TNPCB)	Industrial effluents, river water quality, BOD/COD data	T-20 to To

Agency	Data Domain	Reference Period
CMWSSB (Chennai)	Urban water supply, NRW, STP operations, reuse data	T-10 to To
Cauvery Water Management Authority (CWMA)	Inter-state Cauvery allocation, release data	T-20 to To
Census of India / NSSO	Population, rural water access, health and livelihoods data	T-20 to To
NITI Aayog	Composite Water Management Index, state rankings	2018 to To
Jal Jeevan Mission (GoI)	Rural tap coverage, scheme progress	T-5 to To
Source Row	All data attributed to primary agency + publication + year in each table	

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SECTION A | INDIA — TERRITORIAL & CIVILIZATIONAL OVERVIEW

The National Water Context

THE CENTRAL THESIS — THREE PROPOSITIONS THAT GOVERN EVERY ASSESSMENT

THESIS 1: India's water challenge is not scarcity alone. Scarcity and system response interact.

THESIS 2: Rainfall is an input. Water availability is an outcome. The gap between them is governance.

THESIS 3: Systems fail because the system is invisible. Digital intelligence makes it visible.

India is the seventh-largest country by area and the most populous democracy on earth, carrying 17.5% of the world's population on 2.4% of its land area. Its water endowment — expressed as average annual rainfall — is substantial. The challenge India faces is not one of rainfall deficit. It is one of system response: the capacity to capture, store, recharge, deliver, govern, and account for the water that falls on its territory.

This Atlas is built on the recognition that the gap between rainfall received and water available to people is produced by specific, identifiable, and reversible disconnections in the water system — not by the inadequacy of nature. Every volume in the India Water Systems Atlas series is organized around this diagnostic framework.

India — Key Parameters

Parameter	Value	Context
Total Area	32.87 lakh sq km	Seventh largest country by area
Population (2011 Census)	121.02 Crore	17.5% of world population
Population (Projected 2026)	~143 Crore	Most populous country globally

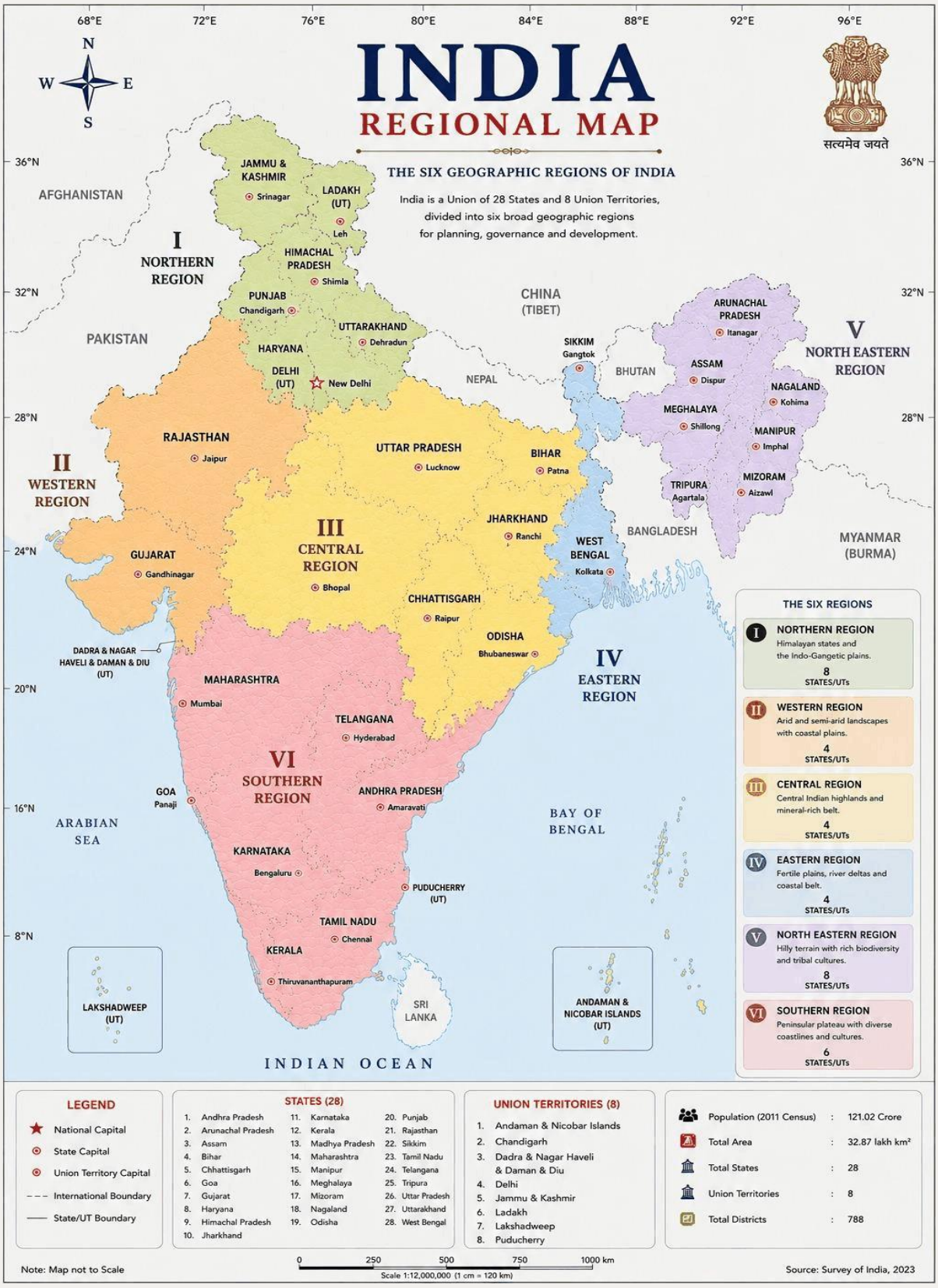
Parameter	Value	Context
Number of States	28 States + 8 UTs	Federal democratic republic
Total Districts	788	Primary administrative units
Annual Average Rainfall	1,170 mm (LPA)	Substantial — distribution is the challenge
Total Water Endowment	~4,000 BCM/year	Rainfall + rivers + groundwater
Utilisable Water	~1,123 BCM/year	Surface: 690 BCM + GW: 433 BCM
Per Capita Water Availability	~1,545 m^3/year (2011)	Approaching water stress threshold (1,700 m^3)
Overexploited GW Blocks	1,592 of 6,965 assessed	22.8% — distribution uneven
Major River Basins	12 major + 46 medium basins	Ganga, Brahmaputra, Indus, Cauvery, Krishna, Godavari
Groundwater Dependency	~62% of irrigation needs	World's largest GW user
Tank / Traditional Systems	Declining nationally	Policy gap — not infrastructure gap

India — Water Indicators

Indicator	T-20 (2004–06)	To (2024–26)	% Change	Direction
Per Capita Water Availability (m^3/yr)	~1,820	~1,545	-15%	Declining
GW Overexploited Blocks	~839	~1,592	+90%	Severe deterioration
Urban Water Demand (BCM/yr)	~35	~74	+111%	Rising rapidly
Irrigated Area under GW (%)	~45%	~62%	+38%	Increasing dependency
Wetland Area (lakh ha)	~152	~128	-16%	Declining
Forest Cover (%)	~20.6%	~21.7%	+1.1%	Marginal recovery
Treated Wastewater Reuse (%)	~3%	~12%	+300%	Improving — still insufficient

(Appendix E)

Indicator	T-20 (2004–06)	To (2024–26)	% Change	Direction
NITI Aayog WMI Score (top states)	N/A (pre-index)	~65–70/100	Reference	Top performers
Source Row	CGWB 2024 | CWC 2024 | IMD 2024 | Census 2011 | MoEFCC | NITI Aayog WMI 2019–224			



MAP-IN-01 | India Regional Map — Six Geographic Zones | Source: Survey of India, 2023

SECTION B | REGIONAL INTRODUCTION — SOUTHERN ZONE

The Peninsular Water System Context

SOUTHERN ZONE CHARACTER

The Southern Zone is defined by three geographical imperatives: the Deccan Plateau hard-rock basement, the dual monsoon system (Southwest June–September + Northeast October–December), and the Western Ghats as the dominant rainfall capture and recharge spine.

The zone is home to India's most complex interstate river governance challenge — the Cauvery — and carries some of the most severe groundwater stress on hard-rock aquifers in the world.

Tamil Nadu, Karnataka, Andhra Pradesh, Telangana, Kerala, and Puducherry share these characteristics with important variations in rainfall geography, aquifer type, and governance history.

States in the Southern Zone — Comparative Water Profile

State	Area (sq km)	Population (Crore)	GW Stage (%)	Primary Stress	T+5 Outlook
Tamil Nadu	1,30,058	7.21	73.5%	Hard-rock GW depletion. Tank decline. Cauvery dependency.	Critical, T+5 not re-based
Karnataka	1,91,791	6.11	~65–70%	Hard-rock aquifer stress. Cauvery governance. Tank decline.	High stress — worsening
Andhra Pradesh	1,62,975	4.95	~55–60%	Krishna-Godavari dependency.	Moderate-High

State	Area (sq km)	Population (Crore)	GW Stage (%)	Primary Stress	T+5 Outlook
				Coastal salinity.	
Telangana	1,12,077	3.52	~60–65%	Mission Bhagiratha. Hard-rock aquifer.	Moderate — improving
Kerala	38,852	3.34	~45–50%	Western Ghats pressure. Monsoon variability.	Moderate
Puducherry (UT)	479	0.12	~85%+	Extreme GW stress. Urban coastal dependency.	Critical
Source Row	CGWB Dynamic GW Resources 2024 | Census 2011 | State Water Boards				

The Cauvery — Defining Interstate Dependency of the Southern Zone

CAUVERY INTERSTATE DEPENDENCY

The Cauvery is the defining river system of the Southern Zone. It originates in Karnataka (Coorg/Kodagu), flows 800 km through Tamil Nadu, and discharges into the Bay of Bengal at the Cauvery Delta.

Cauvery Water Disputes Tribunal final award (2007), as modified by the Supreme Court (2018): Karnataka 284.75 TMC | Tamil Nadu 404.25 TMC | Kerala 30 TMC | Puducherry 7 TMC | Environmental protection 10 TMC | Inevitable escape 4 TMC | Total 740 TMC.

Tamil Nadu's actual receipt at T0: ~290 TMC against allocation of 404.25 TMC — a structural deficit of ~114 TMC in normal years, worsening in distress years.

The Cauvery Water Management Authority (CWMA) was constituted in 2018. Inter-state data sharing remains incomplete. AI seasonal flow forecasting is absent. This is not a water scarcity problem. It is a governance and visibility problem.



MAP-IN-02 | South India Political Map | Source: Survey of India, 2023

SECTION C | STATE HISTORICAL & CIVILIZATIONAL BACKGROUND

The Tank Civilization of Southern India

Tamil Nadu's relationship with water is not modern. It is civilizational. For over 1,500 years, the people of the southern peninsula designed, built, maintained, and governed one of the most sophisticated decentralized water systems in human history — a system that fed millions, recharged aquifers, sustained rivers, and built social institutions around the shared management of rainfall. To understand what Tamil Nadu's water system has lost, and what it can recover, the analyst must first understand what it was.

The tank — the eeri or oorani — was not merely a storage pond. It was the structural unit of the Tamil water system. A tank captured rainfall runoff from its catchment, held it through the dry season, provided drinking water, supported fisheries and livestock, recharged the groundwater table beneath and around it, and discharged surplus through carefully engineered weirs into the next tank in the cascade. Thousands of tanks were connected in cascade networks that spanned entire watersheds — each tank a node in a living hydraulic system that moved water across the landscape slowly, productively, and permanently. The Chola dynasty built and maintained this system at scale across the Cauvery delta. The Pandya kingdom governed it across the southern dry belt. The Pallava and Vijayanagara empires extended it across the northern and western corridors. This was not primitive engineering. It was systems thinking at civilizational scale.

The Grand Anicut — Kallanai — built by the Chola king Karikalan on the Cauvery river around the second century CE, is one of the oldest water regulation structures in the world still in functional use. It diverts Cauvery water into the delta channels that irrigate Thanjavur — the rice bowl of Tamil Nadu — to this day. The Upper Anicut at Mukkombu, the Mettur Dam built in 1934 on the same river, and the modern Cauvery delta canal network are direct successors of a hydraulic tradition that began with stone and community labour two thousand years ago. The Cauvery was not merely a river. It was a managed water system — the infrastructure of the delta civilization.

The dismantling of this system has happened within one generation. Canal maintenance was deprioritized as groundwater became cheaper and easier to extract. Tanks were encroached upon as land values rose and administrative boundaries grew unclear. Ooranis were filled for roads, buildings, and housing as urbanization accelerated without spatial intelligence. The cascade connections between tanks were severed as roads, railways, and settlements interrupted the flow paths. The

community governance structures — the eri organisers, the neerkattis, the tank committees — were dissolved as state water agencies expanded their mandates without the institutional capacity to replace what communities had sustained for centuries. What took 1,500 years to build has been weakened in forty.

> *Tamil Nadu built its water security over 1,500 years with stone, silt, and community governance. It is dismantling that system in a generation with concrete, desalination plants, and institutional neglect. The architecture of recovery is not a new invention. It is a return to a design that already worked.*

SECTION D | STATE INTRODUCTION

Tamil Nadu — Territorial Parameters & Water Character

Tamil Nadu — State Parameters

Parameter	Value	Notes
Total Area	1,30,058 sq km	11th largest state in India
Coastline Length	~1,076 km	Second longest coastline in India. Bay of Bengal, Palk Strait, Gulf of Mannar.
Number of Districts	38 districts	Reorganized. Includes Kallakurichi, Tirupattur, Ranipet, Tenkasi, Chengalpattu, Mayiladuthurai.
Population (2011 Census)	7.21 Crore	Sixth most populous state. Urbanization: ~49%.
State Capital	Chennai	Primate city. Population ~1.1 Crore. Water Security Index: 1.8/5.0.
Historically Significant Cities	Madurai, Tiruchirappalli, Coimbatore, Salem, Tirunelveli	Civilizational water heritage. Secondary urban water

Parameter	Value	Notes
		analysis in relevant cluster chapters.
River Basins	17 basins (1 major, 13 medium, 3 minor)	Cauvery (major), Palar, Vaigai, Tamirabarani, Ponnaiyar, Bhavani, Noyyal, Vellar, Kollidam and others.
Annual Average Rainfall (LPA)	~925 mm	Bimodal: SW Monsoon (June–Sep) + NE Monsoon (Oct–Dec). High inter-annual variability.
Groundwater Stage	73.5% (CGWB assessment 2025)	Hard-rock gneiss and charnockite cover about 78% of mapped area and alluvium about 20% (CGWB 2012). Stage read 74.02% in 2022, 74.26% in 2024 and 73.50% in 2025. Recharge is slow on hard rock. Depletion is difficult to reverse.
Overexploited GW Blocks	392 of 1,202 firkas (32.6%)	Assessment unit is the firka (GWRA 2024, G.O.Ms 36 of 18.07.2025). 56 Critical, 239 Semi-Critical, 481 Safe, 34 Saline. Nine districts extract more than 100% of their resource. Schemia holds no T-20 firka count. Highest share of over-exploited firkas in C2 (52.7%) and C1 (42.2%).
Tank Count (T-20)	39,532 (at Independence)	Independence-era count carried in Schemia (Grade C). Schemia holds no tank count for 2004-06.
Tank Count (T0)	<27,281 functional	About 69% of the Independence count (Grade C). 12,251 tanks (31%) lost or non-functional since Independence. Independent inventories differ by definition, 14,306 WRD tanks, 41,123 irrigation tanks (DES 2022-23), 43,837 tanks (First Census of Water Bodies).
Oorani Count (T-20)	~65,000 (historical)	Village-level rainwater harvesting tanks. Schemia dates this as historical, not 2004-06.

Parameter	Value	Notes
Oorani Count (To)	~35,000	Down 46%. Tanker dependency 52%+ in Ramanathapuram.
Cauvery Allocation to TN	404.25 TMC	Tribunal final award 2007, modified by the Supreme Court on 16 February 2018.
Cauvery Actual Receipt (To)	~290 TMC	Structural deficit ~114 TMC. Worsens in distress years.
GW Used for Irrigation (%)	62.8% of net irrigated area (2022-23)	Wells and borewells 18.34 lakh ha of 29.21 lakh ha. Canals 23.4%, tanks 13.7%. The 42% at T-20 is Atlas-carried and not held independently.
Water Security Index	2.1 / 5.0	Atlas composite, not held in Schemia V1.77. Two of its six inputs (groundwater stage, tank functionality) were restated in Revision 1.1, so the score needs recomputation. Reference May 2026.
Pre-Monsoon GW Depth (state avg)	92% of wells shallower than 10 m bgl (post-monsoon, Nov 2023)	The ~19.4 m bgl state average and 6.8 m T-20 figure of v1.0 are not in Schemia and the CGWB yearbook distribution does not support them. Withdrawn pending source.

Territorial Character

Tamil Nadu occupies the southeastern extremity of the Indian Peninsula, bounded by the Western Ghats to the west, Karnataka and Andhra Pradesh to the north and northwest, the Bay of Bengal to the east, and the Indian Ocean to the south. Its territory compresses within its boundaries an extraordinary range of hydrological

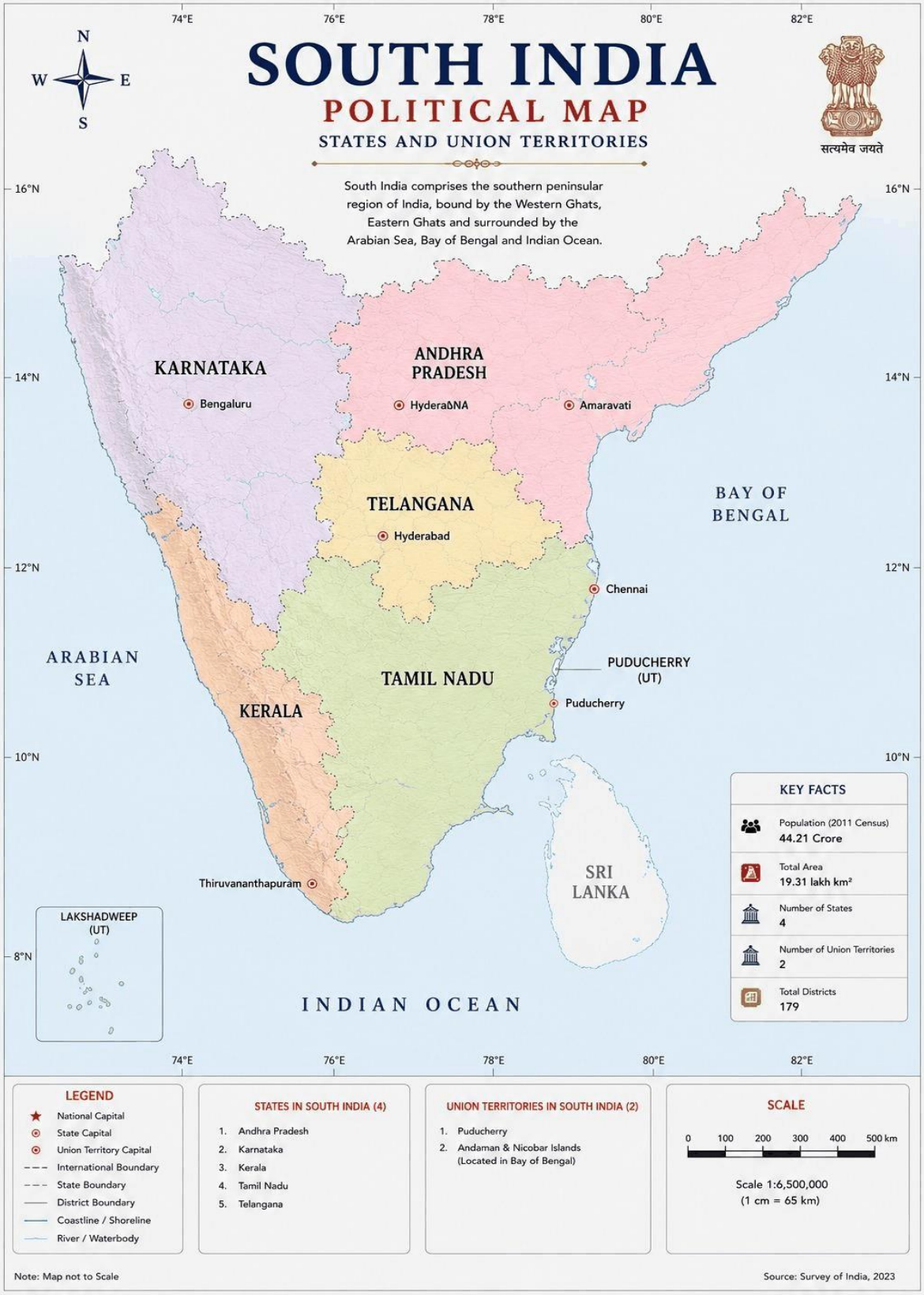
environments: the rainfall-saturated Nilgiris Biosphere with over 3,000 mm annual rainfall, the semi-arid central plains receiving 600–750 mm, the coastal delta receiving 1,000–1,200 mm through the northeast monsoon, and the dry southern

interior receiving below 600 mm. This diversity is not a geological accident. It is a territorial reality that the traditional water system was specifically designed to manage — moving water across gradients, storing it at altitude, releasing it at demand, and recharging it through distributed infrastructure across the landscape.

