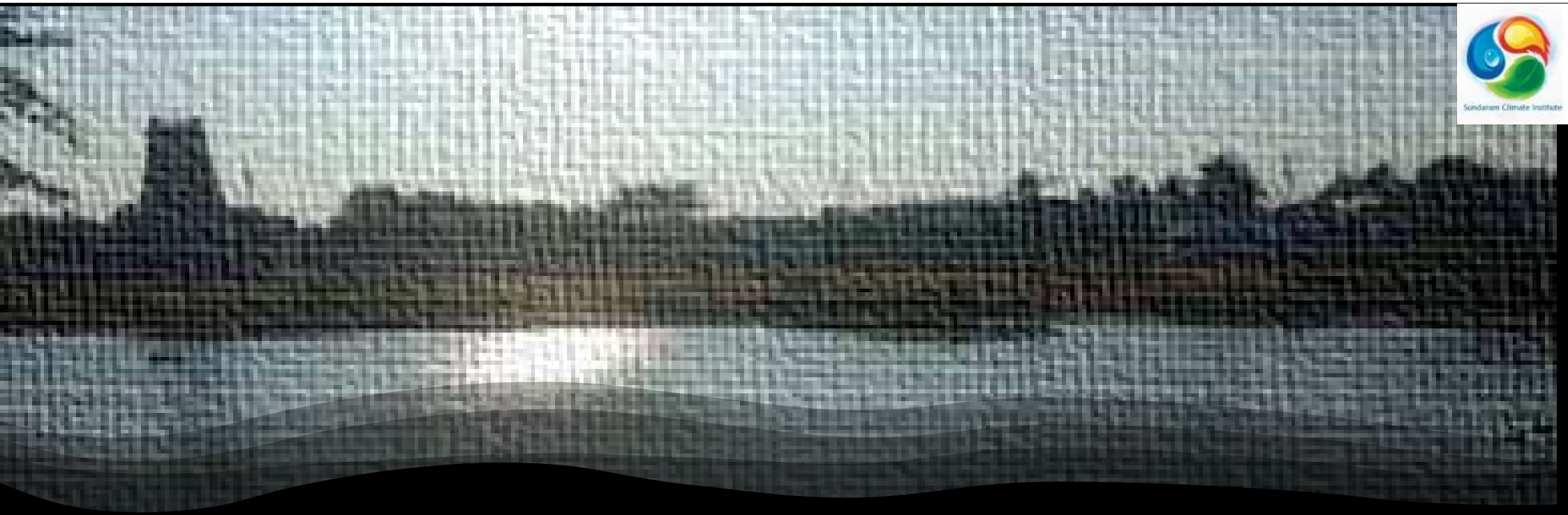
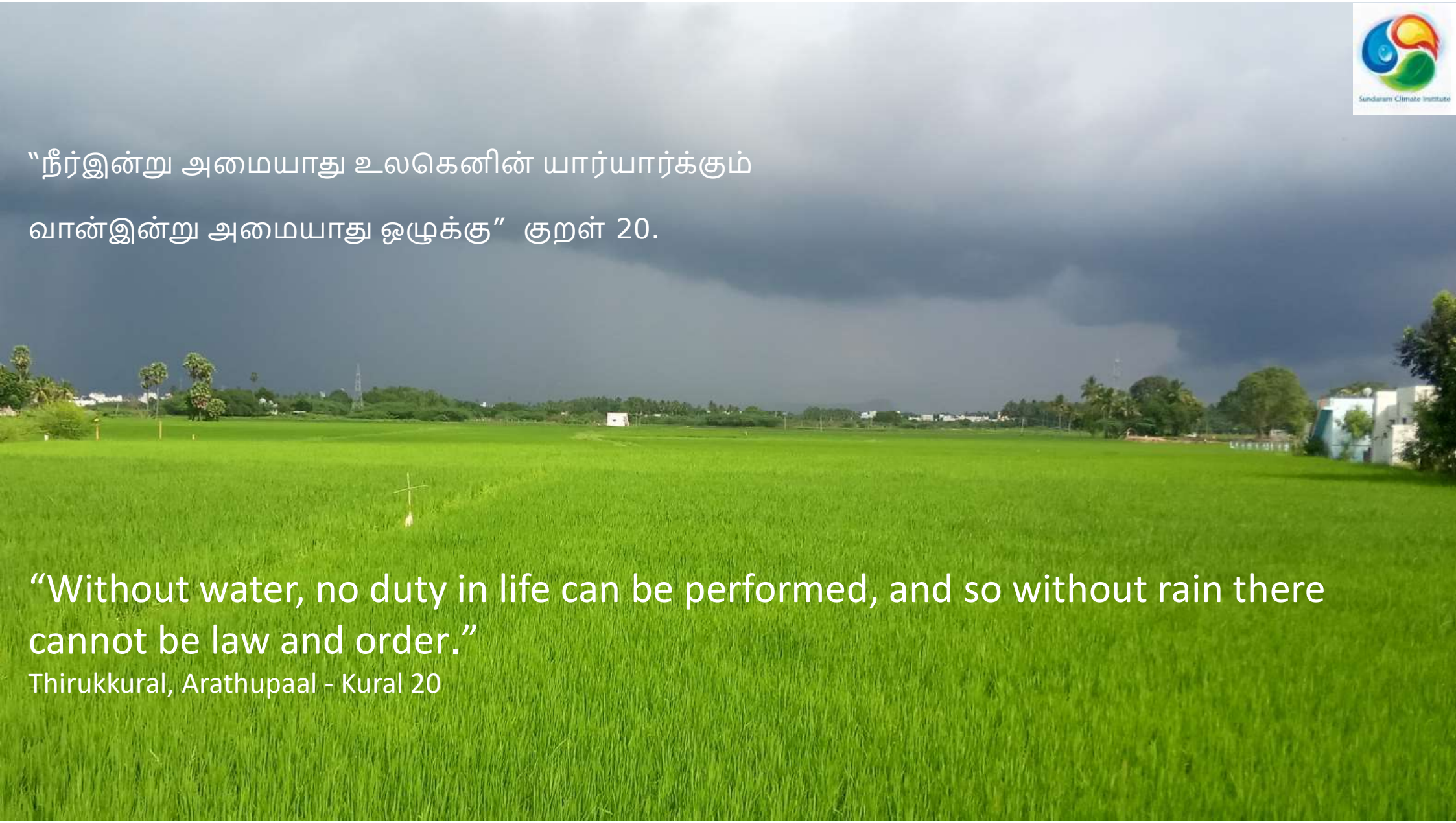


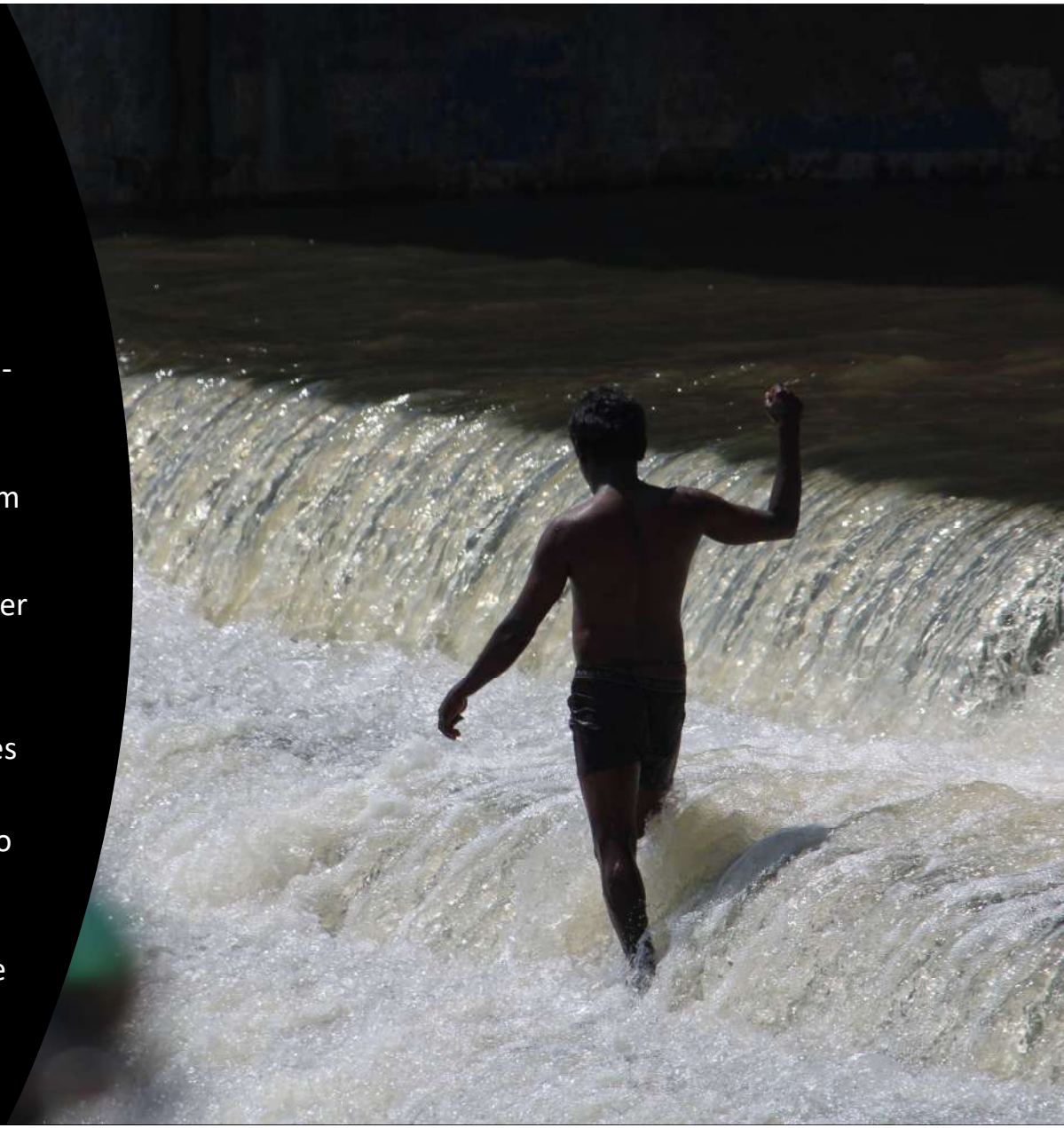
Making India Water Resilient

- Lessons from Madurai


“நீர்இன்று அமையாது உலகெனின் யார்யார்க்கும்
வான்இன்று அமையாது ஒழுக்கு” குறள் 20.
“Without water, no duty in life can be performed, and so without rain there cannot be law and order.”
Thirukkural, Arathupaal - Kural 20

Why read this?

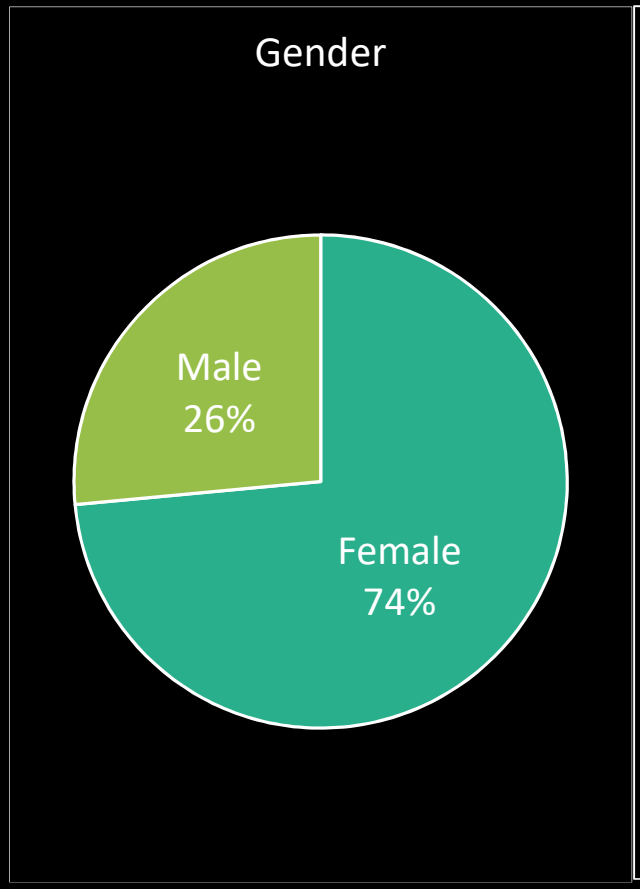
- Despite good intentions and plenty of money, India's water crisis is only getting worse, especially as the climate heats up.
- We at SCI believe a deep understanding of water risks confronting Indian cities based on extensive, granular, ground-level field data can help design interventions that can help alleviate this crisis.
- What follows is a laying out of India's Water Crisis as seen from one city and its periurban surroundings. This singular focus, spread over many years, unpacks the crisis in rich detail that helps point out what is broken, where, when and why? In other words, the crisis is not monochromatic – in space or in time. One neighbourhood is water secure, while another, barely 3 kilometres away is not. The city is water secure most of the time, but in summers, in dry years, the poorest spend fortunes they do not have to meet their daily drinking water needs.
- But there is hope. We offer solutions that have been shown to work, and which work within political feasibility and financial viability.
- For policy makers, leaders and every citizen of India, our hope is that this report helps you understand and build water resilience in your neighbourhood.

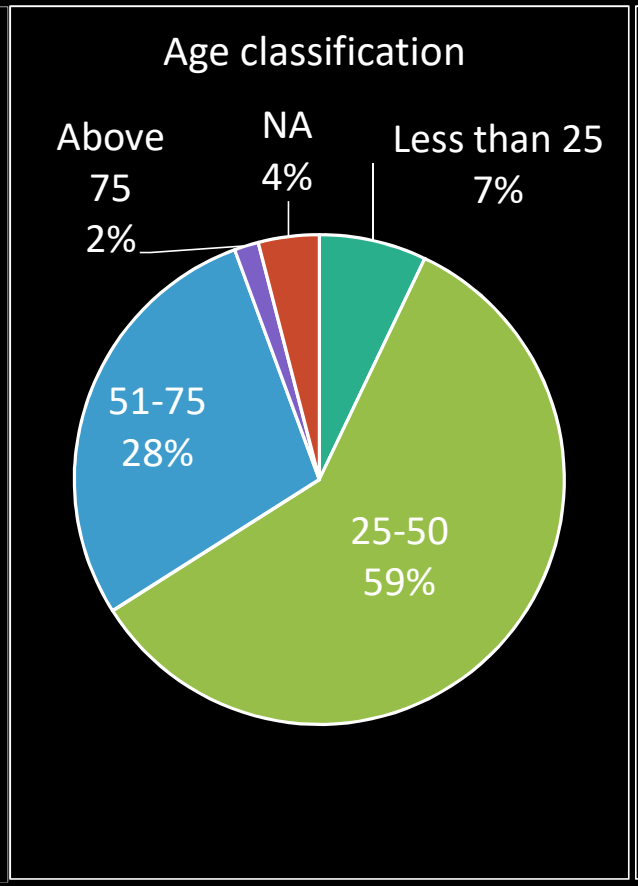


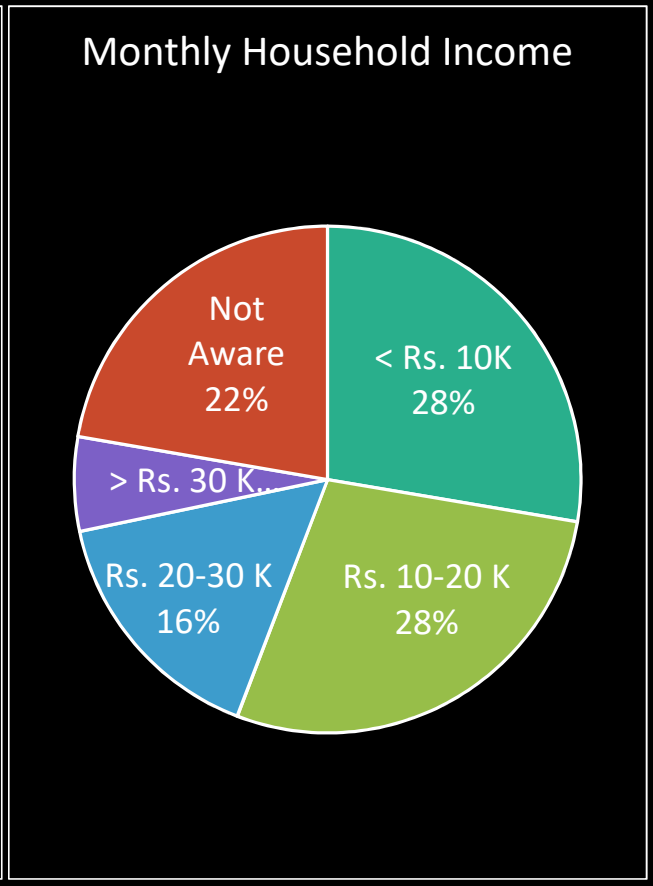
Background

- This report is primarily based on five studies of Sundaram Climate Institute.
  - SCI Madurai Waste & Water Study 2018-2021 studying the waste and water realities and perceptions of over 2000 households over a 4-year period in Madurai.
  - SCI Madurai Rural Tank Study 2019 understanding stakeholder views of 29 tanks in rural/peri-urban and urban Madurai.
  - SCI Madurai Tank Study 2019-2020 which studies tank dynamics and crowdsourced groundwater levels around the tanks from nearly 3000 persons living in the tank vicinity. Groundtruthed satellite data combined with water testing gave a rich understanding of tank functioning.
  - SCI Madurai Temple Tank Study 2020-2021 covering 15 tanks in Madurai which helped in understanding the water culture.
  - SCI Tank Tourism Study 2020-2021, where we spoke to over 130 vendors and counted livelihoods around 3 tanks to understand the local tourism potential of tanks, which could generate cash flow for communities living around tanks, thereby strengthening the bond between community and tank.
- Suggested Citation: 'Making India Water Resilient – Lessons from Madurai', Sundaram Climate Institute, 2023.

Between 2018 & 2021, SCI surveyed 2118 households to understand their waste & water realities. We focussed on economically vulnerable segments since their voices are often muffled in policy discussions.

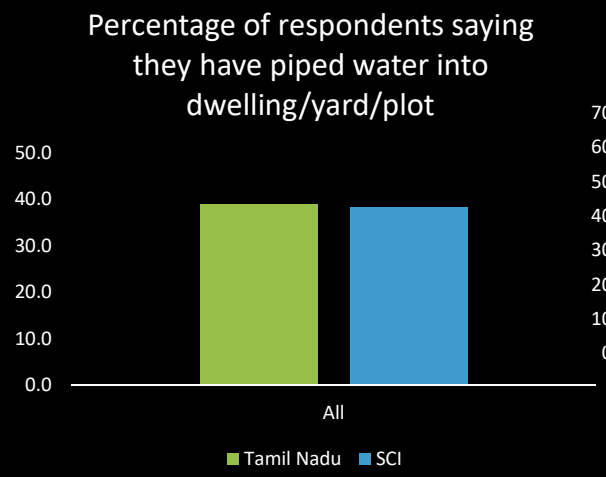


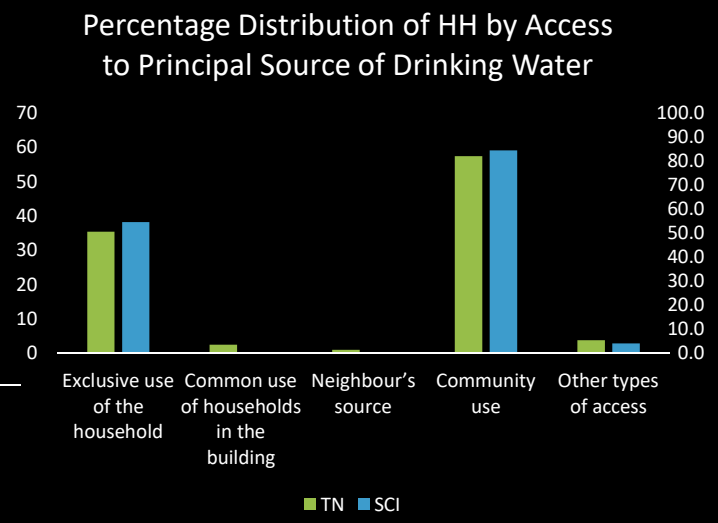


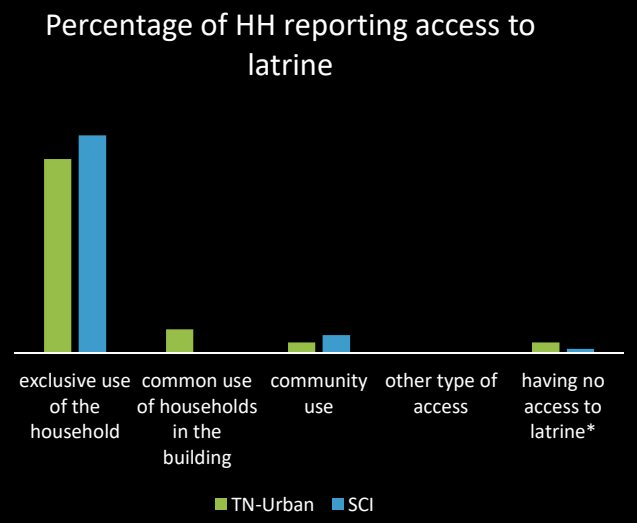


Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=2118)

Our findings, where data overlap, tally well with findings from the latest NSSO study, adding credibility to our survey methodology.







Source: 'Multiple Indicator Survey in India', NSS 78th Round, Ministry of Statistics & Programme Implementation, Government of India, 2023; Sundaram Climate Insitute Waste & Water Study 2018-2021 (n=1113).

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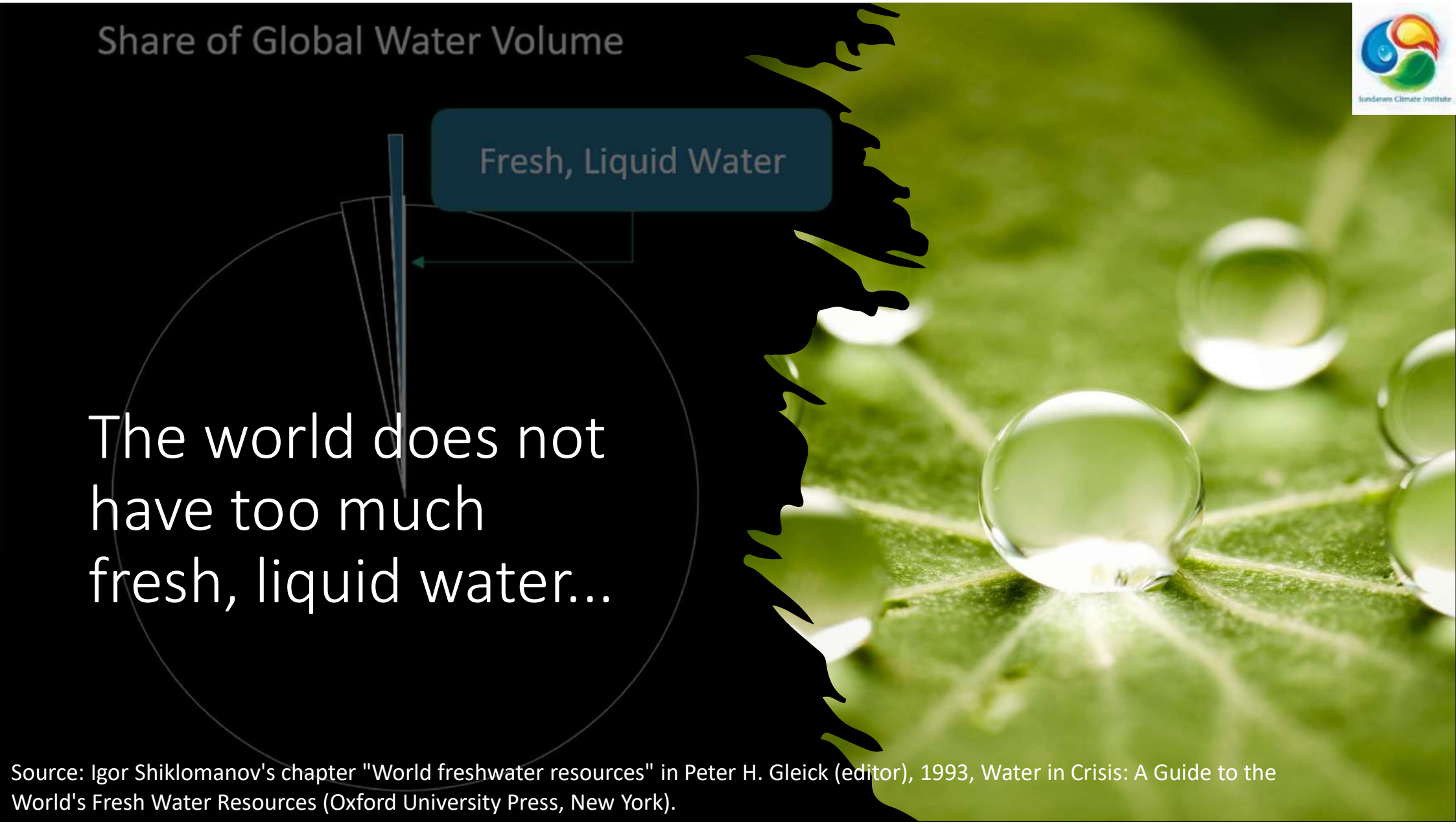
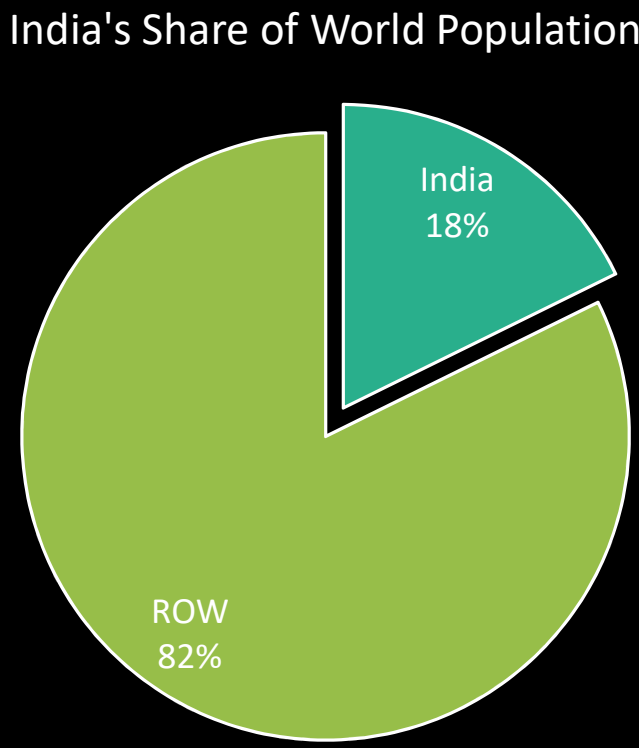


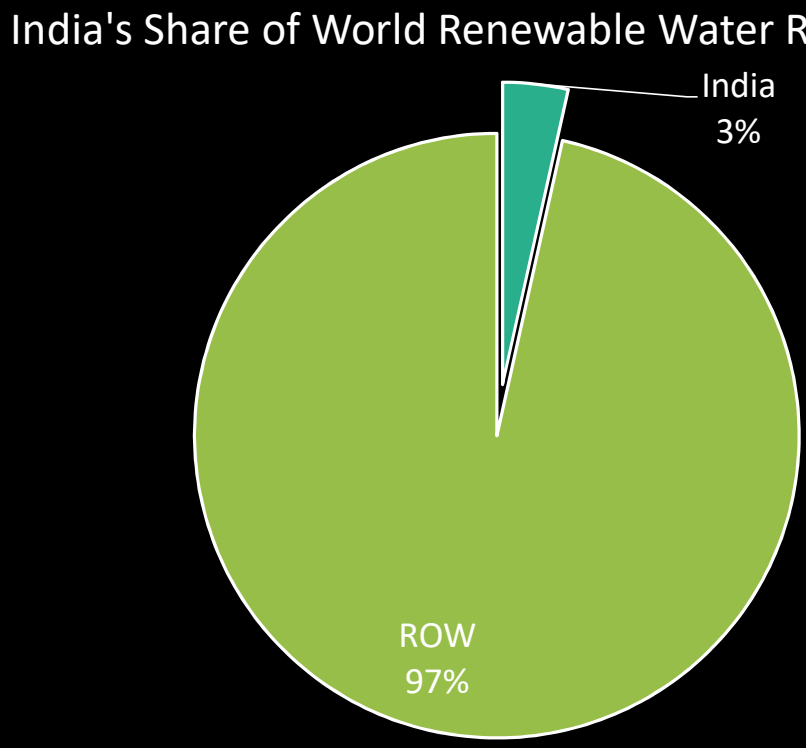
The world does not have too much fresh, liquid water...

