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DEEP DIVE

# India's Water Crisis

## When Scarcity Becomes Policy Failure

GS-I · Geography | GS-II · Governance | GS-III · Environment, Economy

Less Noise. More Retention.

## Table of Contents

# The Core Argument

*Read this first. Everything else flows from here.*

**Central Thesis**

India does not have a water shortage problem. It has a water governance problem disguised as a geography problem. The country receives enough rainfall — about 4,000 billion cubic metres — every year. The crisis exists because of what we do, or fail to do, before, during, and after the rain falls.

Most notes list facts: 18% of world population, 4% of freshwater, 600 million stressed. These numbers are real. But they miss the deeper question — why does a country that receives abundant monsoon rain keep running out of water? The answer lies not in nature but in decades of bad incentives [poor policy design that rewards wrong behaviour], fragmented governance [multiple agencies managing the same resource with no coordination], and the political inability to reform agriculture.

Think of India as a household that earns a decent income but spends 90% of it on one habit (water-intensive crops), ignores leaking pipes (40% distribution losses), and has no savings account (no groundwater recharge [the natural process of rainwater seeping back into underground water stores]). The salary has not shrunk. The management has collapsed.

# Fact Sheet

*Numbers every aspirant must know*

| | |
|---|---|
| **Annual Rainfall** | ~4,000 BCM [billion cubic metres] received — only ~1,123 BCM usable |
| **Population vs Water** | 18% of world population \| only 4% of global freshwater |
| **Reservoir Storage 2026** | 28% of capacity across 166 major reservoirs (CWC [Central Water Commission]) |
| **Groundwater Extraction** | 240 BCM/year — world's highest; far exceeds natural recharge |
| **Agriculture's Share** | 85–90% of all freshwater used by agriculture alone |

| | |
|---|---|
| **Water Stress Pop.** | 600 million face high-to-extreme water stress (NITI Aayog CWMI) |
| **Per-Capita Availability** | ~1,544 m³/year (down from 5,177 in 1951) — near 'stressed' threshold |
| **Annual Deaths** | ~2 lakh deaths/year from contaminated or inadequate water |
| **Surface Water Quality** | 70% of India's surface water unfit for consumption |
| **WQI Rank** | 120th out of 122 countries in global Water Quality Index |
| **GDP Risk by 2030** | 6% GDP contraction projected if gap is not addressed |
| **Urban Water Losses** | 30–40% of treated water lost in transit (NRW — Non-Revenue Water) |
| **Sewage Treatment Gap** | Cities generate 72,368 MLD [million litres per day] — capacity for only ~28% |
| **JJM Coverage** | Rural tap connectivity: 17% (2019) → 81%+ (2024) |

## Understanding the Crisis

*Why does a monsoon country run out of water?*

India's water crisis has three layers. Most people — and most notes — only see the first.

**LAYER 3 — GOVERNANCE FAILURE**
*The real crisis. Fixable with political will.*

**LAYER 2 — EXTRACTION PROBLEM**
*World's largest groundwater extractor. Policy-driven.*

**LAYER 1 — GEOGRAPHY**
*Monsoon dependence & uneven distribution. Cannot be changed.*

### Layer 1 — The Geography (What we cannot change)

India's rainfall is monsoon-dependent [reliant on seasonal wind-driven rains]: 75% of annual rain falls in just 100–120 days. It is also deeply uneven — Cherrapunji gets 11,000mm/year while Jaisalmer gets under

200mm. This structural vulnerability cannot be eliminated. But good policy can manage it. Bad policy amplifies [makes worse] it.

### Layer 2 — The Extraction Problem (What we are doing to groundwater)

India extracts 240 BCM of groundwater [water stored underground in rock and soil layers called aquifers] per year — the highest in the world. The problem is not extraction itself; it is that recharge [refilling of underground water] is far slower than extraction. NASA's GRACE satellite has confirmed that the Indo-Gangetic plain is losing groundwater at a rate that cannot be naturally recovered within any human planning horizon [in any timeframe that matters to us]. Once a deep aquifer [underground water reservoir] compacts [collapses inward due to water loss], centuries are required to refill it.