Hard rock underlies about three quarters of Tamil Nadu and is the defining geological fact of its water system. Unlike the alluvial plains of northern India where deep aquifers can buffer multiple years of extraction, Tamil Nadu's crystalline and fractured rock aquifers have limited storage capacity, slow natural recharge rates, and near-irreversible depletion dynamics once extraction crosses the recharge threshold. The state's 1,500-year tradition of tank construction and cascade management was precisely an engineering response to this geological reality — a civilization that understood that on hard rock, the only reliable strategy is to slow the water, spread it across the landscape, and store it close to where it falls.

Water Reckoning — Five Key Metrics

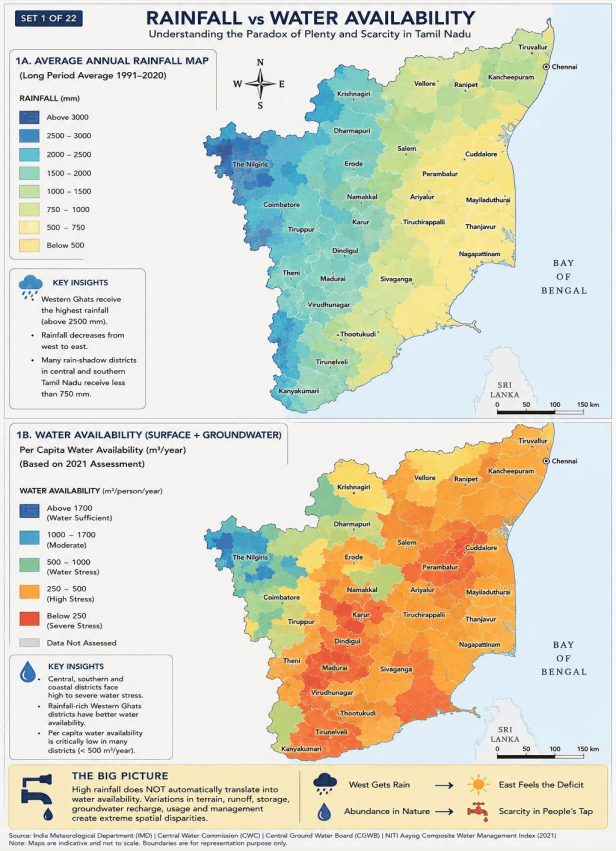
Metric	What It Means
Water Security Index: 2.1 / 5.0 — Deteriorating, Accelerating ‡	Tamil Nadu's composite water security is below the midpoint and moving in the wrong direction at increasing speed. The trajectory — not the absolute level — is the emergency signal.
392 of 1,202 Firkas Over-Exploited (32.6%). Stage 73.5%	Extraction exceeds the extractable resource in one firka in three, and in nine districts as a whole. The stage has held near 74% across the 2022, 2024 and 2025 assessments, so the problem is concentrated and not spreading evenly. Recovery on hard-rock aquifers needs years of recharge without extraction.
31% of Independence-Era Tanks Lost or Non-Functional (39,532 to <27,281)	About 12,251 of the 39,532 tanks counted at Independence are no longer functional. That is 31%, and it built up over decades, not 14 years. Independent inventories disagree on the count itself, from 14,306 WRD tanks to 43,837 in the First Census of Water Bodies, so the figure stays at Grade C.
Cauvery Receipt: ~290 TMC vs 404.25 TMC Allocation	A structural deficit of ~114 TMC in normal years. In 7 of the last 15 years, releases fell below 740 TMC long-term average. The delta rice economy is built on water that does not reliably arrive.
Wells and Borewells 62.8% of Net Irrigated Area (2022-23)	Wells and borewells irrigate 18.3 lakh of 29.2 lakh hectares of net irrigated area. Canals supply 23.4% and tanks 13.7%. Groundwater is the leading source and it draws on aquifers that recharge slowly.



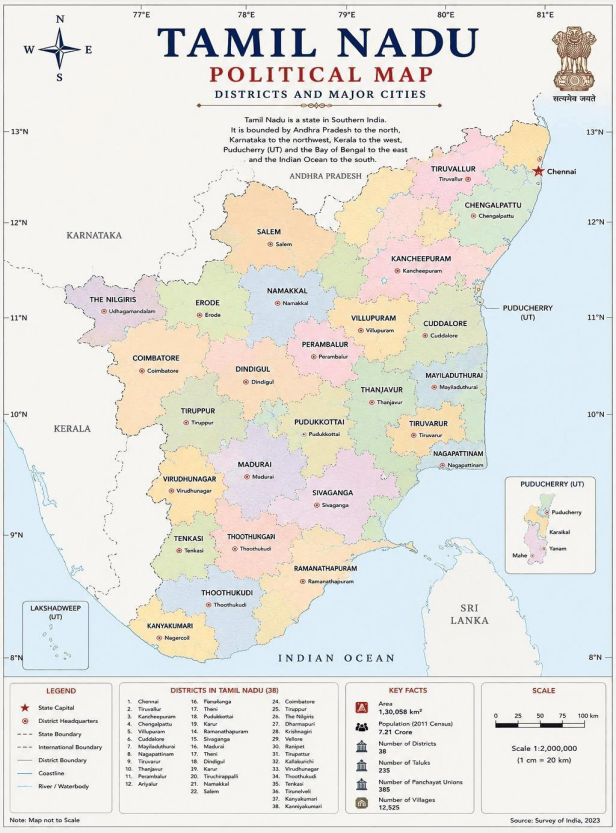
MAP-TN-01 | Tamil Nadu District Map — 38 Administrative Districts | Source: Govt. of Tamil Nadu, 2023



MAP-TN-02 | Tamil Nadu Rivers Map — Major Rivers and Drainage Systems | Source: Water Resources Dept., Govt. of TN, 2023



MAP-TN-03 | Tamil Nadu Political Map — Districts and Major Cities | Source: Survey of India, 2023



MAP-TN-27 | Rainfall vs Water Availability — The Paradox of Plenty and Scarcity | Source: IMD, CWC, CGWB, NITI Aayog, 2021

SECTION E | DISTRICT INTELLIGENCE REGISTER

All 38 Districts — Territorial Water System Interpretation

This register interprets each of Tamil Nadu's 38 districts as a water system actor. Each district is characterized by its territorial role in the hydrological system, its dominant water behaviour, its primary stress, its recovery potential, and its cluster assignment. This is not an administrative list — it is an intelligence register designed to inform cluster-level analysis and district-specific intervention architecture.

#	District	Cluster	Territorial Role	Dom. Water Behaviour	Primary Stress	Recovery Potential
1	Ariyalur	C1	Interior delta transition;	Canal-fed paddy; hard-rock GW	GW depletion; canal tail-	Tank desilting; watershed treatment

#	District	Cluster	Territorial Role	Dom. Water Behaviour	Primary Stress	Recovery Potential
			limestone terrain	supplementation	reach failure	
2	Chengalpattu	C4	Chennai peri-urban fringe; GW extraction zone	Borewell-dependent; lake recharge dependency	Urban encroachment; GW over-extraction	Lake restoration; rainwater harvesting mandate
3	Chennai	C4	Primate city; engineered water dependency; historical 280-lake network	Import-dependent: Cauvery + desalination + tankers	Lake collapse; flood-scarcity paradox; sewage load	Wastewater reuse scaling; lake restoration — DEDICATED CAPITAL SECTION
4	Coimbatore	C2	Industrial hub; Noyyal headwaters; intense GW extraction	Industrial + agri demand; Noyyal pollution corridor	Overexploited GW blocks; river degradation	Watershed treatment; ZLD enforcement; micro-irrigation
5	Cuddalore	C1	Delta coastal interface; SIPCOT industrial corridor	Canal + GW; coastal salinity pressure	Industrial pollution; salinity intrusion	Mangrove buffer; canal restoration
6	Dharmapuri	C2	Dry zone transition; watershed head; mango belt	GW-dependent agriculture; seasonal rivers	Hard-rock GW stress; watershed degradation	Watershed restoration; micro-irrigation expansion
7	Dindigul	C3	Hillfort terrain; Kodaikanal water tower; granite landscape	Mixed tank-GW; hill-fed stream systems	Hard-rock depletion; encroachment	Rainwater harvesting; tank cascade restoration
8	Erode	C2	Bhavani river junction; textile corridor; sugarcane belt	Bhavani canal + GW; industrial extraction	Bhavani degradation; GW overexploitation	ZLD compliance; river restoration; watershed

#	District	Cluster	Territorial Role	Dom. Water Behaviour	Primary Stress	Recovery Potential
9	Kallakurichi	C1	Newly created; delta-interior transition; tank systems	Tank and canal-fed; hard-rock GW	Tank encroachment; GW stress	Tank revival; watershed treatment
10	Kancheepuram	C4	Pilgrimage city; Chennai water shadow; peri-urban expansion	GW dependent; temple tank systems	Urban sprawl; GW overextraction	Temple tank restoration; rainwater harvesting
11	Kanyakumari	C5	Southernmost tip; tri-ocean meeting; high-rainfall Western Ghats flank	Perennial streams; Western Ghats recharge	Tourism pressure; coastal erosion	Forest protection; ecotourism governance
12	Karur	C2	Amaravathi river; handloom corridor; reservoir-dependent zone	Reservoir + canal + GW; handloom water demand	GW stress; river pollution from dyeing	Amaravathi watershed; wastewater treatment
13	Krishnagiri	C2	Horticulture belt; mango export hub; hard-rock plateau	Tank + GW; horticulture intensive	GW overextraction; tank encroachment	Watershed restoration — DEMONSTRATED +0.8m GW improvement
14	Madurai	C3	Temple city; Vaigai river; semi-arid interior	Vaigai reservoir + GW; urban tanker market	GW depletion; Vaigai degradation	Vaigai rejuvenation; oorani restoration
15	Mayiladuthurai	C1	Newly created from Nagapattinam; core	Canal-fed paddy; salinity pressure at coast	Saline intrusion; delta sedimentation	Canal desilting; coastal mangrove restoration

#	District	Cluster	Territorial Role	Dom. Water Behaviour	Primary Stress	Recovery Potential
			delta rice zone			
16	Nagapattinam	C1	Cyclone-prone coast; tsunami memory; fishing economy	Coastal GW + canal; salinity intrusion severe	Salinity; cyclone flooding; mangrove loss	Mangrove restoration; early warning systems
17	Namakkal	C2	Poultry belt; Salem corridor; highway economy	Hard-rock GW; poultry water demand intensive	GW stress; poultry effluent contamination	ZLD compliance; watershed restoration
18	Nilgiris	C5	Water tower of TN; tea estates; tourism pressure; Nilgiris Biosphere	Stream-fed recharge; high rainfall; shola ecosystem	Forest degradation; tourism carrying capacity breach	Shola restoration; stream protection; ecotourism limits
19	Perambalur	C1	Limestone plateau; quarrying zone; delta interior	Hard-rock GW; rain-fed agriculture	GW stress; quarrying impacts on aquifer	Tank restoration; watershed treatment
20	Pudukottai	C5	Tank-rich interior; coastal fishing; Vellar river system	Tank + hard-rock GW; seasonal rivers	Tank encroachment; GW stress	Tank cascade revival; community governance
21	Ramanathapuram	C3	LOW RAINFALL (903.7 mm, 8th lowest of 38); oorani heartland; Pamban coast	Oorani-dependent; coastal salinity; scarce rainfall	Groundwater stage low (10.3%) but 9 firkas saline; 2026 monsoon -57% vs normal; tanker dependency 52%+ ‡	Oorani Mission scaling — EMERGENCY PRIORITY
22	Ranipet	C4	Leather tanning corridor; Palar river;	Palar system + GW; tannery	Tannery pollution; Palar degradation; GW	ZLD tannery enforcement; Palar restoration

#	District	Cluster	Territorial Role	Dom. Water Behaviour	Primary Stress	Recovery Potential
			SIPCOT zone	effluent load severe	contamination	
23	Salem	C2	Steel city; Mettur dam head; Cauvery tributary zone	Mettur reservoir + GW; industrial demand	GW stress; Thirumanimuthar degradation	Watershed restoration; micro-irrigation
24	Sivagangai	C3	Ancient tank civilization zone; Velar river; pilgrim economy	Tank + hard-rock GW; seasonal rainfall dependent	Tank encroachment; GW depletion	Traditional tank restoration; oorani revival
25	Tenkasi	C3	Western Ghats rain shadow exit; Courtallam waterfall; agri-forest fringe	Stream + tank + GW; high-rainfall western edge	Forest fragmentation; stream drying	Forest protection; stream restoration
26	Thanjavur	C1	Rice bowl of TN; Grand Anicut legacy; temple economy	Canal-fed paddy; GW substitution under Cauvery stress	GW over-extraction as canal supplement	Tank cascade restoration — 840 TANKS PROVEN, +0.58m GW RECOVERY
27	Theni	C3	Vaigai headwaters; spice economy; hill terrain interface	Vaigai system + hard-rock GW; plantation demand	GW overextraction; watershed degradation	Vaigai catchment restoration; plantation efficiency
28	Thoothukudi	C5	Port city; sea salt industry; Tamirabarani outlet; Mannar Gulf	Coastal GW + Tamirabarani; salt pans as wetland	Salinity intrusion; industrial coastal pressure	Mangrove restoration; salt pan wetland protection
29	Tiruchirappalli	C1	Grand Anicut city; Kollidam	Cauvery + Kollidam + GW; urban	GW stress in peri-urban; river	River bank protection;

#	District	Cluster	Territorial Role	Dom. Water Behaviour	Primary Stress	Recovery Potential
			junction; major urban centre	extraction rising	encroachment	urban lake restoration
30	Tirunelveli	C5	Tamirabarani civilization; MOST PERENNIAL RIVER IN TN; paddy south	Tamirabarani-fed; most water-secure TN district	Coastal salinity fringe; sand mining Tamirabarani	Sand mining regulation; mangrove buffer
31	Tirupattur	C4	Silk corridor; hilly terrain; Palar headwaters zone	Hard-rock GW; seasonal streams	GW overextraction; silk dyeing effluents	Watershed restoration; industrial water audit
32	Tiruppur	C2	Knitwear capital; Noyyal middle reach; export economy	Noyyal + GW; 700 TPD fabric, 100-150 litres/kg	Noyyal BOD 72 mg/l; GW overextraction	ZLD — 186 UNITS PROVEN; scale to 4,000+
33	Tiruvallur	C4	Chennai northern fringe; Araniyar river; SIPCOT zone	GW + surface water; peri-urban extraction rising	Urban sprawl; industrial effluent; flood risk	Lake network restoration; stormwater management
34	Tiruvannamalai	C4	Pilgrimage economy; Cheyyar river; hard-rock plateau	Hard-rock GW; seasonal streams	GW overextraction; Cheyyar degradation	Rainwater harvesting; temple tank restoration
35	Tiruvarur	C1	Deepest delta zone; Kollidam-Cauvery split; paddy economy	Canal-fed paddy; salinity at tidal interface	Saline intrusion; sedimentation; tail-reach failure	Canal desilting; saline mitigation
36	Vellore	C4	Medical city; Palar river; leather	Palar + GW; tannery pollution legacy	Tannery effluent; GW	Palar restoration; ZLD compliance

#	District	Cluster	Territorial Role	Dom. Water Behaviour	Primary Stress	Recovery Potential
			tanning region		contamination	
37	Villupuram	C1	Delta-to-interior transition; Ponnaiyar system; marginal agriculture	Tank + hard-rock GW; Ponnaiyar seasonal	GW stress; tank encroachment	Tank revival; MGNREGS pond restoration
38	Virudhunagar	C3	Fireworks economy; dry belt heartland; Vaigai tributaries	Hard-rock GW; oorani-dependent villages	Severe GW depletion; tanker economy	Oorani rejuvenation; micro-watershed treatment
Source Row	TN Revenue Records | CGWB District Reports | TWAD Board | Atlas Field Assessment 2026					

DISTRICT REGISTER — ANALYTICAL NOTE

Three districts carry EMERGENCY designations:

Ramanathapuram: low rainfall (903.7 mm long-term, 43.3 mm against a 101.4 mm normal in the 2026 southwest monsoon to 18 September). Tanker dependency >52%. Oorani restoration is

survival infrastructure — not a development programme.

Tiruppur: Industrial extraction-recharge imbalance at system limit. ZLD compliance at 186 units is proven and must scale to 4,000+ units.

Thanjavur: The 840-tank restoration programme (2018–2023) is the most important proven recovery model in the Atlas. It must be replicated across all 10 C1 districts.

SECTION F | DOMAIN ACTIVATION MATRIX

26 Domains × 5 Clusters — Systems Intelligence Layer

This matrix governs the depth of analytical treatment for each domain within each cluster. Activation level determines whether a domain receives a full data table (Critical/Primary), a summary table (Secondary), or acknowledgement only (Tertiary). No domain is absent from this matrix. Every domain affects every cluster — activation level varies, presence does not.

ACTIVATION LEVEL LEGEND

CRITICAL (Dark Red): Emergency threshold. Domain approaching or at irreversible failure. Maximum assessment depth. All data tables mandatory. Pull quote mandatory.

PRIMARY (Navy): Core assessment domain. Full T-20 to T+5 data table. Interpretation box mandatory. Recovery signals mandatory where present.

SECONDARY (Steel Blue): Supporting domain. Summary data table. Referenced in statewide synthesis.

TERTIARY (Pale Blue): Acknowledged in matrix. Referenced in relevant sections. No standalone data table required.

Code	Domain	C1 Delta	C2 Western	C3 Dry Belt	C4 Chennai	C5 Coastal
D01	Groundwater Systems	Primary	Primary	**Critical**	**Critical**	Primary
D02	Rivers & Surface Water	Primary	Secondary	Tertiary	Secondary	Primary
D03	Tanks/Lakes/Wetlands	Primary	Secondary	Primary	Primary	Primary
D04	Agriculture & Irrigation	Primary	Primary	Primary	Secondary	Secondary
D05	Urban Water Systems	Tertiary	Secondary	Tertiary	Primary	Secondary
D06	Industrial Water Systems	Tertiary	Primary	Tertiary	Secondary	Tertiary
D07	Sewage & Wastewater	Secondary	Primary	Tertiary	Primary	Secondary
D08	Water Quality & Pollution	Secondary	Primary	Secondary	Primary	Primary
D09	Flooding & Drainage	Secondary	Tertiary	Tertiary	Primary	Secondary
D10	Coastal Systems & Salinity	Primary	Tertiary	Tertiary	Primary	Primary
D11	Ecology & Forest-Water	Primary	Secondary	Secondary	Secondary	Primary
D12	Climate Vulnerability	Secondary	Secondary	Primary	Primary	Primary
D13	Recharge & Watersheds	Primary	Primary	Primary	Primary	Secondary
D14	Drinking Water Systems	Secondary	Secondary	Primary	Primary	Secondary
D15	Infrastructure Systems	Secondary	Primary	Tertiary	Primary	Secondary
D16	Governance & Institutions	Primary	Primary	Secondary	Primary	Secondary
D17	Interstate/Interbasin	Primary	Secondary	Tertiary	Primary	Tertiary
D18	Rural Water Security	Secondary	Secondary	Primary	Tertiary	Secondary
D19	Energy-Water Linkages	Tertiary	Primary	Tertiary	Primary	Tertiary
D20	Livelihoods/Fisheries	Primary	Secondary	Primary	Secondary	Primary
D21	Health & Contamination	Secondary	Secondary	Primary	Secondary	Secondary
D22	Land Use & Encroachment	Secondary	Primary	Secondary	Primary	Primary
D23	Sand Mining/River Morphology	Secondary	Secondary	Tertiary	Tertiary	Primary
D24	Recovery Systems	Primary	Primary	Primary	Primary	Primary
D25	System Risk & Future	Primary	Primary	Primary	Primary	Primary
D26	Digital Water Systems	Secondary	Primary	Secondary	Primary	Secondary

D26 DIGITAL WATER SYSTEMS — POSITIONING LOCK

Technology is System Visibility Infrastructure — not gadgets, not smart-city marketing, not futuristic branding.