Source: Igor Shiklomanov's chapter "World freshwater resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources (Oxford University Press, New York).


India's situation is even more dire, because...

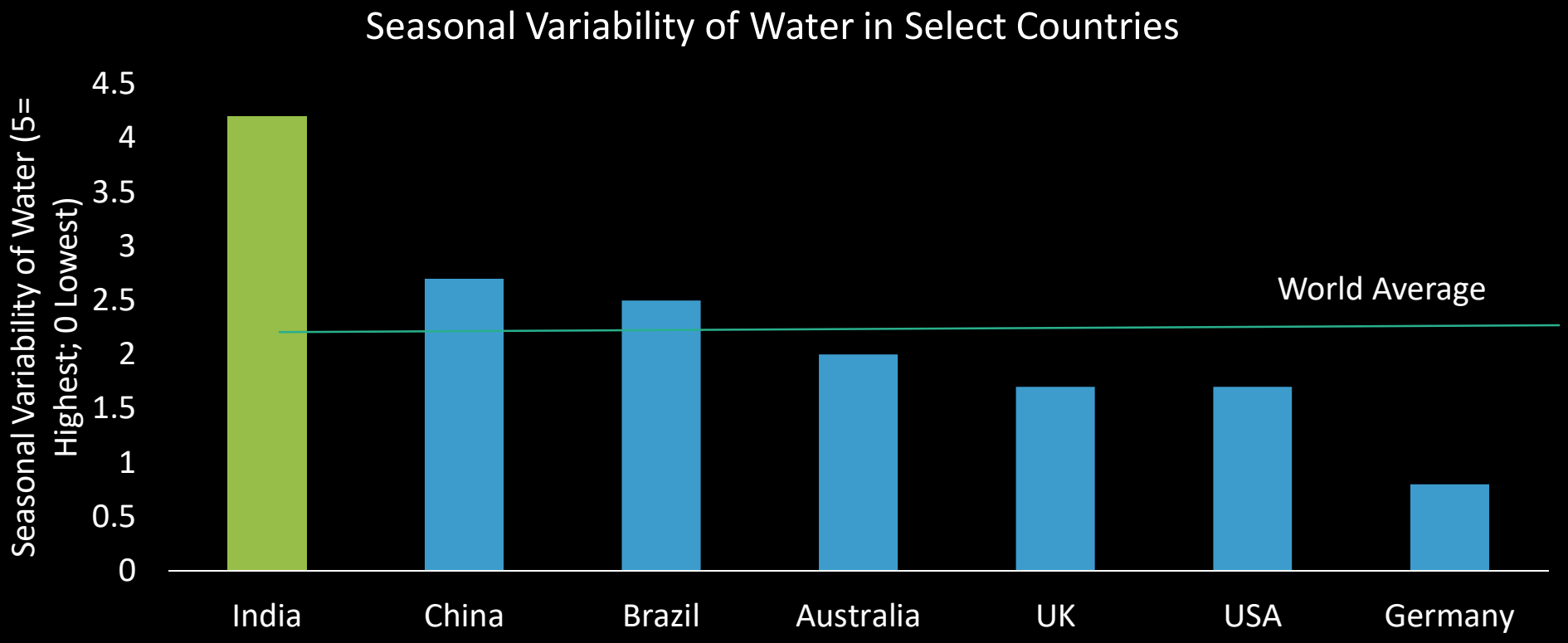
India asks nearly a fifth of the world's population to make do with less than one twentieth of the world's renewable water resources!





Source: AQUASTAT FAO's Information System on Water and Agriculture, 2023.

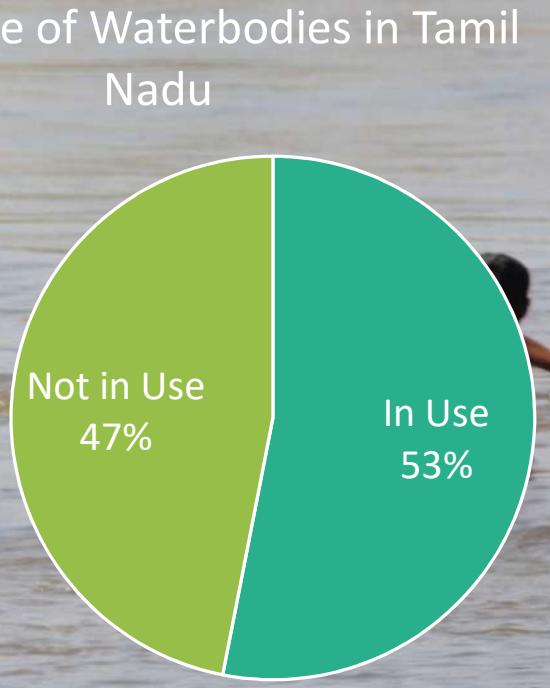
Meeting everyday water demand is made even harder because India's water is one of the most seasonal in the world.



Source: AQUASTAT FAO's Information System on Water and Agriculture, 2023.

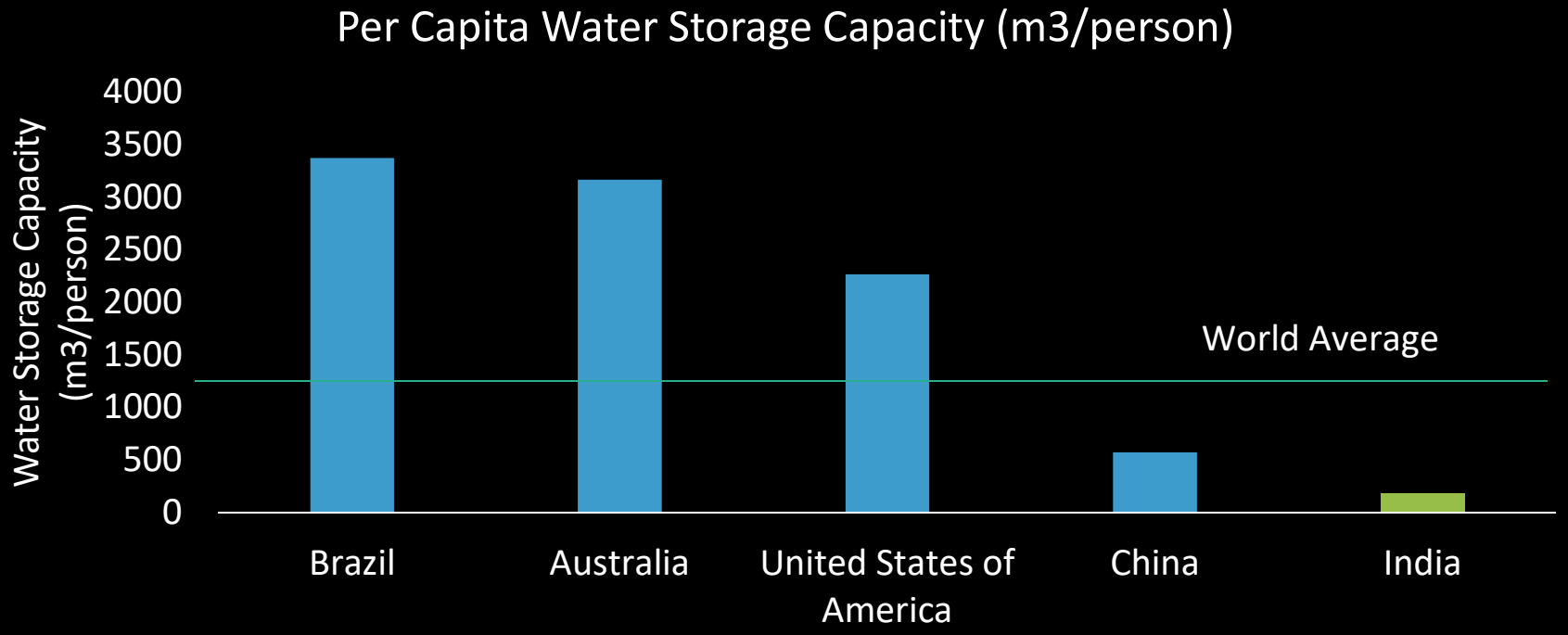
Our ancestors understood this all too well and built thousands of water storage structures across the country to store this highly seasonal water and use it.

- India has 24,24,540 water bodies, 78% of which are manmade.
- Tamil Nadu has 1,06,957 water bodies, of which 41% are irrigation tanks.
- Sadly, nearly half of Tamil Nadu's water bodies, or 50,197 water bodies, are not in use – either because they have dried up or been built over or silted up. This is compares poorly with the all-India average of not in use water body percentage of 16.3%.



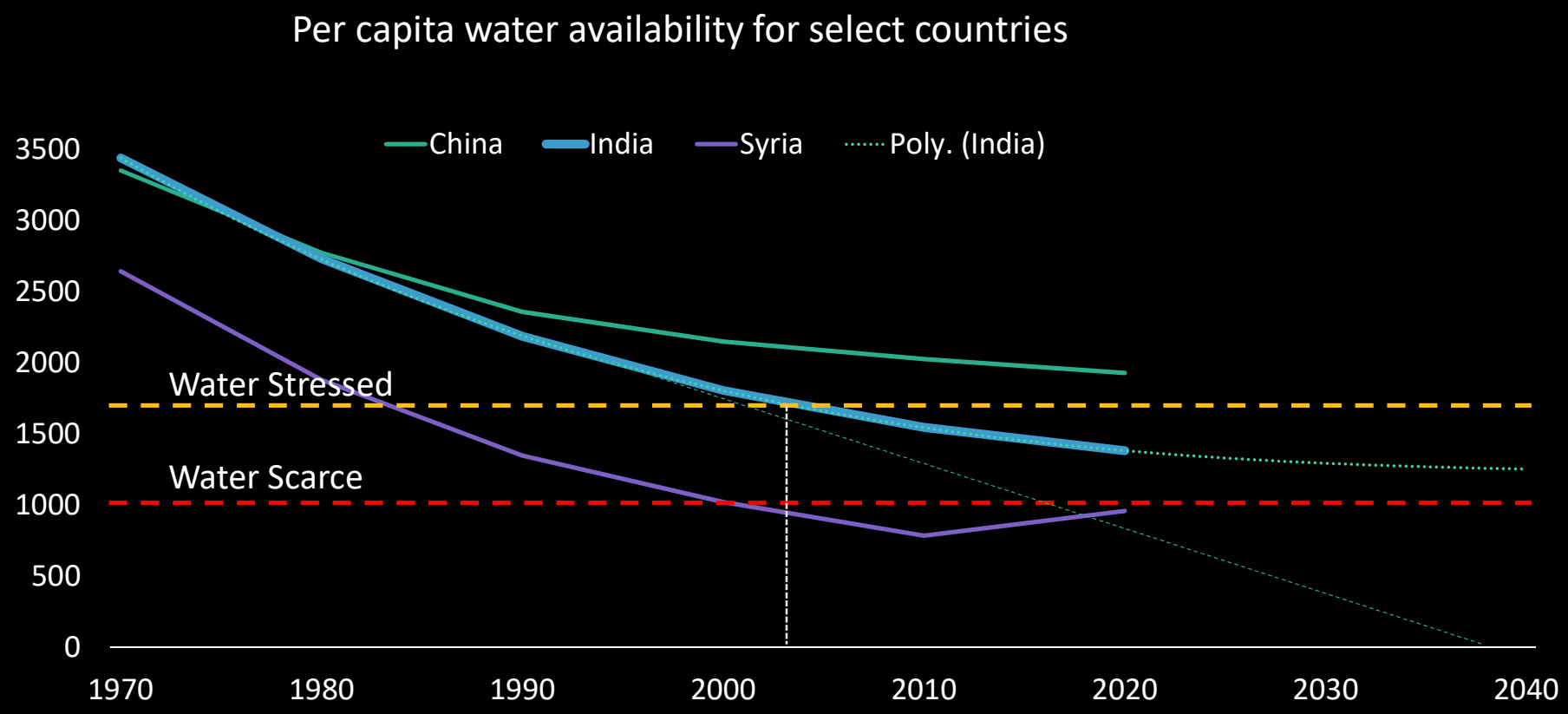
Source: AQUASTAT FAO's Information System on Water and Agriculture, 2023. 'Water Bodies First Census Report 2023', Ministry of Jal Shakti, Government of India, 2023.

Already India has one of the lowest per capita water storage in the world. Losing existing storage when climate change makes India's water supply more seasonal still, is almost like chopping off a leg just before running a marathon.

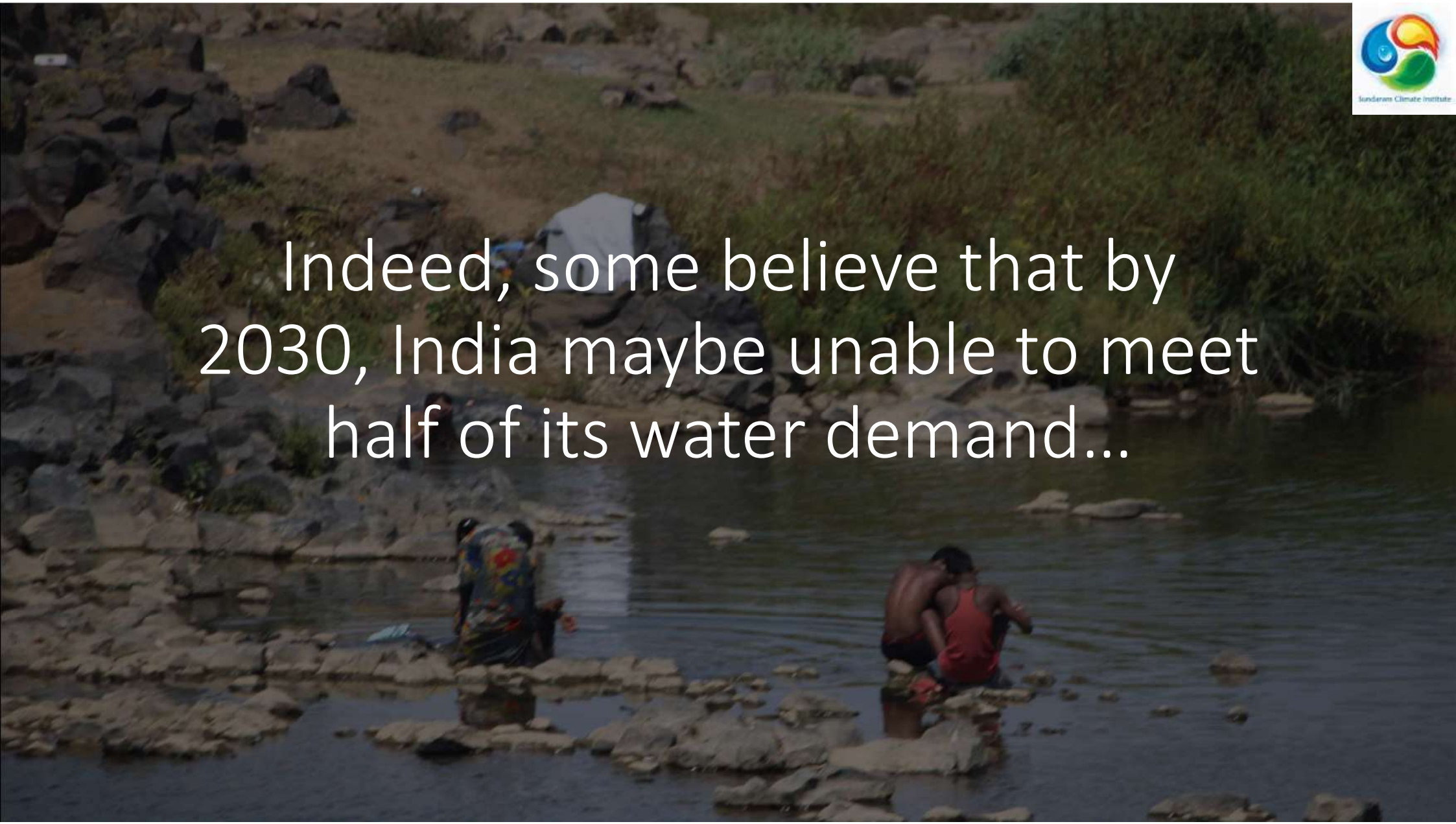


Source: AQUASTAT FAO's Information System on Water and Agriculture, 2023.

India became officially water stressed this century, even as per person water availability continues to fall. If current trends persist, India may become water scarce in the coming decades.



Source: AQUASTAT FAO's Information System on Water and Agriculture, 2023.


Indeed, some believe that by
2030, India maybe unable to meet
half of its water demand…

Even today, parts of India already face debilitating water scarcity…


Why Chennai's water crisis should worry you

IT COULD BE YOUR CITY NEXT: Reckless Destruction Of Water Bodies, Poor Planning — Today, Citizens Are Paying A Very Heavy Price


Water Crisis Hits Kashmir

We are hardly able to manage supplies: Official

3 flights cancelled due to fog

Turtle doves, migratory birds stay away from Kashmir


TIMES REGION | UTTARAKHAND

Experts warn of water scarcity in Himalayan states

IPCC Report On Depleting Snow Led To Conclusion


REGULAR FEATURE EVERY SUMMER: LOCALS

TOI | APR 18, 2019

Water woes back in pockets of Salt Lake as mercury soars

Water filled from roadside taps are being supplied to houses in many Salt Lake blocks

There is supply shortage for some… We are not getting enough water locality. It seems the supply time has been reduced. Many are being forced to hire water tankers

Kavita Pal | HB BLOCK RESIDENT


PARCHED!

CITY THIRSTS & TANKER MAFIA RULES AS POLITICIANS PLAY BLAME GAME

300

45%

3rd


NATION NOW

WATER CRISIS, A REALITY

WATER SCARCITY HITS JAIPUR

mirrornow

WATER CRISIS HITS RAJASTHAN'S CAPITAL

MIRROR NOW

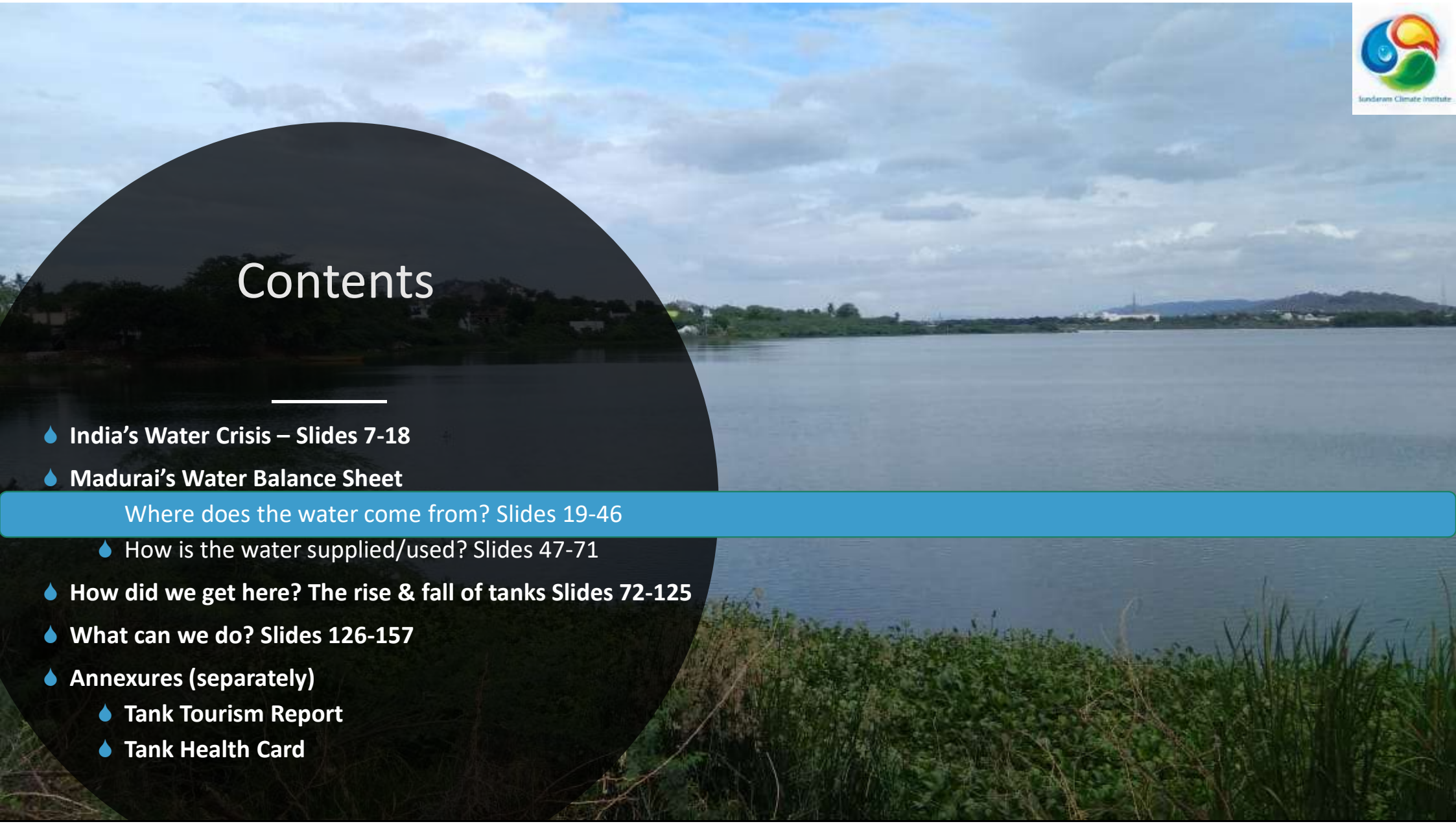

THE TIMES

As water crisis worsens, is B'luru heading for Day Zero?

Solving the crisis needs answers to key questions...

- What kind of water risks do Indian cities face?
  - Demand
    - How much water do Indian cities need?
    - Do India's cities get enough water?
    - Do all citizens receive the same quantum of water?
  - Supply
    - Where do Indian cities get their water from?
    - How is the quality of water?
- Why are water bodies disappearing?
- How will climate change affect India's water?
- How bad is the crisis?
- Why did we get to crisis point?
- Is water a voting issue?
- What solutions can work?

Given that India’s water comes largely from the monsoon, it has common facets across the country. Thus, lessons from Madurai apply to other parts of the country as well.
What do they tell us?

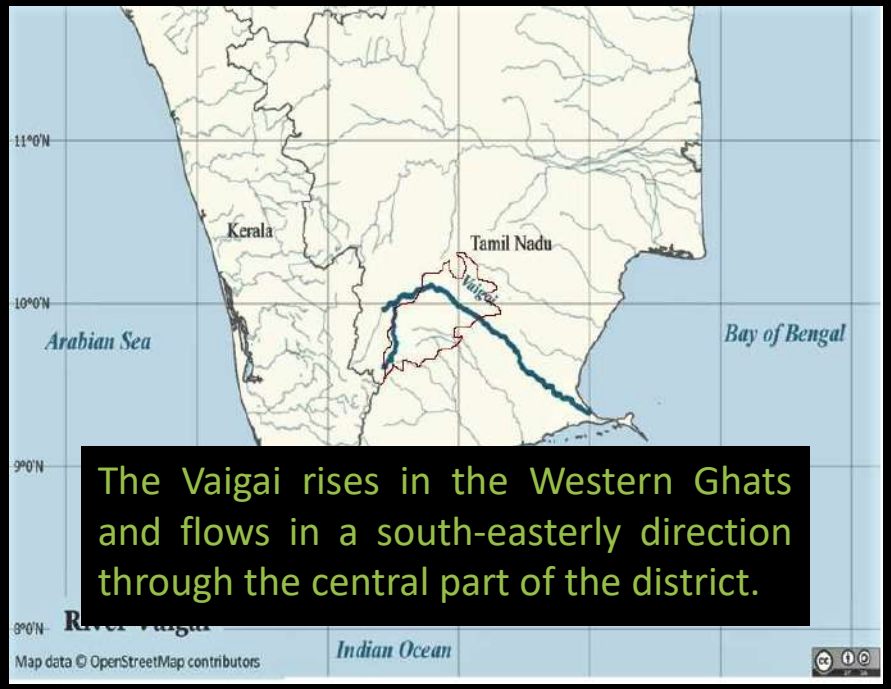


Contents

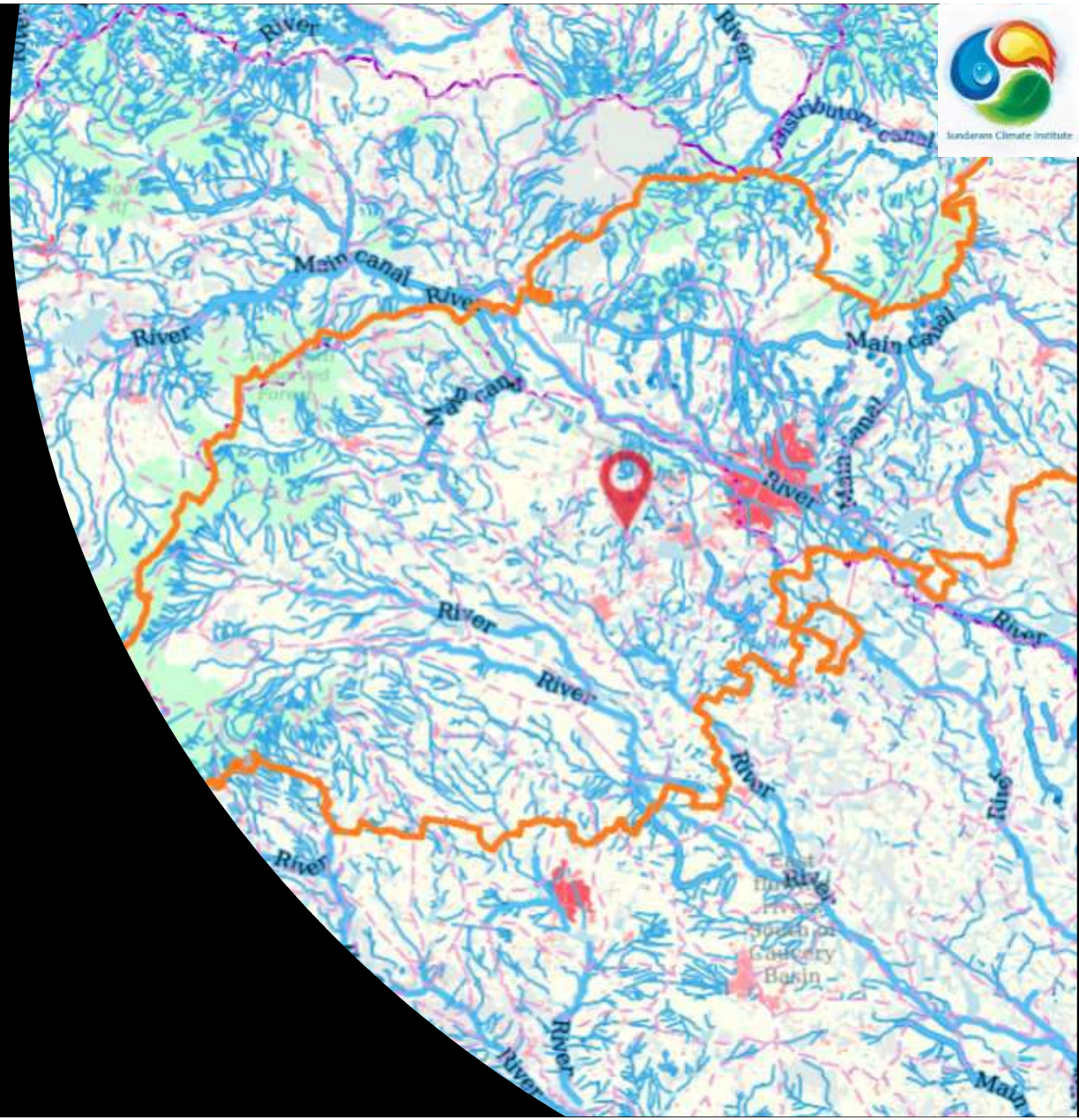
Like many Indian cities, Madurai too depends on a variety of sources for its water