> **Example:** *Punjab and Haryana — both semi-arid [receiving very low rainfall] — were made India's primary rice-growing states through MSP [Minimum Support Price — the government-guaranteed price for crops] policy. Rice is a crop that evolved in swamps. Cultivating it on a dry plain using tube-well water is not a natural disaster. It is a policy-manufactured one.*

### Layer 3 — The Governance Failure (The real crisis)

India's water governance [the system of rules, institutions, and policies for managing water] is split across dozens of ministries, state departments, and civic bodies that do not share data and do not coordinate. The agency supplying drinking water rarely knows what the irrigation department is extracting from the same aquifer. Crucially, groundwater rights in India are still governed by the Indian Easement Act of 1882 — a colonial law that gives landowners unlimited right to extract groundwater from beneath their property. The state has no legal tool to say stop.

> **The Core Paradox**
>
> India exports millions of tonnes of Basmati rice and sugarcane every year. Embedded in those exports is virtual water [the hidden water used to produce a product — the water that 'travels' with the export]. We are a water-bankrupt country selling water to the world at the price of rice.

## Causes

*Structural, not seasonal*

The standard narrative blames population growth and poor rainfall. Both are partial truths used to avoid harder questions. India's per-capita water availability [water available per person per year] has fallen from 5,177 m³ in 1951 to ~1,544 m³ today. Population has grown, yes. But the bigger story is what we chose to do with what we had.

- **Agricultural Policy Distortion:** Agriculture consumes 85–90% of India's water, most of it through flood irrigation [simply flooding fields with water — extremely wasteful]. MSP policy rewards water-intensive crops. A farmer growing water-efficient millets earns less than one growing paddy. The price signal [the economic message telling farmers what to grow] runs exactly backwards.
- **Colonial-Era Groundwater Law + Free Power:** The Easement Act of 1882 makes groundwater a private right, not a public resource. Free or subsidised [government-reduced cost] electricity removes any cost signal from pumping. This is not farmer greed — it is rational behaviour under irrational rules.
- **Urban Sewage Failure:** Indian cities generate 72,368 MLD of sewage per day. Treatment capacity covers ~28%. The rest flows directly into rivers, lakes, and groundwater. The Yamuna through Delhi is chemically dead [so polluted it cannot support life] for most of its urban stretch — not because Delhi lacks money, but because accountability [clear ownership of the problem] is fragmented [split] across agencies.
- **Destruction of Natural Water Infrastructure:** Rapid urbanisation has paved over wetlands [low-lying land that absorbs water naturally], lakes, and floodplains — the earth's own water storage system. Chennai built IT parks on the Pallikaranai marsh, then discovered its reservoirs ran dry in 2019. The two events are directly connected.
- **Institutional Fragmentation:** Water supply, sewage management, groundwater monitoring, and flood control operate under separate ministries and departments that share no real-time data. Policy is built on guesswork.
- **NRW — Non-Revenue Water Losses:** Cities lose 30–40% of treated water through corroding, leaking pipes before any tap is reached. This is Non-Revenue Water [NRW — water produced and paid for but never sold or used] — water that has already been extracted, treated, and pumped at real cost, and simply disappears underground.

## Consequences

*The domino effect*

Water crises do not stay in one sector. They cascade [spread in a chain reaction]. The chain runs: water stress → crop failure → food inflation → rural migration → urban stress → political instability. Each link in that chain has already started moving in India.

### The Consequence Chain

**Governance Failure** → **Over-Extraction** → **Crop Failure**

*Bad laws, subsidies, fragmented agencies* | *240 BCM groundwater drained annually* | *Weak monsoon + dry aquifers = harvest loss*

↓ continues ↓

**Food Inflation** *CPI spikes, RBI rate pressure* → **Rural Migration** *Bundelkhand, Marathwada empty out* → **Urban Crisis** *Water mafias, city taps run dry*

## Economic

- By 2030, demand will be twice the supply. NITI Aayog projects a 6% GDP contraction [shrinkage in the total size of the economy].
- Thermal power plants [coal/gas-based electricity generators] need river water for cooling. They are already shutting down seasonally. Power shortages follow water shortages.
- Data centres require up to 20 lakh litres/day per 100MW facility. Most are being built in already water-stressed cities — Bengaluru, Hyderabad — without any water-use regulation.

## Social

- Marathwada and Bundelkhand villages empty every summer. These are not climate refugees [people displaced by weather]. They are governance refugees [people displaced by failed policy].
- Women and girls bear the water burden disproportionately [carry a much larger share of the burden]. In water-stressed Rajasthan, girls drop out of school to fetch water. Every water crisis is also a gender crisis.
- Water mafias — illegal tanker operators — have emerged in Chennai, Bengaluru, and Bhopal. Poor families spend up to 20% of daily income buying water from private tankers.
- Inter-state water disputes — Cauvery, Mahadayi, Krishna — are constitutional crises in slow motion, inflaming regional identity politics and paralysing cooperative federalism [the principle that Centre and states work together rather than compete].