The core diagnostic: Systems fail because the system is invisible. AI and digital systems make water system behaviour visible.

Every D26 assessment in this Atlas asks: What is invisible that needs to be seen? What is currently invisible that enables failure?

D26 is Primary in C2 (industrial effluent monitoring) and C4 (urban command systems). Secondary in C1, C3, C5.

SECTION G | CRITICALITY DASHBOARD

Executive Water Security Overview — Tamil Nadu

WATER SECURITY INDEX: 2.1 / 5.0

Direction: DETERIORATING | Velocity: ACCELERATING | Reference: May 2026

Tamil Nadu scores 2.1 on a 5-point composite water security index. Below midpoint. Trajectory worsening faster than the absolute score suggests.

The Index measures: Groundwater Stage | Surface Water Reliability | Tank/Wetland Functionality | Urban Water Security | Climate Resilience | Governance Effectiveness

Revision 1.1 note. This index is an Atlas composite and is not held in Schemia V1.77. Two of its six inputs, groundwater stage and tank functionality, were restated, so 2.1 needs recomputation before it is quoted.

Domain	T-20 Status	To Status	Direction	Severity	T+5 [PRJ] BAU	Priority
D01 Groundwater Systems	No primary T-20 baseline. Stage 74.0% in 2022.	Stage 73.5% (2025). 392 of 1,202 firkas OE.	HIGH, FLAT 2022-25	CRITICAL	Not re-based [PRJ]	EMERGENCY
D03 Tanks/Lakes/Wetlands	39,532 tanks at Independence.	<27,281 functional (about 69%). Grade C.	DETERIORATING	CRITICAL	Not re-based [PRJ]	EMERGENCY
D17 Cauvery/Interstate	Receipt ~380 TMC. Variability high.	Receipt ~290 TMC. Deficit structural.	DETERIORATING	CRITICAL	~250 TMC BAU	EMERGENCY
D04 Agricultur	GW for irrig: 42%.	GW for irrig: 70%.	DETERIORATING	HIGH	80% GW dependency	HIGH

Domain	T-20 Status	To Status	Direction	Severity	T+5 [PRJ] BAU	Priority
e/Irrigation	Canal dominant.	Canal declining.				
D10 Coastal/Salinity	Intrusion 2–5 km inland.	1–2 km/decade advance. Mangrove 22%.	DETERIORATING	HIGH	Mangrove 16% BAU	HIGH
D08 Water Quality	Noyyal BOD ~18 mg/l.	Noyyal BOD 72 mg/l ‡. 392 OE firkas.	DETERIORATING	HIGH	BOD 90+ BAU	HIGH
D24 Recovery Systems	Minimal formal recovery.	840 tanks restored. 4,200 ooranis. ZLD 186 units.	IMPROVING	INSUFFICIENT SCALE	Recovery pace insufficient vs depletion pace	SCALE NOW
Source Row	CGWB 2024 | TWAD Board 2024 | CWMA 2024 | TNPCB 2024 | CWC 2024 | Atlas Assessment May 2026					

SECTION H | EXECUTIVE SYNTHESIS

Five Structural Disconnections — Tamil Nadu Water System Diagnosis

Tamil Nadu's water crisis is not a rainfall crisis. The state receives an annual average of 925 mm of rainfall — a substantial endowment by any measure. Its rivers are among the most historically managed in the world. Its tank systems represent 1,500 years of distributed water engineering. The crisis is a disconnection crisis: five specific breaks in the water system architecture that are converting rainfall into scarcity, converting abundance into fragility, and converting a proven water civilization into a desalination-dependent emergency management state.

Disconnection 1 — Rainfall Arrives. Recharge Does Not.

Tamil Nadu receives an annual average of 925 mm of rainfall across a territory of 1.30 lakh square kilometres. That is approximately 120 billion cubic metres of water falling on the state every year. Yet groundwater extraction now takes 73.5% of the annual extractable resource (CGWB assessment 2025). The stage read 74.0% in 2022 and 74.3% in 2024, so the load has stayed heavy and has not climbed. It is also unevenly spread. Of 1,202 assessment units, 392 are over-exploited and 481 are safe, and nine districts extract more than 100% of their resource. Rainfall has not collapsed. The tanks (39,532 at Independence, fewer than 27,281 functional today), the ooranis (about 65,000 historically, fewer than 35,000 now), the forest cover and the open riverbeds once turned rainfall into recharge, and they have been weakened. Rain falls. But the system that should slow it, spread it, and sink it into the hard-rock aquifer has been broken. The aquifer receives less. The aquifer is drawn more. The gap widens every season.

Disconnection 2 — The Canal System Declined. Groundwater Replaced It. Both Are Now in Crisis.

In 2022-23, wells and borewells supplied 62.8% of Tamil Nadu's net irrigated area. Canals supplied 23.4% and tanks 13.7%. The 42% groundwater share earlier carried for T-20 is not held independently, so no rate of change is stated. This shift happened for a simple reason: canal water became unreliable as Cauvery flows declined, as canal infrastructure aged without adequate maintenance, and as the governance framework for inter-state water sharing produced increasing distress-year frequency. Farmers did what rational economic actors do — they drilled deeper, pumped harder, and substituted groundwater for the surface water that no longer reliably arrived. The consequence is a double crisis: the canal system has declined further as its user base shifted to groundwater, and the groundwater system is now carrying a load it was never designed to sustain on hard-rock aquifers with limited storage and slow recharge rates. The two crises reinforce each other. Fixing one requires fixing both simultaneously.

Disconnection 3 — Traditional Infrastructure Was Built Over Generations. It Is Being Lost in One.

Tamil Nadu's traditional water infrastructure — 39,532 tanks, approximately 65,000 ooranis, cascade networks spanning entire watersheds, community governance structures managing thousands of water bodies — was accumulated over 1,500 years. Of the 39,532 tanks counted at Independence, fewer than 27,281 are functional, about 69%. Since Independence, 12,251 tanks have been lost to siltation, encroachment, catchment degradation, and institutional neglect. Oorani count has fallen from approximately 65,000 to approximately 35,000 — a 46% decline. Ramanathapuram, one of the lowest-rainfall districts, now has tanker dependency exceeding 52% of households — households that once depended on ooranis for free water and now pay ₹800–1,200 per month for trucked supply. This is not a development story. It is a governance failure story: a 1,500-year water security system is being allowed to collapse because no administrative structure has been held accountable for its maintenance at the speed and scale at which it is being lost.

Disconnection 4 — Interventions Are Proven. Scale Has Not Followed.

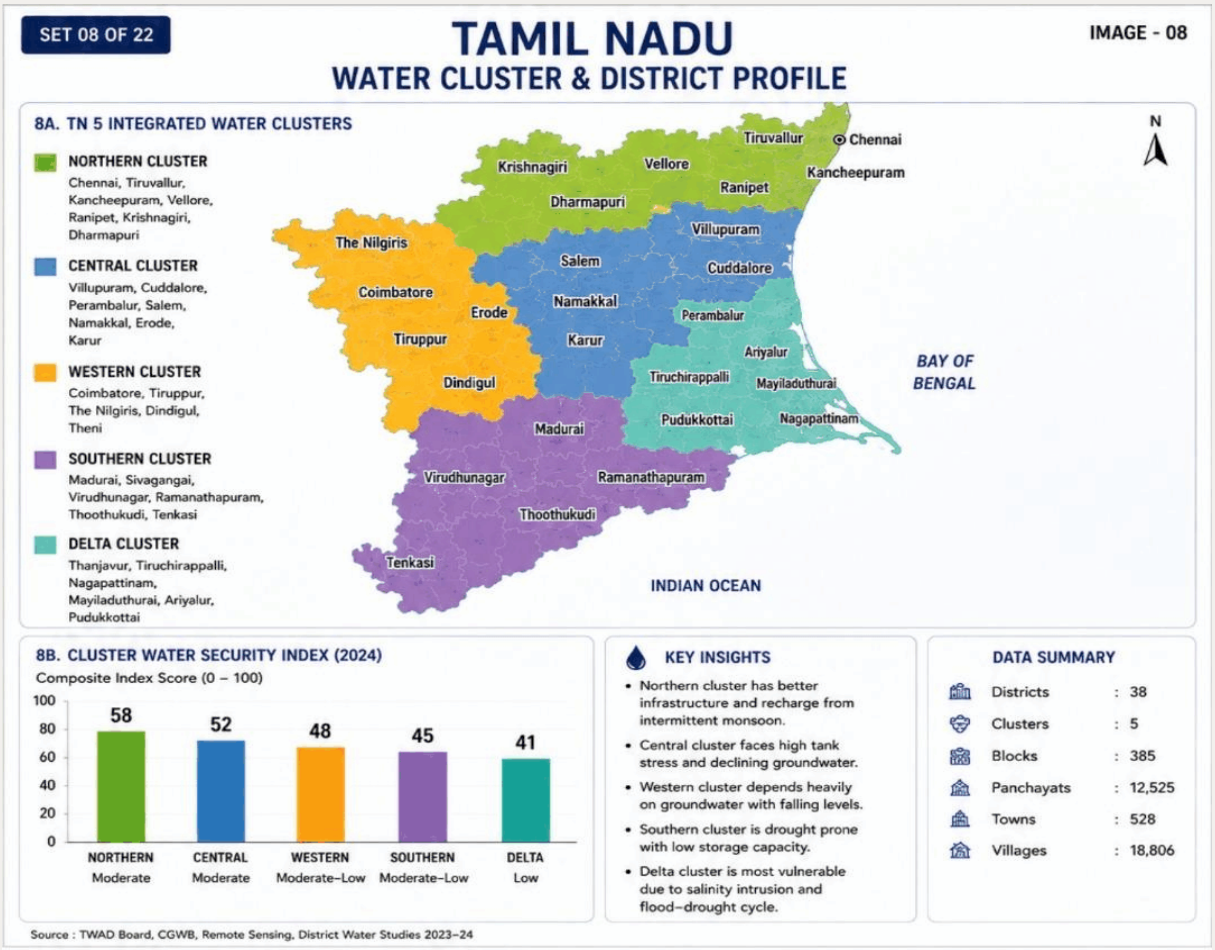
Tamil Nadu has produced some of the most clearly evidenced water system recovery signals in India. The 840-tank restoration programme in Thanjavur between 2018 and 2023 produced an average groundwater level recovery of 0.58 metres in adjacent blocks — a measured, attributed, verifiable recovery. Krishnagiri district's watershed treatment programme delivered a documented 0.8-metre groundwater improvement. The Zero Liquid Discharge programme in Tiruppur, now covering 186 units, has reduced Noyyal BOD from its pre-ZLD trajectory. Chennai's treated

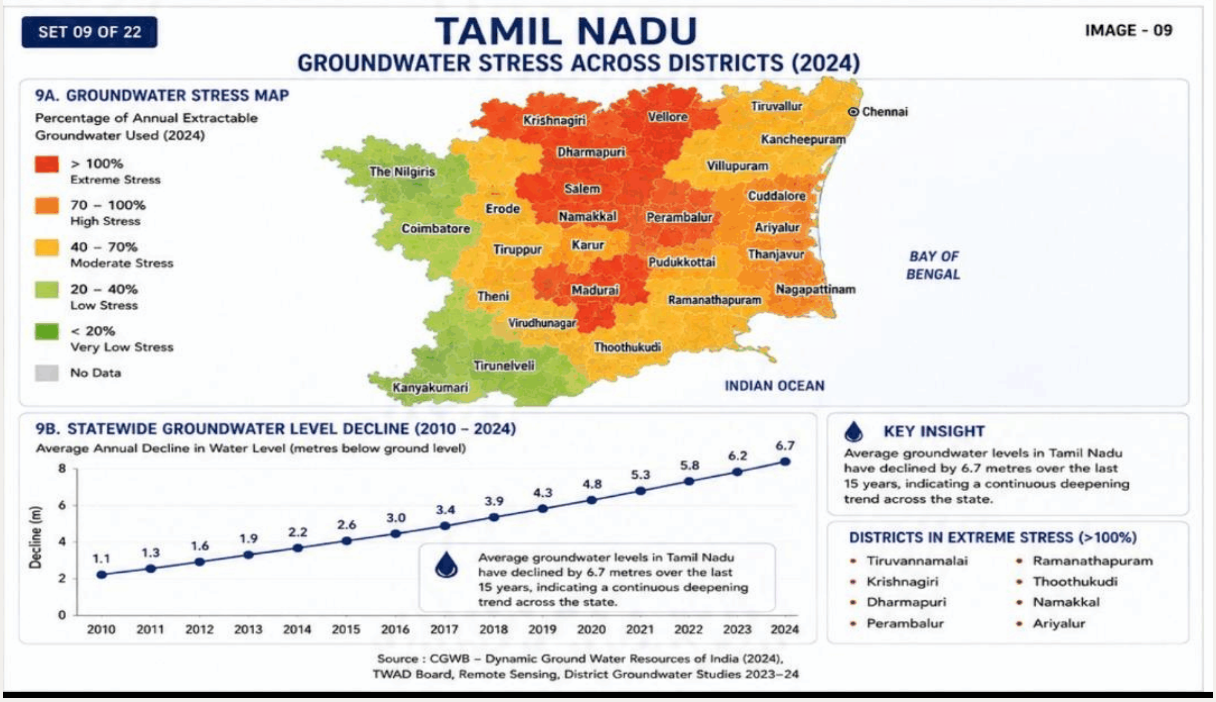
wastewater reuse programme has grown from 12 MLD at T-20 to 280 MLD at To — a 2,233% increase — demonstrating that the institutional capacity for ambitious water system transformation exists when political will aligns with programme design. The problem is not that solutions are unknown. The problem is that proven interventions have not been scaled. The Thanjavur model exists in one cluster. Tamil Nadu has five clusters and 38 districts. The scale gap between what is proven and what is deployed is the fourth disconnection — and it is a governance choice, not a technical constraint.

Disconnection 5 — The System Is Invisible to Those Who Must Govern It.

Tamil Nadu's water system is managed by nine agencies with overlapping mandates, incomplete data sharing, and no integrated operational dashboard covering the full system. Canal tail-reach sensors are absent — meaning the water that leaves Mettur Dam cannot be tracked to the field. Groundwater telemetry covers only 24 overexploited blocks (Atlas-carried figure, not in Schemia) out of 392 over-exploited firkas. The tanker market — approximately 1,500 to 2,000 tankers operating daily in Chennai alone — is entirely informal and untracked. Oorani restoration is monitored manually. Drought prediction systems are absent in the Southern Dry Belt where they are most urgently needed. A system that cannot be seen cannot be managed. A system that cannot be managed cannot be governed. And a system that cannot be governed will continue to fail regardless of how much infrastructure is built, how many programmes are announced, and how many crisis interventions are deployed. The fifth disconnection is the one that enables all others to persist: the system is invisible.

> *Tamil Nadu built its water security over 1,500 years with stone, silt, and community governance. The dismantling happened in one generation. The rebuilding is not a technical challenge — it is a political and administrative choice. The interventions are documented. The evidence is clear. The window is open.*





MAP-TN-04 | TN Water Cluster Architecture & Groundwater Stress Profile | Sources: TWAD Board, CGWB, Remote Sensing, District Water Studies 2023–24

SECTION K | STATE CAPITAL — CHENNAI

Standalone Water Systems Intelligence | Urban Modules U1–U8

Chennai is not a district. It is not a cluster sub-section. It is a standalone analytical unit — a primate city of approximately 1.1 crore people that represents the most visible, most politically consequential, and most complex water story in Tamil Nadu. Its diagnosis illuminates the core failures of the state water system at urban scale. Its recovery signals define the outer boundary of what is possible. Chennai is treated here in full — before the cluster chapters — because its systems intersect every cluster and its choices shape the water future of the entire state.

> *Chennai floods during every intense rainfall event. Chennai faces acute scarcity during every pre-monsoon period. These are not two problems. They are the same problem: the natural water system that absorbed and stored the rain has been destroyed and replaced with engineered fragility that can do neither.*

U1 — Capital City Water Dependency Systems

Chennai does not have enough local water. It depends on distant sources, complex engineered systems, and continuous supply chains that are vulnerable to climate variability, infrastructure failure, and inter-state governance breakdowns. This is not a recent development — it is the cumulative consequence of four decades of rapid urbanization without water system planning.

Source	Distance from City	Volume (approx.)	Share of Supply	Vulnerability
Cauvery System (Poondi, Chembarambakkam, Red Hills, Cholavaram)	35–60 km	~550–600 MLD in good years	60–70%	CRITICAL — interstate governance. Cauvery flow variability directly affects city supply.
Telugu Ganga / Veeranam Transfer	~400 km / ~230 km	~20–30 MLD supplemental	~3%	HIGH — long-distance transfer. Climate-dependent.

Source	Distance from City	Volume (approx.)	Share of Supply	Vulnerability
Desalination Plants (Minjur + Nemmeli)	~25 km north / south	200 MLD total	10–15%	MEDIUM — energy-intensive. High cost. Climate-independent.
Peri-Urban Groundwater (borewells)	Peri-urban fringe	~180–200 MLD (estimated)	~20%	HIGH — unregulated. Aquifer declining. No digital tracking.
Tanker Market	Various peri-urban sources	~60–80 MLD (estimated)	~5% (crisis supplement)	HIGH — informal, untracked. 1,500–2,000 tankers/day. ₹400–800/KL.
Source Row	CMWSSB Reports 2024 | Chennai Corporation | CGWB District Reports | CWC Cauvery Data			

INTERPRETATION — U1 — WATER DEPENDENCY SYSTEMS

Chennai's fundamental water security problem is structural dependency: 70% of its supply arrives from sources more than 35 kilometres away, managed through a system that involves inter-state governance (Cauvery), long-distance pumping infrastructure (400+ km pipelines), and energy-intensive treatment.

Every rainfall deficit year in Karnataka reduces Chennai's reservoir storage.

Every infrastructure failure along the 400-km transmission chain reduces supply.

The city has no meaningful local water system to fall back on — because it destroyed it. The peri-urban groundwater extraction that supplements supply is unregulated, untracked, and drawing down the aquifer that is the last local buffer.

The desalination plants, while climate-independent, cost 4–6 times more per litre than reservoir water and consume 3–5 kWh per cubic metre of electricity. Chennai is building water security in the wrong direction.

Chennai — Capital City Verdict

CHENNAI WATER SYSTEMS VERDICT — MAY 2026

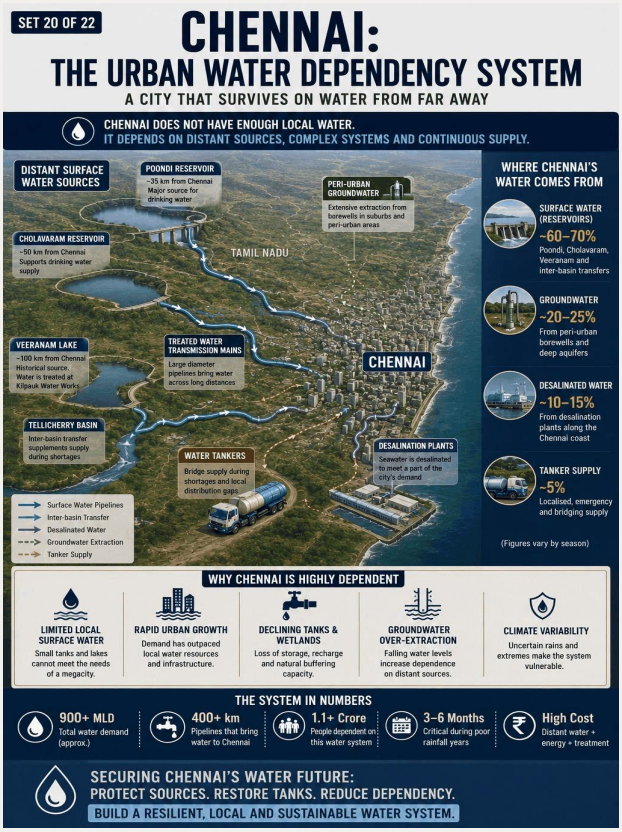
DIAGNOSIS: Chennai is a city that has systematically dismantled its local water security infrastructure while building complex, energy-intensive, climate-vulnerable systems to replace it.

HIGHEST-LEVERAGE INTERVENTION: Treated wastewater reuse. Proven. Economic. Scalable. From 280 MLD to 500 MLD in five years. This is the single most impactful near-term action.