- River water
- Rainfall
- Groundwater
- Private (Tanker) water
- Treated sewage

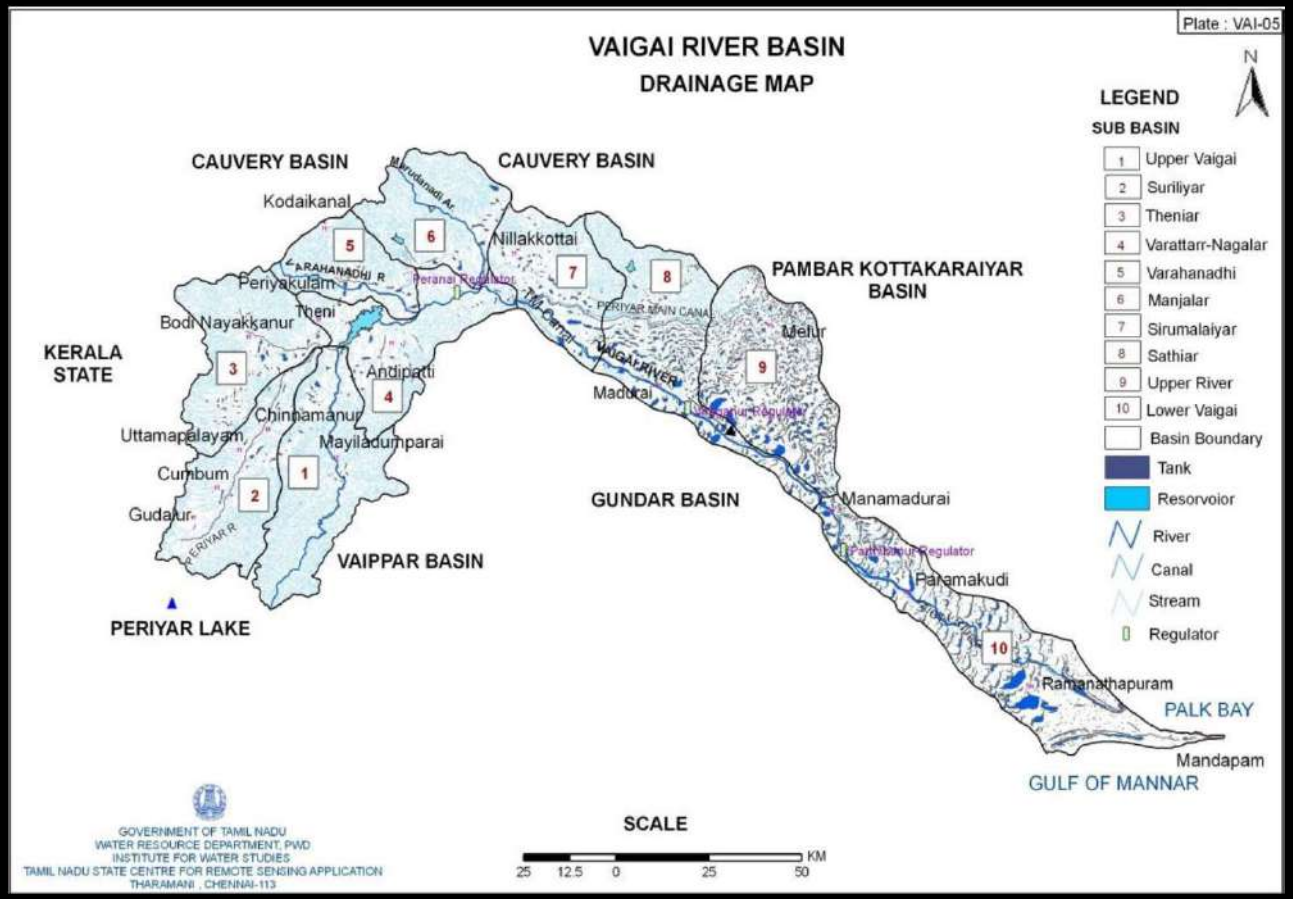
The river Vaigai is the primary source of Madurai's water



The Vaigai rises in the Western Ghats and flows in a south-easterly direction through the central part of the district.



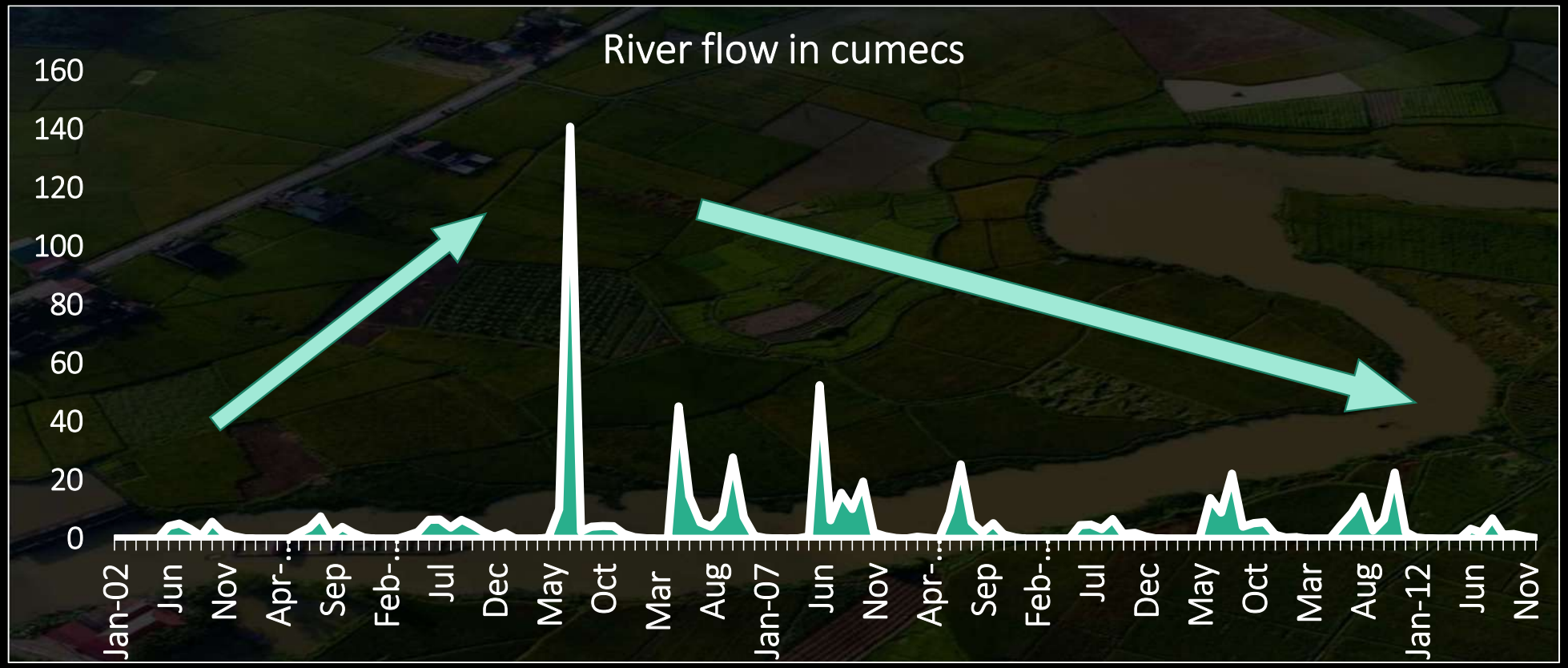
The main body of the river is fed by numerous streams that drain the district



Source : National Water Mission, 'Vaigai Basin', 2017.

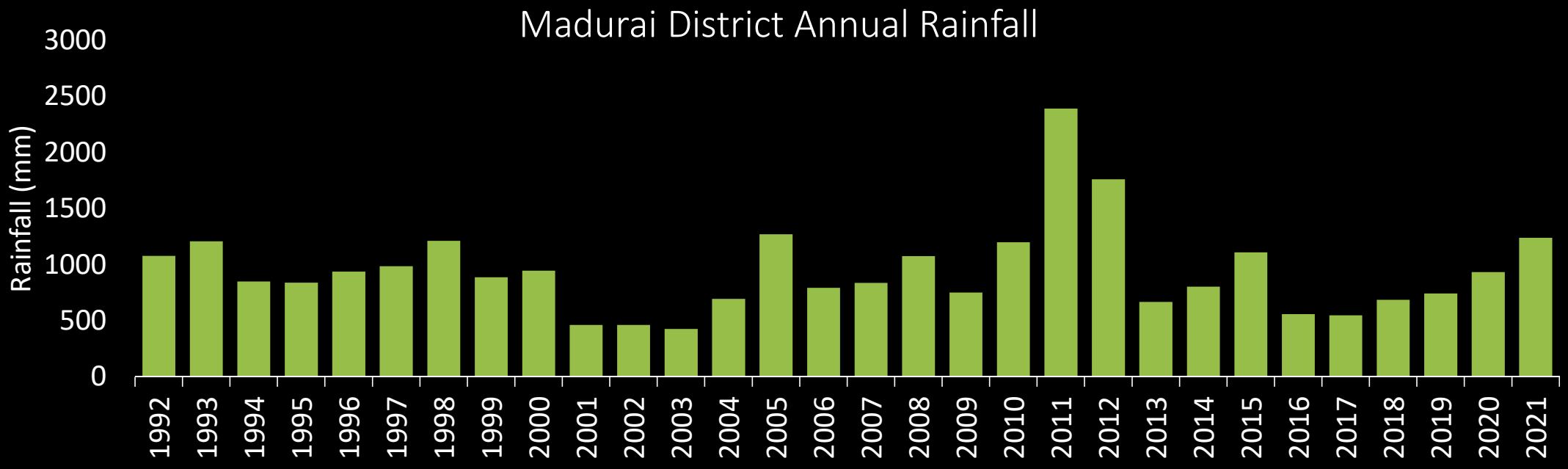
Streams such as the Suruliyar,
Theniar, Manjalar and Sathiar are today stressed and polluted. The fabled Krithumala river is now essentially a drain.

Like many of India's rivers, the Vaigai's water flow level varies considerably within and between years. To match the varying river flow with the steady city water needs, we need to store the river water.



Source: WRIS, Ministry of Jal Shakti, Government of India.

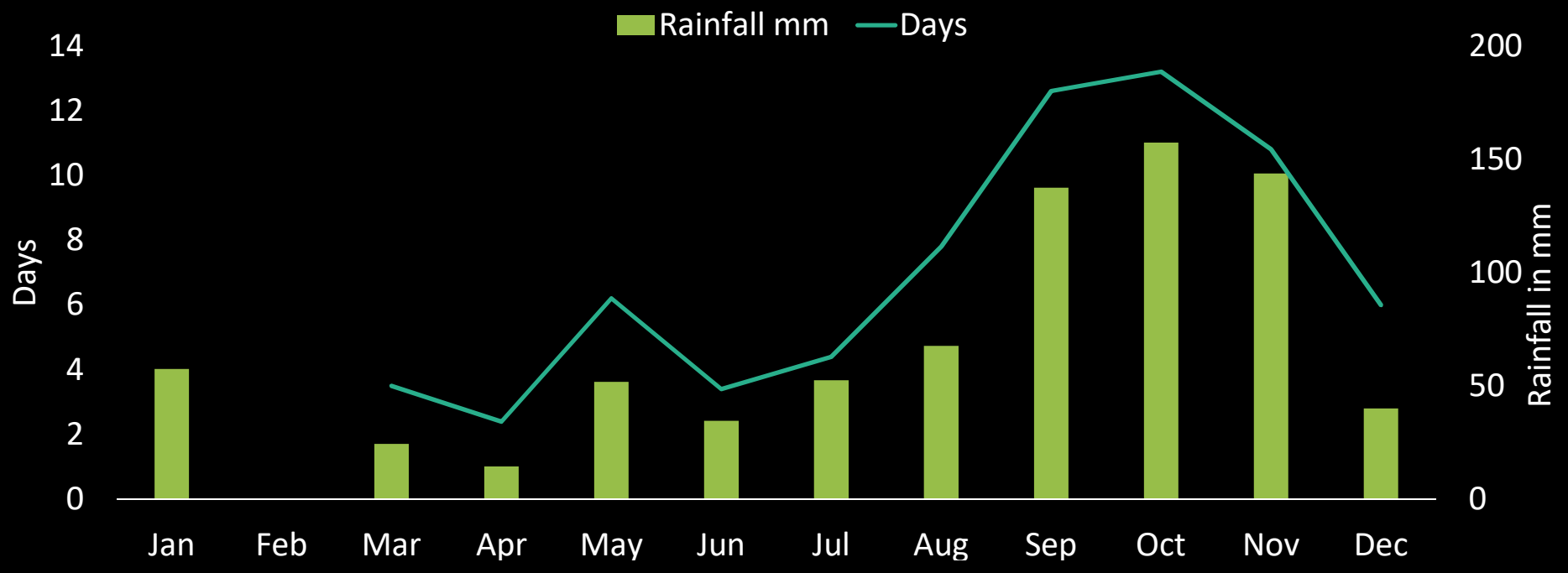
Madurai district's rainfall also varies tremendously across years, making water storage a central pillar for building the water resilience.



Source : India Water Resources Information System, Ministry of Jal Shakti, Government of India

Within any given year, Madurai's rainfall is highly seasonal, again making storing rainwater critical.

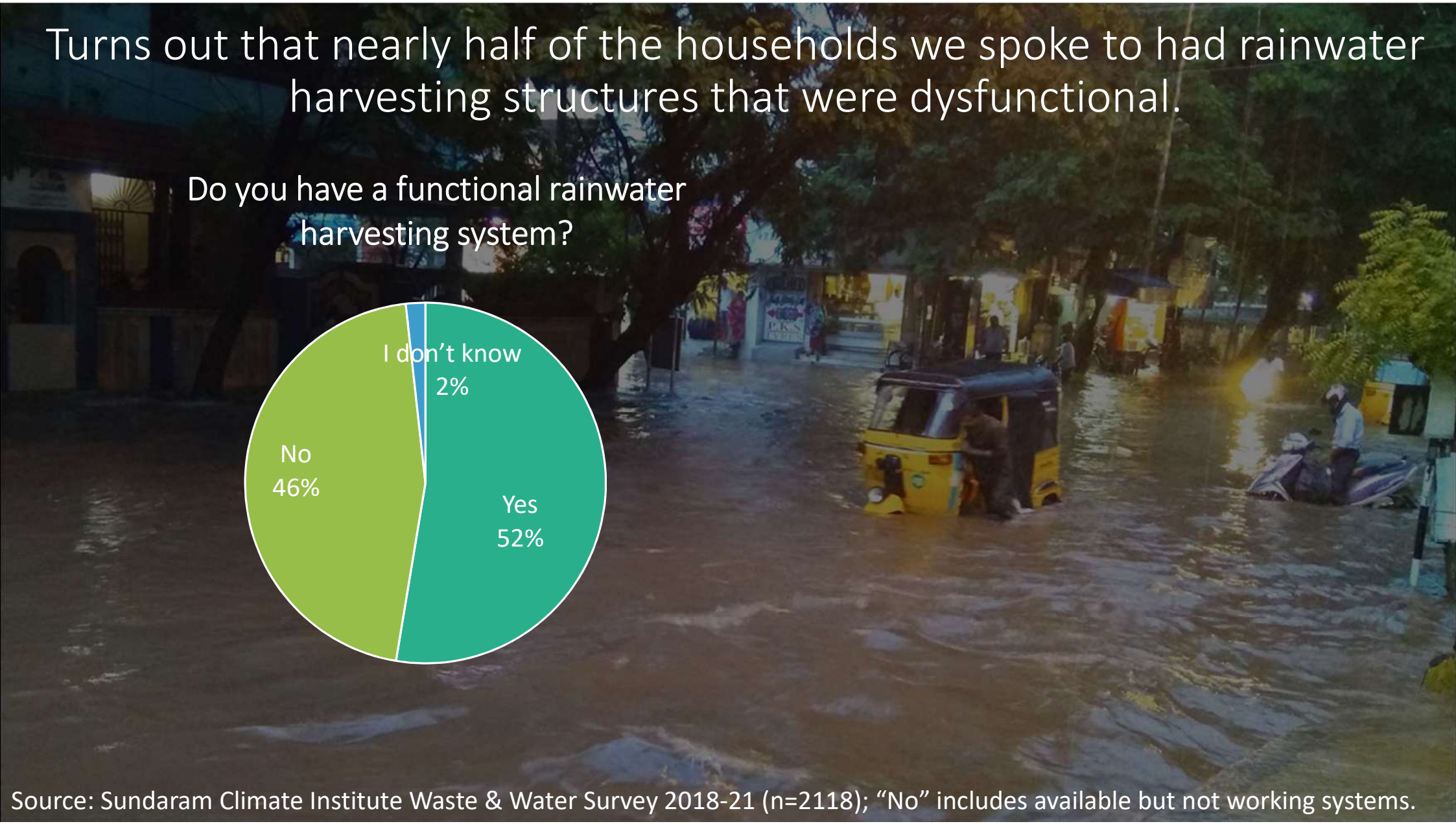
Avg. Rainfall: 813 mm
Range: 548 – 1156 mm
No. of Rain Days: 71
Range: 54 – 99



Source : India Water Resources Information System, Ministry of Jal Shakti, Government of India; Note: Rain day = day on which rainfall > 2.5 mm

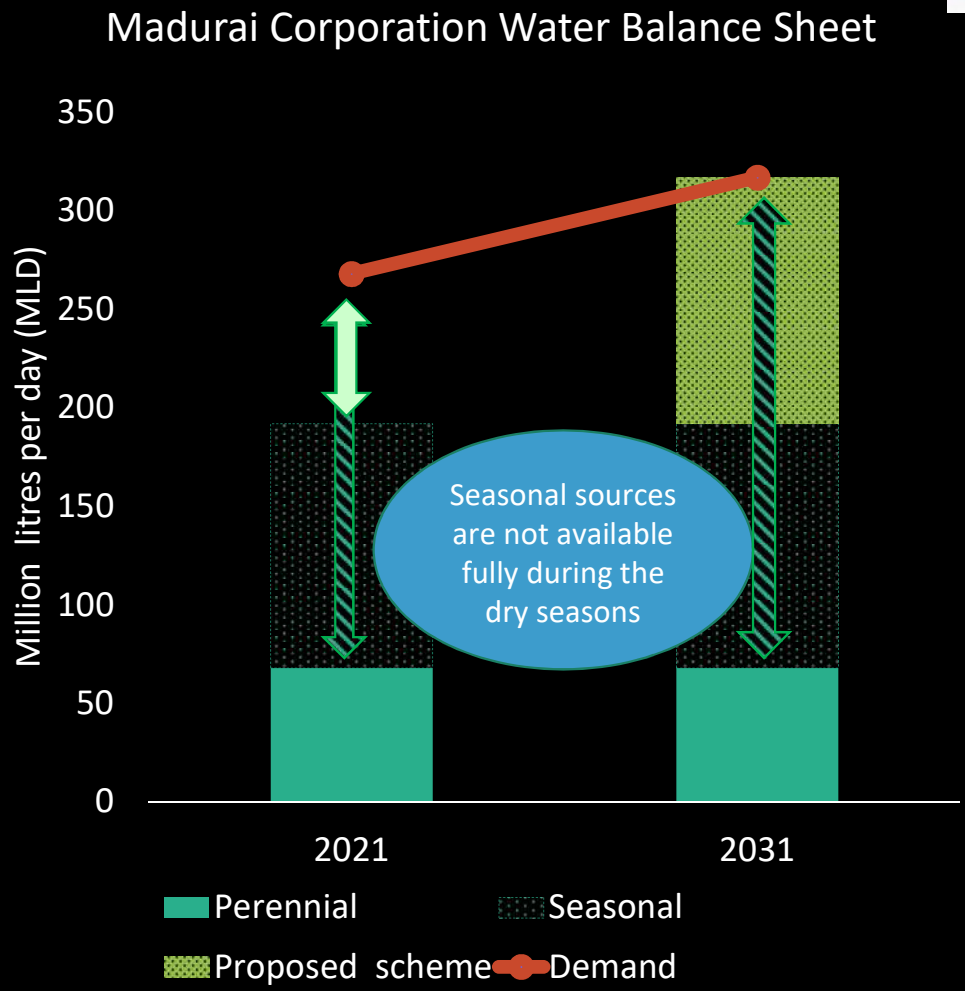
But does Madurai store its rain effectively? To answer that we turned to the results from SCI's Waste & Water Study

Turns out that nearly half of the households we spoke to had rainwater harvesting structures that were dysfunctional.



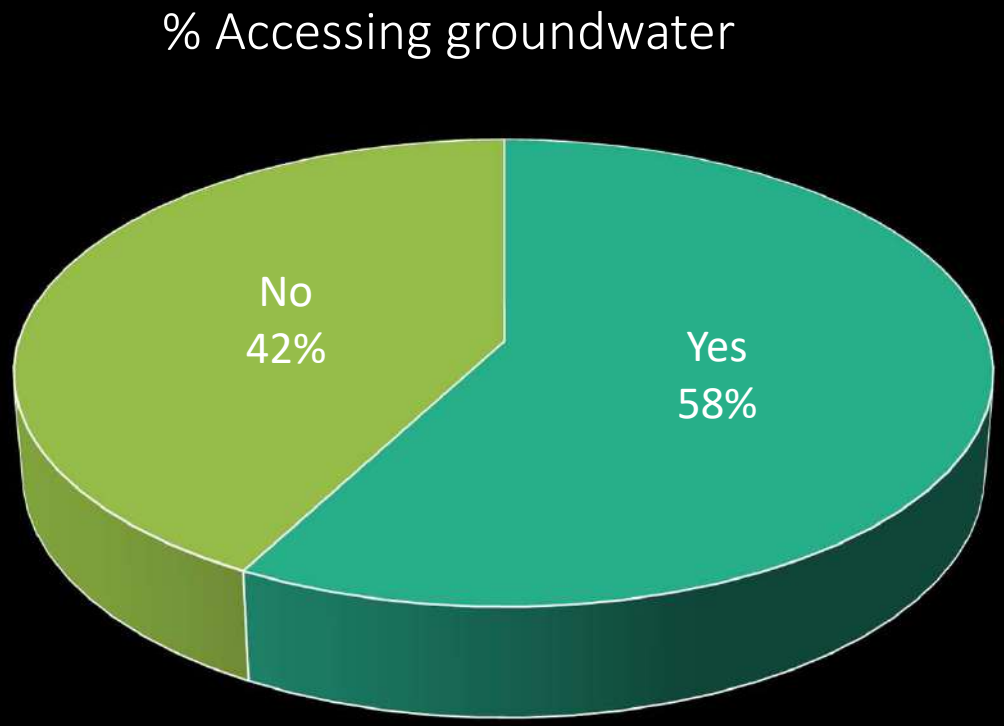
Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=2118); "No" includes available but not working systems.

What you see here is Madurai's water balance sheet. The red line is Madurai's daily water demand today and in the future. The bar graphs are Madurai's water supply, with the dotted bar signifying that the supply is seasonal and not available through the year. As you can see, Madurai struggles to meet its water demand today, especially in the dry season. Going forward, although the proposed water supply scheme will make Madurai more water secure, rising demand and the increased seasonality of the sources will still leave Madurai vulnerable in dry months. This is a reality that plagues almost every Indian city.



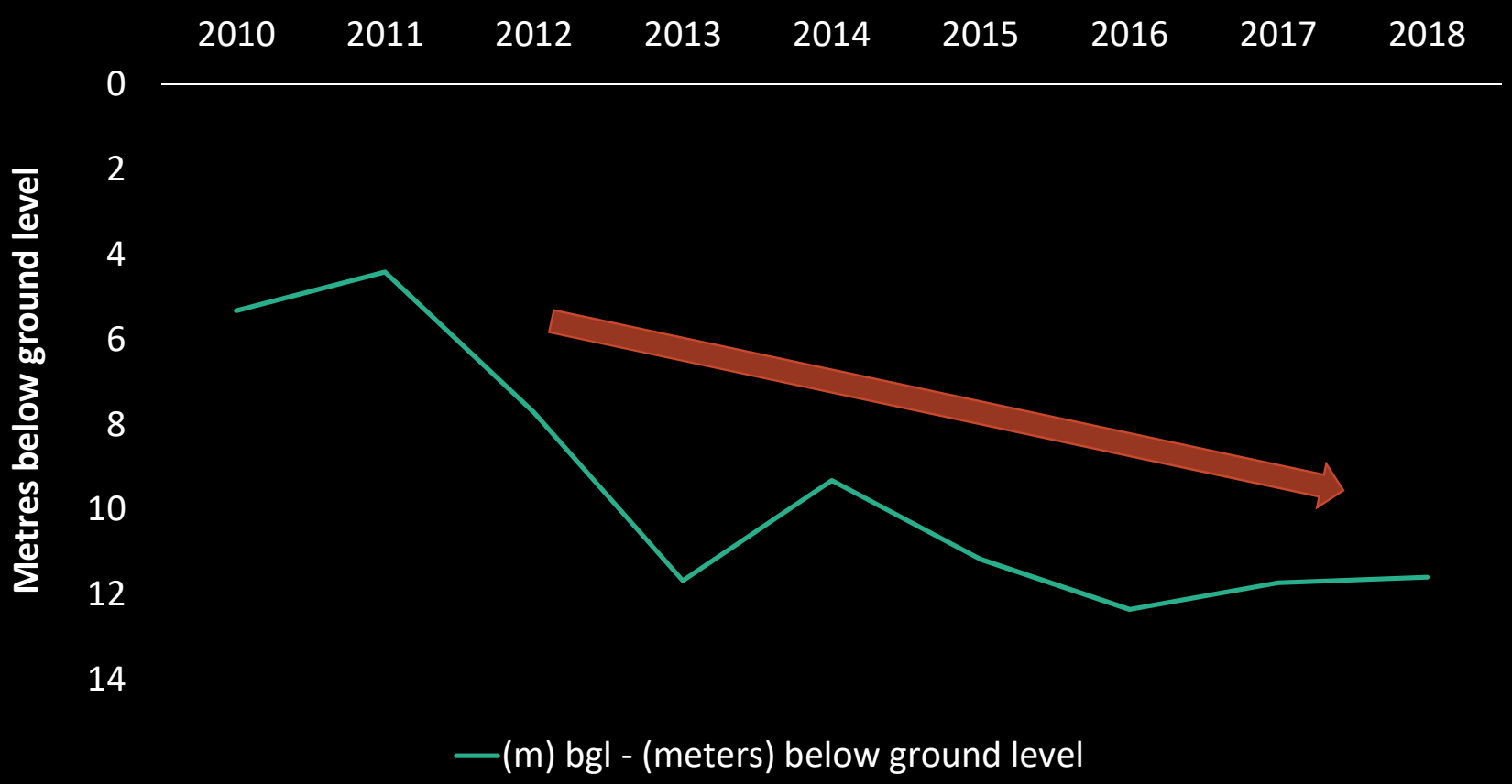
Source : Tamil Nadu Urban Flagship Investment Program (Tranche 2) – Dedicated Water Supply Scheme for Madurai Municipal Corporation from Mullai Periyar River at Lower Camp; June 2019 prepared by the Madurai Corporation for the Asian Development Bank.