## Ecological

- The Ganga and Yamuna carry more sewage than water through their urban stretches.
- Wetlands like Deepor Beel (Assam) and Loktak Lake (Manipur) are shrinking, destroying biodiversity [variety of plant and animal life] and fishing livelihoods.
- Over-extraction causes aquifer compaction [the ground sinks as underground water is removed], permanently reducing future storage capacity. This damage is irreversible [cannot be undone].

# Government Response

*What has been done — and what is missing*

India's policy response has improved since 2019. The creation of the Ministry of Jal Shakti — merging drinking water and irrigation under one umbrella — was a genuine structural reform. But the gap between policy announcement and ground-level outcome remains wide.

## What is Working

- **Jal Jeevan Mission:** Rural tap connectivity rose from 17% to 81%+ in five years. The scale is unprecedented [nothing like it has been done before]. The challenge now shifts to maintenance — thousands of connections exist on paper but deliver no water.
- **Mission Amrit Sarovar:** 68,000+ ponds restored nationwide. Decentralised [local-level, not central] surface storage is the right approach. Long-term success depends on community maintenance, not inauguration ceremonies.
- **Atal Bhujal Yojana:** World Bank-assisted programme training communities to create their own water budgets [plans for how much water is available and how to use it] and shift to water-efficient crops. Community ownership over groundwater governance is the correct model.
- **PMKSY — Per Drop More Crop:** Drip and sprinkler irrigation reduces water use by 40–50% over flood irrigation. Uptake [adoption by farmers] is growing but remains a fraction of total irrigated area.

## What is Still Broken

- Agricultural electricity subsidies are untouched. No major state has successfully metered [measured and charged for] tube-wells at scale. Without this reform, every groundwater intervention papers over [hides without fixing] a crack in the foundation.
- Sewage treatment capacity has not kept pace with urban growth. Industrial effluent [toxic liquid waste from factories] control — under a separate regulatory body — remains weak.
- The Easement Act of 1882 has not been replaced. A National Water Framework Bill has circulated for years without passage. Groundwater legally remains a private right.
- Inter-ministerial data sharing is still largely manual and delayed. Real-time aquifer [underground water reservoir] monitoring covers only a fraction of India's stressed zones.

# Global Case Studies

*What actually worked elsewhere*

Three models are directly relevant to India. The lesson across all three is the same: water security is an institutional [built through strong governance systems] achievement, not a natural gift.

### Israel — Recycling as a Resource

Israel receives less rainfall than Rajasthan. Yet it is water-secure. The reason: 90% of municipal wastewater [used water from homes and cities] is treated and reused for agriculture. Drip irrigation was invented here — out of necessity. Water is priced at its true cost, and the state maintains full visibility [complete knowledge and control] over extraction and use. India imports the drip technology while ignoring the pricing and governance framework that makes it work.

### Singapore — The Four Taps Model

Singapore has no river, no meaningful aquifer, and almost no land. It built water security through four sources: local collection, imports, reclaimed water [treated wastewater reused as clean water] (NEWater), and desalination [removing salt from seawater]. NEWater now meets 40% of demand. The insight: Singapore treats water as a strategic national asset [something vital to national survival], not a utility [basic service] managed by a municipal corporation.

> **Example:** *Indian metros could begin with NEWater for industrial and non-potable [not for drinking] uses, reducing freshwater demand by 20–30% without requiring a single new dam.*

### Tokyo — Fixing Leakage First

Tokyo reduced water leakage from 20% in the 1950s to under 3% today through systematic [planned and thorough] pipe replacement and acoustic leak detection [using sound waves to find leaks]. Indian cities average 30–40% losses. The technology exists. The obstacle is that Indian municipal bodies lack both the funds and the institutional incentive [reason to act] — fixing pipes earns no ribbon-cutting moment.

| Model | Core Strategy | Key Lesson | India Relevance |
|---|---|---|---|
| **Israel** | 90% wastewater recycled; true-cost pricing | Price = behaviour | High — agriculture |
| **Singapore** | Four-source resilience; NEWater | No single point of failure | High — metros |
| **Tokyo** | <3% leakage; pipe-by-pipe repair | Fix waste before adding supply | High — all cities |
| **Australia** | Tradeable water rights market | Markets allocate scarce goods | Medium — needs institutions first |

# Key Challenges

*Why solutions do not scale*

Most technical solutions to India's water crisis are already known. The barriers are political and institutional, not scientific. This distinction matters enormously for Mains answers.