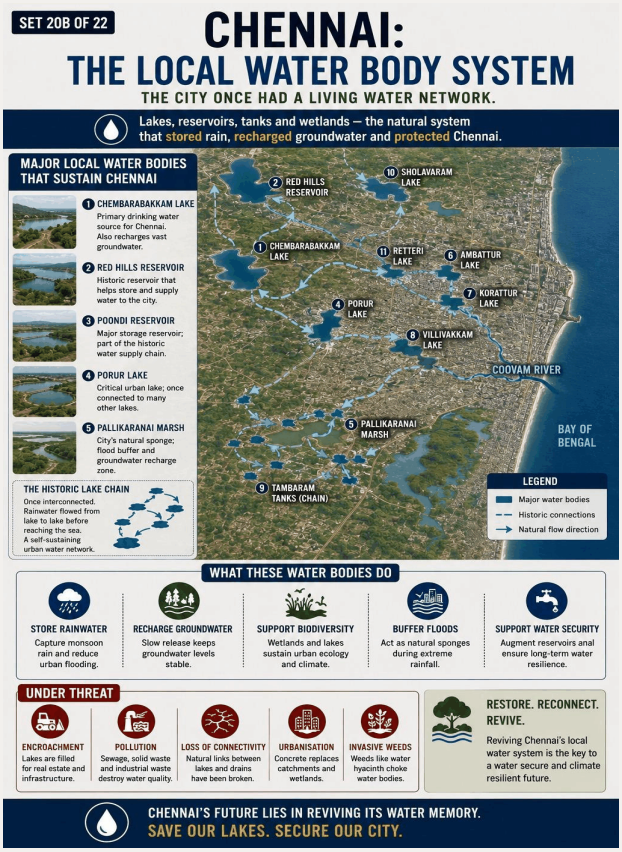
STRUCTURAL PRIORITY: Lake restoration at scale. 32 lakes is a beginning. The city needs 150+ restored with reconnected cascade channels. Every restored lake simultaneously reduces flood risk and increases dry-season storage.

GOVERNANCE EMERGENCY: 9 agencies. 4 coordination meetings per year. No integrated water command. The city's water security cannot improve until its governance structure matches the complexity of its water challenge.

FORWARD SIGNAL: The 2,233% growth in treated wastewater reuse proves that Chennai's institutions can transform when the programme design is right. That institutional capacity must now be applied to lake restoration, NRW reduction, and distribution network intelligence.



MAP-TN-05 | Chennai: The Urban Water Dependency System | Sources: CMWSSB, TWAD Board, CWC Basin Data, 2024



MAP-TN-06 | Chennai: The Local Water Body System | Source: CMWSSB Lake Survey, NRSC Remote Sensing, 2024



MAP-TN-07 | Urban Tamil Nadu: The Flood-Scarcity Paradox | Source: NDMA, IMD, CMWSSB, 2024

C1 | CAUVERY DELTA & CENTRAL IRRIGATION BELT

10 Districts | Canal-Fed Delta Rice Economy | Interstate Dependency Critical

Cluster C1 is Tamil Nadu's agricultural heartland and its most politically consequential water system. Ten districts — Thanjavur, Tiruvarur, Nagapattinam, Ariyalur, Perambalur, Cuddalore, Mayiladuthurai, Tiruchirappalli, Villupuram, and Kallakurichi — carry the delta rice economy, the Grand Anicut legacy, and the deepest dependency on Cauvery water in the state. This cluster is where Tamil Nadu's water story has been written across two millennia — and where its most serious contemporary failures are concentrating.

C1 | Schemia V1.77 Evidence Panel A, Groundwater by District

District	Stage 2024 (%)	OE firkas	Critical	Semi-crit.	Safe	Saline	Stage 2025 (%)	Wells falling 2025 (%)
Thanjavur	100.8	34	2	8	6	0	100.8	33
Tiruvarur	67.2	12	0	1	11	4	n/r	n/r
Nagapattinam	n/r	0	0	0	0	16	0.0	0
Ariyalur	52.2	0	1	3	11	0	48.5	40
Perambalur	109.4	7	0	1	3	0	105.8	40
Cuddalore	65.0	11	3	3	15	0	63.3	29
Mayiladuthurai	123.5	13	0	0	1	1	116.6	0
Tiruchirappalli	73.1	18	0	3	22	0	84.7	44
Villupuram	87.3	10	6	9	9	0	n/r	n/r
Kallakurichi	83.4	8	3	4	9	0	n/r	n/r
Cluster (10)	**n/a**	**113**	**15**	**32**	**87**	**21**	**84.4 (n=7)**	**n/a**

Source Schemia V1.77 MASTER DATA, GW-STAGE-D7 (IDs 893-930, CGWB 2024 report and G.O.Ms 36 of 18.07.2025), GW-2025-SOE and GW-2025-WL-FALL (Rajya Sabha Q.1055, 9 Feb 2026). Firka counts are notified categories. The 2025 cluster figure is extraction over extractable resource for the districts reported (n). n/r means not reported in the Schemia.

C1 | Schemia V1.77 Evidence Panel B, Irrigation, Tanks, Water Supply and Rainfall

District	Net irrigated (000 ha)	Wells (%)	Canals (%)	Tanks (%)	Irrigation tanks (n)	Rural taps 2023 (%)	Long-term rain (mm)	SW monsoon 2026 vs normal (%)
Thanjavur	195.2	18.0	82.0	0.0	428	81.1	1038	-33
Tiruvarur	148.5	0.0	100.0	0.0	0	61.7	1165	-28
Nagapattinam	52.9	0.0	98.5	0.0	0	10.9	1233	-62
Ariyalur	39.9	86.9	8.3	4.8	564	67.8	1027	-7
Perambalur	26.7	100.0	0.0	0.0	252	48.2	948	-8
Cuddalore	137.3	67.3	31.6	0.9	592	54.6	1092	-31
Mayiladuthurai	68.3	0.0	100.0	0.0	0	71.1	1233	-30
Tiruchirappalli	87.1	59.4	37.1	3.5	1767	82.5	873	-33
Villupuram	134.1	87.8	0.5	11.7	1359	50.6	1013	-27
Kallakurichi	105.6	84.6	0.3	14.7	726	47.5	1013	-40
Cluster (10)	**995.5**	**45.0**	**51.1**	**3.8**	**5688**	**61.2**	**n/a**	**n/a**

Source DES Statistical Handbook 2022-23 Tables 5.1 to 5.3 and Chapter 6, Schemia V2-13 (rural taps at 1 April 2023, Chennai has no rural table), MASTER DATA CL-001 (CCCDM 1951-2020 district means, Class C) and CL-002 (IMD, cumulative to 18 September 2026). Shares are of net irrigated area.

C1 | REVISION 1.1 RECONCILIATION NOTE

Wells and borewells supply 45.0% of C1 net irrigated area (2022-23, 9.95 lakh ha) and canals supply 51.1%. C1 is still canal-led, so the reading of a completed shift to groundwater does not hold at cluster level.

The weighted groundwater stage is 84.4% across the seven districts reported for 2025, and 113 of 268 firkas are over-exploited (42.2%). Thanjavur, Perambalur and Mayiladuthurai exceed 100%. Nagapattinam is entirely saline (16 firkas). Tiruvarur, Villupuram and Kallakurichi carry no 2025 assessment in the Schemia.

The Thanjavur recovery signal (+0.58 m across 156 wells after 840 tanks) stands in the Schemia. The district stage is 100.8%, 34 of its 50 firkas are over-exploited and 33.3% of analysed wells fell in 2025, so the signal has to be read beside that context.

The Cauvery delta farmer does not face a water shortage in the long run — the basin receives enough rainfall. What the farmer faces is a shortage of governance: mechanisms to share water equitably, measure it accurately, release it predictably, and recharge it systematically have not kept pace with the climate stress they were always going to face.

D03 — Groundwater Systems — C1

Parameter	T-20 (2004–06)	T-10 (2014–16)	T-5 (2019–21)	To (2024–26)	% Chg T20→T0	T+5 [PRJ] 2029–31
GW Stage — C1 Average (%) §	~55% ‡	~65% ‡	~72% ‡	84.4% (2025, 7 of 10 districts)	n/c	Not re-based [PRJ]
Over-Exploited Firkas — C1 §	n/a (unit changed)	n/a (unit changed)	n/a (unit changed)	113 of 268 firkas (42.2%)	n/c	Not re-based [PRJ]
Pre-Monsoon Depth — C1 avg (m bgl) ‡	~7.2	~10.8	~14.5	~17.8	+147%	~23 BAU [PRJ]

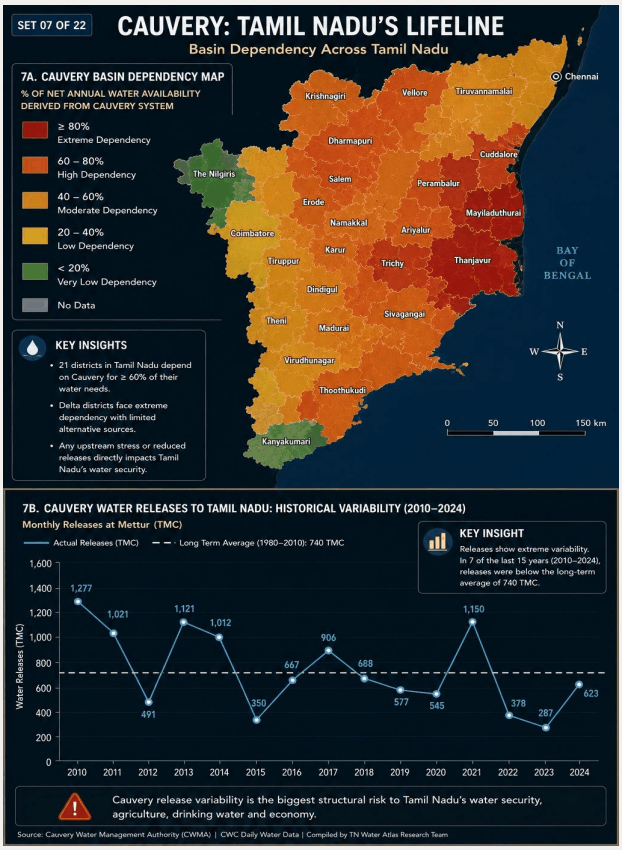
Parameter	T-20 (2004–06)	T-10 (2014–16)	T-5 (2019–21)	To (2024–26)	% Chg T20→T0	T+5 [PRJ] 2029–31
Post-Monsoon Recovery (m) ‡	~2.8	~2.2	~1.8	~1.5	-46%	Declining — recharge infrastructure loss
Source Row	CGWB Dynamic GW Resources 2024 | TWAD Board | State GW Dept. | CGWB Monitoring Wells C1 Districts					

‡ Atlas-carried value with no counterpart in Schemia V1.77, retained from v1.0. § To re-based to Schemia V1.77, earlier periods carry ‡ and the projection is withdrawn until re-based. n/c means not computable.

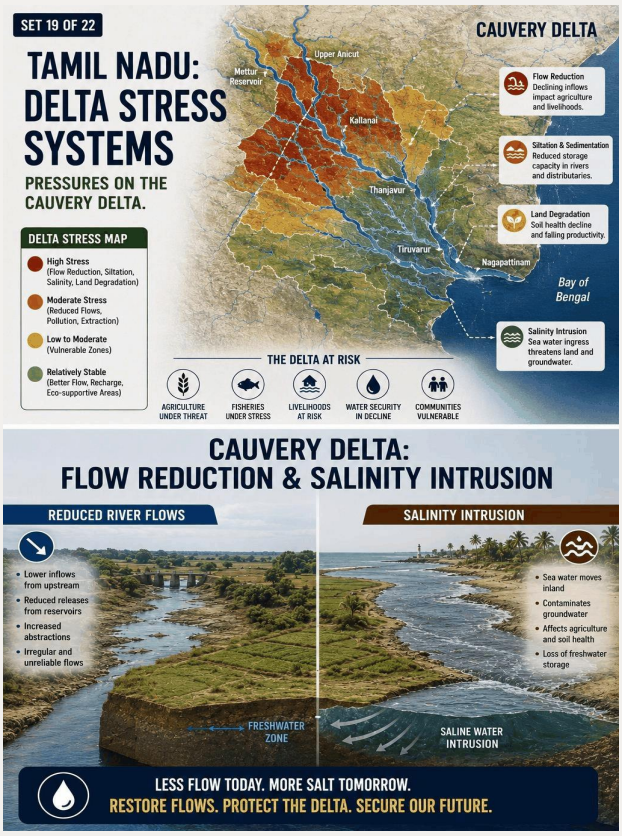
C1 — Priority Response Table

Priority	Action	Target	Horizon	Lead
EMERGENCY	Scale Thanjavur tank restoration model to all 10 C1 districts	8,200 tanks restored over 7 years	T+5	TWAD Board + District Collectors
EMERGENCY	Install Cauvery canal tail-reach sensor network	100% canal delivery monitored	2 years	CWC + CWMA + TNPWD
HIGH	Complete CWMA inter-state real-time data sharing platform	Karnataka + TN real-time access	18 months	CWMA + MoJS
HIGH	Deploy AI Cauvery seasonal flow forecasting	Predictive 3-month allocation intelligence	2 years	CWC + IMD + CWMA
HIGH	Mangrove restoration — Nagapattinam-Cuddalore coast	38% coverage target from 22%	T+5	Forest Department + NRSC

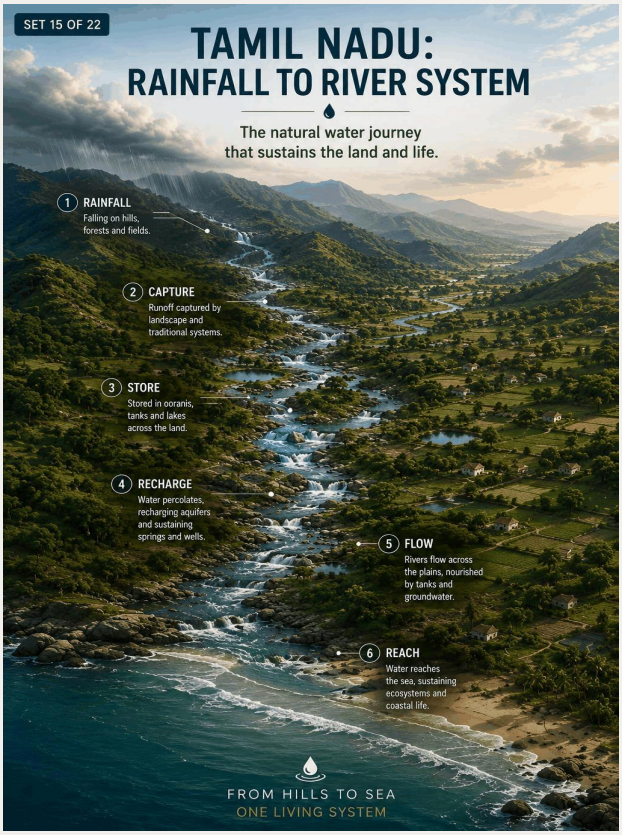
Priority	Action	Target	Horizon	Lead
MEDIUM	Scale micro-irrigation in C1 paddy districts	45% coverage from 16%	T+5	TN Agriculture Dept. + TNAU
MEDIUM	Canal lining programme — major distributaries	Delivery efficiency 38% → 55%	T+5	PWD Irrigation + TWAD Board



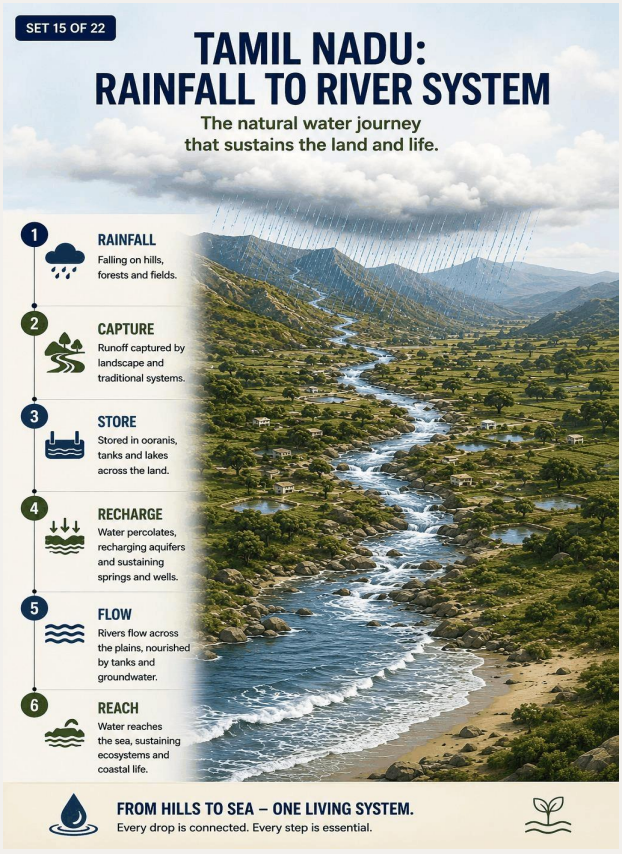
MAP-TN-08 | Cauvery: Tamil Nadu's Lifeline — Basin Dependency Across TN | Source: CWMA, CWC, 2024



MAP-TN-09 | Tamil Nadu: Delta Stress Systems — Cauvery Delta Under Pressure | Source: NRSC, CWC, CGWB, 2024



MAP-TN-10 | Tamil Nadu: Rainfall to River System — The Natural Water Journey | Source: Atlas Research Team, 2024



MAP-TN-11 | Tamil Nadu: Rainfall to River System — System Framework | Source: Atlas Research Team, 2024

C2 | WESTERN INDUSTRIAL & TEXTILE CORRIDOR

8 Districts | Industrial Water Corridor | Hard-Rock GW Stress | Watershed Transformation Zone

Cluster C2 is Tamil Nadu's economic engine and its most acute groundwater depletion zone. Eight districts — Coimbatore, Tiruppur, Erode, Salem, Namakkal, Krishnagiri, Dharmapuri, and Karur — contain the textile, knitwear, leather, steel, and horticulture sectors that generate a substantial share of Tamil Nadu's GDP. They also sit on hard-rock aquifers that are being extracted at rates that approach or exceed the physical limits of recharge — a trajectory that, if uncorrected, will undermine the economic base that drives the extraction.

C2 | Schemia V1.77 Evidence Panel A, Groundwater by District

District	Stage 2024 (%)	OE firkas	Critical	Semi-crit.	Safe	Saline	Stage 2025 (%)	Wells falling 2025 (%)
Coimbatore	86.7	22	5	5	6	0	91.8	25
Tiruppur	83.6	9	3	14	7	0	85.9	66
Erode	81.5	12	2	9	12	0	76.8	49
Salem	146.7	35	3	3	3	0	147.5	38
Namakkal	112.4	22	1	4	5	0	115.9	72
Krishnagiri	95.9	11	0	11	9	0	92.4	29
Dharmapuri	95.5	12	2	5	4	0	89.6	24
Karur	96.9	12	1	5	2	0	103.1	31
Cluster (8)	**n/a**	**135**	**17**	**56**	**48**	**0**	**97.8 (n=8)**	**n/a**

Source Schemia V1.77 MASTER DATA, GW-STAGE-D7 (IDs 893-930, CGWB 2024 report and G.O.Ms 36 of 18.07.2025), GW-2025-SOE and GW-2025-WL-FALL (Rajya Sabha Q.1055, 9 Feb 2026). Firka counts are notified categories. The 2025 cluster figure is extraction over extractable resource for the districts reported (n). n/r means not reported in the Schemia.

C2 | Schemia V1.77 Evidence Panel B, Irrigation, Tanks, Water Supply and Rainfall

District	Net irrigated (000 ha)	Wells (%)	Canals (%)	Tanks (%)	Irrigation tanks (n)	Rural taps 2023 (%)	Long-term rain (mm)	SW monsoon 2026 vs normal (%)
Coimbatore	119.7	85.7	14.2	0.2	48	84.7	1027	n/r
Tiruppur	131.8	76.2	22.7	1.0	43	74.0	1003	-24
Erode	118.0	58.8	41.2	0.0	698	69.9	896	-24
Salem	117.5	98.2	1.8	0.0	546	70.8	928	-33
Namakkal	67.1	85.3	12.4	0.0	259	80.9	866	-51
Krishnagiri	75.1	88.6	0.7	10.6	1327	46.8	851	-38
Dharmapuri	60.6	100.0	0.0	0.0	1015	25.7	895	-30
Karur	47.5	83.7	16.3	0.0	266	71.3	810	-59
Cluster (8)	**737.3**	**83.0**	**15.5**	**1.3**	**4202**	**66.0**	**n/a**	**n/a**

Source DES Statistical Handbook 2022-23 Tables 5.1 to 5.3 and Chapter 6, Schemia V2-13 (rural taps at 1 April 2023, Chennai has no rural table), MASTER DATA CL-001 (CCCDM 1951-2020 district means, Class C) and CL-002 (IMD, cumulative to 18 September 2026). Shares are of net irrigated area.