To fill the gap, households turn to groundwater. Half the households we spoke to told us that they tap into their groundwater.



Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=2118)

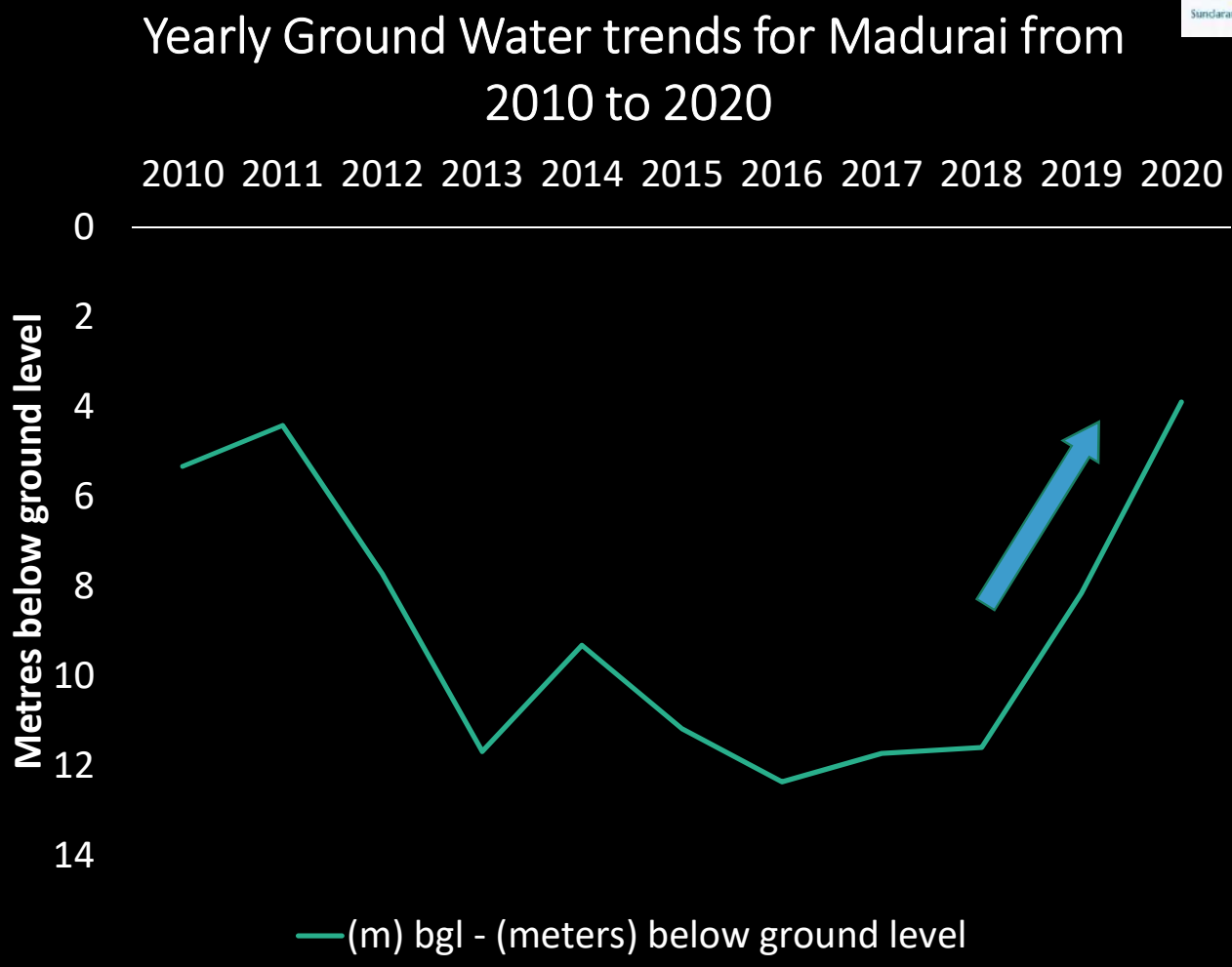
Yearly Ground Water trends for Madurai from 2010 to 2018



With few restrictions on groundwater use, Madurai's groundwater levels have fallen between 2010 & 2019.

Source : India Water Resources Information System, Ministry of Jal Shakti, Government of India

Groundwater levels have risen sharply in 2020 thanks to good rains and most importantly, rejuvenated tanks.



Source : India Water Resources Information System, Ministry of Jal Shakti, Government of India; 2021 data was not available

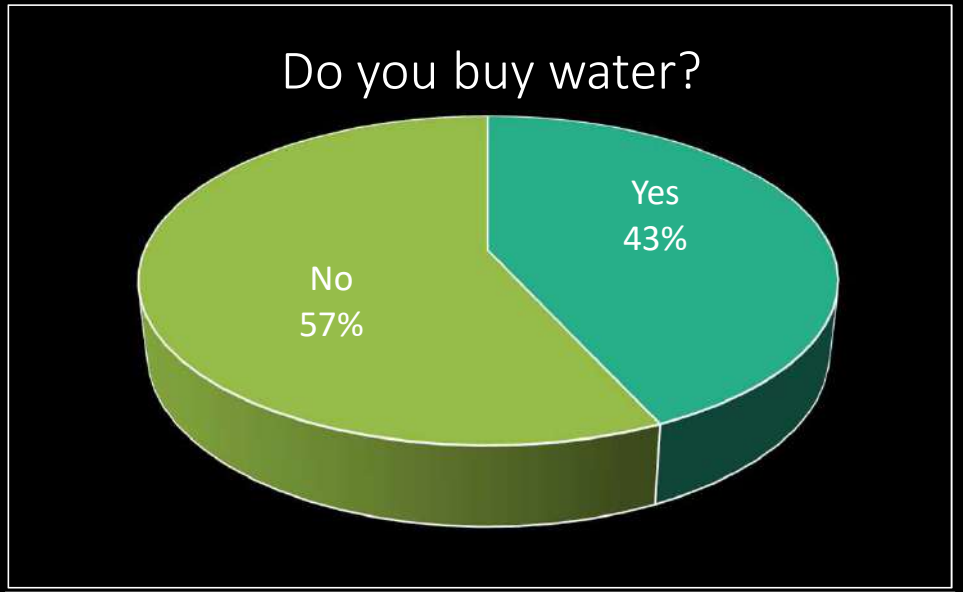
However, in El Nino or low rainfall years especially, families continue to struggle to meet their water needs

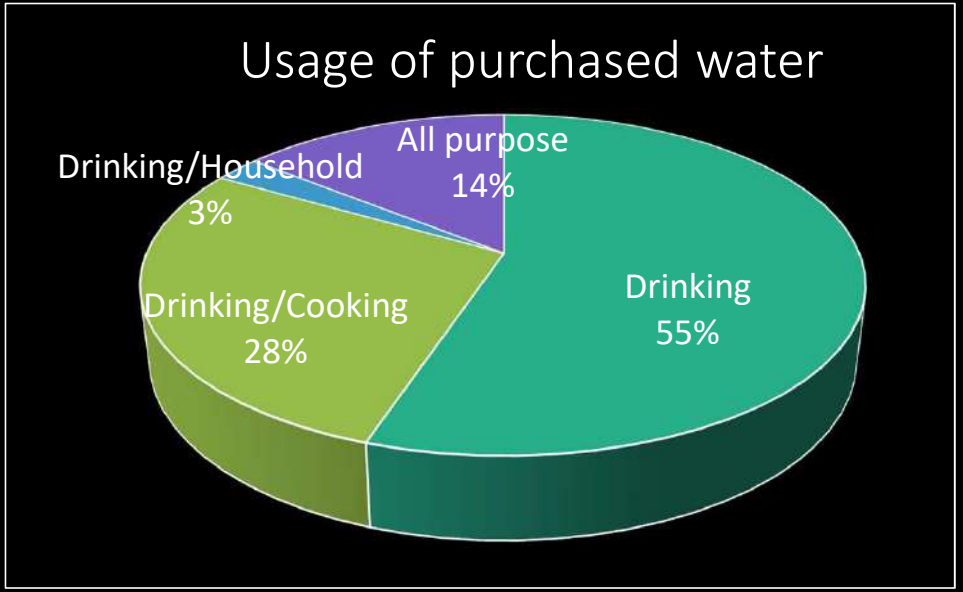
Note: El Nino refers to a global weather pattern, which repeats every 2-7 years and can result in low rainfall in India.

And in the months where municipal supply falls and groundwater dries up, households turn to tanker water

We found that a significant fraction of the households we spoke to buy water to meet some part of their needs. The average per household income in our survey was < Rs. 20,000, meaning even the economically vulnerable bought water for some of their needs, some of the time.

Weighted Average Monthly Spend per household = Rs. 455 +/- Rs. 30





Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=2118)

A Rs. 400-500 monthly expense becomes an “El Nino Tax” on poor urban households in the summers of low rainfall years.

What about treated sewage? Can’t that help?

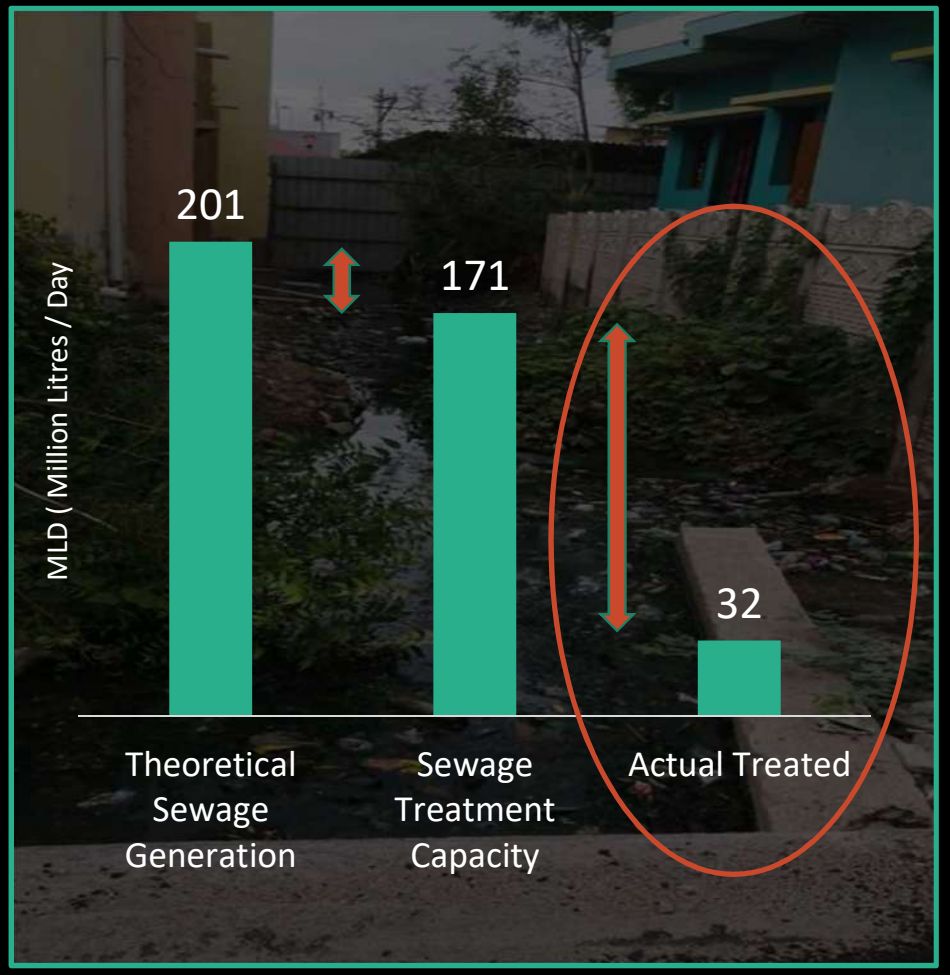

Israel & Singapore make great use of their treated sewage. Can Indian cities like Madurai do this too?

Like other Indian cities, Madurai's sewage problem has three components: capacity, connectivity and awareness.

Source - Madurai Corporation

Madurai's Sewage Treatment Dilemma

While capacity can be augmented, a far bigger problem is that capacity is not fully fed. That's because household sewage does not make it to the centralized treatment plants for several reasons.

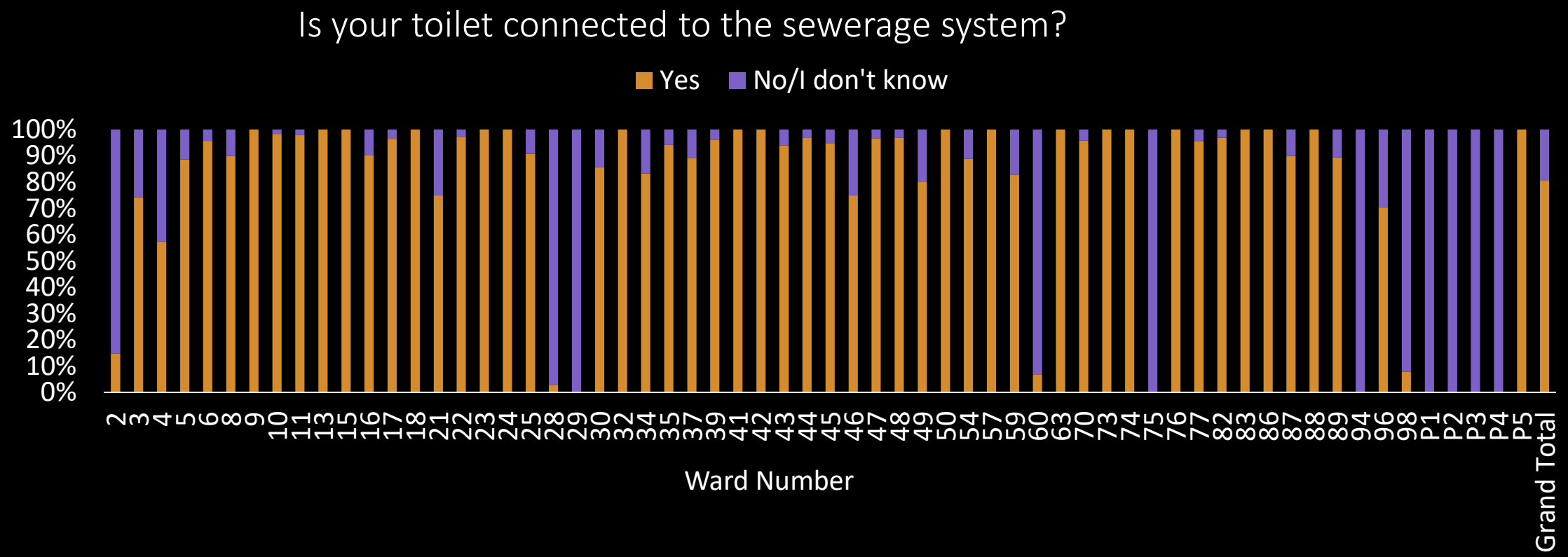


Source: Sewage treatment capacity and Actual treated taken from National Inventory of Sewage Treatment Plants, Central Pollution Control Board, March 2021; Sewage generation assumed to be 75% of water demand.

Reasons why sewage does not make it to central treatment plants

- Pipeline Breakages
- Power outages (pumping to the central treatment plant is stopped)
- Sewage released midway – e.g., into a local tank
- Drain blocked with solid waste
- Lack of connectivity: About 18% of the households we spoke to were not connected to sewerage network

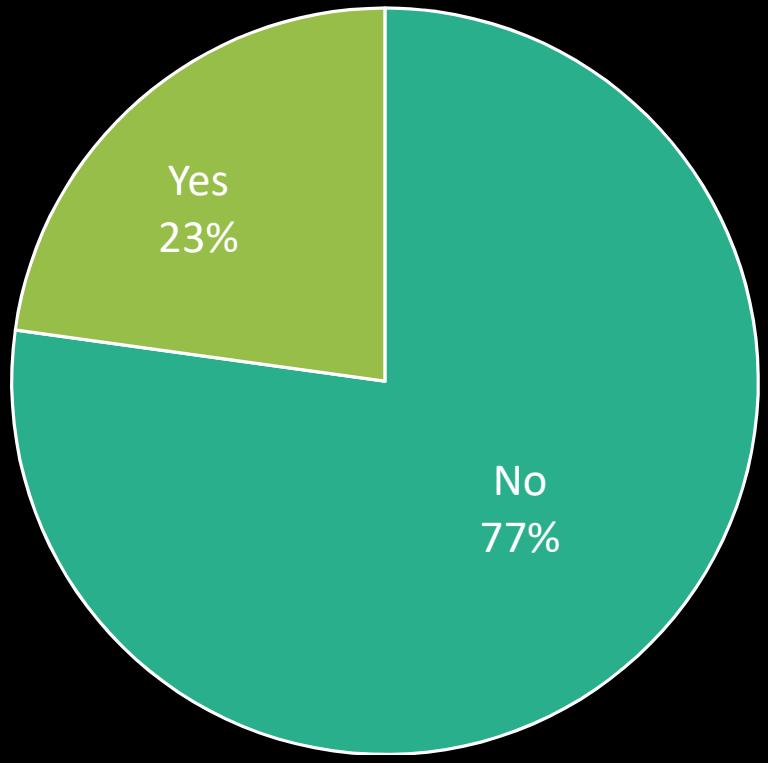
Connectivity appeared to be ward-specific problem: apart from a few wards, most households we spoke to were connected to the sewerage system.



Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=2118)

“Awareness” is another challenge in unlocking the power of treated sewage. Most households we spoke to did not know that sewage could treated and reused.

Do you know about the concept of treating sewage for reuse?



Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=2118)

What about the Climate Change?

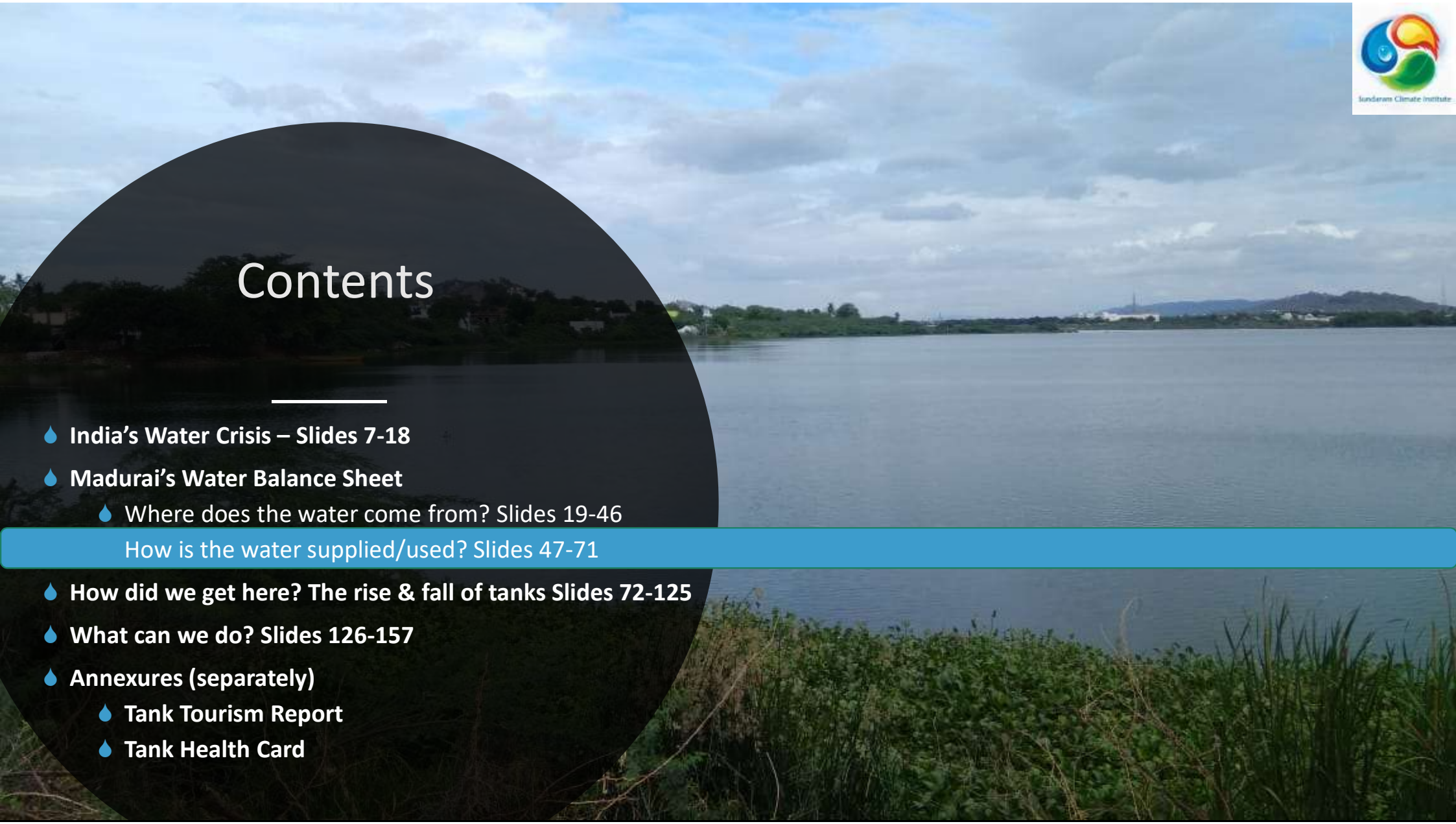
- Uncertainty over rainfall projections:
  - There is considerable uncertainty on what will be the impact of climate change on the district's rainfall over the near term (2021-2040). Using a regionally-downscaled climate model and in a moderate emissions scenario, Madurai's rainfall is projected to rise in the near future, although there is low model agreement on the same. Meanwhile, the TN ENVIS projections (based on IMD models) say that rainfall over the district might decrease by 1% over the near term.
- Greater certainty on rainfall volatility and demand increase:
  - There are likely to be more episodes of intense rainfall, and the seasonality of rainfall will likely rise, while the number of rainy days will likely decrease.
  - Temperatures will rise, and water demand will likely rise alongside.
- Water management is key:
  - Madurai's water supply will become more volatile while demand will rise, making water *management* key. Three important pillars of this are (a) Water storage, (b) Treating & reusing sewage, and (c) Protecting upstream forests. In this regard, protecting the forests that nurture the Vaigai through the creation of the Meghamalai Tiger Reserve is a welcome move.

Source: Iturbide, M., et al (2021) Repository supporting the implementation of FAIR principles in the IPCC-WG1 Atlas. Zenodo, DOI: 10.5281/zenodo.3691645. Available from: https://github.com/IPCC-WG1/Atlas; : CCC&AR and TNSCCC (2015). Climate Change Projection (Rainfall) for Madurai. In: District-Wise Climate Change Information for the State of Tamil Nadu. Centre for Climate Change and Adaptation Research (CCC&AR), Anna University and Tamil Nadu State Climate Change Cell (TNSCCC), Department of Environment (DoE), Government of Tamil Nadu, Chennai, Tamil Nadu, India. Available at URL. www.tnsccc.in

In short, a hotter climate will make supply more seasonal and more volatile and demand rise. This makes managing water a necessity.

Sources of water – So What?

- Madurai's water resilience will decrease if we continue with "business-as-usual" because supply volatility and demand will both rise, leaving Madurai parched in summer months.
- Madurai needs to manage its water better:
  - By storing more water – both in tanks and by harvesting rainwater better at the household level.
  - Sewage must be treated and reused by creating more decentralized sewage treatment facilities.
- These conclusions have resonance for most Indian cities.



Contents

Water use: Demand is a black hole

- India's water demand, due to a lack of metering, is a black hole and usually a guestimate. There are few studies to show how much or *how* water is used, and fewer still that do it over years.
- This is a problem – managing demand is an important pillar of building water resilience in a city.

How did we try to understand water demand and realities?

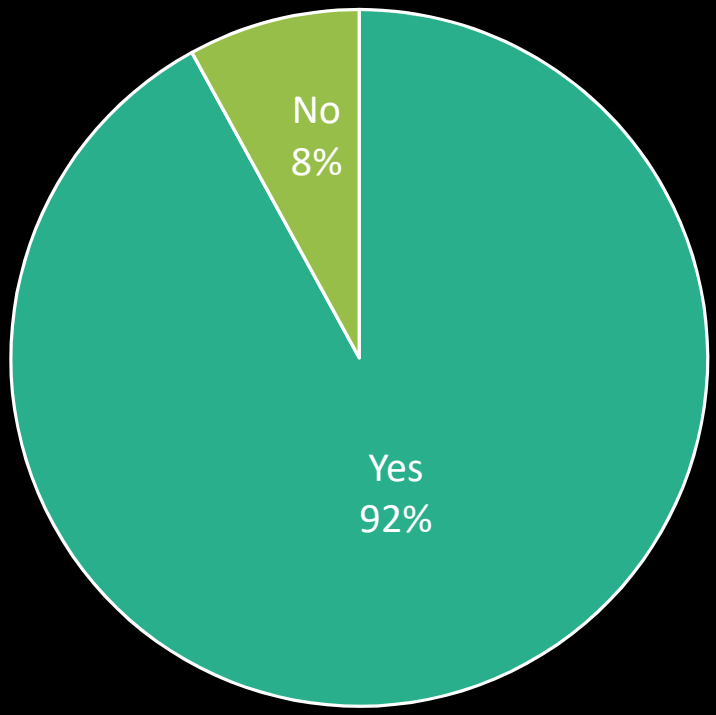
- Sundaram Climate Institute designed and used a rigorous questionnaire to understand the waste and water realities of 2118 households between 2018-2021.
- The study covered 57 wards (33 “interior” wards and 24 “peripheral” wards) of Madurai’s 100 wards.
- In each ward, we surveyed at least 30 households to ensure representativeness. Clustering households also helped understand if a given response was an outlier and why. Our survey focused on the typically understudied – the average annual income of our study group was Rs. 98,162, substantially less than the average annual per capita income of Madurai (Rs. 127115 in 2018-19 extrapolated from 2011 Census income using the historical income growth rate). Our respondents covered a wide spectrum and included petty shop keepers, auto drivers, household helps, flower-vendors, pushcart vendors, teachers, office goers and business people.
- We spoke to every household at their doorstep. All interviews were conducted in person by trained Sundaram Climate Institute researchers.

We tried to answer questions on both demand and supply as well as perception.

- We studied aspects of demand and supply:
  - Where, how and how often did households get their water? Was it enough?
  - How much water did households consume?
  - Has household water use changed over time? Was the system equitable?
  - Did households buy water? What did they use the 'bought' water for?
  - Was their toilet connected to a sewerage system? What type of toilet did they use?
  - Did they have a functional rainwater harvesting system?
- We also checked perceptions:
  - What did they see their role in managing the water crisis?
  - Were people aware that sewage could be treated?
  - Was water a voting issue?
  - What problems did they face?