- **Political Economy of Subsidies:** Free power for agriculture is an electoral promise [promise made to win votes] in every farming state. No government has successfully metered tube-wells at scale. This single political failure undermines [weakens] every other groundwater effort.
- **Federal Design:** Water is a State List subject [matter controlled by state governments, not Centre]. The Centre can fund and guide, but implementation rests with states. States under fiscal stress [financial difficulty] deprioritise [put lower on the agenda] operations and maintenance of water infrastructure after inauguration.
- **Weak Urban Local Bodies:** Most Urban Local Bodies [city and town governments] lack the engineering staff, financial health, and data systems to manage complex water infrastructure. Central grants arrive but sit unspent [unused] because cities cannot manage large engineering contracts.
- **Data Blindness:** A major city cannot tell you how much water it actually uses, wastes, or extracts. Without real-time metering [measuring water flow continuously] and aquifer data, policy is built on estimates. NAQUIM [National Aquifer Mapping Programme] is underway but incomplete.
- **Digital Economy's Hidden Water Cost:** India's push to become a tech hub is creating a new, largely unregulated water demand in its most stressed cities. A 100MW data centre consumes up to 20 lakh litres per day with no specific regulatory framework in place.

# Way Forward

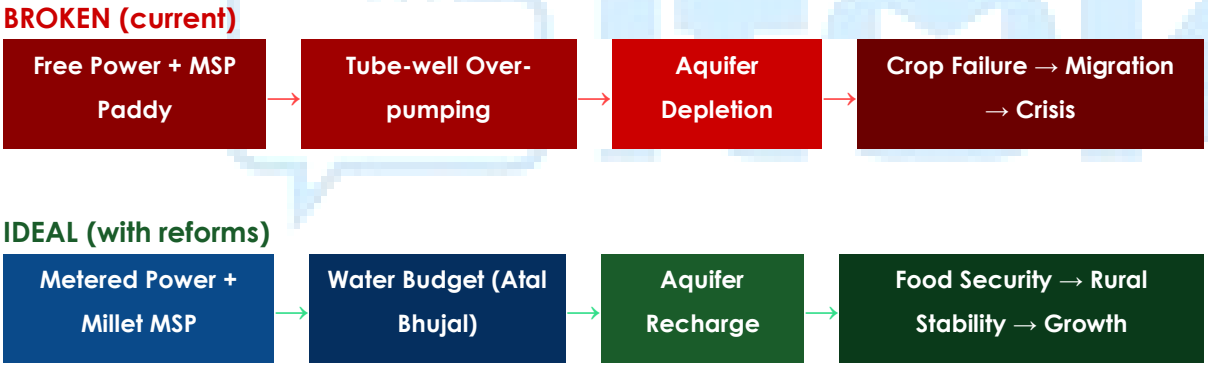
*What an intelligent answer should argue*

A strong Mains answer does not list solutions — it argues a framework. India must shift from supply augmentation [building more dams and pipes] to demand management [using less water more wisely], from centralised engineering to decentralised [community-level] governance, and from treating water as a free input to pricing it as a scarce resource.

- **Agriculture: Fix the Incentive:** Reform MSP to reward water-efficient crops. Pilot Virtual Water Credits — compensating [paying] farmers in water-scarce zones who shift from paddy and sugarcane to millets and pulses. A market mechanism [using economic incentives], not a mandate [forced order].

- **Legal Reform: End the 1882 Regime:** Replace the Easement Act of 1882 with a National Groundwater Rights Framework. Define groundwater as a public trust resource [something that belongs to all citizens, managed by the state on their behalf]. Give district water authorities legal power to enforce extraction caps [limits].
- **Circular Water Economy:** Mandate that all new industrial complexes, data centres, and large residential projects treat and recycle 100% of wastewater on-site [at the same location]. Build dual-pipe infrastructure [two separate pipe systems] in cities — potable [drinkable] water and treated greywater [lightly used water from sinks and showers] on separate lines.
- **Community Groundwater Stewardship:** Scale Atal Bhujal Yojana to all over-exploited [drained beyond sustainable limits] blocks. Village-level water budgeting through Gram Panchayats and Jal Samitis is the only mechanism that creates local accountability for groundwater use.
- **Data Infrastructure:** Complete NAQUIM mapping. Make aquifer data public and real-time. Fund smart meters in all urban distribution networks. You cannot manage what you cannot measure.
- **Protect Natural Infrastructure:** Legally protect urban wetlands and floodplains under a national water body registry. Encroachment [illegal occupation of land] should trigger automatic disqualification of development approvals.