C2 | REVISION 1.1 RECONCILIATION NOTE

C2 carries the heaviest groundwater load in the state. Weighted stage is 97.8% (2025, all eight districts) and 135 of 256 firkas are over-exploited (52.7%). Salem (146.7%) and Namakkal (112.4%) exceed 100% at district level.

Wells and borewells supply 83.0% of net irrigated area (2022-23, 7.37 lakh ha), close to the 84% carried earlier. The earlier net irrigated area of 2.8 lakh ha is replaced by 7.37 lakh ha. Named local-body STP capacity in C2 districts is 518.7 MLD (TNPCB 2024-25), against about 240 MLD carried earlier.

The Krishnagiri +0.8 m recovery signal has no counterpart in the Schemia. Krishnagiri stands at 95.9% with 11 of 31 firkas over-exploited.

The extraction-recharge ratio in Western Tamil Nadu has crossed 1.84 in the hardest-pressed blocks. Extraction is nearly double recharge. The aquifer is not being stressed. It is being emptied.

D01 — Groundwater Systems — C2

Parameter	T-20 (2004–06)	T-10 (2014–16)	T-5 (2019–21)	T0 (2024–26)	% Chg T20→T0	T+5 [PRJ] 2029–31
GW Stage — C2 Average (%) §	~62% ‡	~74% ‡	~84% ‡	97.8% (2025, 8 of 8)	n/c	Not re-based [PRJ]
Over-Exploited Firkas — C2 §	n/a (unit changed)	n/a (unit changed)	n/a (unit changed)	135 of 256 firkas (52.7%)	n/c	Not re-based [PRJ]
Pre-Monsoon Depth — C2 avg (m bgl) ‡	~8.5	~13.2	~17.8	~21.6	+154%	~28+ BAU [PRJ]
Borewell Failure Rate (%) ‡	~12%	~22%	~32%	~42%	+250%	~58% BAU [PRJ]
Watershed Treated Area (%) ‡	~8%	~14%	~20%	~24%	+200%	~38% Intervention [PRJ]
Source Row	CGWB Dynamic GW Resources 2024 | TWAD Board | State GW Dept | TNPCB Industrial Water Surveys					

‡ Atlas-carried value with no counterpart in Schemia V1.77, retained from v1.0. § T0 re-based to Schemia V1.77, earlier periods carry ‡ and the projection is withdrawn until re-based. n/c means not computable.

INTERPRETATION — D01 — GROUNDWATER — C2

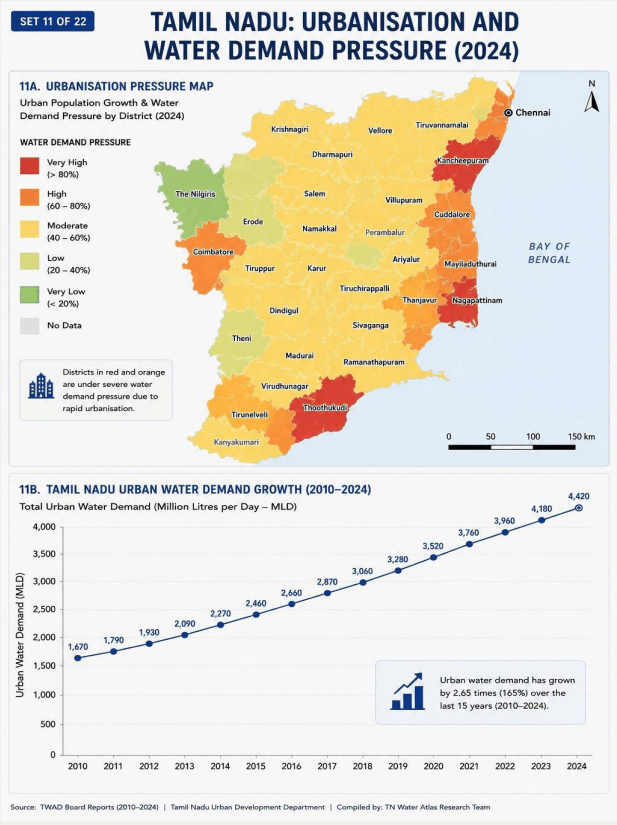
The C2 groundwater trajectory is the most alarming in the Atlas. The weighted GW stage across the cluster reads 97.8% in the 2025 assessment, so the cluster as a whole sits just under the overexploited threshold. Individual units are past it. Of 256 firkas in the eight districts, 135 (52.7%) are over-exploited, and Salem (146.7%) and Namakkal (112.4%) exceed 100% at district level. Schemia holds no T-20 firka count for C2, so the earlier trend claim is withdrawn. On hard-rock aquifers, this is not a recoverable situation without active intervention. The Krishnagiri watershed restoration programme demonstrates that intervention works: documented 0.8-metre groundwater improvement in treated zones. The gap is scale.

RECOVERY SIGNAL	
SIGNAL Krishnagiri district watershed restoration programme: Documented +0.8m groundwater level improvement in treated zones. Tank restoration component: functional tank count increased from 42% to 67% in treated panchayats.	**INTERVENTION** MGNREGS-funded watershed treatment. Krishnagiri District Collector leadership. TWAD Board technical supervision. Community watershed committees trained and activated. 2016–2023 implementation period.
EVIDENCE CGWB Krishnagiri Monitoring Report 2023. Pre- and post-treatment GW observation wells — 48 wells across 12 treated panchayats. IMD rainfall-adjusted analysis confirms recovery is intervention-attributed, not rainfall-driven.	**NEXT STEP** Scale Krishnagiri model to Dharmapuri, Salem, Namakkal watersheds — hydrologically connected. Estimated ₹680 Crore over 5 years. GW stage improvement projected: -12 to -15 percentage points across treated zones.

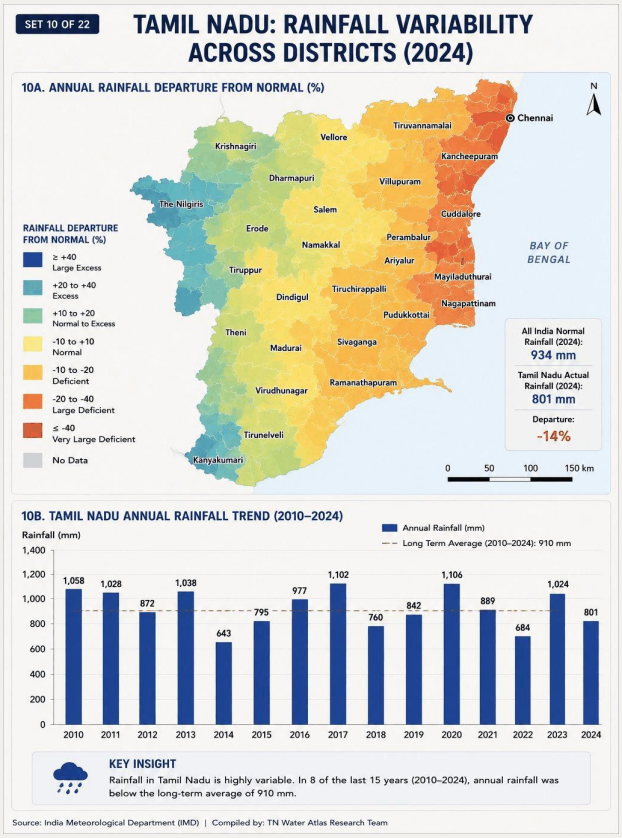
C2 — Priority Response Table

Priority	Action	Target	Horizon	Lead
EMERGENCY	Mandatory borewell registration + IoT logger installation	100% registered, 80% monitored	2 years	State GW Dept + CGWB
EMERGENCY	ZLD mandate enforcement —	350+ ZLD units operational	T+5	TNPCB + High Court compliance

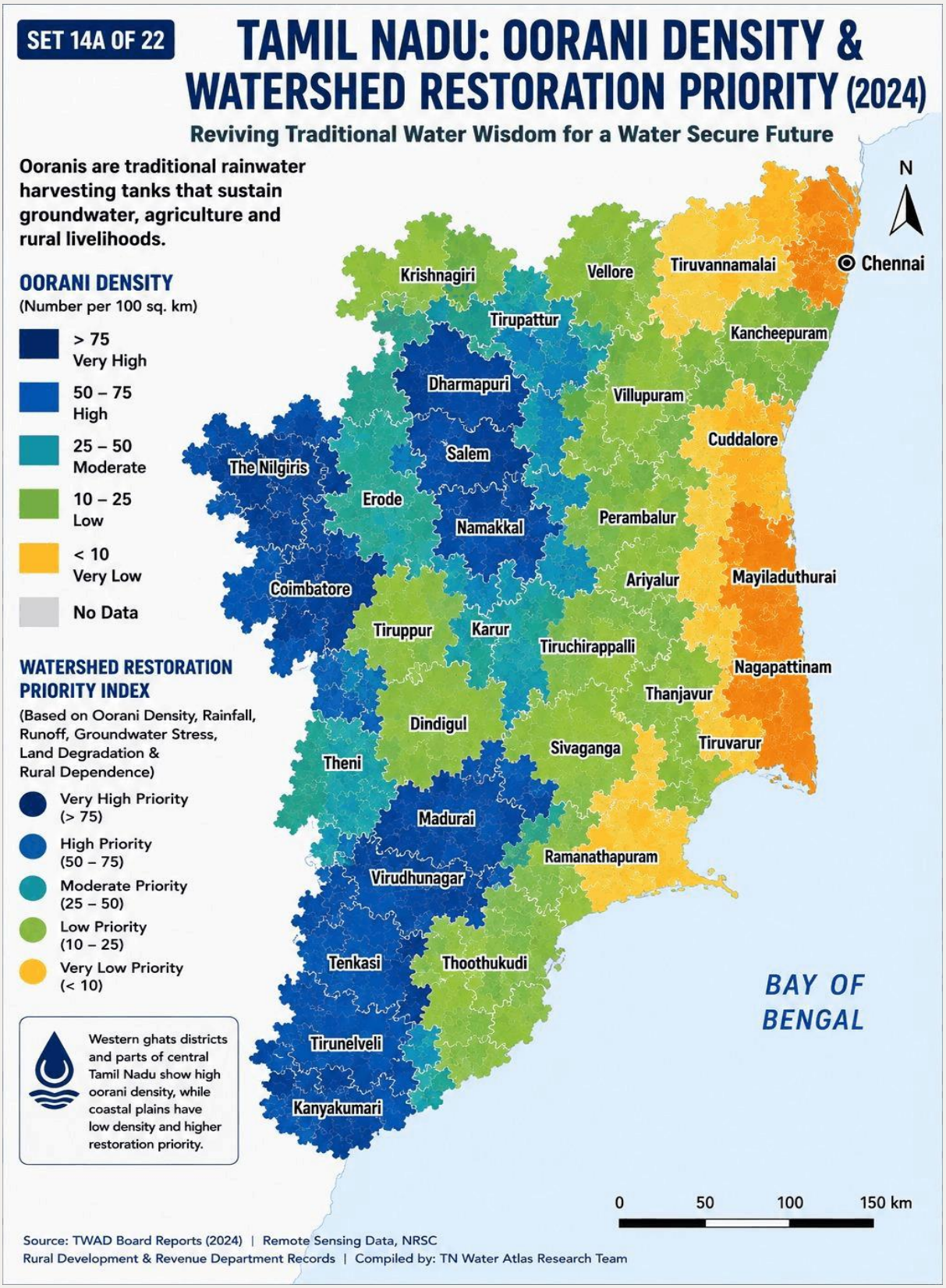
Priority	Action	Target	Horizon	Lead
	scale to 4,000+ units			
HIGH	Scale Krishnagiri watershed model to 4 districts	38% watershed area treated	T+5	TWAD Board + MGNREGS
HIGH	Noyyal-Bhavani full real-time BOD monitoring	22 continuous monitoring stations	18 months	TNPCB + CWC
HIGH	AI industrial water demand forecasting platform	C2 industrial sectors covered	2 years	TWAD Board + TNPCB + Industries Dept.
MEDIUM	Amaravathi watershed restoration — Karur	Amaravathi base flow recovery	T+5	PWD + Forest Dept.



MAP-TN-12 | Tamil Nadu: Industrial Water Use Across Districts | Source: TWAD Board, TN Industries Dept., 2024



MAP-TN-13 | Tamil Nadu: Groundwater Decline — Two Decades of Falling Water Levels | Source: CGWB, TWAD Board, IMD, 2024



MAP-TN-14 | Tamil Nadu: Groundwater Failure Above Ground | Source: CGWB, NRSC, 2024

C3 | SOUTHERN DRY BELT & TANK SYSTEM REGION

7 Districts | Low Rainfall | Oorani & Tank Dependent | Traditional System Collapse Most Acute

Cluster C3 is where the failure of India's traditional water system is most visible and most consequential. Seven districts — Madurai, Virudhunagar, Ramanathapuram, Sivaganga, Dindigul, Theni, and Tenkasi — occupy the semi-arid heart of Tamil Nadu's southern interior. Ramanathapuram averages 903.7 mm a year, the eighth lowest of 38 districts. These are districts where the oorani was not a supplementary water source — it was the only water source. And it is being lost at a pace that is converting water-secure communities into tanker-dependent ones within a single generation.

C3 | Schemia V1.77 Evidence Panel A, Groundwater by District

District	Stage 2024 (%)	OE firkas	Critical	Semi-crit.	Safe	Saline	Stage 2025 (%)	Wells falling 2025 (%)
Madurai	67.0	5	6	14	26	0	70.5	43
Virudhunagar	55.8	4	1	12	22	0	64.3	36
Ramanathapuram	10.3	0	0	0	29	9	11.0	38
Sivagangai	29.4	0	0	0	39	0	26.0	56
Dindigul	110.8	26	1	8	5	0	117.5	59
Theni	76.5	5	0	4	8	0	83.6	40
Tenkasi	76.7	9	2	8	11	0	76.2	20
Cluster (7)	**n/a**	**49**	**10**	**46**	**140**	**9**	**61.2 (n=7)**	**n/a**

Source Schemia V1.77 MASTER DATA, GW-STAGE-D7 (IDs 893-930, CGWB 2024 report and G.O.Ms 36 of 18.07.2025), GW-2025-SOE and GW-2025-WL-FALL (Rajya Sabha Q.1055, 9 Feb 2026). Firka counts are notified categories. The 2025 cluster figure is extraction over extractable resource for the districts reported (n). n/r means not reported in the Schemia.

C3 | Schemia V1.77 Evidence Panel B, Irrigation, Tanks, Water Supply and Rainfall

District	Net irrigated (000 ha)	Wells (%)	Canals (%)	Tanks (%)	Irrigation tanks (n)	Rural taps 2023 (%)	Long-term rain (mm)	SW monsoon 2026 vs normal (%)
Madurai	77.2	62.2	14.4	23.4	2288	58.7	972	-21
Virudhunagar	53.5	57.1	0.0	42.9	997	37.5	983	-7
Ramanathapuram	64.4	17.5	0.0	82.5	1694	23.1	904	-57
Sivagangai	77.1	29.2	0.0	70.8	4960	36.9	936	n/r
Dindigul	96.1	88.4	5.4	4.7	3104	58.2	927	-28
Theni	59.1	79.4	16.2	4.4	150	80.5	1221	n/r
Tenkasi	61.5	58.0	7.8	34.2	1003	57.3	1042	n/r
Cluster (7)	**488.9**	**57.2**	**6.3**	**36.2**	**14196**	**48.7**	**n/a**	**n/a**

Source DES Statistical Handbook 2022-23 Tables 5.1 to 5.3 and Chapter 6, Schemia V2-13 (rural taps at 1 April 2023, Chennai has no rural table), MASTER DATA CL-001 (CCCDM 1951-2020 district means, Class C) and CL-002 (IMD, cumulative to 18 September 2026). Shares are of net irrigated area.

C3 | REVISION 1.1 RECONCILIATION NOTE

C3 is a tank and oorani cluster before it is a groundwater cluster. It holds 14,196 of the state's 41,123 irrigation tanks (DES 2022-23). Tanks irrigate 36.2% of its net irrigated area and wells 57.2%. The earlier figures of 97% stage and 90% groundwater share are replaced by 61.2% (2025, weighted) and 57.2%.

Over-exploitation is concentrated. Dindigul stands at 110.9% with 26 of 40 firkas over-exploited, while Sivagangai (29.5%) and Ramanathapuram (10.3%) sit far below 100%. Ramanathapuram averages 903.7 mm a year, the eighth lowest of 38 districts, so the description of it as the lowest-rainfall district is withdrawn. Its 2026 southwest monsoon total to 18 September is 43.3 mm against a normal of 101.4 mm.

Rural tap coverage in C3 was 48.7% at 1 April 2023. The earlier T0 figure of 68% has no source in the Schemia. The statewide figure for September 2026 is 90.91% (V1.38) with no district split.

Ooranis are not archaeological heritage. They are operational water infrastructure. Every encroached oorani in Ramanathapuram is a household paying ₹800–1,200 per month for tanker water that a functional oorani provided free. The economics of restoration are unambiguous. The institutional will has been the gap.

D01 — Tanks, Lakes & Wetlands — C3 (Oorani Systems)

Parameter	T-20 (2004–06)	T-10 (2014–16)	T-5 (2019–21)	T0 (2024–26)	% Chg T20→T0	T+5 [PRJ] 2029–31
Functional Ooranis — C3 ‡	~28,000	~22,000	~18,000	~14,500	-48%	~11,000 BAU / ~22,000 Mission [PRJ]
Functional Tanks — C3 (% of total) ‡	~68%	~55%	~47%	~38%	-44%	~28% BAU / ~60% Restored [PRJ]
Tanker Dependency — Ramanathapuram (%) ‡	~8%	~22%	~38%	~52%+	+550%	~70% BAU [PRJ] — EMERGENCY

Parameter	T-20 (2004–06)	T-10 (2014–16)	T-5 (2019–21)	To (2024–26)	% Chg T20→T0	T+5 [PRJ] 2029–31
Tanker Cost per KL (₹) ‡	~₹120	~₹280	~₹420	~₹600–800	+567%	Rising BAU [PRJ]
Oorani GW Recharge Contribution (BCM) ‡	~0.48	~0.38	~0.30	~0.22	-54%	~0.18 BAU / ~0.42 Mission [PRJ]
Restored Ooranis (4,200 restored 2019–23) ‡	N/A	N/A	Baseline	4,200 restored	Recovery signal	Scale required — 20,500 remain depleted
Tanker Dependency — Treated Panchayats ‡	N/A	N/A	Pre-restoration	-22% reduction post-restoration	Recovery attributed	Scale to all C3 panchayats
Source Row	TN Rural Development Dept. Oorani Survey | TWAD Board | CGWB District Reports | Census 2011 Rural Water Access					

‡ Atlas-carried value with no counterpart in Schemia V1.77, retained from v1.0. § To re-based to Schemia V1.77, earlier periods carry ‡ and the projection is withdrawn until re-based. n/c means not computable.

INTERPRETATION — D01 — TANKS & OORANIS — C3

The C3 tank and oorani system is collapsing faster than any restoration programme is rebuilding it. At T-20, approximately 28,000 ooranis were functional across C3 districts. At To, approximately 14,500 are functional — a 48% decline. In the same period, tanker dependency in Ramanathapuram has grown from 8% to 52%+. These two numbers are the same event expressed from two directions: every lost oorani is a household shifted from free water to paid water. The 4,200 oorani restoration programme (2019–2023) has produced a documented 22% reduction in tanker dependency in treated panchayats — confirming that the model works. The gap: 20,500

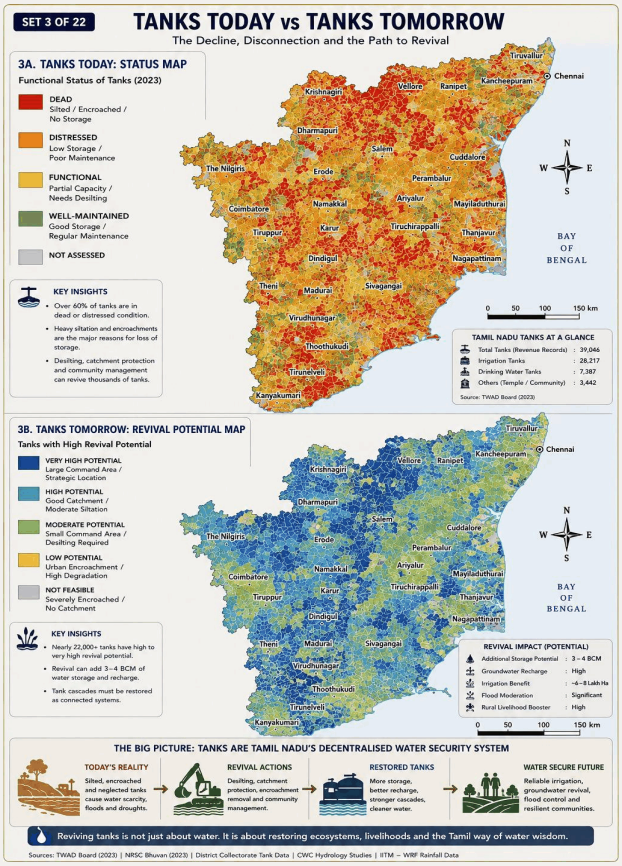
ooranis remain non-functional. At current restoration pace, the tanker economy will be institutionalized across C3 before restoration catches up.