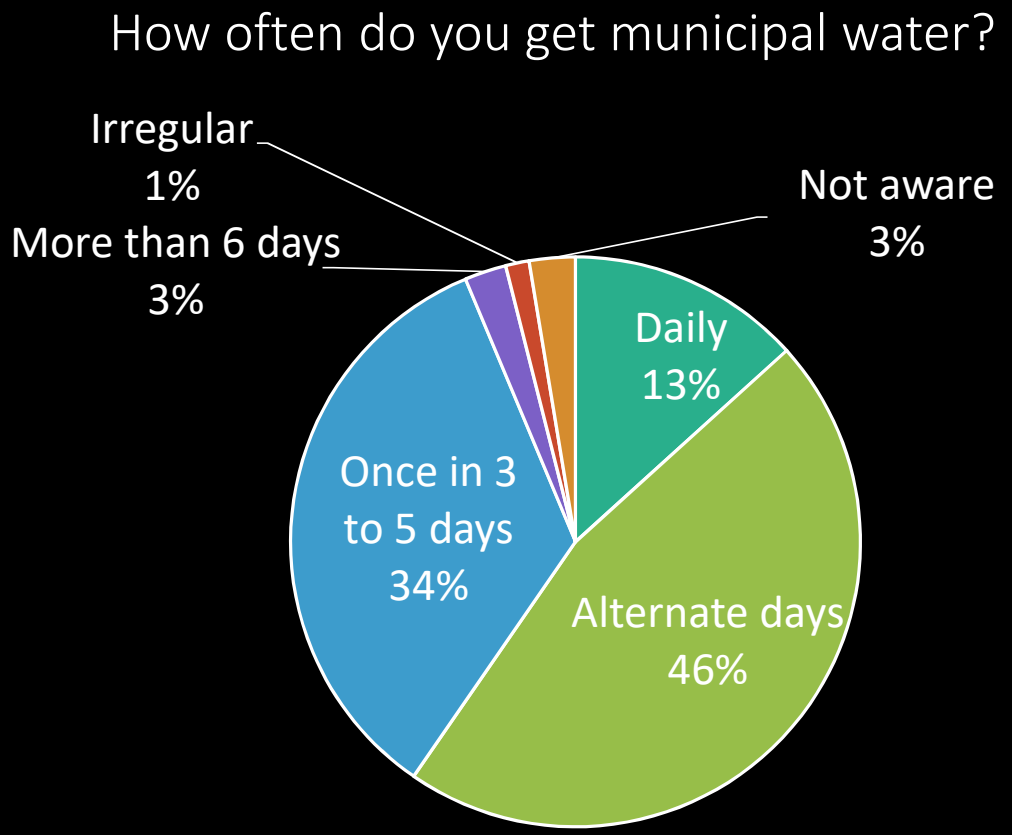
We discovered that the water crisis is not monochromatic - a wide variety of water realities existed.

For example, while most of Madurai gets municipal water…



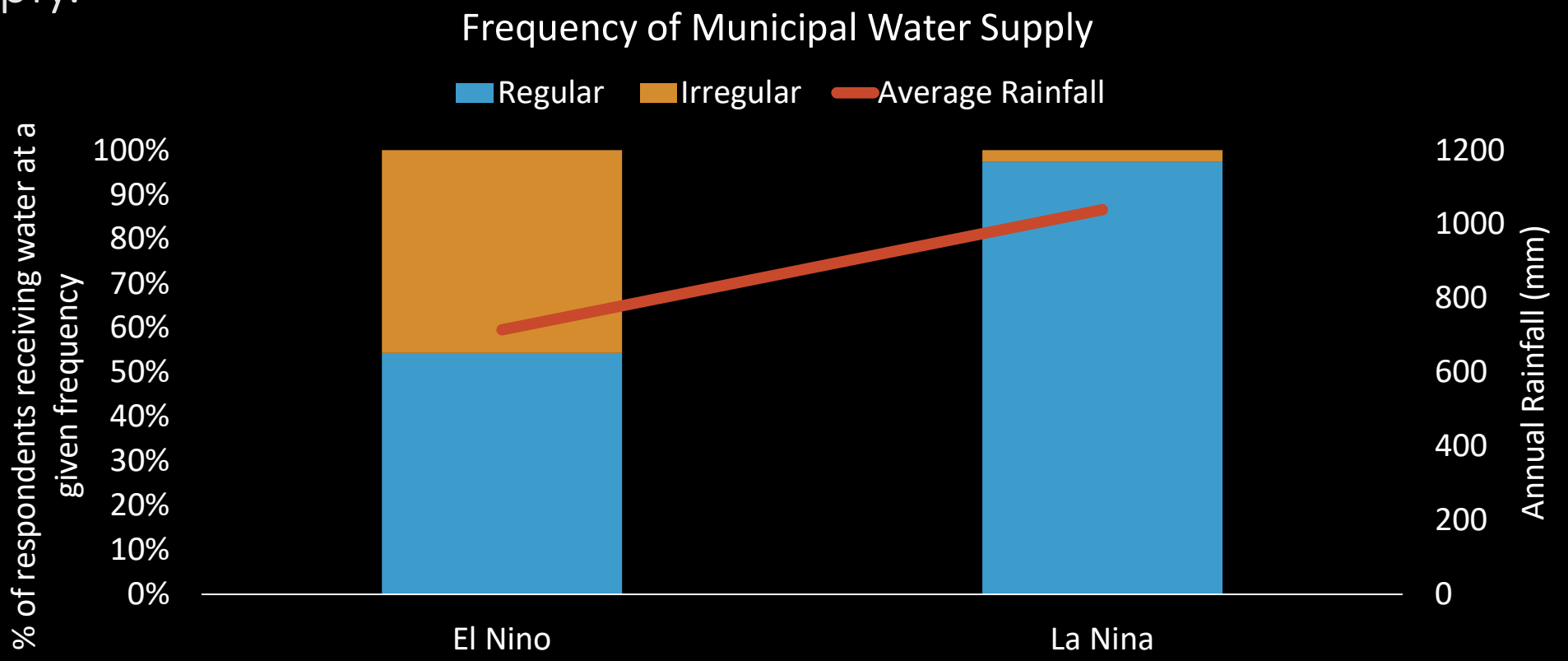
Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=2118)

Water is not available 'on tap': there is considerable variation between households in how often they get water.



Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=2118)

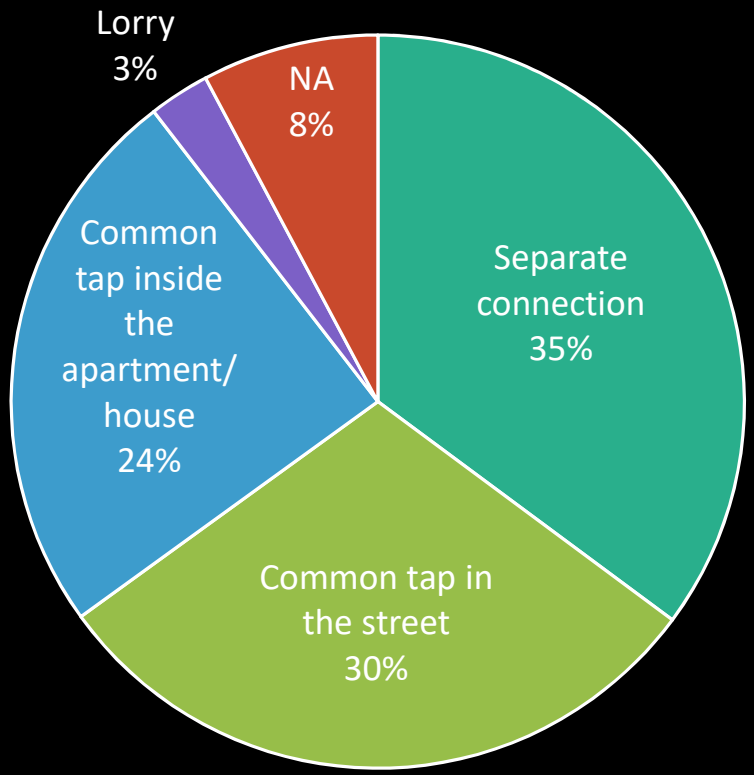
One driver of this water volatility is the interannual variation of rainfall : El Nino years, with lower rainfall resulted in more irregular supply.



Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=1898); rainfall data from India WRIS. El Nino = 2018, 2019; La Nina: 2020, 2021. Regular Frequency: Receiving water daily or on alternate days. Irregular Frequency: Receiving water less often, covers 3-5 days, once a week, once a fortnight, and never. Sample excludes 220 persons who replied not aware/not applicable.

There is also a wide variation in *how* households get their water.

How do you get your water?



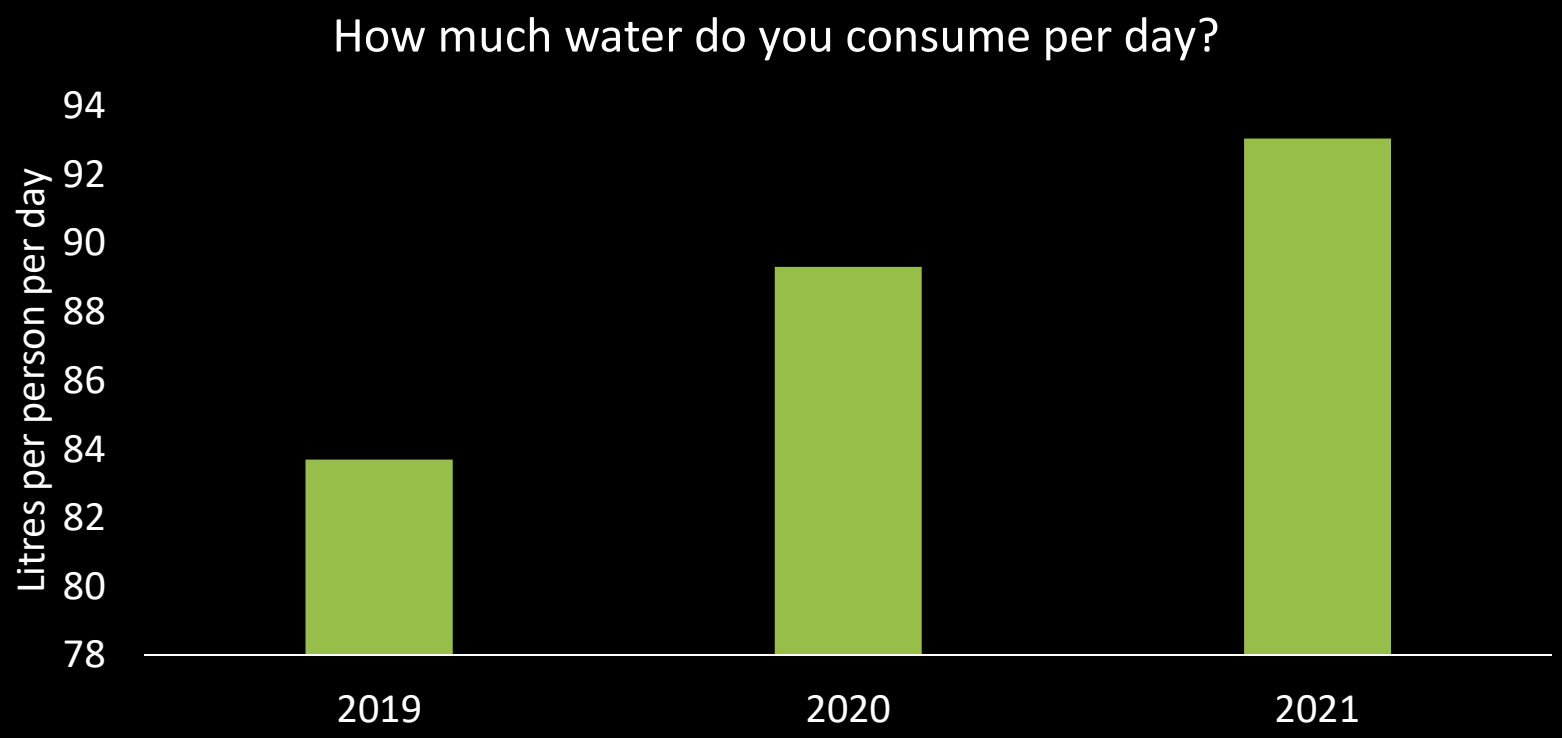
Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=2118)

Did supply meet demand?

A lack of metering made estimating demand a difficult exercise. We did ask households how much water they used…but were they able to accurately gauge how much water they used? In our reckoning, the only households who knew exactly how much water they used were those without borewell access and who collected municipal water in pots.

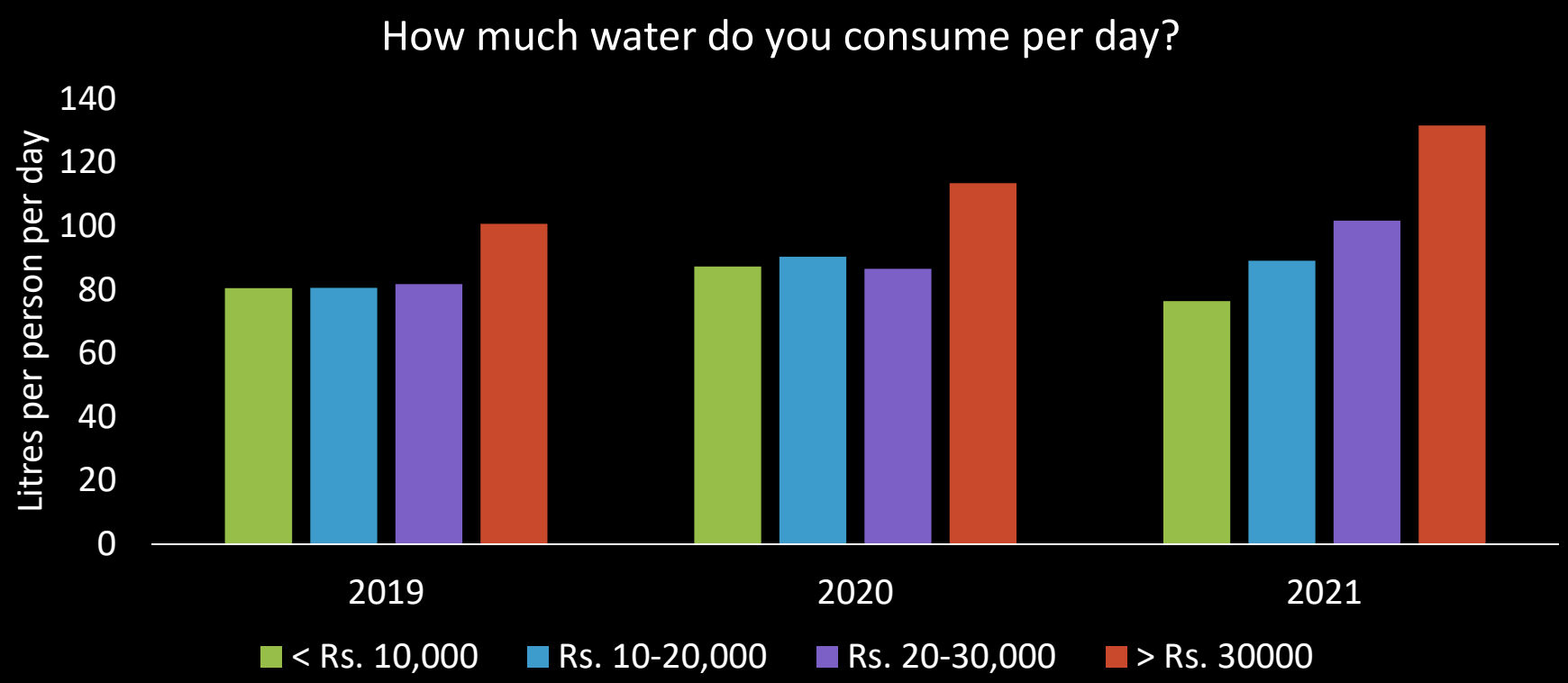
With that caveat, we found that water demand varied by year, often limited by supply. The wealthy consumed more, as did those with access to borewells.

Water consumption varied by year…



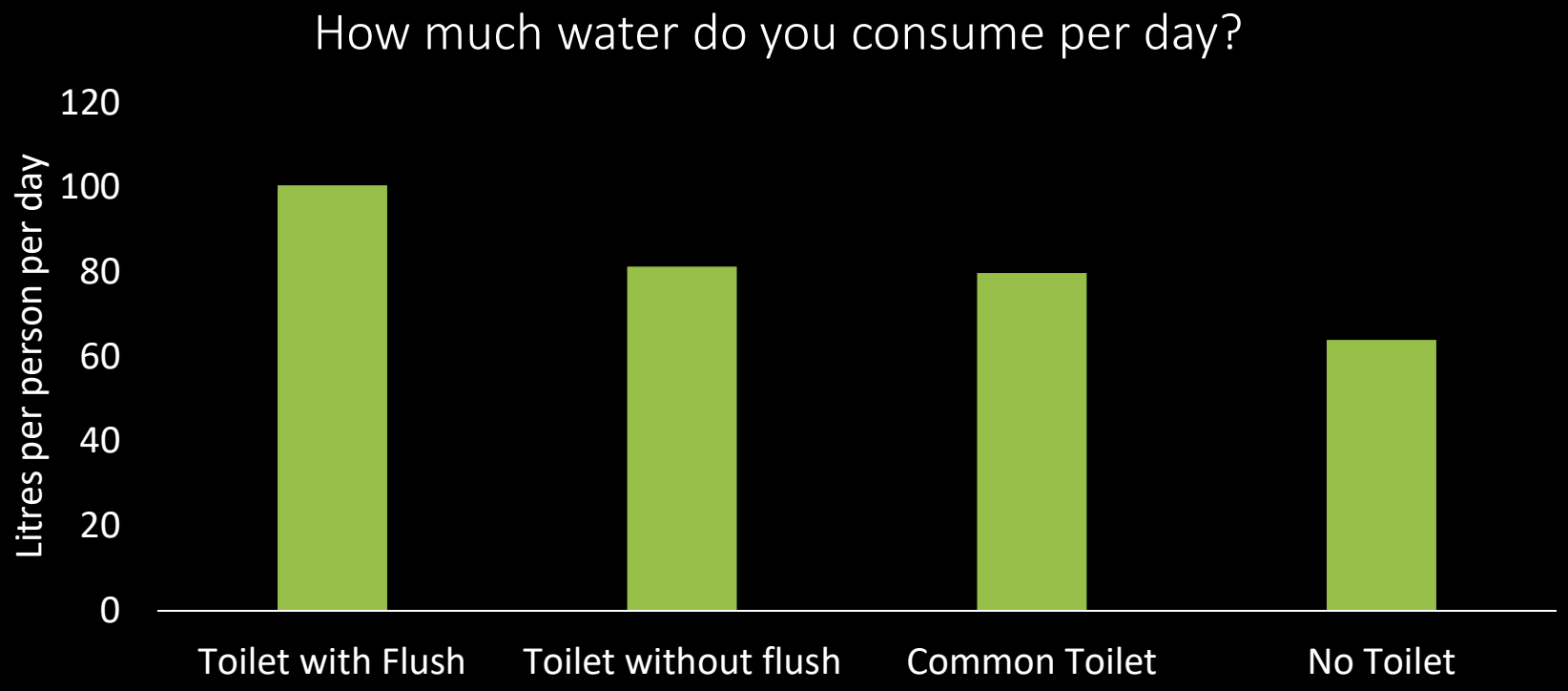
Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=1050); Asking persons for their own estimates of consumption began from 2019. Excludes responses from people who said they did not know how much water they used.

Predictably, within a year, a higher income translated to a higher water consumption.



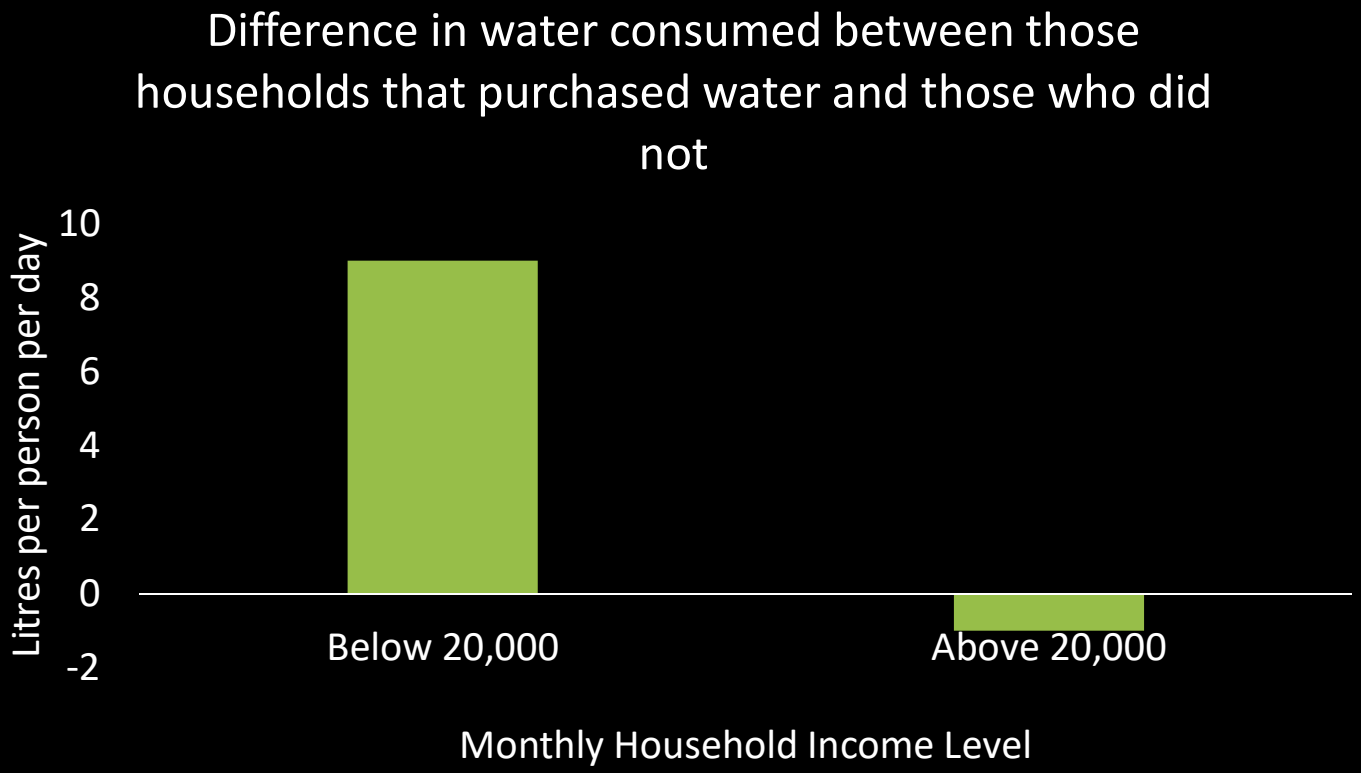
Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=1050); Asking persons for their own estimates of consumption began from 2019. Excludes responses from people who said they did not know how much water they used.

One reason for this could be the type of toilet – households with flushable toilets consumed more water.



Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=1050); Excludes responses from people who said they did not know how much water they used. The type of toilet used was not covered in the version of the survey done in 2018.

Income played an important role in modulating the water consumption of those who purchased water.

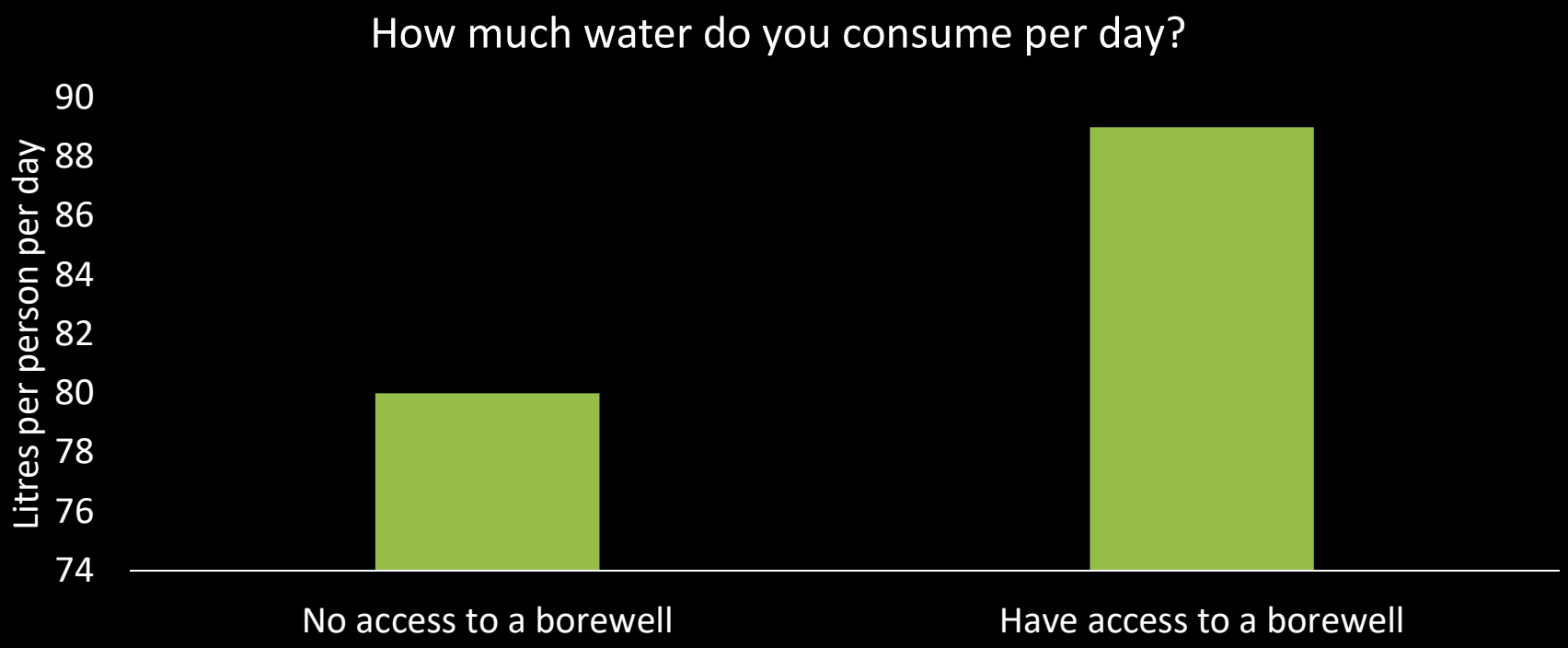


For the poor, buying expensive tanker water translated to using less water, while for those above an income threshold, buying water did not appear to alter their water consumption.

Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=1990); Excludes responses from people who said they did not know how much water they used.

Education levels correlated with income levels, making dicing out the separate influences challenging. However, we did find that for those at a given level of education, a higher income translated to higher consumption.

Those with borewells consumed more water



Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=1050); Excludes responses from people who said they did not know how much water they used.

Rising demand will make Madurai water-insecure

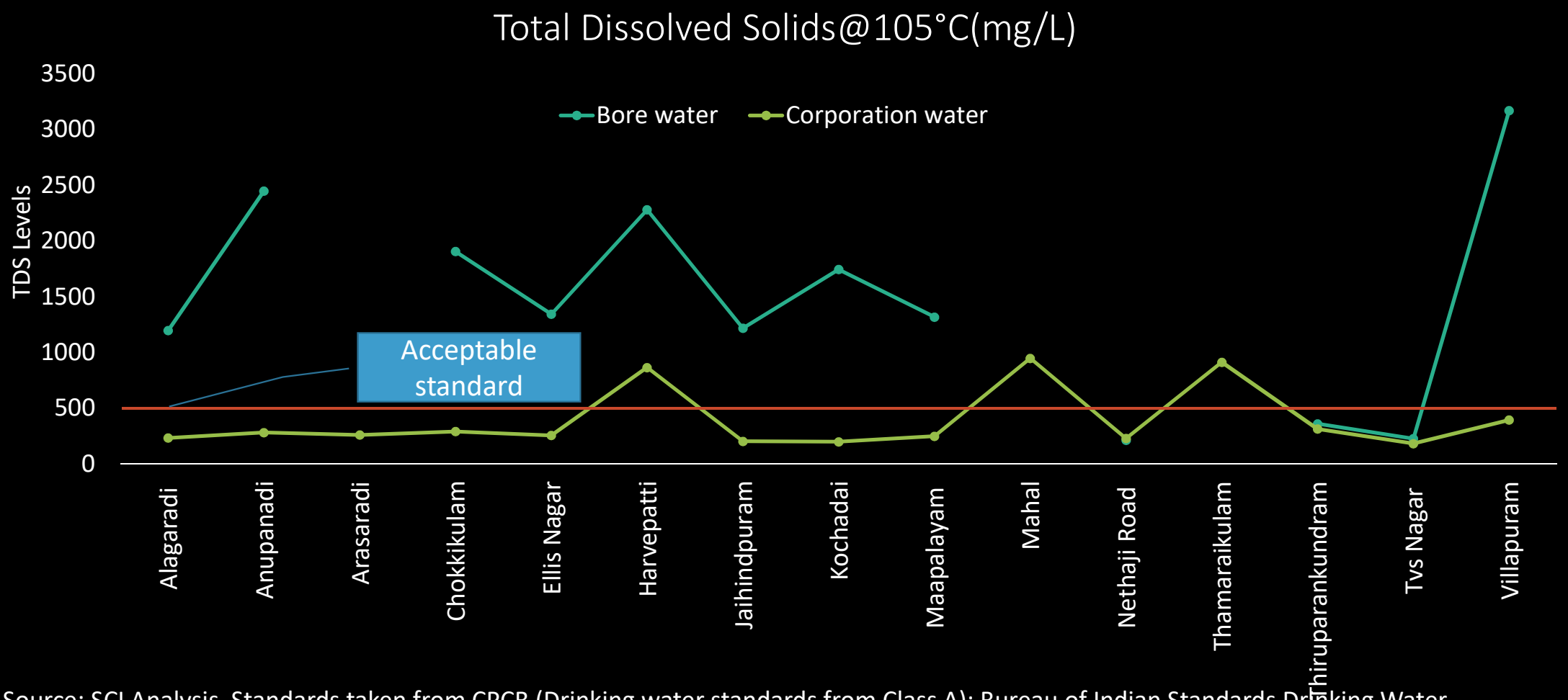
- Our data suggests that as more people install toilets within their homes (especially those with flushes), Madurai's water demand will rise, possibly by about 20-30%.
- Today, the average person in our survey consumes about 90 litres of water per day, much less than the 135 litres per day per person required by the Bureau of Indian Standards.
- As incomes grow, and more households install flushable toilets and washing machines in their homes, even with the new water scheme, Madurai may remain water-insecure. This is likely true for every city in India.