## Current Broken Loop vs Ideal Policy Loop




### The Examiner's Lens

The best answers on this topic will argue that India's water crisis is a governance design failure — bad incentives in agriculture, a colonial legal framework for groundwater, fragmented institutional responsibility, and a political system that rewards infrastructure inauguration over maintenance. Every model that has worked — Israel, Singapore, Tokyo — shares three features: clear legal authority, real-time data, and prices that reflect true scarcity. India has none of the three at scale.

## Mains Practice

**Q "India's water crisis is less a problem of rainfall and more a problem of governance." Critically examine. (GS-III, 15 marks)**

**Model Answer**

India annually receives approximately 4,000 billion cubic metres of rainfall — a figure that places it among the better-endowed nations hydrologically [in terms of water from rain]. Yet over 600 million citizens face high-to-extreme water stress, and per-capita availability has declined from 5,177 m³ in 1951 to ~1,544 m³ today. The persistence of scarcity in a monsoon country demands interrogation of governance, not merely geography.

## Governance as the Primary Driver

- **Colonial legal legacy:** The Indian Easement Act of 1882 vests [places] groundwater rights in landowners, making it a private rather than public resource. The state has no legal authority to limit extraction on private land. This single provision has enabled India to become the world's largest groundwater extractor — 240 BCM annually — far exceeding natural recharge.
- **Policy-manufactured scarcity:** MSP guarantees and free electricity have incentivised [created economic reward for] paddy cultivation in semi-arid Punjab and Haryana — regions ecologically unsuited for swamp crops. Agriculture consumes 85–90% of freshwater yet operates under zero price signals. The distortion [imbalance] is entirely policy-created.
- **Institutional fragmentation:** Water supply, sewage management, groundwater monitoring, and flood control operate under separate agencies that share no real-time data. The result is reactive [responding after the crisis] rather than preventive governance.
- **Urban infrastructure neglect:** Indian cities lose 30–40% of treated water through aging pipes. Cities generate 72,368 MLD of sewage daily; treatment capacity exists for ~28%. The remainder re-enters the water supply chain. These are not acts of nature — they are acts of administrative neglect [failure to take responsibility].

## Where Geography Is a Genuine Constraint

The monsoon's temporal and spatial unevenness [varying across time and location] is a real structural challenge. 75% of annual rainfall arrives in 100–120 days, requiring substantial storage infrastructure. Climate change — through events like the 2026 Super El Niño — further compresses [shortens] the rainfall window. These are genuine constraints that governance must work around.

## Critical Assessment

The statement holds substantively [is broadly correct], with qualification. Geography creates the constraint; governance determines whether that constraint becomes a crisis. Israel — with lower rainfall than Rajasthan — achieved water security through institutional discipline: water priced at true cost, 90%

wastewater recycled, and state-level visibility over all extraction. India has the rainfall Israel lacks, yet faces the crisis Israel does not. The difference is governance.

The path forward requires legal reform (replacing the 1882 Easement Act), agricultural pricing reform, institutional consolidation [bringing fragmented agencies under one coordinated system], and political courage on subsidy reform. Until these governance failures are addressed, infrastructure investment — however large — will produce diminishing returns [less and less benefit]. India does not need more dams. It needs a different relationship between the state, the citizen, and water.

**Q Discuss the role of agricultural policy in accelerating India's groundwater depletion. Suggest reforms. (GS-III, 15 marks)**

### Model Answer

India is the world's largest consumer of groundwater, extracting 240 billion cubic metres annually — more than the United States and China combined. The proximate [immediate] cause is agriculture, which consumes 85–90% of all freshwater. The deeper cause, however, is the policy architecture [the system of rules and incentives] surrounding agriculture, which has systematically eliminated every incentive to conserve water.