RECOVERY SIGNAL	
SIGNAL 4,200 ooranis restored across C3 (2019–2023). Tanker dependency in treated panchayats: -22% within 2 monsoon cycles. Groundwater levels in adjacent wells: +0.4–0.7m average recovery.	**INTERVENTION** TN Rural Development Department Oorani Rejuvenation Programme. MGNREGS labour for desilting, bund strengthening, inlet protection. Community water committees reinstated as governance structure. Institutional anchor: District Rural Development Agencies.
EVIDENCE TN Rural Development Dept. Survey Report 2023. CGWB monitoring wells — pre and post monitoring across 340 treated panchayats. Independent village survey: Ramanathapuram District Water Security Assessment 2024.	**NEXT STEP** Scale from 4,200 to 20,000+ restored ooranis within T+5 window. Triple current annual restoration pace. Mandatory community committee formation as condition of restoration funds. Integrate oorani restoration with JJM rural tap coverage to eliminate tanker dependency as policy objective.

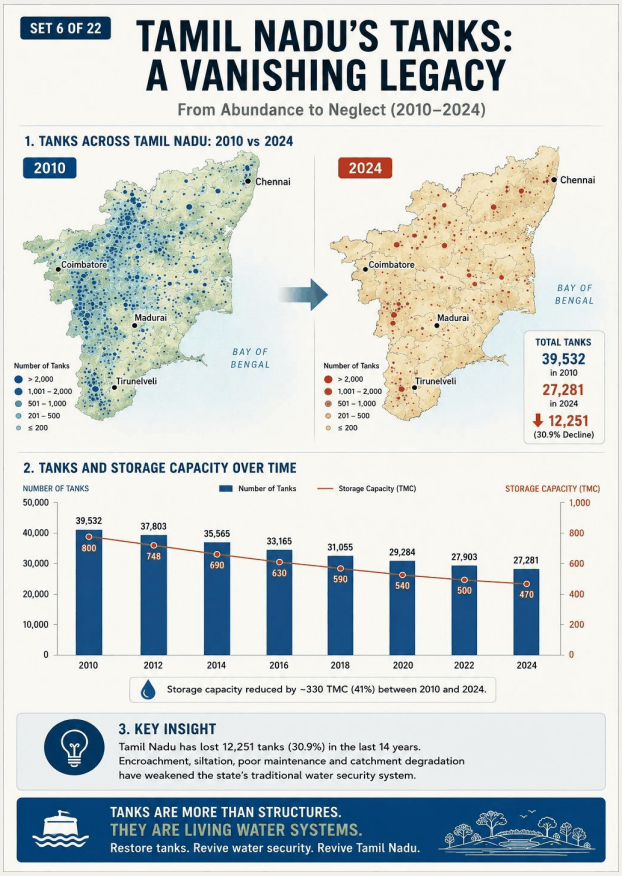
C3 — Priority Response Table

Priority	Action	Target	Horizon	Lead
EMERGENCY	Scale oorani restoration to 20,000+ in C3	Eliminate tanker dependency in restored panchayats	T+5	TN Rural Dev. Dept + MGNREGS
EMERGENCY	Deploy Drought Early Warning System — C3	Village-level drought prediction 90 days advance	18 months	IMD + TN Agriculture Dept.
HIGH	Satellite-based oorani storage monitoring	14,500 functional ooranis monitored in real time	2 years	NRSC + TN Rural Dev. Dept.
HIGH	Tanker market digital registry —	Price transparency,	1 year	District Collector + TWAD Board

Priority	Action	Target	Horizon	Lead
	Ramanathapuram pilot	route monitoring, demand tracking		
HIGH	JJM + Oorani integration — rural tap + local recharge	Dual security: piped supply + local GW recharge	T+5	TWAD Board + JJM Mission
MEDIUM	Fluoride-safe drinking water — contaminated blocks	Safe water access in 38% contaminated blocks	T+5	TWAD Board + Health Dept.



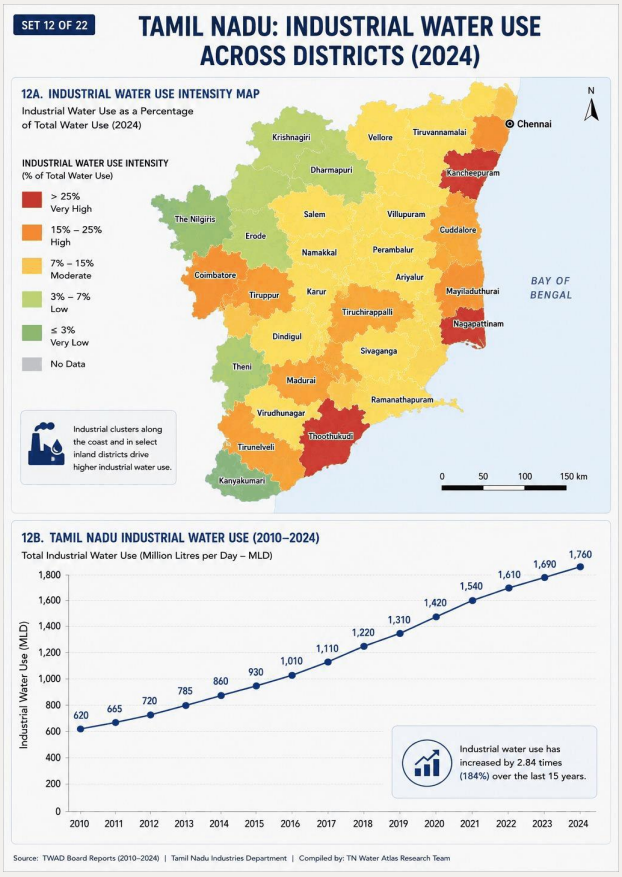
MAP-TN-15 | Tanks Today vs Tanks Tomorrow — Decline, Disconnection and the Path to Revival | Source: TWAD Board 2023, NRSC 2023



MAP-TN-16 | Tamil Nadu's Tanks: A Vanishing Legacy | Source: TWAD Board, Revenue Records, 2024



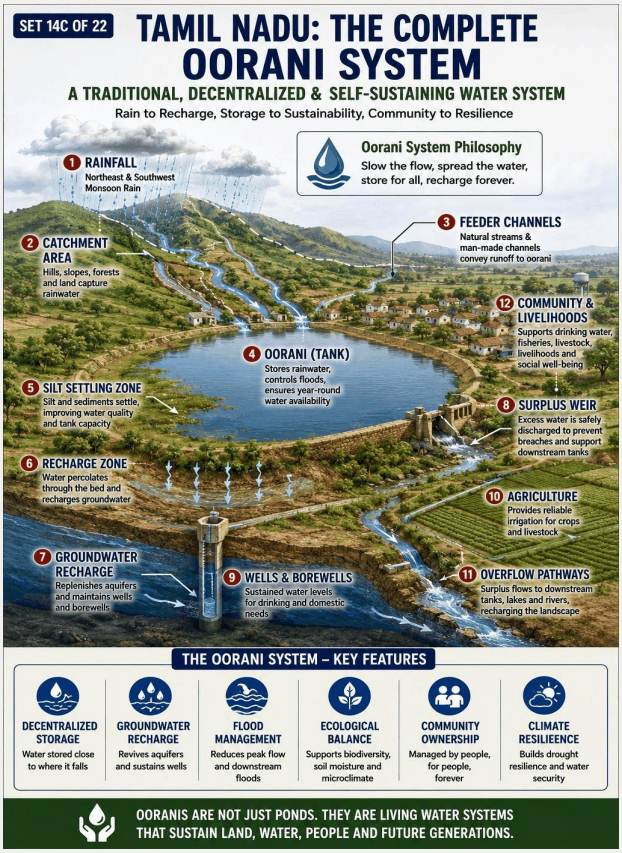
MAP-TN-17 | Tamil Nadu: Tank Cascade Systems | Source: TWAD Board, Atlas Research Team, 2024



MAP-TN-18 | Tamil Nadu: Oorani Revival & Watershed Restoration | Source: TWAD Board, NRSC, 2024



MAP-TN-19 | Tamil Nadu: Oorani Density & Watershed Restoration Priority | Source: TWAD Board, NRSC, 2024



MAP-TN-20 | Tamil Nadu: Oorani Restoration — Before and After | Source: Atlas Research Team, 2024



MAP-TN-21 | Tamil Nadu: The Complete Oorani System | Source: Atlas Research Team, 2024

C4 | CHENNAI METROPOLITAN & NORTH COASTAL CORRIDOR

8 Districts | Urban Water Crisis | Lake Network Collapse | Palar Pollution Corridor

Cluster C4 is the urban face of Tamil Nadu's water crisis. Eight districts — Chennai, Tiruvallur, Kancheepuram, Chengalpattu, Vellore, Ranipet, Tirupattur, and Tiruvannamalai — span the northern coastal corridor from the state capital to the Andhra Pradesh border. They share a hard-rock geological base, a bimodal monsoon pattern, intense urban and peri-urban groundwater extraction, and a corridor of industrial water pollution (the Palar leather tanning corridor) that has contaminated groundwater across multiple districts. Chennai's water systems are treated in the dedicated Capital Section above. The cluster analysis here covers the broader metropolitan corridor and its system dynamics.

C4 | Schemia V1.77 Evidence Panel A, Groundwater by District

District	Stage 2024 (%)	OE firkas	Critical	Semi-crit.	Safe	Saline	Stage 2025 (%)	Wells falling 2025 (%)
Chennai	124.9	46	0	3	2	0	121.7	47
Tiruvallur	54.6	2	0	14	31	1	55.4	19
Kancheepuram	49.4	1	2	4	18	0	48.9	36
Chengalpattu	68.3	2	2	16	20	0	64.2	36
Vellore	121.5	12	0	8	0	0	121.8	11
Ranipet	88.8	4	0	13	1	0	84.5	33
Tirupattur	139.2	12	0	3	0	0	142.9	6
Tiruvannamalai	82.9	15	9	18	12	0	86.0	23
Cluster (8)	**n/a**	**94**	**13**	**79**	**84**	**1**	**74.4 (n=8)**	**n/a**

Source Schemia V1.77 MASTER DATA, GW-STAGE-D7 (IDs 893-930, CGWB 2024 report and G.O.Ms 36 of 18.07.2025), GW-2025-SOE and GW-2025-WL-FALL (Rajya Sabha Q.1055, 9 Feb 2026). Firka counts are notified categories. The 2025 cluster figure is extraction over extractable resource for the districts reported (n). n/r means not reported in the Schemia.

C4 | Schemia V1.77 Evidence Panel B, Irrigation, Tanks, Water Supply and Rainfall

District	Net irrigated (000 ha)	Wells (%)	Canals (%)	Tanks (%)	Irrigation tanks (n)	Rural taps 2023 (%)	Long-term rain (mm)	SW monsoon 2026 vs normal (%)
Chennai	0.3	85.1	0.0	14.9	91	n/r	1186	-4
Tiruvallur	85.4	93.9	0.0	6.1	1867	87.4	1128	-25
Kancheepuram	38.8	34.6	0.0	65.3	749	99.8	1147	-35
Chengalpattu	65.6	41.6	0.5	57.9	1130	78.5	1167	-55
Vellore	21.4	100.0	0.0	0.0	341	94.0	939	-41
Ranipet	41.7	95.3	0.0	4.7	618	100.0	939	-24
Tirupattur	29.8	100.0	0.0	0.0	396	60.3	939	-57
Tiruvannamalai	186.8	92.3	0.1	7.6	1966	70.3	1006	-40
Cluster (8)	**469.7**	**81.9**	**0.1**	**18.0**	**7158**	**82.1**	**n/a**	**n/a**

Source DES Statistical Handbook 2022-23 Tables 5.1 to 5.3 and Chapter 6, Schemia V2-13 (rural taps at 1 April 2023, Chennai has no rural table), MASTER DATA CL-001 (CCCDM 1951-2020 district means, Class C) and CL-002 (IMD, cumulative to 18 September 2026). Shares are of net irrigated area.

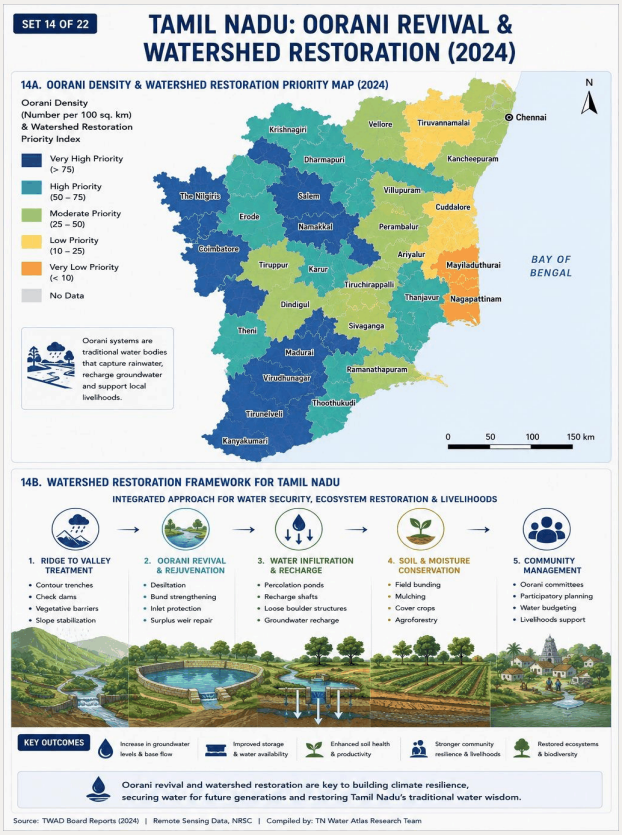
C4 | REVISION 1.1 RECONCILIATION NOTE

C4 holds three of the nine districts that extract more than their resource. Chennai (124.9% in 2024, 121.7% in 2025), Vellore (121.5%) and Tirupattur (139.2%) are past 100%. Across the cluster 94 of 271 firkas are over-exploited (34.7%) and the weighted stage is 74.4%, close to the state figure.

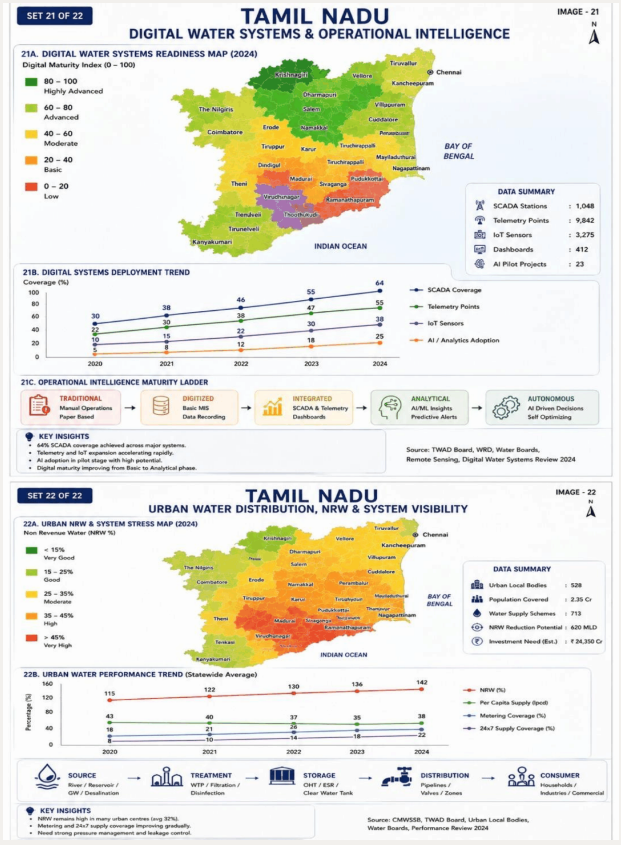
Chennai has 46 over-exploited firkas out of 51, which fits a fully urban aquifer. Named local-body STP capacity in C4 districts is 1,176.1 MLD (TNPCB 2024-25), dominated by Chennai. The lake counts, tanker shares, reuse volumes and NRW figures of this chapter have no counterpart in the Schemia and are marked.

C4 — Priority Response Table

Priority	Action	Target	Horizon	Lead
EMERGENCY	Palar ZLD enforcement — scale to 100% tannery compliance	65% compliance within T+5	T+5	TNPCB + Madras HC oversight
HIGH	DMA rollout — NRW reduction Chennai-Kancheepuram	NRW from 28% to 15%	T+5	CMWSSB + World Bank Programme
HIGH	Tanker market digital registry — Chennai	Price transparency + demand tracking	1 year	CMWSSB + District Collector
HIGH	Lake restoration — scale from 32 to 150+ lakes	Stormwater retention recovery to 60% of design	T+5	Chennai Corporation + CMWSSB
MEDIUM	Treated wastewater reuse — scale to 500 MLD	Reduce freshwater demand by 220 MLD	T+5	CMWSSB + TNPCB + Industry
MEDIUM	Temple tank restoration — Kancheepuram, Tiruvannamalai	GW recharge in pilgrimage corridors	T+5	Hindu Religious Endowments Board



MAP-TN-22 | Tamil Nadu: Urbanisation and Water Demand Pressure | Source: TWAD Board, TN Urban Development Dept., 2024



MAP-TN-23 | Tamil Nadu: Digital Water Systems & NRW — Operational Intelligence | Source: TWAD Board, CMWSSB, WRD, 2024

C5 | SOUTH COASTAL & ECOLOGICAL SYSTEMS

5 Districts | Coastal Salinity Intrusion | Tamirabarani | Western Ghats Water Tower

Cluster C5 is Tamil Nadu's most ecologically diverse and hydrologically contrasting cluster. Five districts — Tirunelveli, Thoothukudi, Kanyakumari, Pudukottai, and the Nilgiris — span from the southernmost tip of the Indian subcontinent to the highest peaks of the Western Ghats. They include Tamil Nadu's most water-secure river system (the Tamirabarani, the only truly perennial river in the state), the state's primary ecological water tower (the Nilgiris Biosphere), its most cyclone-exposed coastline, and the salt pan wetlands of Thoothukudi. C5 is also the model cluster for what the Atlas argues Tamil Nadu must protect: the Nilgiris forest condition directly determines the baseflow of rivers that sustain lowland districts in multiple clusters.

C5 | Schemia V1.77 Evidence Panel A, Groundwater by District

District	Stage 2024 (%)	OE firkas	Critical	Semi-crit.	Safe	Saline	Stage 2025 (%)	Wells falling 2025 (%)
Tirunelveli	43.2	0	1	2	27	0	41.0	24
Thoothukudi	34.9	1	0	6	34	0	27.6	54
Kanyakumari	16.7	0	0	1	21	0	13.8	77
Pudukottai	50.8	0	0	17	25	3	49.3	61
Nilgiris	6.8	0	0	0	15	0	n/r	n/r
Cluster (5)	**n/a**	**1**	**1**	**26**	**122**	**3**	**37.1 (n=4)**	**n/a**

Source Schemia V1.77 MASTER DATA, GW-STAGE-D7 (IDs 893-930, CGWB 2024 report and G.O.Ms 36 of 18.07.2025), GW-2025-SOE and GW-2025-WL-FALL (Rajya Sabha Q.1055, 9 Feb 2026). Firka counts are notified categories. The 2025 cluster figure is extraction over extractable resource for the districts reported (n). n/r means not reported in the Schemia.