Source: Sundaram Climate Institute Waste & Water Survey 2018-21

What about water quality?

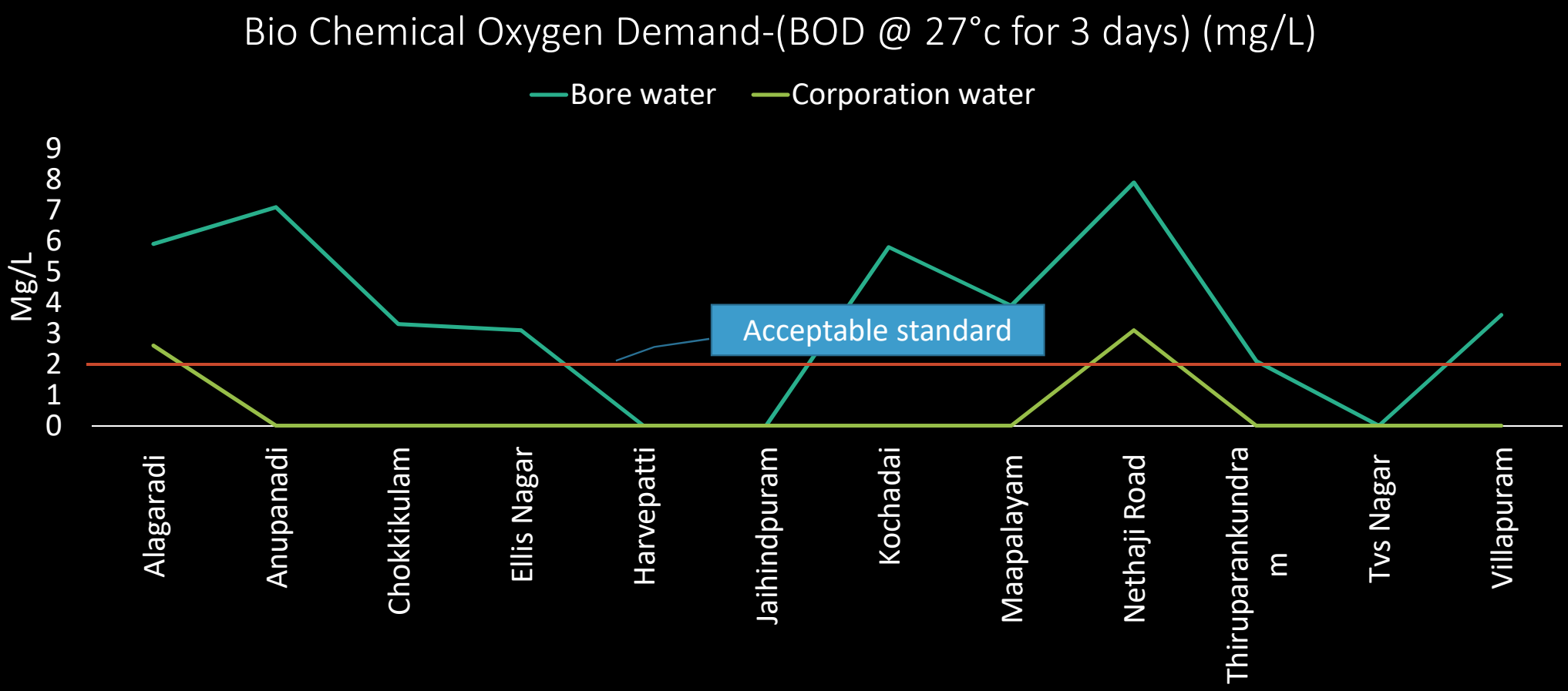
While most samples we drew from corporation supply in select wards conformed to basic parameters of pH, total dissolved solids and BOD (a measure of biological contamination), many bore water samples we drew did not. Since households used a combination of water for their needs, this does present a problem.

While most corporation water samples conformed to drinking water quality, most borewater samples did not.



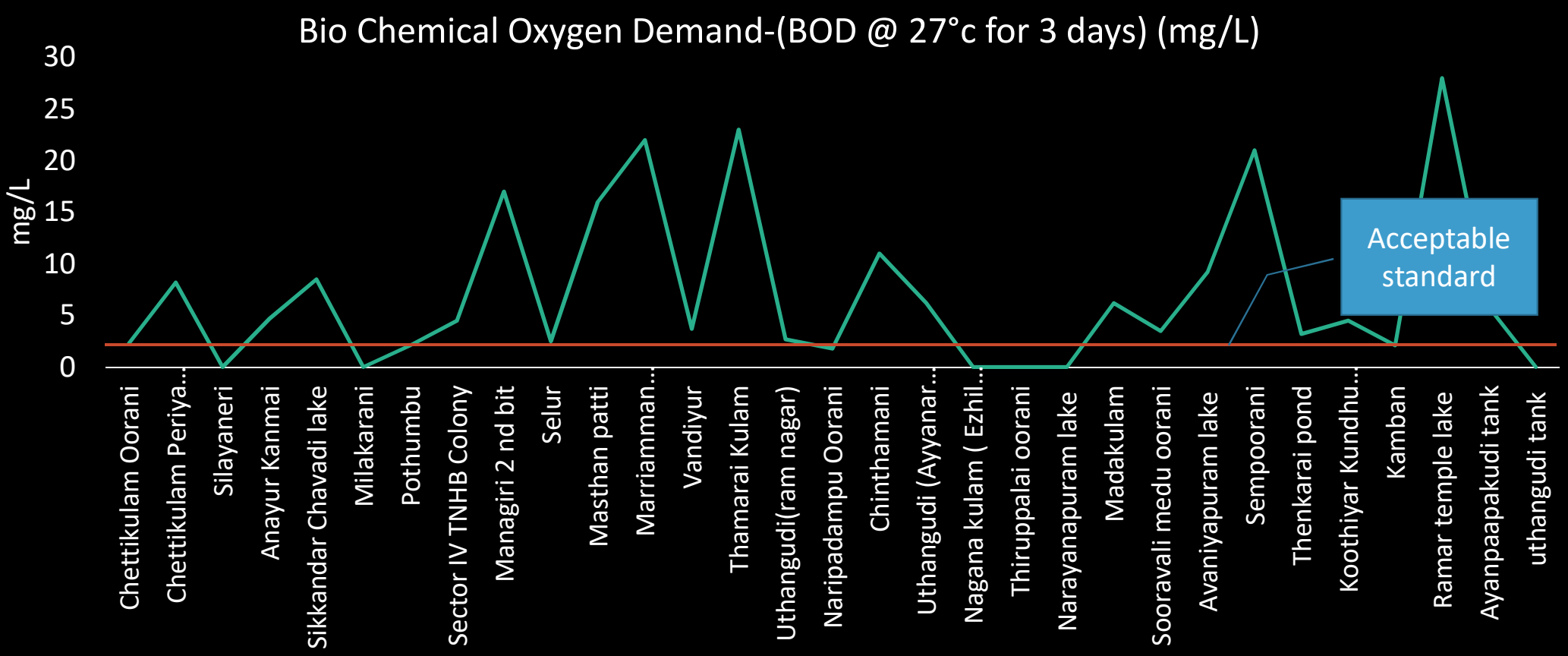
Source: SCI Analysis, Standards taken from CPCB (Drinking water standards from Class A); Bureau of Indian Standards Drinking Water Standard IS10500; Samples were drawn from corporation pipes in the select wards or from bore water from select wards.

While most corporation water samples conformed to drinking water quality, borewater samples did not.



Source: SCI Analysis, Standards taken from CPCB (Drinking water standards from Class A); Bureau of Indian Standards Drinking Water Standard IS10500; Samples were drawn from corporation pipes in the select wards or from bore water from select wards.

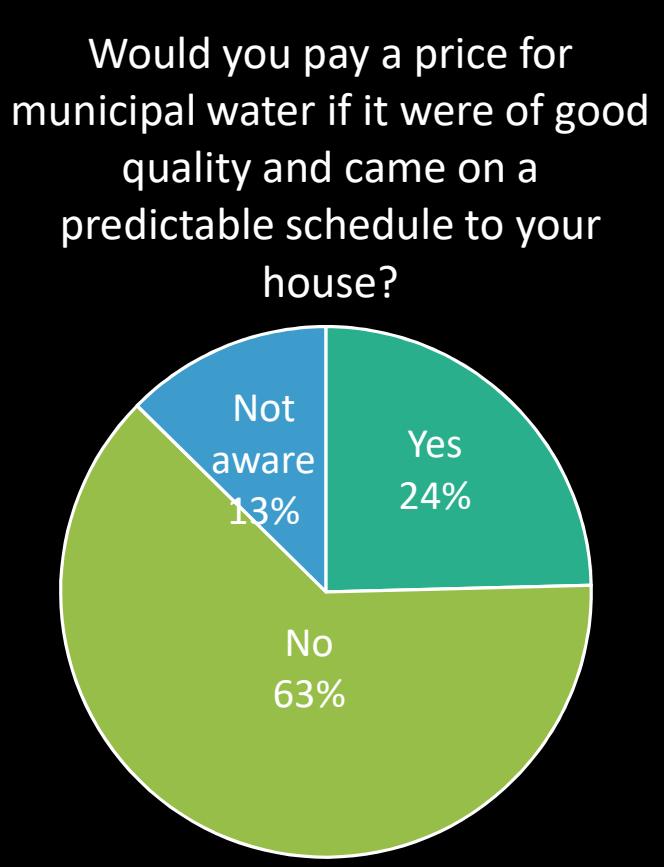
However, the quality of the water in most tanks in our study failed to meet drinking water quality standards.



Source: SCI Analysis, Standards taken from CPCB (Drinking water standards from Class A); Bureau of Indian Standards Drinking Water Standard IS10500; Samples were drawn from select water tanks

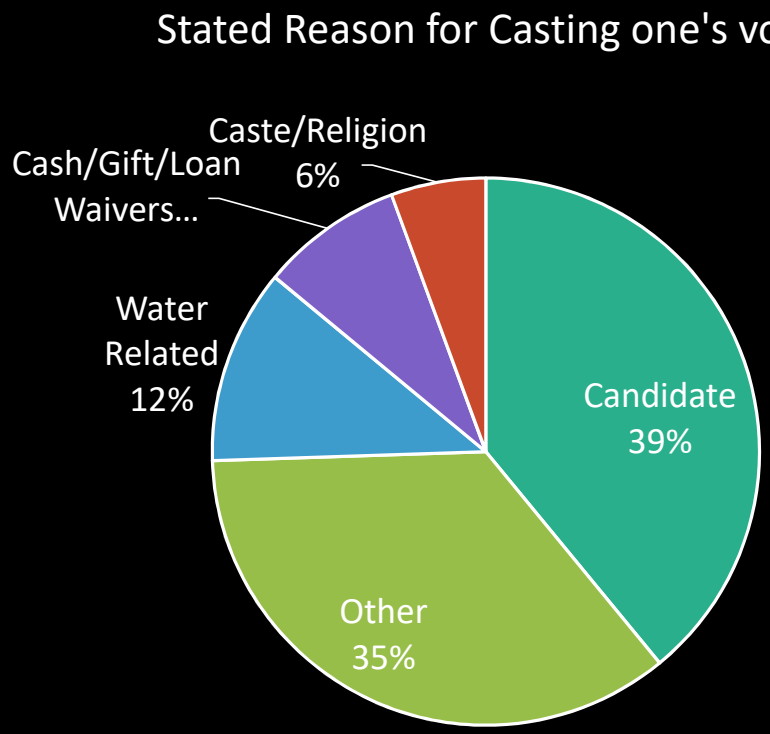
To supply a higher volume of treated water, the corporation needs to more money to cover higher running costs.

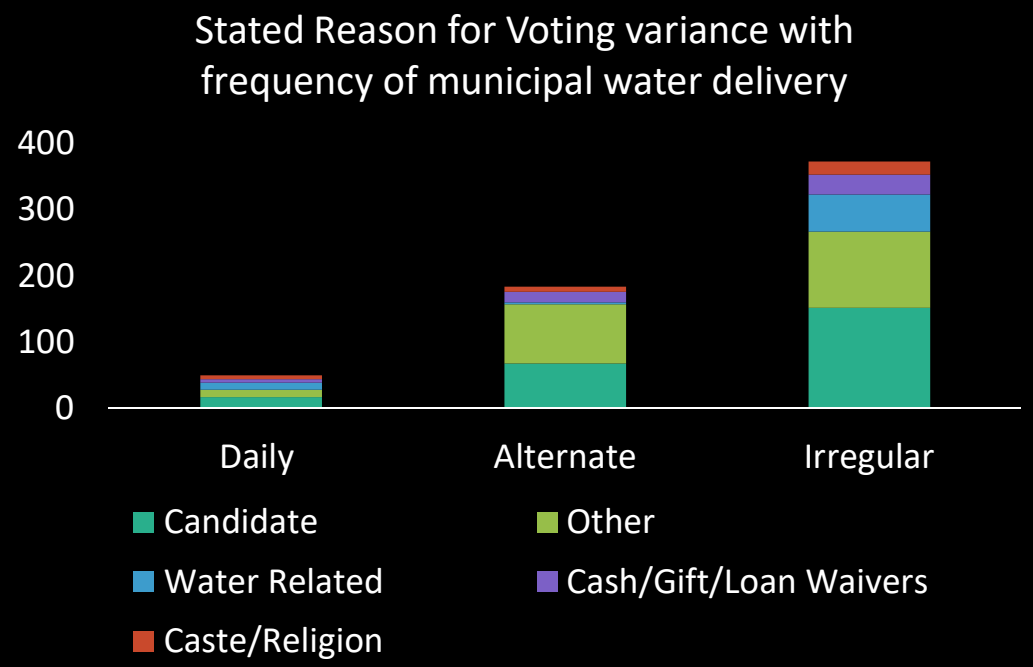
This is going to be difficult as most of the households we spoke to said that they were unwilling to pay for municipal water even if it came predictably and was of good quality.



Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=1118)

Moreover, water does not appear to be a critical voting issue. In 2019, in the midst of severe water crisis, we spoke to 947 persons on what they voted on. Water did not figure meaningfully as a voting reason.



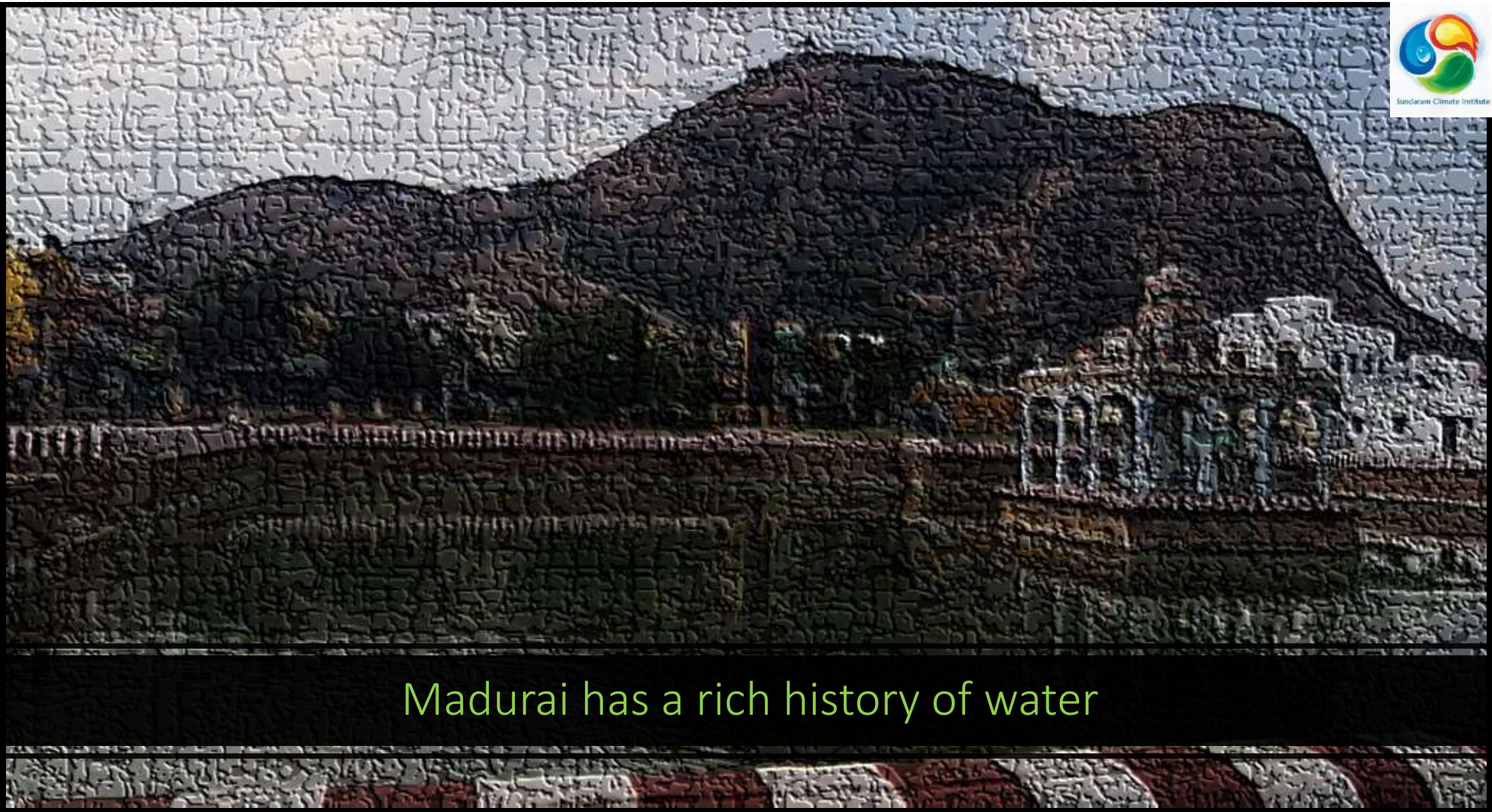


Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=947); 607 persons gave an answer.

Summary – Water use

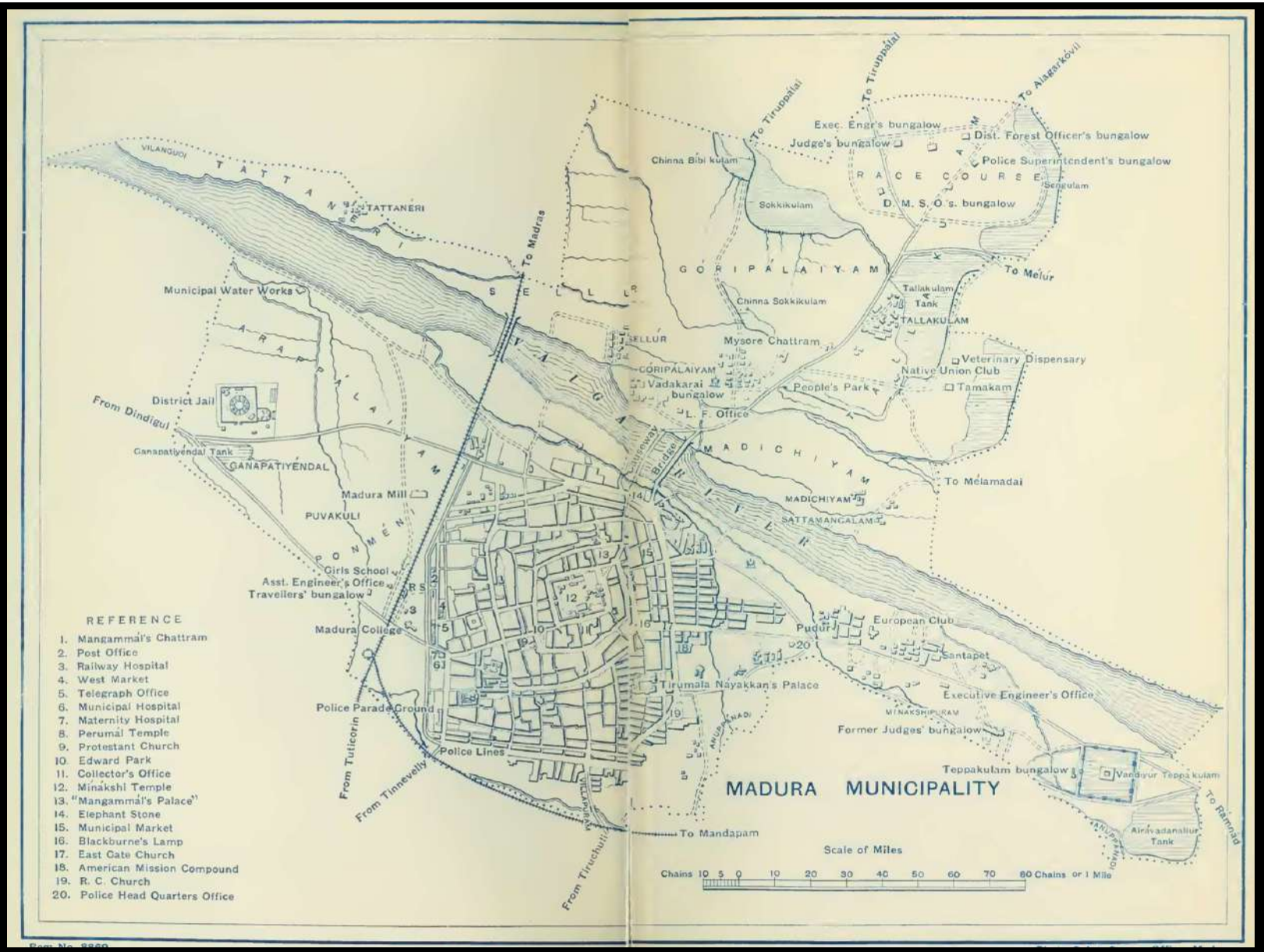
- Much of Madurai gets too little water in too uncertain a fashion. This is partly because of a lack of funds to invest in better water infrastructure.
- As demand rises, due both to rising populations and wealth, this demand-and-supply gap will widen especially during lean water months and during El Nino years.
- However, the public does not appear either to be supportive of paying for clean, regular water supply or voting on water issues. This presents a dilemma in how to bring about water management and must be kept in mind while crafting solutions.
- This dynamic of rising demand and volatile supply is a recurring theme across Indian cities.

Contents



Madurai has a rich history of water

Once, Madurai was a river fort city, endowed with the waters of two rivers – the Vaigai and the smaller Krithumala, which acted as a moat.



Source : Map of Madura Municipality – 1906 - W. Francis ICS, Madura district Gazetteers – 1906

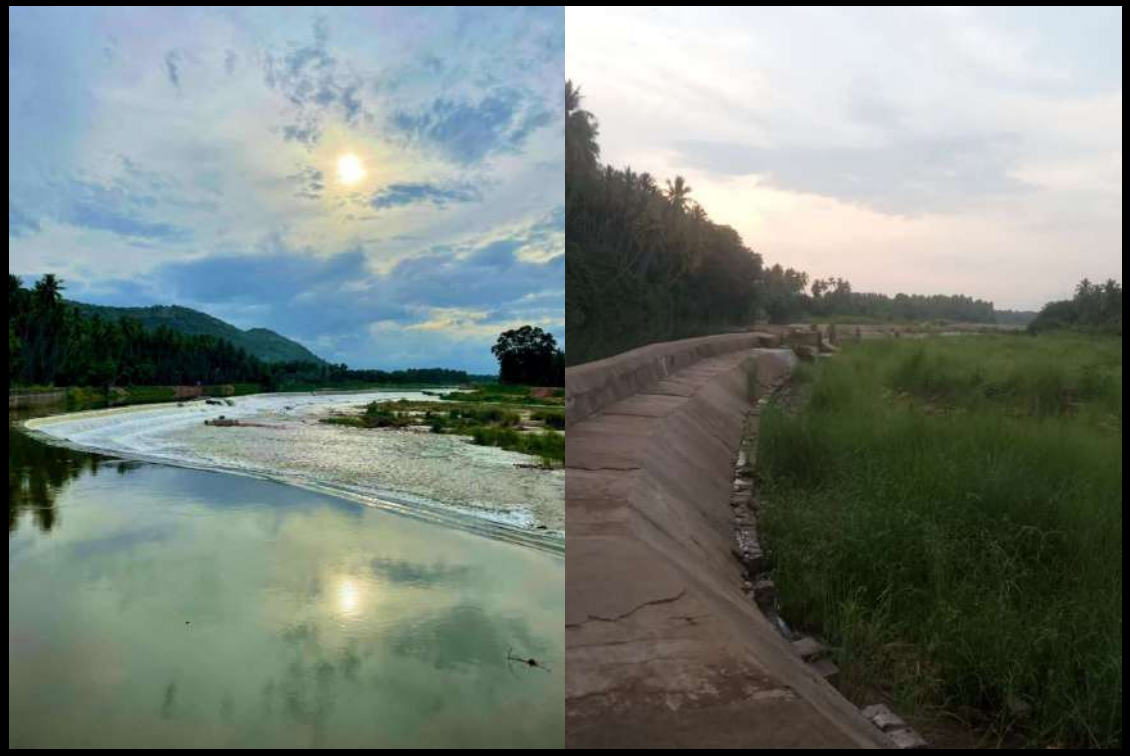
There are various lines of evidence suggesting that water was highly respected in ancient India. We found archaeo-epigraphical, literary, linguistic, societal and cultural evidence to support this point of view.

Sundaram Climate Institute

Archaeological & Epigraphical evidence: The Sitranai

The Sitranai is thought to be an 8th century granite check dam built across the Vaigai River. 12th century inscriptions say that Pandya kings had constructed these check dams to divert the water into channels and thence to the tanks. For instance, Parakrama Pandian constructed the Sitranai to divert river water into a system of tanks to supply Madurai. He built the dam using granite quarried from a nearby hill as per an inscription found in the Kuruvithurai Perumal Temple.

During times of low water flow in the river, the Sitranai diverts water into the channel system, while during the high flow times, water flows over the dam into the main body of the river. The crescent shape, and position prevent siltation behind the dam. This dam shows that early Tamil rulers understood the seasonality of India's waters and the silt distribution processes of river systems.



Source : 'The history of water management', The Hindu, 2015. Communications with Dr Srinivas Veeravalli, 2022.

Literary Evidence: Thiruvilaiyadal and the legendary importance of water management

Madurai revolves around the Meenakshi Amman temple. One of the temple legends is of a time when the Vaigai was in spate, and the city was in danger. Echoing the collective nature of water maintenance, the king ordered each family to help in building a massive bund to guard the city. One old woman, Vanthiammai, a rice cake seller, lived alone and was physically unable to help with construction. She offered her *puttu* to any able-bodied man in exchange for helping her. But no one came forward.