## How Agricultural Policy Creates Water Crisis


## How Policy Drives Depletion

- **MSP and crop choice distortion:** The Minimum Support Price [government-guaranteed price for crops] regime heavily favours wheat and paddy. Punjab — a semi-arid state receiving 400–700mm of annual rainfall — became the nation's primary rice producer because MSP procurement [government buying] made it economically rational [financially sensible]. The groundwater consequence — a water table [the level below which ground is saturated with water] falling by 0.5 metres per year — was entirely predictable and entirely ignored.
- **Free and subsidised electricity:** Agricultural electricity subsidies [government covering most of the electricity cost] have severed [cut] the link between pumping and cost. A farmer with free power has no economic reason to stop extracting. Tube-well proliferation [rapid spread of water pumps] — now exceeding 20 million across India — has followed predictably.
- **Flood irrigation dominance:** Despite drip and sprinkler irrigation reducing water use by 40–50%, over 80% of India's irrigated area still uses flood irrigation [simply flooding fields with water]. The under-subscription [low uptake] of PMKSY's Per Drop More Crop scheme reflects inadequate extension support [guidance given to farmers by government officials].

- **Virtual water exports:** India exports millions of tonnes of Basmati rice and sugarcane. Each kilogram of rice requires approximately 3,000 litres of water to produce. These exports represent a permanent outflow [loss] of groundwater from already-stressed aquifers, subsidised [funded] by the Indian state and priced below their true cost.

## Reforms

- **Differentiated MSP:** Extend competitive MSP to water-efficient crops — millets, pulses, oilseeds — and apply agro-climatic conditionality [conditions based on local weather and soil] to procurement: water-intensive crops should not receive MSP support in water-stressed districts.
- **Electricity metering for agriculture:** Introduce feeder-level metering [measuring electricity use at the supply point] with a two-part tariff [pricing system]: a low-cost baseline allowance and market-rate pricing above it. This preserves social protection [safety net for poor farmers] while creating a conservation incentive.
- **Virtual Water Credits:** Create a tradeable credit system rewarding farmers who shift to water-efficient crops in over-exploited zones. Credits can be purchased by industries requiring water permits, creating a market-based cross-subsidy [industries paying farmers to conserve water].
- **Community water budgeting:** Scale Atal Bhujal Yojana nationwide. Gram Panchayats equipped with aquifer-level data and seasonal water budgets [plans for how much water is available each season] can make informed crop choices. Top-down mandates have failed; bottom-up accountability [communities holding themselves responsible] is the only model that works.

Agricultural water reform is the single highest-leverage intervention [the action with the biggest impact] in India's water crisis. No amount of urban water recycling or dam construction can compensate for a sector that consumes 90% of freshwater under a policy framework that actively discourages conservation. Reform here is not optional — it is the prerequisite [necessary condition] for everything else.

**Q Examine the implications of India's inter-state water disputes on cooperative federalism. (GS-II, 10 marks)**

### Model Answer

Water is a State List subject under the Seventh Schedule [the part of the Constitution that divides powers between Centre and states] of the Constitution, yet India's river systems are indifferent to state boundaries. The resulting tension — between constitutional design and hydrological [water-related] reality — has produced some of the most protracted [long-running] disputes in Indian federal history.

## Nature of the Disputes

The Cauvery dispute between Karnataka and Tamil Nadu has run through tribunals [special courts], the Supreme Court, and the political sphere for over a century. The Mahadayi dispute between Goa and

Karnataka illustrates how even modest [small] water demands become existential [survival-level] political questions. The Krishna and Godavari disputes involve multiple states whose relative political influence shapes allocation [distribution] outcomes more than hydrological equity [fairness based on actual water flow].

## Implications for Cooperative Federalism

- **Zero-sum framing:** States approaching water as a fixed, competitive resource — rather than a managed, shared one — makes cooperation structurally irrational [logically impossible]. Electoral incentives reinforce [strengthen] this: releasing water upstream is politically costly, receiving water is a win.
- **Institutional inadequacy:** The Inter-State River Water Disputes Act, 1956 has produced tribunals that take decades to render [deliver] awards — the Cauvery tribunal took 17 years. Compliance [following the ruling] with awards remains voluntary in practice. Article 262 bars Supreme Court jurisdiction [authority] over water disputes, creating a vacuum [gap in authority] that delays resolution and invites political manipulation.
- **Weaponisation of data:** States share water flow and rainfall data selectively [only what suits them] with tribunals and the Centre. The absence of a neutral, real-time national hydrological [water flow] database allows states to contest [argue about] facts, not just interpretations, further entrenching [deepening] disputes.
- **Federalism under stress:** Water disputes have fuelled demands for separate statehood, strained Centre-state relations, and created domestic friction that mirrors [resembles] international water diplomacy in its adversarial [opposing-sides] character. When states treat each other as enemies over water, the concept of cooperative federalism [Centre and states working together as partners] loses all practical meaning.