C5 | Schemia V1.77 Evidence Panel B, Irrigation, Tanks, Water Supply and Rainfall

District	Net irrigated (000 ha)	Wells (%)	Canals (%)	Tanks (%)	Irrigation tanks (n)	Rural taps 2023 (%)	Long-term rain (mm)	SW monsoon 2026 vs normal (%)
Tirunelveli	47.9	45.7	21.6	32.7	1152	60.8	1042	n/r
Thoothukudi	34.6	50.5	27.9	21.6	653	55.7	854	-64
Kanyakumari	24.5	25.2	32.5	42.3	2623	92.3	1027	-7
Pudukottai	117.7	50.4	0.9	48.8	5451	43.6	946	-19
Nilgiris	5.2	98.4	0.0	0.0	0	56.3	1333	-30
Cluster (5)	**229.8**	**47.8**	**12.6**	**39.5**	**9879**	**59.4**	**n/a**	**n/a**

Source DES Statistical Handbook 2022-23 Tables 5.1 to 5.3 and Chapter 6, Schemia V2-13 (rural taps at 1 April 2023, Chennai has no rural table), MASTER DATA CL-001 (CCCDM 1951-2020 district means, Class C) and CL-002 (IMD, cumulative to 18 September 2026). Shares are of net irrigated area.

C5 | REVISION 1.1 RECONCILIATION NOTE

C5 is the least stressed cluster on groundwater. Weighted stage is 37.1% across the four districts reported for 2025 and only 1 of 153 firkas is over-exploited. Nilgiris (6.8%) and Kanyakumari (16.7%) carry the lowest stages in the state, and Tirunelveli (43.2%) supports its description as the most water-secure district.

A low stage does not mean rising water tables. Kanyakumari, Pudukottai and Thoothukudi are among seven districts where more than half of analysed wells showed a level fall in 2025. Saline firkas in C5 number three, all in Pudukottai.

Thoothukudi received 18.1 mm in the 2026 southwest monsoon to 18 September against a normal of 50.2 mm (-64%). Tirunelveli received 397.6 mm against 71.5 mm. The Nilgiris forest cover share and the Tamirabarani flow figures have no counterpart in the Schemia.

D01 — Ecology & Forest-Water Systems — C5

Parameter	T-20 (2004–06)	T-10 (2014–16)	T-5 (2019–21)	T0 (2024–26)	% Chg T20→T0	T+5 [PRJ] 2029–31
Nilgiris Forest Cover (%) ‡	~60%	~57%	~54%	~52%	-13%	~44% BAU / ~65% Protection [PRJ]

Parameter	T-20 (2004–06)	T-10 (2014–16)	T-5 (2019–21)	To (2024–26)	% Chg T20→T0	T+5 [PRJ] 2029–31
Shola-Grassland Complex (% of Nilgiris) ‡	~28%	~24%	~21%	~18%	-36%	~12% BAU / ~28% Restoration [PRJ]
Tamirabarani Base Flow (TMC/year) ‡	~7.2	~6.8	~6.4	~6.1	-15%	~5.4 BAU [PRJ]
Stream Count — Nilgiris (perennial) ‡	~320	~290	~265	~245	-23%	~195 BAU [PRJ]
Invasive Species Cover — Nilgiris (%) ‡	~18%	~25%	~32%	~38%	+111%	~50% BAU [PRJ]
Source Row	FSI Forest Survey of India Biennial Reports | CWC Tamirabarani Gauging | NRSC Land Cover | Nilgiris Biosphere Reserve Authority					

‡ Atlas-carried value with no counterpart in Schemia V1.77, retained from v1.0. § To re-based to Schemia V1.77, earlier periods carry ‡ and the projection is withdrawn until re-based. n/c means not computable.

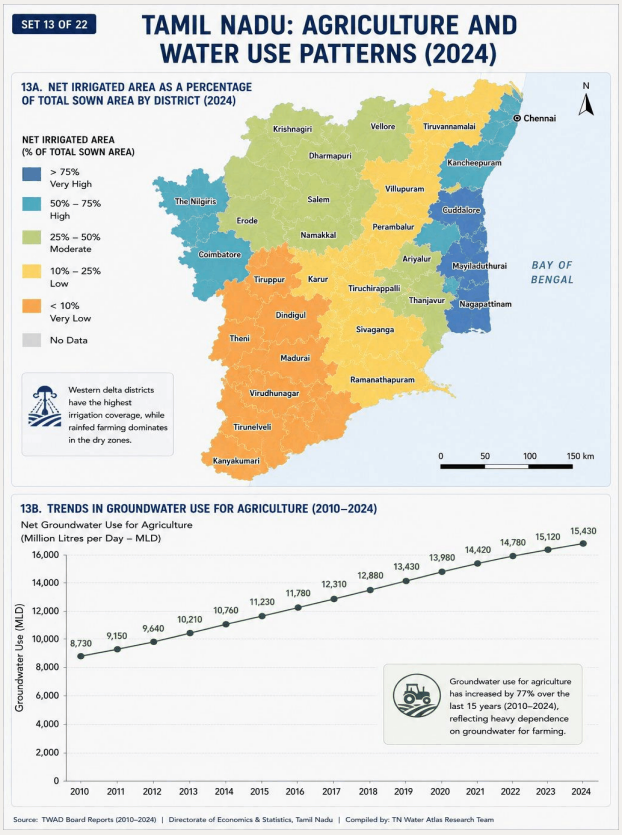
INTERPRETATION — D01 — ECOLOGY & FOREST-WATER — C5

The Nilgiris is not a nature park. It is a water infrastructure system — the most important water infrastructure in Tamil Nadu that does not appear in any water department budget. The shola-grassland complex of the Nilgiris is the primary recharge mechanism for the streams that feed the Tamirabarani, the Bhavani, the Moyar, and the feeder streams of multiple major reservoirs. Every shola hectare lost to invasive plants, plantation expansion, or tourism pressure reduces the

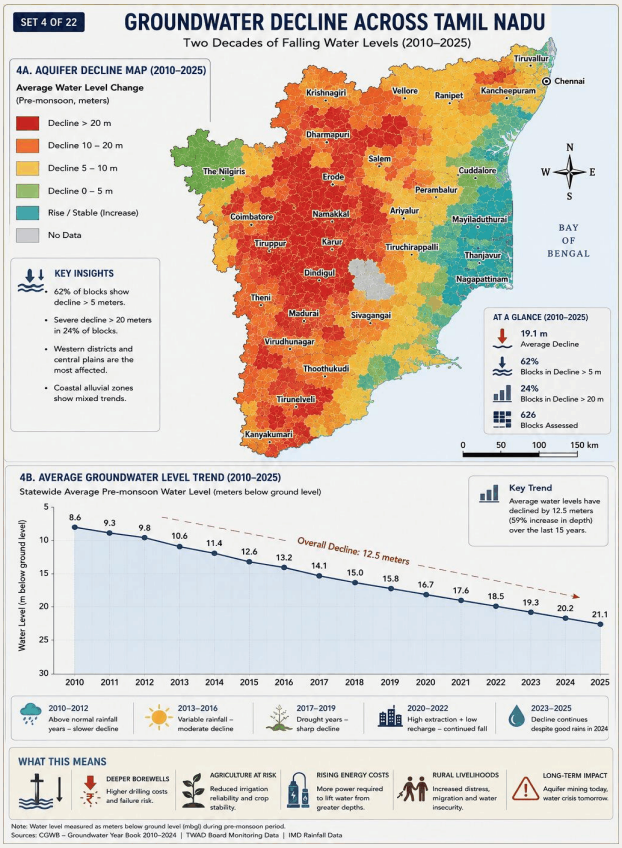
baseflow of rivers that sustain agriculture, drinking water supply, and industry across five districts and two clusters. The 13% forest cover loss is not a small number in a water accounting framework — it is a measurable reduction in Tamil Nadu's natural water production infrastructure.

C5 — Priority Response Table

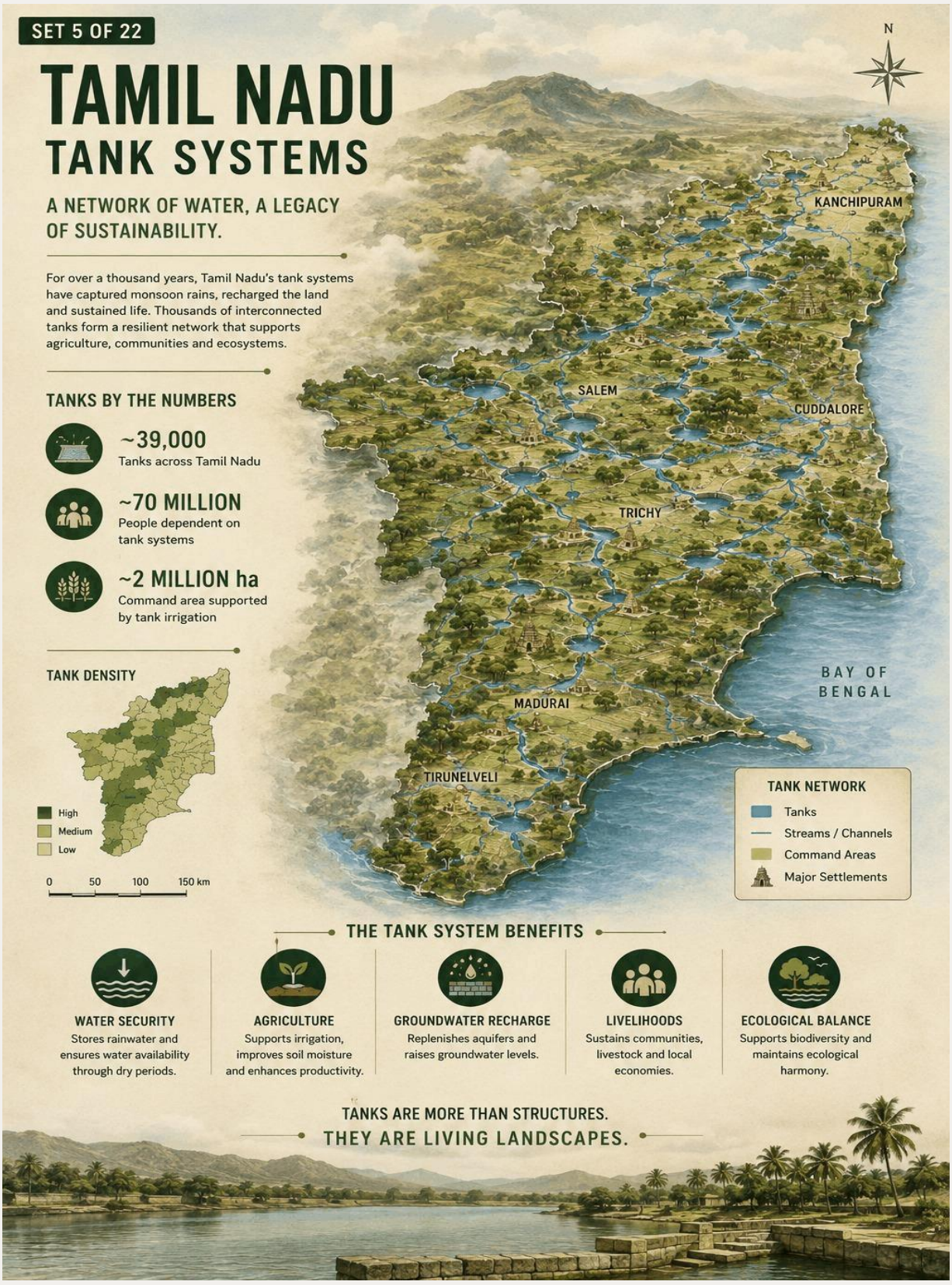
Priority	Action	Target	Horizon	Lead
EMERGENCY	Nilgiris shola-grassland protection and invasive species removal	Shola cover stabilized — 18% → 25%	T+5	Forest Dept. + Wildlife Board + NRSC
HIGH	Mangrove restoration — Thoothukudi and Nagapattinam coasts	Mangrove cover 15% → 28%	T+5	Forest Dept. + Coastal Zone Authority
HIGH	Nilgiris stream flow telemetry — 60 new gauges	All major Nilgiris streams monitored	2 years	CWC + Forest Dept. + NRSC
HIGH	Sand mining regulation — Tamirabarani	Zero unregulated mining; river bed recovery	T+5	District Collector + Mines Dept.
MEDIUM	Pudukottai tank cascade revival	Tank functionality 38% → 65% in C5	T+5	TWAD Board + RD Dept.
MEDIUM	Coastal GW salinity monitoring — Thoothukudi	Real-time salinity intrusion tracking	18 months	CGWB + State GW Dept.



MAP-TN-24 | Tamil Nadu: Agriculture and Water Use Patterns | Source: TWAD Board, Directorate of Economics & Statistics, 2024



MAP-TN-25 | Tamil Nadu: Rainfall Variability Across Districts | Source: IMD, 2024



MAP-TN-26 | Tamil Nadu Tank Systems — A Network of Water, A Legacy of Sustainability | Source: TWAD Board, 2024

SECTION R | STATEWIDE SYNTHESIS

Inter-Cluster Dependencies | Critical Corridors | Future Risk Trajectories

The five clusters of Tamil Nadu are not independent water systems. They are five interconnected zones of a single territorial water system — where what happens in one cluster directly affects the hydrology, the economy, and the water security of others. This synthesis maps the critical inter-cluster linkages, identifies the corridors where multiple system failures converge, and traces the five future risk trajectories that will determine whether Tamil Nadu crosses irreversible thresholds within the T+5 window.

Six Critical Inter-Cluster Dependencies

Linkage	Description	Consequence of Failure
C1 ↔ C2	Bhavani and Noyyal rivers carry C2 industrial effluents into C1 delta fringe. GW stress in C2 reduces lateral recharge into C1 aquifer. ZLD enforcement in C2 is partly a C1 protection intervention.	C2 industrial pollution migrates into C1 agricultural groundwater. Delta rice contamination. Canal-adjacent aquifer compromise.
C1 ↔ C4	Both clusters compete for Cauvery allocation. Chennai's 70% dependency reduces delta availability in distress years. Delta agricultural losses in distress years produce urban migration pressure on Chennai infrastructure.	Zero-sum competition between agricultural and urban Cauvery demand intensifies in every distress year. Urban growth accelerates rural water stress.
C3 ↔ C1	Vaigai system originates in C3 and feeds into C1 fringe. Oorani restoration in C3 reduces distress migration into Chennai and Madurai. GW stress in C3 is partly a consequence of Cauvery unavailability driving upstream extraction.	C3 collapse accelerates migration into C4 and C1 urban areas. Urban water demand grows faster than infrastructure. Rural water systems not restored.
C5 ↔ C1	Tamirabarani health determines salinity front position along southern coast. Nilgiris forest condition determines Tamirabarani baseflow. Mangrove restoration in C5 is the model for Nagapattinam-Cuddalore coast (C1).	Nilgiris degradation reduces Tamirabarani baseflow. Southern coast salinity intrusion advances into C1 agricultural territory. Delta fisheries collapse accelerates.
C4 ↔ C5	Nilgiris catchment feeds catchments supplying Chennai's Poondi and Chembarambakkam	Nilgiris forest loss reduces Chennai reservoir recharge. Chennai dependency on

Linkage	Description	Consequence of Failure
	reservoirs. Nilgiris forest protection is Chennai water security expressed in ecological terms.	Cauvery increases as local catchment capacity declines. Desalination becomes default, not supplement.
C2 ↔ C3	Salem-Dharmapuri-Krishnagiri watershed connects C2 recharge zones to C3 GW systems. Watershed treatment in C2 benefits downstream GW in C3 Dindigul-Madurai fringe.	C2 watershed degradation reduces recharge transmission to C3. GW depletion in C3 accelerates beyond the pace that C3-specific interventions alone can address.

Five Future Risk Trajectories — T+5 Window

Risk Trajectory	Window	BAU Path	Intervention Path	Tipping Point Signal
GW Threshold Risk	2028–2032	Western Corridor units, Dindigul and the Delta fringe approach physical exhaustion in the hardest-stressed firkas. Borewell failure rate exceeds 50%. Emergency water trucking becomes state policy.	Watershed restoration + borewell moratorium brings 30 blocks back from overexploited category. Extraction-recharge ratio drops from 1.84 to 1.2 in treated zones.	Block-average GW depth crossing 30 m bgl in hard-rock terrain. Recovery from this depth requires decade-scale intervention.
Cauvery Conflict Intensification	2027–2030	Climate change reducing KRS inflows 8–12% while both states increase command area demand. Distress-year frequency exceeds 6 of 10 years. Agricultural losses compound annually.	CWMA real-time data sharing + AI seasonal forecasting enables predictive allocation. Cooperative agreement on climate-adjusted sharing framework reduces conflict frequency.	3 consecutive distress years without inter-state protocol — breaks cooperative norms. Political escalation replaces technical management.

Risk Trajectory	Window	BAU Path	Intervention Path	Tipping Point Signal
Urban Flood Escalation	2026–2030	Chennai impervious surface at 66% with only 35% of original lake buffering. Repeat of 2015-scale rainfall event produces worse flooding with higher economic loss. Insurance gaps widen.	Lake restoration to 150 lakes + DMA network + lake cascade reconnection reduces flood damage exposure by 40%. Urban risk profile improves measurably.	Second consecutive year of ₹20,000+ Crore flood loss triggers political commitment. Or it does not — and the cycle continues.
Coastal Salinity Emergency	2028–2035	Salinity intrusion 12–20 km inland in Nagapattinam and Cuddalore. Coastal agriculture in delta fringe becomes unviable. 1,100+ coastal villages affected. Migration accelerates.	Mangrove restoration to 38% coverage + saline-tolerant variety adoption + coastal GW monitoring buys 15-year window for adaptation. Climate-proof coastal water security.	Agricultural yield loss >40% in coastal blocks signals irreversible transition from rice to salt pan — once converted, recovery cost exceeds restoration cost by 10×.
Tank Cascade Point of No Return	2026–2028	If restoration pace does not triple within two years, cascade fragmentation reaches threshold beyond which individual tank restoration cannot restore system-level recharge function. System connectivity lost — not individual tanks.	Triple restoration pace to 1,200+ tanks/year across state. Restore cascade connections as system units — not individual tank projects. Community governance reinstated as condition of funding.	When cascade disconnect exceeds 60% of historic network — recharge function cannot be restored by individual tank treatment. System-level intervention required, at 5× the cost.

SECTION S | STATE SYNTHESIS — THE VERDICT

Tamil Nadu Water Systems | May 2026

Dominant Transitions — T-20 to To

System Component	T-20 State	To State	Direction	Verdict
Groundwater System	No primary T-20 baseline. 74.0% stage (GWRA 2022)	73.5% stage (GWRA 2025), 392 OE firkas	HIGH AND FLAT, 2022 TO 2025	CRITICAL in concentrated corridors. The stage has held near 74% since 2022, but 392 of 1,202 firkas are over-exploited. Nine districts exceed 100%. They are Salem, Namakkal, Dindigul, Thanjavur, Perambalur, Chennai, Vellore, Tirupattur and Mayiladuthurai.
Tank & Oorani Systems	39,532 tanks at Independence, ~65,000 ooranis (historical)	<27,281 tanks functional (about 69%), <35,000 ooranis	DETERIORATING	CRITICAL: The 1,500-year water infrastructure is being lost at a pace that will make system-level recovery impossible if not arrested within 2–3 years.
Cauvery / Interstate	~380 TMC receipt, 3/10 distress years	~290 TMC receipt, 7/15 distress years	DETERIORATING — STRUCTURAL	HIGH: Not a climate problem — a governance problem. The water exists in the basin. The sharing mechanism does not function under stress.
Urban Water Security	280-lake network partial. Tanker dep. 8%.	110 lakes functional. Tanker dep. 42%.	DETERIORATING — SEVERE	CRITICAL: Chennai has dismantled its local water system while building expensive, climate-vulnerable supply chains. The reversal is possible — the lake restoration model proves it.

(Appendix E)

System Component	T-20 State	To State	Direction	Verdict
Industrial Water Governance	Limited ZLD. Noyyal BOD 18 mg/l.	186 ZLD units. Noyyal BOD 72 mg/l.	MIXED: Governance improving, baseline contamination worsening	HIGH: ZLD enforcement works when applied. Palar corridor shows the cost of delayed application. Scale ZLD mandate now — not after contamination exceeds remediation threshold.
Recovery Systems	Negligible formal recovery at T-20	840 tanks Thanjavur, 4,200 ooranis, 186 ZLD units, 280 MLD reuse	IMPROVING — INSUFFICIENT SCALE	RECOVERY SIGNAL CONFIRMED: The model works. The scale gap between proven and deployed is the governance crisis that must be resolved within T+5.