Finally, Lord Shiva assumed the form of a young man and came to help her. The trickster that he was, Shiva ate the *puttu* but dozed off at the work site. The king discovered him loafing off and had him beaten with a cane. Legend has it that every Madurai citizen felt the blow. A festival based on this story is celebrated in August every year, as a regular reminder that even the gods are subject to the laws of water and its management.

Yet another testament to water’s high status in ancient Tamil Nadu is the rich water vocabulary and numerous roles dedicated to water.

Linguistic Evidence: Ancient Tamilians had a Rich Water Vocabulary that shows their understanding of water.

1. அகழி - Moat
2. அருவி – Waterfall
3. ஆழிக்கிணறு – Well in Seashore
4. ஆறு - River
5. இலஞ்சி -Reservoir
6. உறைகிணறு – Ring well
7. ஊரணி – Drinking water tank
8. ஊற்று - Spring
9. ஏரி – Irrigation tank
10. ஓடை – Brook
11. கட்டுக்கிணறு – Built Well
12. கடல் – Sea
13. கண்மாய் -Irrigation tank (Pandya kingdom for ஏரி)
14. கலிங்கு – Sluice with many vent ways
15. கால்வாய் – Channel
16. குட்டை – Small pond
17. குட்டம் – Tank suitable for cattle to bathe in
18. குண்டம் – Small pond
19. குண்டு – Pool
20. குமிழி - Rock with well
21. குளம் – Tank suitable for bathing
22. கூவம் – Tank with impurities
23. கூவல் - Hollow dug
24. கேணி – Large well
25. சிறை – Reservoir
26. சுனை – Mountain pool
27. சேங்கை -Tank with duck weed
28. தடம் – Beautifully constructed bathing tank
29. தனிக்குளம் - Tank surrounding temple
30. தாங்கல் – Irrigation tank
31. திருக்குளம் – Temple tank
32. தெப்பக்குளம் – Temple tank meant for festivals
33. தொடுகிணறு – Dug well
34. நடை கேணி – Large well with a steps on one side
35. நீராழி – Bigger tank with centre Mandapam
36. பிள்ளைக் கிணறு – Well on the middle of the tank
37. பொங்கு கிணறு – Well with spring
38. பொய்கை – Lake with lotus flower
39. மடு – Deep place in a river
40. மடை – Small sluice with single vent way
41. மதகு – Sluice with many vent ways
42. மறுகால் – Surplus water channel
43. வலயம் – Round tank
44. வாய்க்கால் – Small channel

Source : Velu Jeyaprakash, 'Understand the water', 2018. R Seenivasan Dhan Foundation, 'The Neerkattis The rural water managers', 2003. Verified with Saravanan Tamil Department Head Lakshmi School & Dr Chandran Civil Department, Thiagarajar College of Engineering


திருக்குளம் – Temple tank
ஊரணி – Drinking water tank
ஏரி – Irrigation tank
கண்மாய் – Irrigation tank


ஓடை – Brook
கால்வாய் – Channel
கலிங்கு – Sluice with many openings

Societal Evidence: Ancient Tamil Nadu had several roles dedicated to water management

Ruler (King) ->
(Irrigation Department)
மன்னர் - Mannar
(நீர்ப்பாசனத்துறை - Keerpasanathurai)

1. நீராணிக்கர்கள் - Neeralikararkal

Responsibilities

- ✓ River water Management
- ✓ Storing water in lakes
- ✓ Bringing water for Irrigation

2.நீர்க்கட்டியார் - Neerkatiyaar

Responsibilities

- ✓Safeguarding water in the lake
- ✓Managing Fishing
- ✓Transportation
- ✓Agriculture inside the lake during summer
- ✓Any activity related to the lake

3.குளத்து காப்பாளர்கள் - Kulathukaappalar

Responsibilities

- ✓ Controls encroachments on tanks and lakes

4. மடையர்கள் - Madaiyarkal

Responsibilities

- ✓ **Opening / Closing the sluices**

5. கரையார் - Karaiyaar

Responsibilities

- ✓ **Strengthening the bunds**

6.நீர் வெட்டியார் / நீர்பாய்ச்சி – Neer Vettiyaar / Neerpatchi

Responsibilities

- ✓Ensuring the lake's cleanliness
- ✓Chandelling water for irrigation

7. குளத்து பணியாளர் – Kulathu paniyalar

Responsibilities

- ✓ Maintenance of the lake
- ✓ Removing carrion and weeds

Source : Prepared partially from https://swarnaprashana.org/understand-the-water/; "The Neerkattis The rural water managers" by R Seenivasan Dhan Foundation

Ancient Water Management Roles - Neerkatiyaar

நீர்க்கட்டியார் - Neerkatiyaar

Responsibilities

✓Safeguarding water in the lake

✓Managing water distribution/rotation

✓Any activity related to the lake.

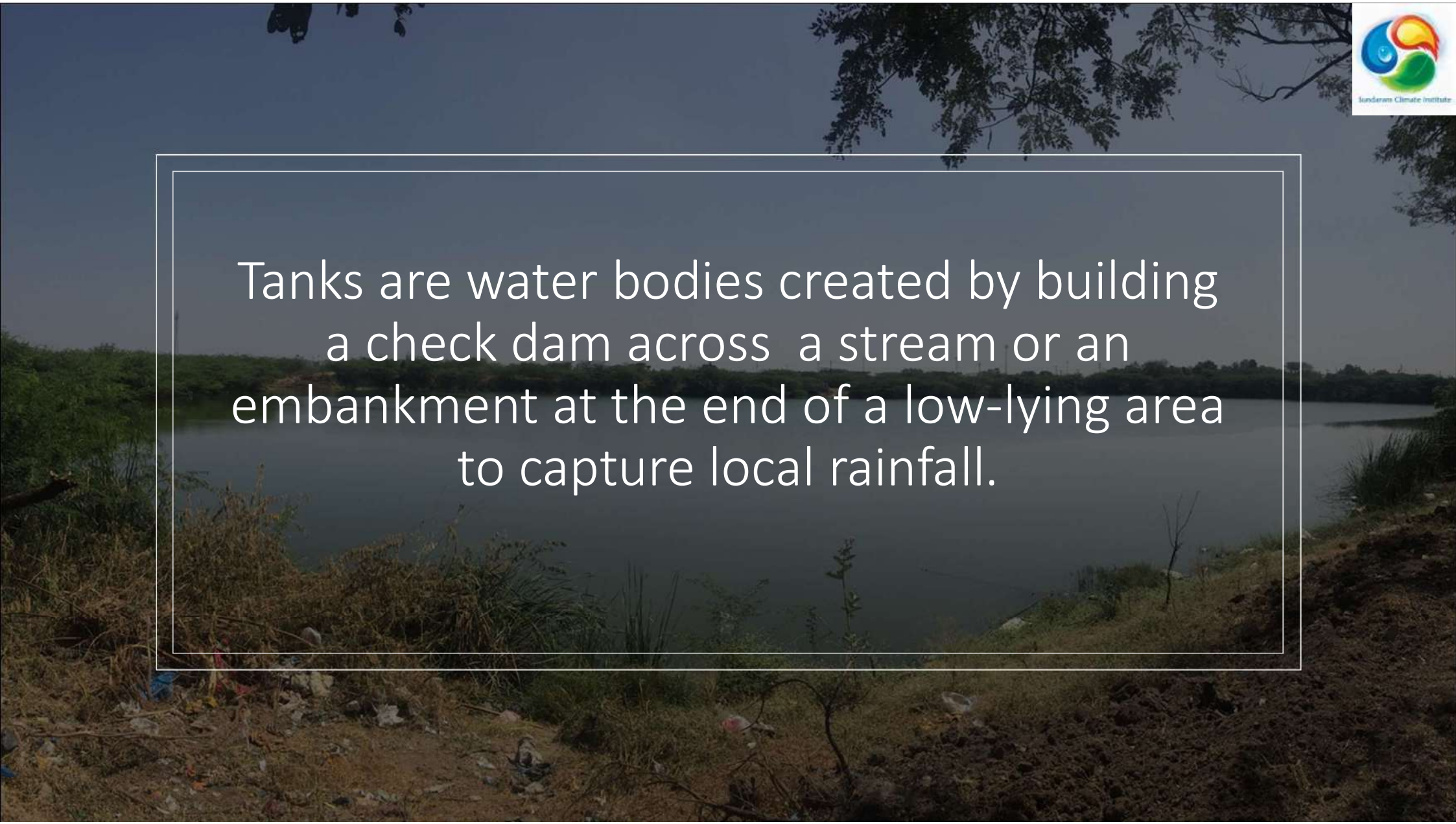
Source : Prepared partially from https://swarnaprashana.org/understand-the-water/; “The Neerkattis The rural water managers” by R Seenivasan Dhan Foundation

Cultural Evidence: Festivals revolving around water and tanks

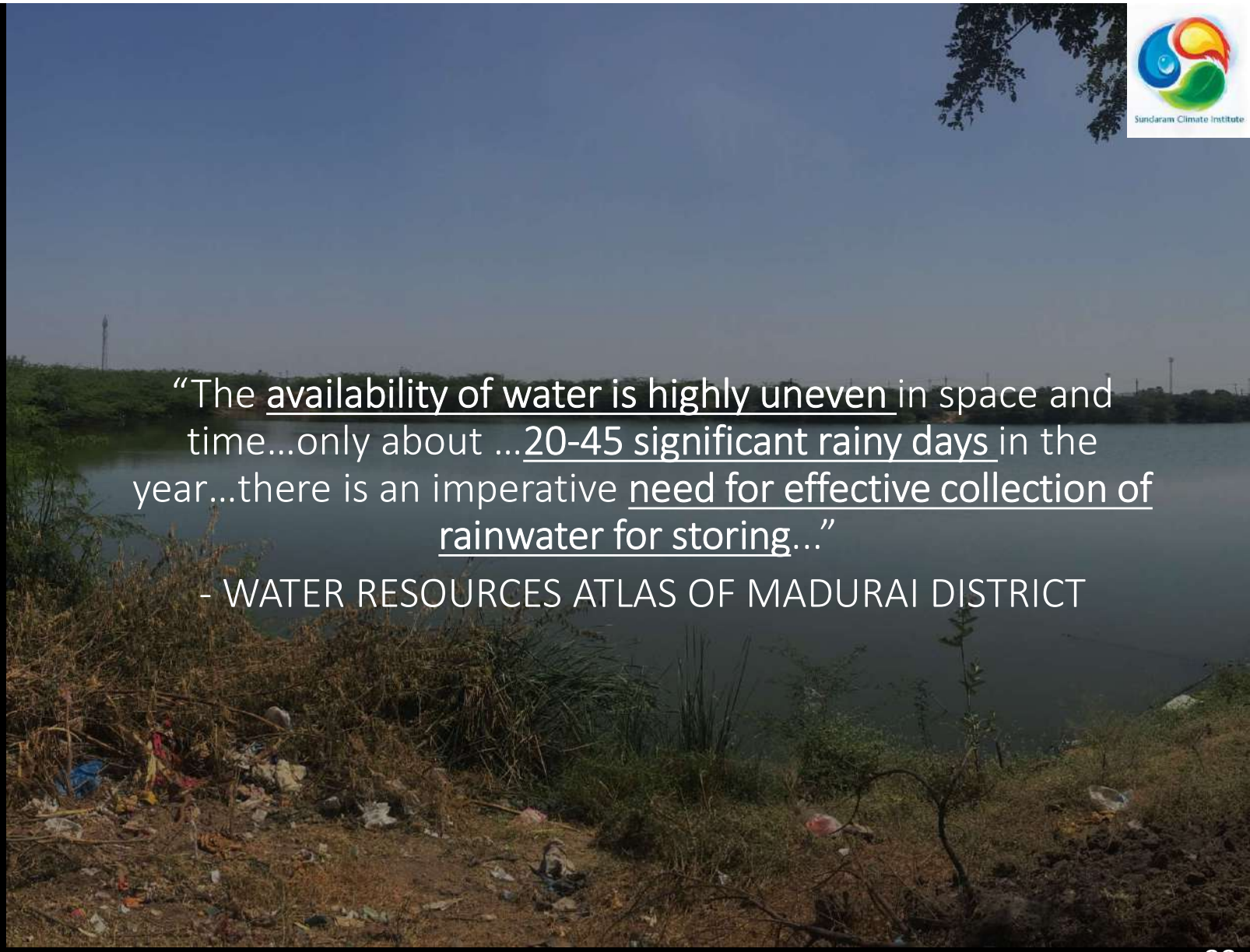
- Many traditional festivals celebrate water
- Aadi Perukku: Celebrated in early August with women and families welcoming the river water and praying for a bountiful harvest
- Teppam Thiruvizha: Usually associated with the processional dieties of temples celebrating the tank.
- Kanmai Azhithal/ Meen pidi thiruvizha: When the village gathers around the tank when the waters are at their low point to catch fish.
- 80 per cent of the tanks in our rural tank study were associated with temples. The temple festival and the status that it conferred was an important motivator for undertaking tank maintenance activities.

This understanding and respect for water translated to good management that made Madurai water resilient.

At the heart of water management lay the tank…


Tanks are water bodies created by building a check dam across a stream or an embankment at the end of a low-lying area to capture local rainfall.

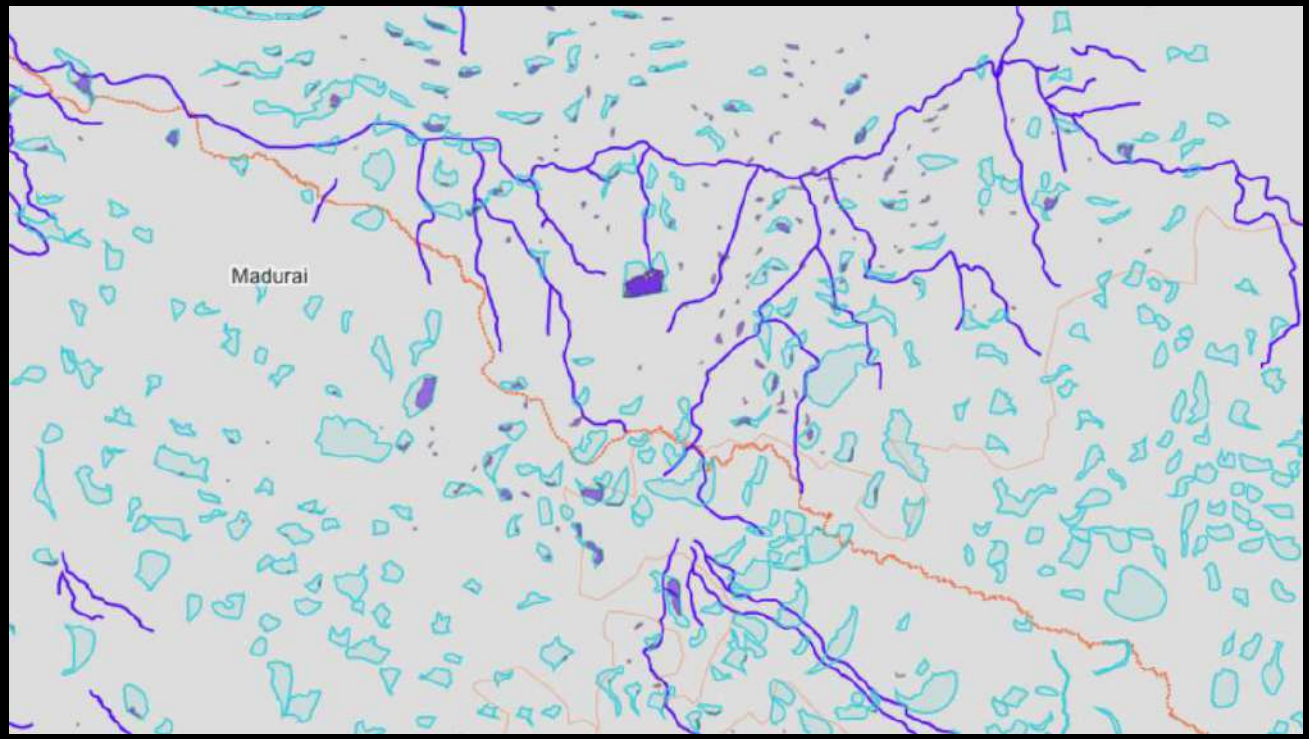
Why are tanks so important?



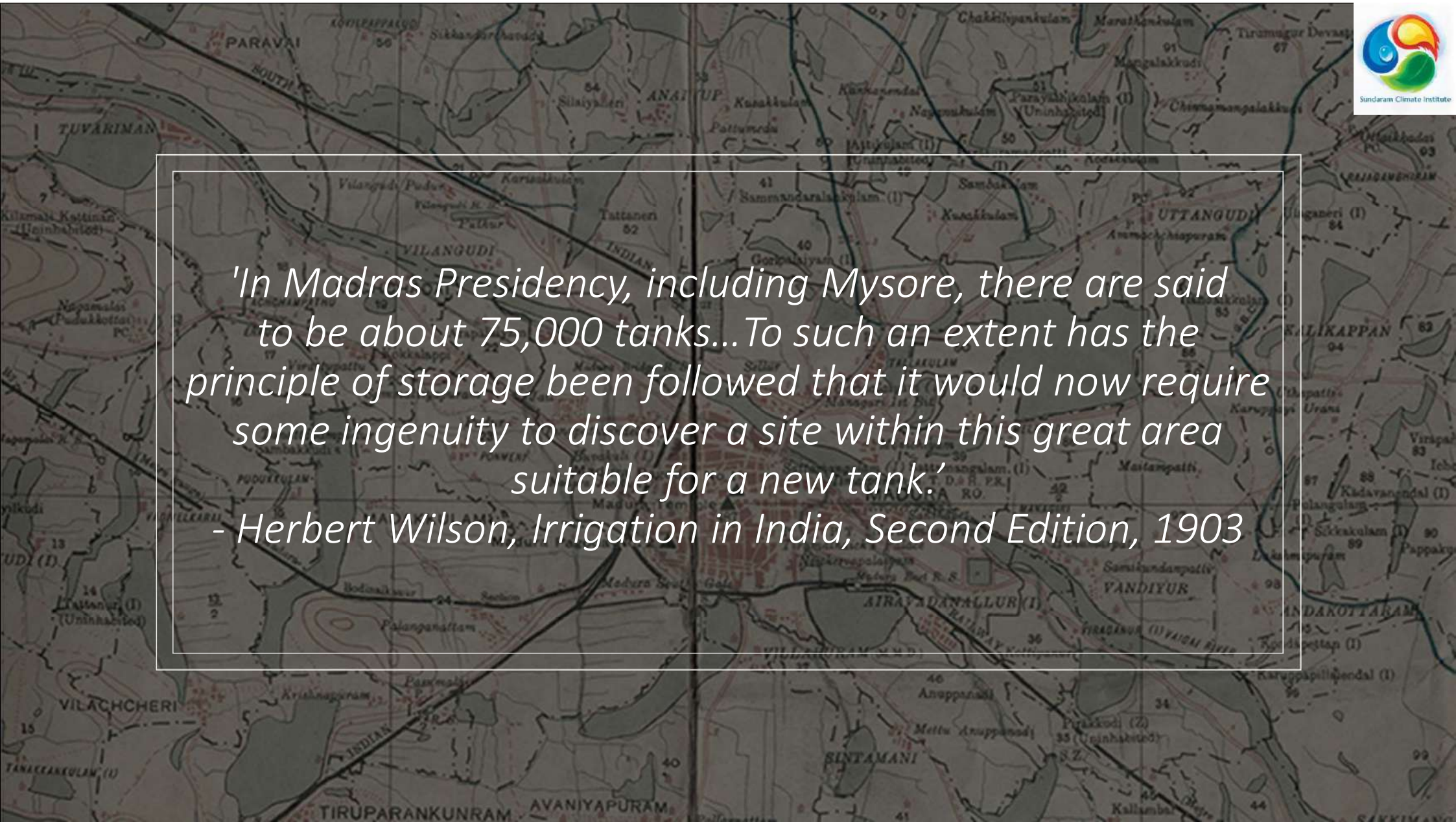
"The availability of water is highly uneven in space and time…only about …20-45 significant rainy days in the year…there is an imperative need for effective collection of rainwater for storing…"

- WATER RESOURCES ATLAS OF MADURAI DISTRICT

This is a satellite image showing Madurai's tanks. One can see that they are created based on a deep understanding of Madurai's watershed and its drainage.

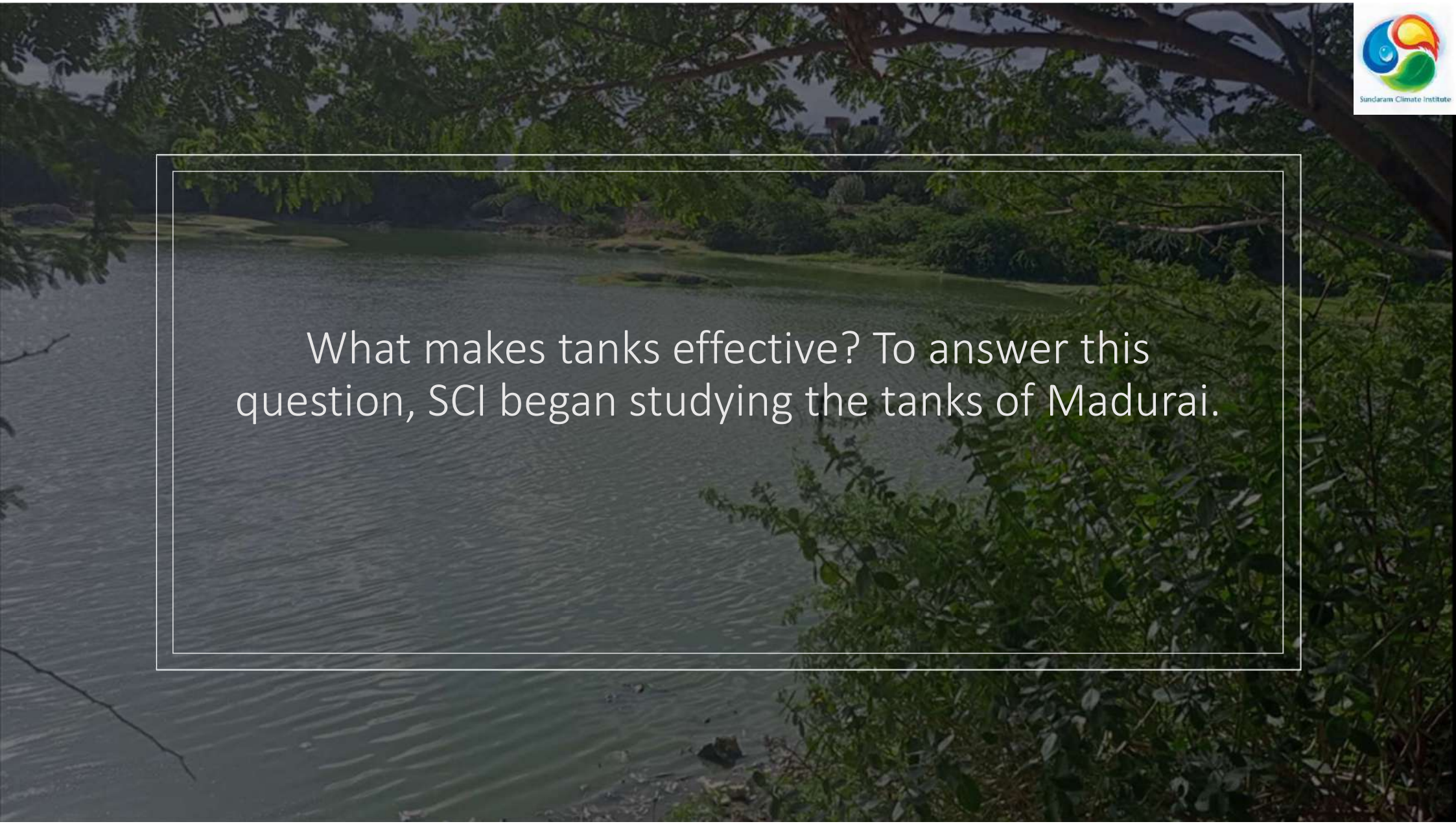


Source: Bhuvan Indian Geo-Platform for ISRO



'In Madras Presidency, including Mysore, there are said to be about 75,000 tanks…To such an extent has the principle of storage been followed that it would now require some ingenuity to discover a site within this great area suitable for a new tank.'

- Herbert Wilson, Irrigation in India, Second Edition, 1903

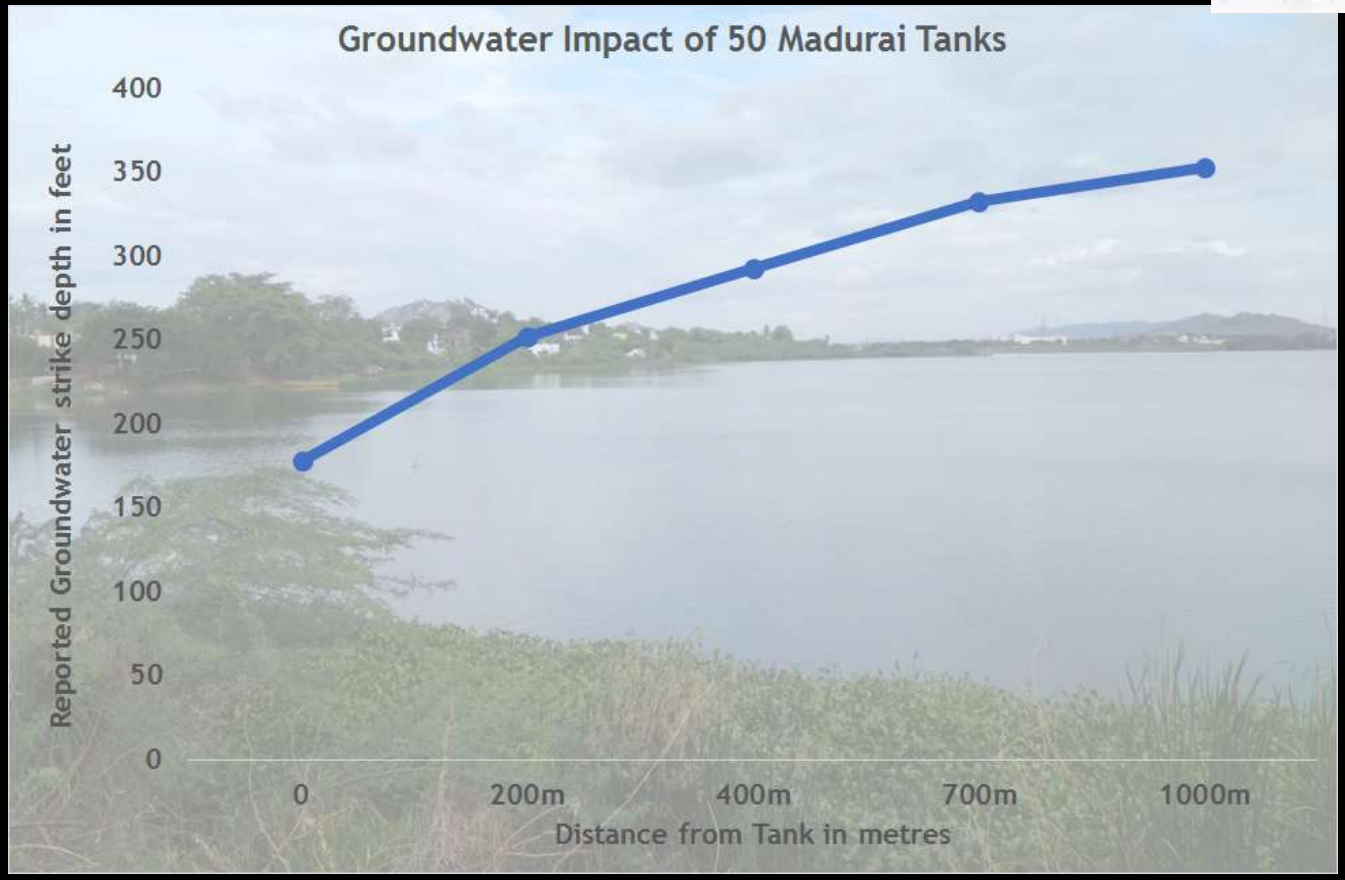

What makes tanks effective? To answer this question, SCI began studying the tanks of Madurai.