## Way Forward

Cooperative federalism on water requires institutional redesign [rebuilding the system], not just goodwill. First, a permanent Inter-State River Basin Authority with real enforcement [legal power to act] and an independent scientific secretariat [expert body providing unbiased data]. Second, a national real-time hydrological data system that removes the incentive for data manipulation. Third, demand-side management [reducing how much water each state uses] so there is less to fight over. Water scarcity will intensify [worsen] inter-state tensions unless the governance architecture changes. Federalism cannot be cooperative when its core inputs [basic resources] are contested [disputed].

**Q How can India transition to a circular water economy? Discuss with reference to global case studies. (GS-III, 15 marks)**

**Model Answer**

A circular water economy replaces the linear model — extract, use, discharge — with a closed loop in which water is continuously treated, recycled, and reused. For India, where 70% of surface water is contaminated and urban sewage treatment covers less than 30% of generation, the transition is not an environmental aspiration [hopeful goal] but an economic and survival imperative [absolute necessity].

## Linear Model vs Circular Water Economy

**LINEAR (current — broken)**


**CIRCULAR (ideal)**


## What a Circular Water Economy Requires

- **Treating wastewater as a resource, not waste:** India generates 72,368 MLD of urban sewage daily. If treated to tertiary standards [the highest level of wastewater purification], this volume could meet a significant share of industrial and non-potable [not for drinking] municipal demand. The first shift is conceptual [a change in thinking]: sewage treatment plants must be designed as water production facilities.
- **Dual-pipe infrastructure:** Cities must separate potable [safe for drinking] water distribution from recycled water distribution. Treated greywater [lightly used water from sinks and showers] — unsuitable for drinking but safe for flushing, landscaping, and cooling towers — can replace freshwater in these uses. This alone could reduce urban freshwater demand by 30–40%.
- **Industrial zero-liquid discharge (ZLD):** ZLD means no liquid waste leaves the factory — all water is treated and recycled on-site. Heavy industries and data centres must be mandated to operate closed-loop [self-contained recycling] systems. A 100MW data centre consuming 20 lakh litres per day becomes self-sufficient with on-site recycling.

## Global Models

- **Singapore's NEWater:** Singapore treats 100% of its municipal wastewater through microfiltration [removing particles], reverse osmosis [forcing water through a membrane to remove impurities], and UV treatment. The resulting NEWater meets 40% of national demand. It demonstrates that treated wastewater is a reliable, climate-independent [not dependent on rainfall] source.
- **Israel's agricultural recycling:** Israel recycles 90% of municipal wastewater for agricultural irrigation — the world's highest rate. This has freed freshwater for domestic and industrial use while sustaining large-scale agriculture in a desert climate. The Shafdan plant supplies 60% of agriculture in Israel's southern regions from what was previously a waste stream [discarded water].

- **Tokyo's distribution efficiency:** Tokyo's sub-3% leakage rate effectively adds millions of litres to usable supply without any new extraction. For India, where 30–40% of treated water is lost in distribution, fixing pipes is the fastest and cheapest form of water augmentation [increasing supply].

## Challenges in the Indian Context

Three barriers complicate the transition. First, capital [money for investment]: advanced treatment technology requires significant upfront investment that most Urban Local Bodies cannot finance. Second, technology inertia [resistance to adopting new technology]: industries view treated wastewater as unreliable, requiring demonstrated quality assurance [proof that the water is consistently safe] over time. Third, public perception [what people believe]: social acceptance of recycled water requires sustained communication and demonstration, even for non-potable uses.

## India's Path

The transition must be sequenced [done in order]. First, mandate zero-liquid discharge for industry and data centres — low social resistance, high impact. Second, build dual-pipe infrastructure in new smart cities and greenfield [newly built from scratch] developments to avoid costly retrofitting [redesigning existing buildings]. Third, scale NEWater-type treatment in water-stressed metros as a supplementary [additional] source. Fourth, use AMRUT funding to reduce Non-Revenue Water losses to below 15% within a decade. The circular water economy is not a distant ideal — it is the only model compatible with India's water arithmetic by 2030.