Recovery Evidence — What Is Working, and Why

Signal	Location	Intervention	Evidence	Grade	Scale Potential
Tank cascade restoration	Thanjavur district	TWAD Board + MGNREGS. 840 tanks. 2018–2023.	+0.58m avg GW recovery. 156 monitoring wells. TWAD Report 2023.	A	C1 — 8,200 tanks. State — 39,000 tanks. Full restoration is civilizational in impact.
Watershed restoration + GW recovery	Krishnagiri district	District Collector-led. MGNREGS. 2016–2023.	+0.8m GW improvement in treated zones. CGWB Krishnagiri Report 2023.	A	C2 — 4 watershed districts. 38% treatment target achievable within T+5.
ZLD industrial compliance	Tiruppur knitwear cluster	Madras HC directive 2011. TNPCB enforcement. Industry investment.	186 ZLD units. Noyyal BOD trajectory partially controlled. TNPCB 2024.	A	C2 and C4 — 4,000+ non-compliant units remain. Enforcement infrastructure exists.

Signal	Location	Intervention	Evidence	Grade	Scale Potential
Treated wastewater reuse	Chennai	CMWSSB performance contracts + industrial pricing at ₹8/KL.	280 MLD — up from 12 MLD at T-20. +2,233%. CMWSSB 2024.	A	C4 — 500 MLD target. Institutional capacity proven. Economics justify scale.
Oorani restoration	C3 districts	TN Rural Dev. Dept. + MGNREGS. 4,200 ooranis. 2019–2023.	-22% tanker dependency in treated panchayats. +0.4–0.7m GW recovery.	A	C3 — 20,500 ooranis remain depleted. Ramanathapuram scale-up: EMERGENCY PRIORITY.
Low-water rice variety	ICAR — Statewide validation	Dr. M.S. Sheshshayee, ICAR-Emeritus, UAS Bengaluru. Scientific collaboration.	~50% water use, comparable yield. Peer-validated at field scale.	A	C1 — full delta adoption would reduce paddy GW demand by ~35%. National replication candidate.

Five Verdicts — Named and Narrated

Verdict 1 — The Aquifer Cannot Wait

Tamil Nadu's groundwater system has crossed from stress into structural depletion in its most economically productive corridors. The Western Industrial Corridor (C2) carries 135 over-exploited firkas out of 256 (52.7%) at a weighted stage of 97.8%. The Cauvery Delta (C1) carries 113 of 268 (42.2%). The Southern Dry Belt (C3) carries 49 of 254 (19.3%) at a weighted stage of 61.2%, so its groundwater problem is real but concentrated in Dindigul. On hard-rock aquifers these numbers are diagnoses. Recovery from hard-rock overexploitation requires active recharge (watershed treatment, tank and oorani restoration) combined with extraction reduction (borewell moratoriums in critical blocks, micro-irrigation mandates, agricultural water pricing

reform). The window for intervention before physical exhaustion is the T+5 window. After that, the groundwater is not a governance problem — it is a geological fact.

Verdict 2 — The Traditional System Is the Recovery Architecture

Every proven recovery signal in this Atlas traces back to traditional water infrastructure: tank restoration, oorani revival, cascade reconnection, watershed treatment. The Thanjavur tank programme delivered +0.58m groundwater recovery. The 4,200 oorani restoration delivered -22% tanker dependency. Krishnagiri watershed treatment delivered +0.8m groundwater improvement. These are not historical curiosities — they are the highest-performing, most evidence-backed water interventions available in Tamil Nadu. The question is not whether the model works. The question is whether the institutional system will scale it at three times the current pace, across all five clusters, within the T+5 window that is already open.

Verdict 3 — Industrial Governance Is the Price of the Western Corridor's Economic Success

The knitwear industry of Tiruppur generates approximately ₹35,000 Crore annually. The leather tanning industry of Vellore-Ranipet generates approximately ₹20,000 Crore annually. Both industries depend on water systems they are degrading. The Noyyal, Bhavani, and Palar rivers carry the evidence of governance failure: BOD levels that render them ecologically dead through the production zones, GW contamination that has migrated into aquifers shared with the communities that surround the industrial corridors. ZLD enforcement works — 186 Tiruppur units prove it. The Palar corridor shows what delayed enforcement costs: permanent aquifer contamination

that will persist for decades regardless of future compliance. The verdict is a policy choice: enforce ZLD at scale now, or pay remediation costs at 10× the enforcement investment later.

Verdict 4 — Chennai Is One Decision Away from a Different Trajectory

Chennai's water situation is severe. But it is not hopeless. The treated wastewater reuse programme — from 12 MLD to 280 MLD in twenty years — proves that

Chennai's institutions can transform water system outcomes when the programme design is right, the pricing signal is real, and the political mandate is sustained. The lake restoration programme — 32 lakes, measurable storage recovery — proves that the city's natural water infrastructure is not beyond recovery. The NRW trajectory — falling from 38% to 28% — proves that distribution system efficiency can improve with investment and accountability. The verdict: Chennai is one political decision away from a different water trajectory. The decision is to treat lake restoration, wastewater reuse, and NRW reduction as infrastructure priorities of the same order as highway construction and metro rail — not as environmental add-ons.

Verdict 5 — The System Is Invisible Because the Choice to See It Has Not Been Made

Tamil Nadu has 9 water governance agencies, 4 formal inter-agency coordination meetings per year, no integrated water command centre, no real-time Cauvery allocation dashboard shared with Karnataka, 42% unregistered borewells in C2, manual monitoring for 4,200 restored ooranis, and a tanker market of 1,500–2,000 vehicles daily in Chennai that no agency tracks. This is not a data collection problem — it is a governance vision problem. The technology to make every one of these

invisible systems visible exists: IoT sensors, SCADA networks, satellite monitoring, AI forecasting, digital dashboards. The cost is a fraction of the water that is being lost. The D26 System Visibility Index of 2.8 out of 10 is not a technology score — it is a governance score. The fifth verdict is the clearest: systems fail because they are invisible. The choice to make them visible is available. It has not been made.

> *The solutions are documented. The interventions are proven. The window is open. The choice belongs to those who govern.*

THE FINAL SENTENCE

Tamil Nadu built water security over 1,500 years with stone, silt, and community governance. It is dismantling that system in a generation with concrete, desalination plants, and institutional neglect.

The solutions are documented. The interventions are proven. The window is open.

The choice belongs to those who govern.

SECTION T | REFERENCES & PRIMARY SOURCES

All Data Sources | Reference Periods | Attribution Standard

Agency	Primary Data Domain	Key Publications	Reference Period	Access
Central Ground Water Board (CGWB)	Groundwater stage, depth, overexploited blocks, aquifer assessment, recharge rates	Dynamic Ground Water Resources of India (Annual). District Hydrogeology Reports. Contamination Atlas of India.	T-20 to T0 (2005–2026)	cgwb.gov.in
Central Water Commission (CWC)	River flows, Cauvery allocations, reservoir storage, dam data, basin reports	Water Year Books. Basin-wise Water Resources Reports. River Basin Atlas of India.	T-20 to T0 (2005–2026)	cwc.gov.in
India Meteorological Department (IMD)	Rainfall data, drought assessment, monsoon variability, district-level statistics	District-wise Rainfall Statistics. Drought Monitoring Bulletins. Monthly Rainfall Reports.	T-20 to T0 (2004–2026)	imd.gov.in
TWAD Board (Tamil Nadu)	Tank count and functionality, rural water supply, irrigation statistics, scheme monitoring	TN Tank Rehabilitation Reports. Rural Water Supply Annual Reports. Irrigation Statistics TN.	T-20 to T0 (2005–2026)	tn.gov.in/twad
Forest Survey of India (FSI)	Forest cover, catchment condition, mangrove atlas, shola/grassland mapping	State of Forest Report (Biennial). Mangrove Cover Atlas. Forest Cover Change Analysis.	Biennial T-20 to T0	fsi.nic.in
NRSC / ISRO	Remote sensing, land use change, waterbody mapping, wetland loss, coastal monitoring	National Wetland Inventory. LULC Change Analysis. Coastal Zone Maps. Bhuvan Data Portal.	T-20 to T0	nrsc.gov.in

Agency	Primary Data Domain	Key Publications	Reference Period	Access
Tamil Nadu Pollution Control Board (TNPCB)	Industrial effluents, river water quality, BOD/COD, ZLD compliance tracking	Annual River Water Quality Reports. Industrial Compliance Status. Noyyal River Studies.	T-10 to T0 (2015–2026)	tnpcb.gov.in
CMWSSB (Chennai)	Urban water supply, NRW, STP operations, reuse, lake monitoring	Annual Performance Reports. NRW Reduction Programme Reports. Lake Restoration Status.	T-10 to T0 (2015–2026)	chennaimetrowater.com
Cauvery Water Management Authority (CWMA)	Inter-state Cauvery allocation, monthly release data, compliance reports	CWMA Monthly Bulletins. Annual Cauvery Water Reports. Interstate Compliance Reports.	T-20 to T0 (2005–2026)	cwma.gov.in
Census of India / NSSO	Population, rural water access, migration, livelihoods, household survey data	Census 2011. NSSO Rural Drinking Water Survey. National Sample Survey Water Data.	Census 2011 + NSSO rounds	censusindia.gov.in
NITI Aayog	Composite Water Management Index, state water rankings, governance assessment	CWMI Report 2018, 2019, 2022. Water Management in India Report.	2018 to T0	niti.gov.in
Jal Jeevan Mission (GoI)	Rural tap coverage, Functional Household Tap Connection (FHTC) progress	JJM Dashboard. State Progress Reports. District-wise Coverage Data.	T-5 to T0 (2019–2026)	jaljeevanmission.gov.in
ICAR — Dr. M.S. Sheshshayee	Low-water rice variety validation. Agricultural water efficiency.	ICAR Research Publications. UAS Bengaluru Field Trial Reports. Scientific Collaboration Documentation.	T-5 to T0	ICAR-Emeritus, UAS Bengaluru
Source Row	All primary data is attributed to specific agency + publication + reference year within each data table in this Atlas.			

Agency	Primary Data Domain	Key Publications	Reference Period	Access
	This reference section provides the master source list. No data in this Atlas has been fabricated or interpolated without explicit notation.			

Appendix B | Conflicts and Decisions for the Author

Ref	Issue	Evidence	Decision needed
B1	Cluster membership	The Schemia DISTRICT REGISTER assigns districts to different C1 to C5 groups. Its C5 is Western Ghats and Hill Watershed (Nilgiris, Dindigul, Theni). The Atlas C5 is South Coastal. Revision 1.1 keeps Atlas membership.	Confirm which register governs.
B2	Domain activation matrix	D01 Groundwater is Critical in C3 but C3 weighted stage is 61.2%. C2 sits at 97.8%.	Consider C2 Critical and C3 Primary. Chapters would need rebalancing.
B3	To lock	Version Governance said T0 was permanently fixed and updates were addenda. Revision 1.1 opens it on your instruction.	Confirm, or reissue as a formal addendum.
B4	Circular tank and oorani figures	Schemia IDs 1, 2 and 6 cite the Atlas itself (IWSA-TN-MASTER-v1.0) as source, so 27,281 and 35,000 are not independent. Independent counts run from 14,306 (WRD) to 41,123 (DES irrigation tanks) to 43,837 (First Census).	A district eri census is needed to settle the count.
B5	Circular groundwater rows	Schemia IDs 7 and 8 (stage 55% to 78%, irrigation share 42% to 70%) also cite the Atlas. They conflict with CGWB primary data (ID 888) and DES 2022-23.	Retire or downgrade IDs 7, 8 and 596 in the Schemia.
B6	Missing 2025 district rows	GW-2025 rows exist for 34 of 38 districts. Kallakurichi, Nilgiris, Tiruvarur and Villupuram are absent though V1.36 states 38 by 5. C1 stage rests on 7 of 10 districts.	Load the four missing districts.
B7	Two current JJM baselines	V1.38 (16 Sep 2026) shows 12,523,553 rural households and 11,385,218 taps (90.91%). V2-14 (15 Sep 2026) shows 10,188,939 households, all with taps.	Reconcile the denominators before citing either.
B8	Which groundwater vintage governs	The Schemia README names GWRA-2024 as governing. V1.36 adds GWRA-2025 as the latest. Revision 1.1 uses 2025 for the state figure and cluster stage, and 2024 for firka categories.	Confirm.
B9	Cauvery distress-year definition	The Atlas defines distress years against 740 TMC. The Schemia records 740 TMC as the total basin allocation across four states and the environment. The 290 TMC receipt is not in the Schemia.	Recheck the definition and source the receipt series.
B10	Thanjavur recovery signal	The +0.58 m across 156 wells stands in the Schemia (ID 4) with a note to pair it with rainfall and extraction context. Thanjavur stage is 100.8% and 33.3% of analysed wells fell in 2025.	Add the pairing before keeping the Grade A label.
B11	Ramanathapuram rainfall rank	CL-001 holds CCCDM 1951-2020 district means (Class C). They rank Ramanathapuram 8th lowest, not lowest.	Check against IMD district normals.
B12	Contamination percentages	Atlas carries 28% to 38% of blocks for fluoride. Schemia WQ-022 shows 15 wells above 1.5 mg/L across 12 districts, with no monitored-well denominator.	Obtain the denominator or withdraw the percentages.
B13	Water Security Index	The 2.1 and 1.8 scores are not in the Schemia. Two of six inputs changed.	Recompute before quoting.
B14	Stale Schemia control sheets	COVERAGE AUDIT and BUILD READINESS still show D7 and D10 as GAP and clusters as thin, although both are populated.	Refresh the two sheets.

Appendix D | Sections Left Out of the Abridged Edition

These sections are in the full volume (IWSA-TN-MASTER-v1.1, 272 pages), which stays the master reference. Page numbers are full-volume page numbers in its PDF edition. All 52 maps are kept here.

Group	Sections and full-volume page
Front matter	Six Interpretation Frameworks (p.60), How to Read a Data Matrix (p.61), Acronyms (p.63), Glossary of Key Terms (p.65)
Statewide sections	National Regionalization — Six Hydrological Zones (p.77), Section I | Methodology & Temporal Framework (p.111), Section J | Cluster Architecture Table (p.113), D02 Agriculture & Irrigation (p.138), Section Q | T+5 Projection Framework (p.248), Six Critical System Corridors (p.252)
Chennai (Section K)	U2 Local Water Bodies & Urban Storage (p.120), U3 Sewage & Polluted Waterways (p.121), U4 Urban Flood-Scarcity Paradox (p.122), U5 Urban Groundwater Stress (p.123), U6 Wastewater & Reuse Systems (p.124), U7 Urban Expansion vs Water Carrying Capacity (p.126), U8 Urban Distribution & NRW Systems (p.126)
C1 Cauvery Delta	D01 Interstate & Interbasin Dependency (p.136), D04 Coastal Systems & Salinity (p.141), D05 Digital Water Systems (p.142), D06 Tanks, Lakes & Wetlands (p.152), D07 Ecology & Forest-Water (p.154), D08 Governance & Institutions (p.155), D09 Recovery Systems (p.156), D10 System Risk & Future Trajectories (p.158)
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C3 Southern Dry Belt	D02 Groundwater Systems (p.185), D03 Climate Vulnerability (p.186), D04 Digital Water Systems (p.187), D05 Agriculture & Irrigation (p.201), D06 Drinking Water Systems (p.202), D07 Rural Water Security (p.204), D08 Health & Contamination (p.205), D09 Livelihoods, Fisheries & Migration (p.206), D10 Recovery Systems (p.207), D11 System Risk & Future Trajectories (p.208)
C4 Chennai and North Coast	D01 Urban Water Systems (p.212), D02 Water Quality & Pollution — Palar Corridor (p.213), D03 Digital Water Systems (p.215), D04 Flooding & Drainage (p.220), D05 Coastal Systems & Salinity (p.221), D06 Infrastructure Systems (p.222), D07 Governance & Institutions (p.223), D08 Interstate & Interbasin Dependency (p.225), D09 Energy-Water Linkages (p.225), D10 Land Use & Encroachment (p.226), D11 Recovery Systems (p.227), D12 System Risk & Future Trajectories (p.229)
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Appendices	Appendix A | Reconciliation Register (p.266), Appendix C | Marked Rows the Schemia Cannot Yet Verify (p.271)

Appendix E | Block-Level Water Balance Pilots (Native Varuni Evidence)

Added from Tamil Nadu Schemia Book Composite V11 (2026-10-04). Condensed for this edition; the full panels (demand/supply detail, waterbody breakdowns, full source and gap notes) are in the full volume.

SCOPE AND STATUS

TN Schemia Book Composite V11 (2026-10-04) adds a related, non-statewide evidence layer: closed native water budgets for three Varuni blocks — Andimadam (Ariyalur), Tiruvadanai (Ramanathapuram) and Thiruvennainallur (Villupuram) — sourced from the Varuni application (wasca.in) and cross-checked against CGWB, IN-GRES, NITI Aayog and district-administration controls. The V1.77 statewide spine that the rest of this Atlas is built on is unchanged; these three blocks are not a statewide update and are not blended into the district and cluster figures elsewhere in this volume. Where a native Varuni value conflicts with an official vintage, the Schemia keeps both and flags the conflict rather than resolving it, and this appendix does the same.

Andimadam | Ariyalur district, C1

Population 217,396.

Water balance (ha.m / year)

Component	Value
Human	874.1
Livestock	60.4
Irrigation	3,585.5
Industrial	0.0
TOTAL DEMAND	4,520.1
Surface water	392.0
Groundwater	2,147.0
Net transfer	66.8
TOTAL SUPPLY	2,605.7
DEFICIT	1,914.3
Available / harvested runoff	9,704.4 / 758.7

Groundwater — vintages

Source / vintage	Stage	Category	Status
Native Varuni / NITI Aayog (2023)	71.26%	Semi Critical	NITI Aayog Water Budgeting in Aspirational Blocks (2025) / IN-GRES; re...
CGWB GWRA-2023	82.62%	Semi-Critical	CONFLICT CONFIRMED — official CGWB assessment-unit control; does not o...

Surface waterbody controls (selected)

Source / type	Count	Storage or area
Tanks/WCS (NITI 2025)	32	—
Total (NITI 2025)	164	758.7 ha.m
Waterbodies register (Ariyalur Rural Dev., Sep-2026)	19	—

Thiruvennainallur | Villupuram district, C1

Population 38,532.

Water balance (ha.m / year)

Component	Value
Human	166.0
Livestock	91.9
Irrigation	6,116.6

Component	Value
Industrial	0.0
TOTAL DEMAND	6,374.5
Surface water (tank + canal)	2,156.8
Groundwater	8,281.1
Net transfer	0.0
TOTAL SUPPLY	10,438.0
SURPLUS	4,063.5
Available / harvested runoff	5,487.6 / 4,023.8

Groundwater — vintages

Source / vintage	Stage	Category	Status
Native Varuni / IN-GRES display	116.14%	Over Exploited	PASS — 8,281.15/7,130.30 = 116.14%, internally consistent
CGWB GWRA-2023	105.04%	Over Exploited	CONFLICT CONFIRMED — official control; not used to overwrite native
CGWB GWRA-2024 (Firka assessment unit)	95.72%	Critical	FLAG — DO NOT OVERWRITE; newer official vintage, different assessment-...

Surface waterbody controls (selected)

Source / type	Count	Storage or area
Tank + canal, native display	—	3,686.91 (area/count) / 2,156.84 ha.m

Tiruvadanai | Ramanathapuram district, C3

Population 117,358.

Water balance (ha.m / year)

Component	Value
Human	353.0
Livestock	157.2
Irrigation	5,031.0
Industrial	0.0
TOTAL DEMAND	5,541.1
Surface water (tank)	4,773.8
Groundwater	48.2
Net transfer	0.0
TOTAL SUPPLY	4,822.0
DEFICIT	719.1
Available / harvested runoff	4,469.0 / 64,081.1

Groundwater — vintages

Source / vintage	Stage	Category	Status
Native Varuni display	0.79%	Safe	NATIVE CONFLICT — 48.24/7,654.34 = 0.63%, not 0.79%; retained unchange...
WASCA-TN GW Assessment, Ramanathapuram (2017-20, pub. Jan-2021)	97.45%	Critical*	SOURCE-BACKED BUT INTERNALLY INCONSISTENT — 165.39/4,584.92 = 3.61%, n...
TN GWRA 2022 / IN-GRES, Thiruvadani Firka (independent control)	0.97%	Safe	CLOSED — assessment-unit control recovered; extractable 2,556.70 ha.m,...
CGWB GWRA-2024 (block)	NOT RECOVERED	NOT RECOVERED	OPEN — exact block-level record not yet found

Surface waterbody controls (selected)

Source / type	Count	Storage or area
Irrigation tanks (Ramanathapuram Dist. Admin., Agriculture)	287	—
Ayacut — PWD + Panchayat Union + Ex-zamin tanks	—	8,132.8 ha

FOOTER ATTRIBUTION — MANDATORY ON ALL PAGES

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Tamil Nadu is the Master Reference State. All Atlas volumes derive their architecture from this volume.

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