The SCI Madurai Tank Study

- SCI conducted a number of studies to understand the dynamics around tanks better: we began by understanding the social dynamics around tanks by interviewing the different stakeholders around a set of 29 rural tanks. We then asked whether tanks recharged groundwater?
- To answer this, we shortlisted 50 tanks and began by reviewing the existing literature.
- Our team made multiple visits to each tank. Often finding a tank involved quite a bit of detective work: because many were little more than empty pieces of land. We then
  - Crowdsourced groundwater data from thousands of people at preset distances around the tank in all directions.
  - Spoke to the community around the tank, to understand groundwater and private water dependence around a tank.
  - Tested the water quality of a tank.
  - Used satellite data to understand the seasonal water levels, land use patterns, urbanization levels, boundaries, encroachment, connectivity of a tank and ground-truthed the inlet condition, land use patterns and encroachments of a tank.
- We analyzed and synthesized our findings into a Tank Report Card and an Action Plan.

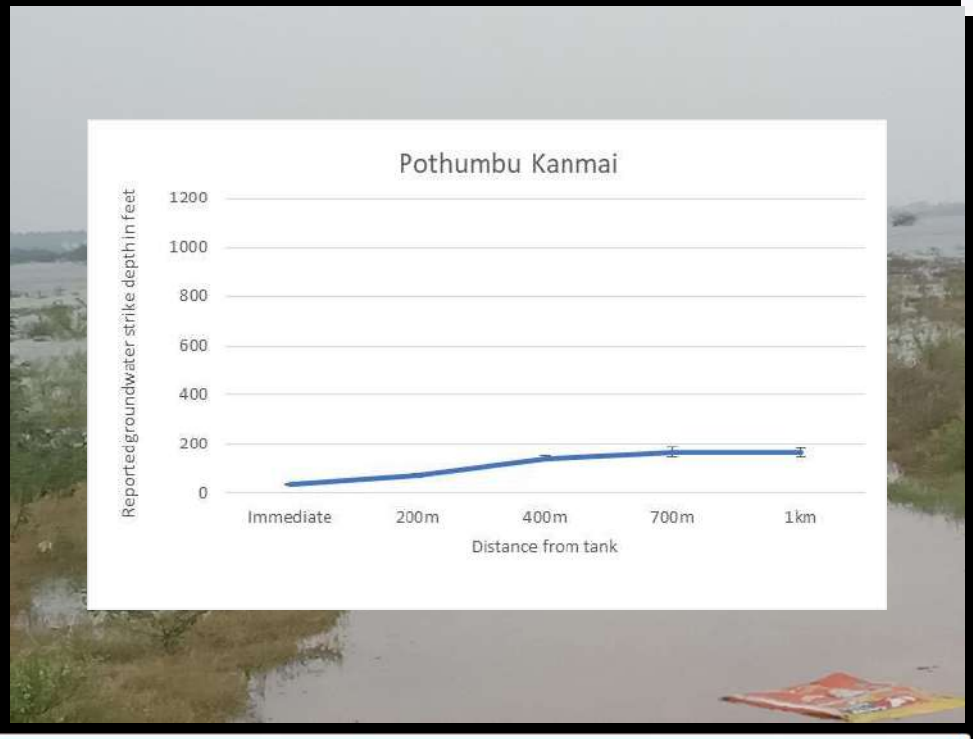
For each tank, we crowd-sourced groundwater levels at set distances (immediate vicinity, 100m, 200m, 400m, 700m & 1km) away from the tank in all directions. This meant 25 points per tank. At each point, we collected between 3-4 responses of groundwater depth.

Averaging these readings across the 50 tanks in our study, we found that tanks recharge water by up to 200 feet in their vicinity



Source: Sundaram Climate Institute Tank Study

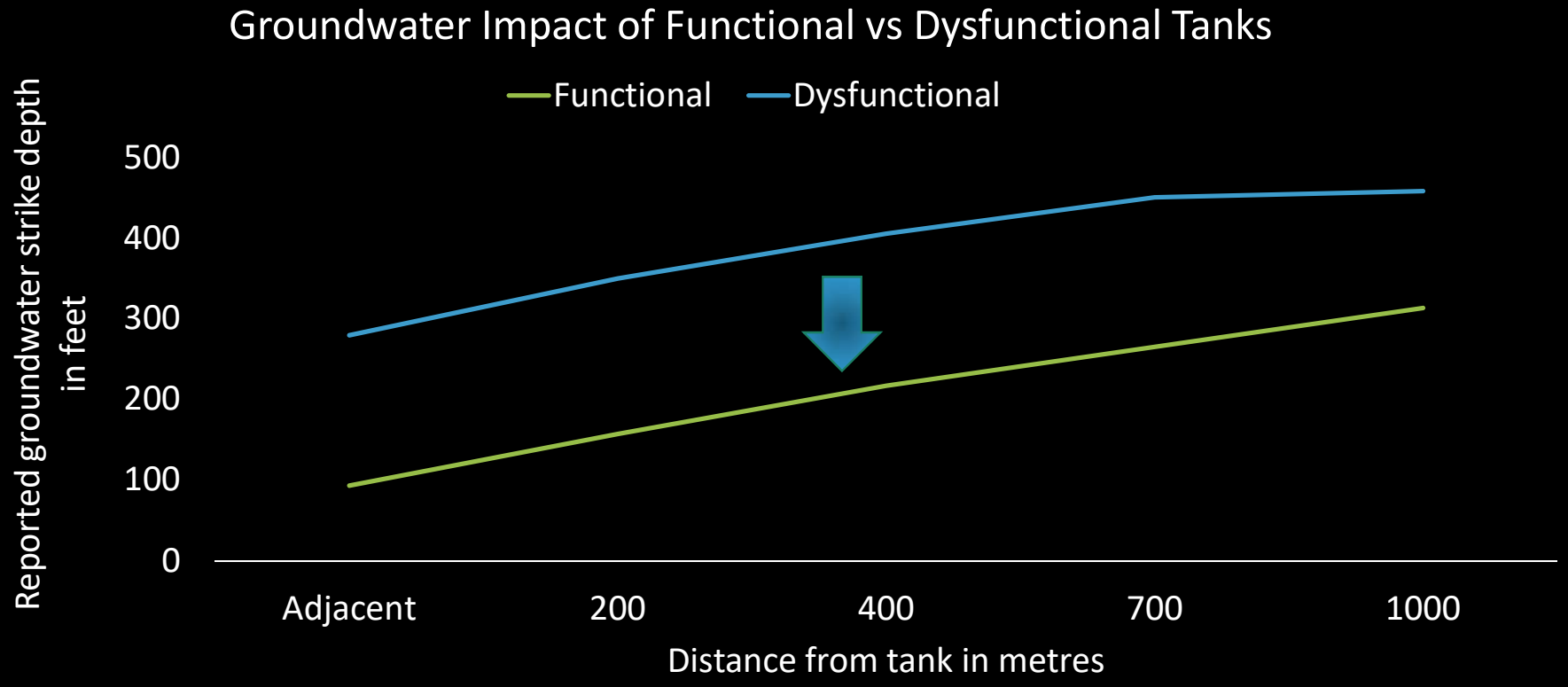
But…not all tanks are alike.



In some tanks, we found that the tank had little influence on adjacent groundwater levels, while in others groundwater levels were high (i.e., groundwater found at shallow depths) and remained higher still next to the tank. Clearly all tanks were not created the same. What made them different?

Source: Sundaram Climate Institute Tank Study

Our data showed that functional tanks kept groundwater levels replenished or higher by about 200 feet. This translated to a Rs.100 monthly savings for households living close to functional tanks while buying water.

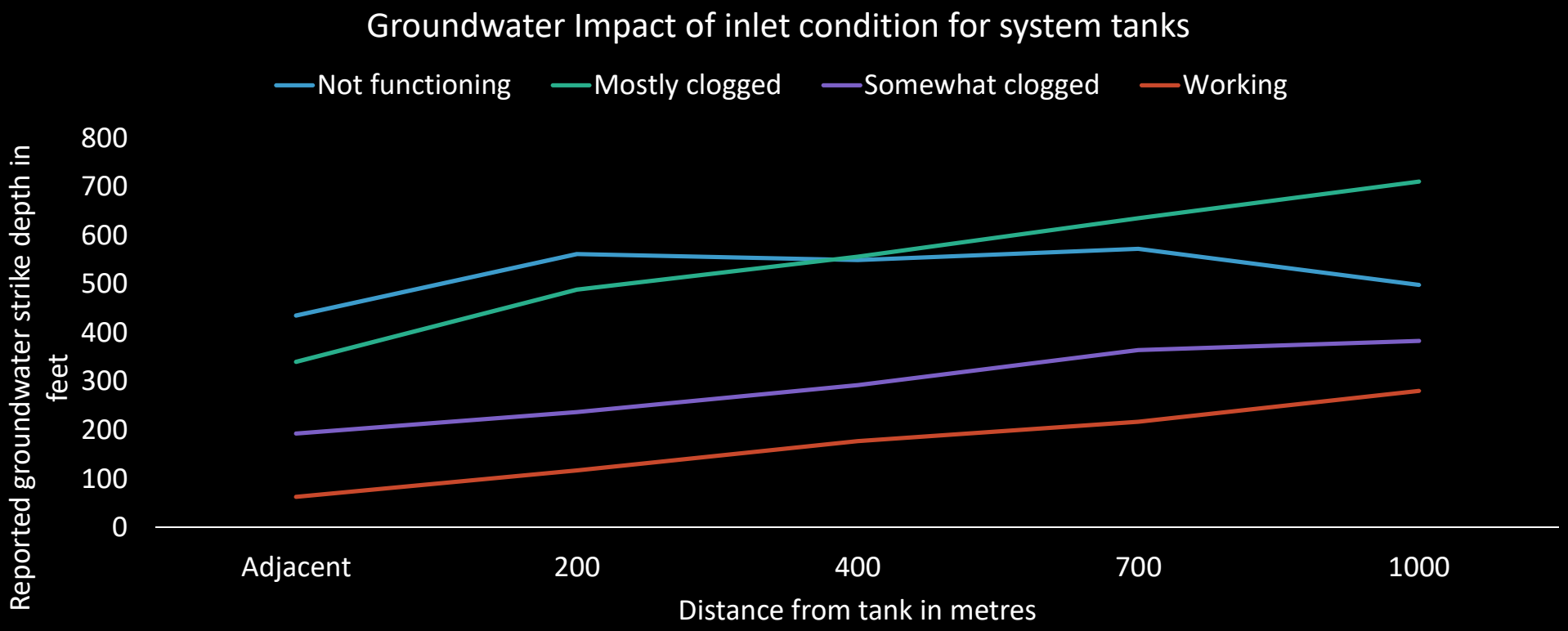


Source: Sundaram Climate Institute Tank Study; Sundaram Climate Institute Waste & Water Study 2018-2021 (n=2118).

What made a tank functional?

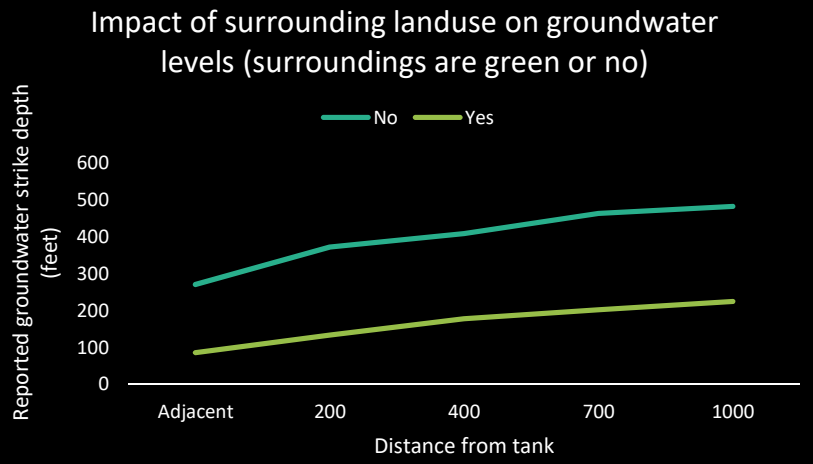
- While analysing how groundwater levels around a tank varied with different tank attributes, we found three attributes were particularly effective at explaining what made tanks functional.
  - System Presence (Clear and functioning inlet)
  - Land use pattern (more green the better)
  - Perenniality (number of months a tank holds water)
- When we probed deeper to ask what made drove performance across these attributes, we found that it was the involvement of the local community.

Functionality – System Presence



System tanks function as a system. They get their water mainly from non-local rainfall through rivers, streams and canals through their inlet. If that inlet, or feeder channel is clogged or encroached, the downstream tank suffers. This pattern was clearly visible in our study: tanks with working and unclogged inlets kept groundwater levels far higher in their surroundings.

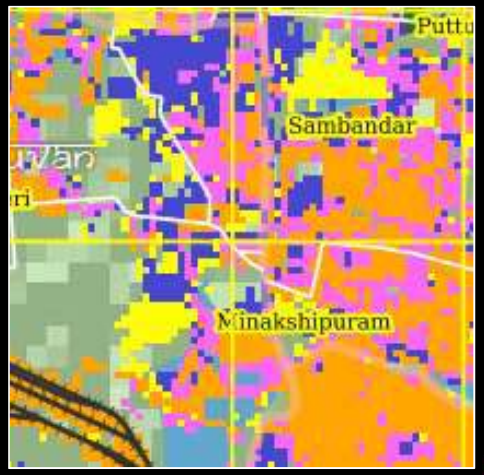
Functionality – Land-use pattern



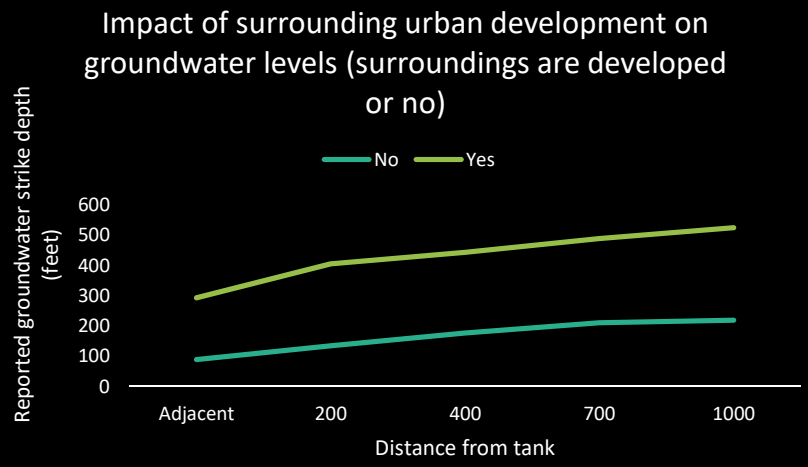
The land-use pattern around a tank has a significant impact on how groundwater patterns behave. To quantify this, we came up with an index, which we called a greenery index. We took an image of a tank and a one kilometre radius on Google Earth. We then divided that image into 25 segments, and looked at the land-use of each segment – we gave higher scores for segments with tree, grass or water cover, while giving lower scores to built up area. We then arrived at an average greenery index score for each tank by averaging the value of all 25 segments. The graph compares tanks with above average greenery index scores with below average green index scores. Tanks with 'greener' surroundings have groundwater levels that are 200 feet higher than those with less green surroundings. This makes sense, as greener surroundings allow for better infiltration of rainfall into the ground. The gap between the two types of tanks is narrowest adjacent to the tank, showing the impact of the tank on groundwater recharge.

Functionality – Land-use – Urban Development

No

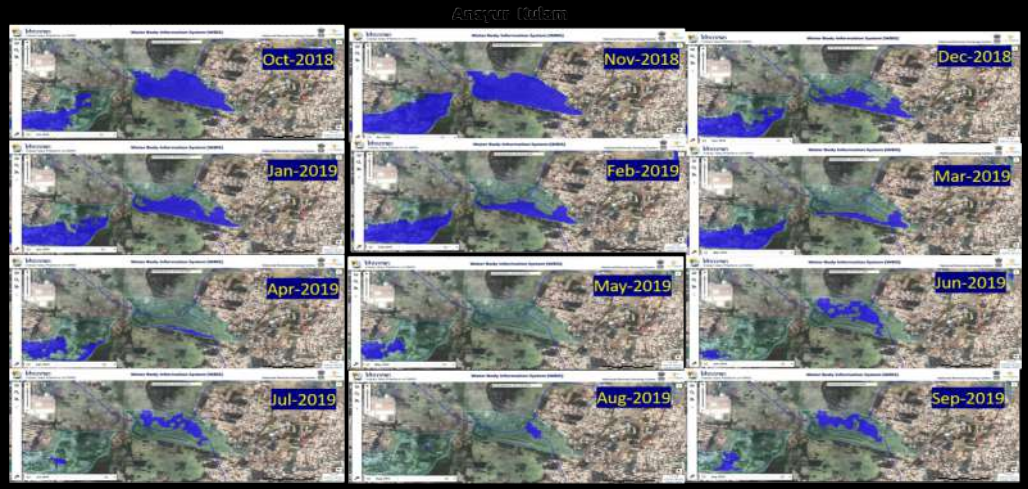


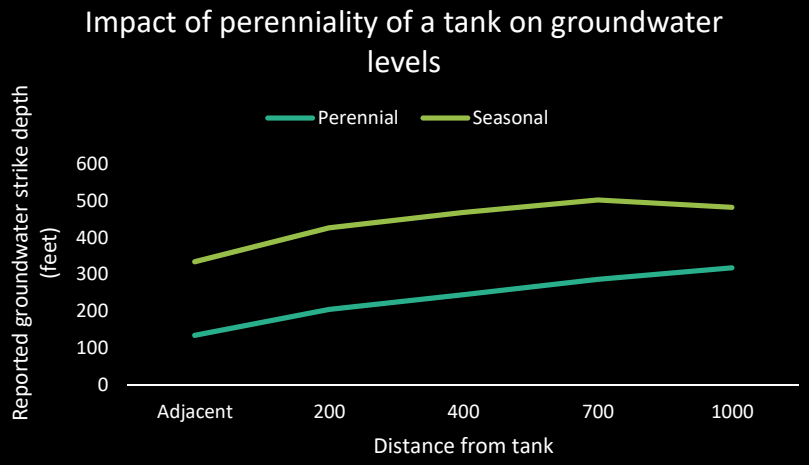
Yes



The degree of urban development around a tank also has a significant impact on how groundwater patterns behave. To quantify this, we came up with an index, which we called a urban development index. We took an image of a tank and a one kilometre radius on Bhuvan (Indian Geo-Platform for ISRO), which shows the level of urban development around a tank. We then divided that image into 9 segments, and looked at the development of each segment. We then arrived at an average urban development score for each tank by averaging the value of all 9 segments. The graph compares tanks with above average urban development scores with below average urban development scores. Tanks with more developed surroundings have groundwater levels that are 250 feet lower than those with less developed surroundings. This makes sense, as more developed surroundings means a greater demand for groundwater. The gap between the two types of tanks is narrowest adjacent to the tank, showing the impact of the tank on groundwater recharge.

Functionality – Perenniality – Water holding in a tank





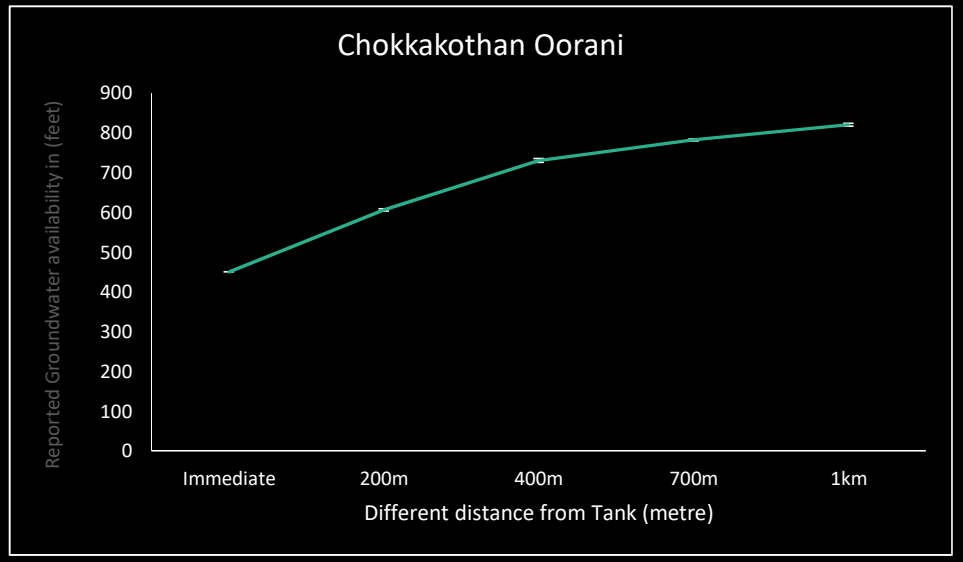
We found that the number of months a tank holds water has a significant impact on surrounding groundwater levels. To test this hypothesis, we took monthly snapshot images from Bhuvan of the water extent in a tank from October 2018 to September 2019. We then counted the number of months a tank held water. We used this number to classify the tank: if a tank held water from 6 or more months, we classified it as “perennial”, else “seasonal”. Perennial tanks keep groundwater levels about 200 feet higher than seasonal tanks.

Conversely, we also asked what made a tank vulnerable.

We found that a tank was particularly vulnerable to encroachment if

- The land value around it was very high
- It is was small
- It was dry
- It had little connection to the local community.

Example: The Chokkakothan Oorani



This water body falls within central Madurai, where land is scarce and highly valuable. It is largely dry, because all feeder channels have been encroached, and its Greenery index is low and its urban development index is high. Lastly, it was one of the smallest tanks in our study group, measuring just 0.11 hectares. This oorani is in imminent danger of disappearing. While the oorani did appear to recharge its groundwater, it appeared in imminent danger of being encroached and taken over.

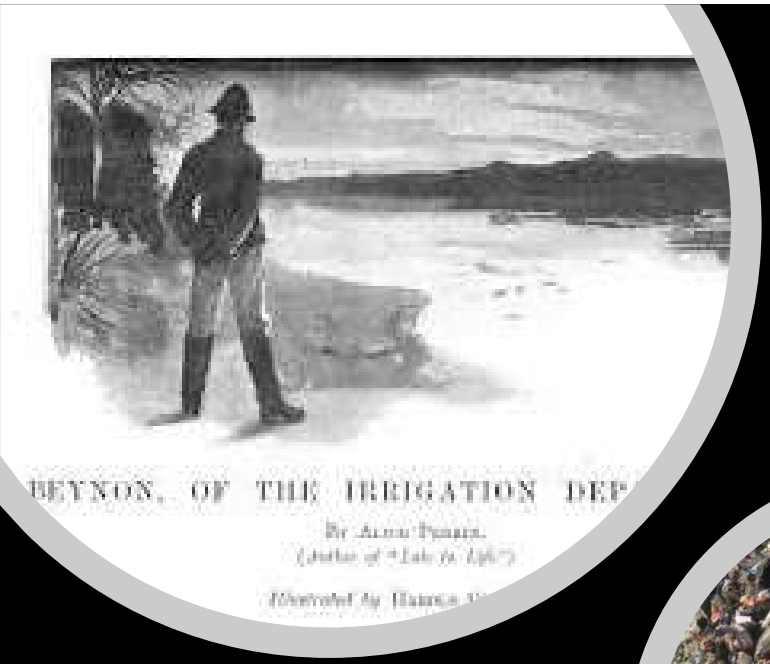
What lay beneath an unclogged inlet? One explanation is the involvement of the local community, who ensured the inlet remained clean, feeder channels were desilted, and the tank itself was free from encroachments.

We found that communities cherished their tank because the tank provided tangible benefits or was considered sacred.

Monetary benefits included irrigation water, cash flow from fishing and supporting livestock.

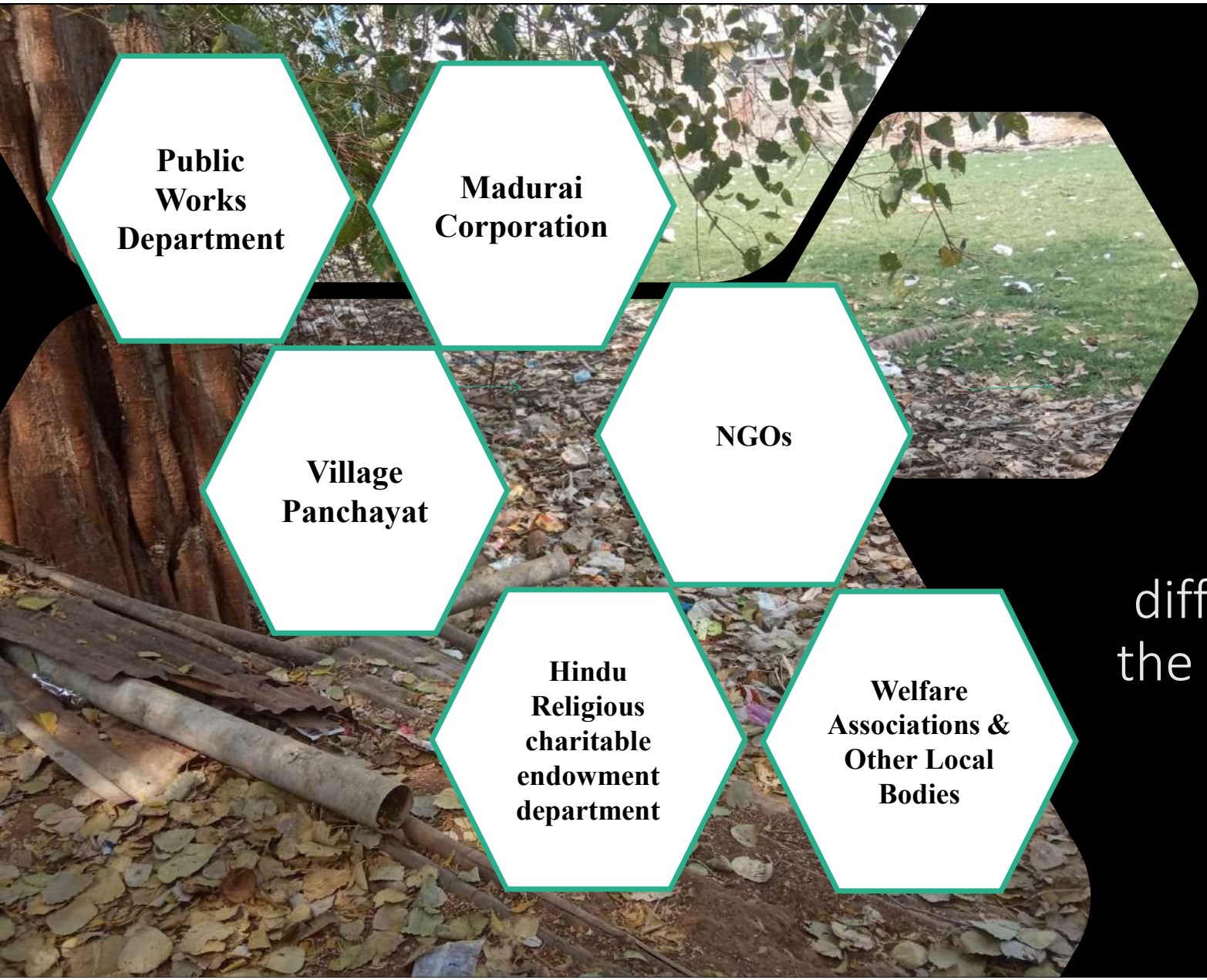
While non-monetary benefits included the status and rights conferred on those who shouldered responsibilities. *


Sadly, over time many tanks have become dysfunctional…



Three trends hastened the fall of tanks

1. Centralization of tank management
2. The rise of the borewell
3. Urbanization



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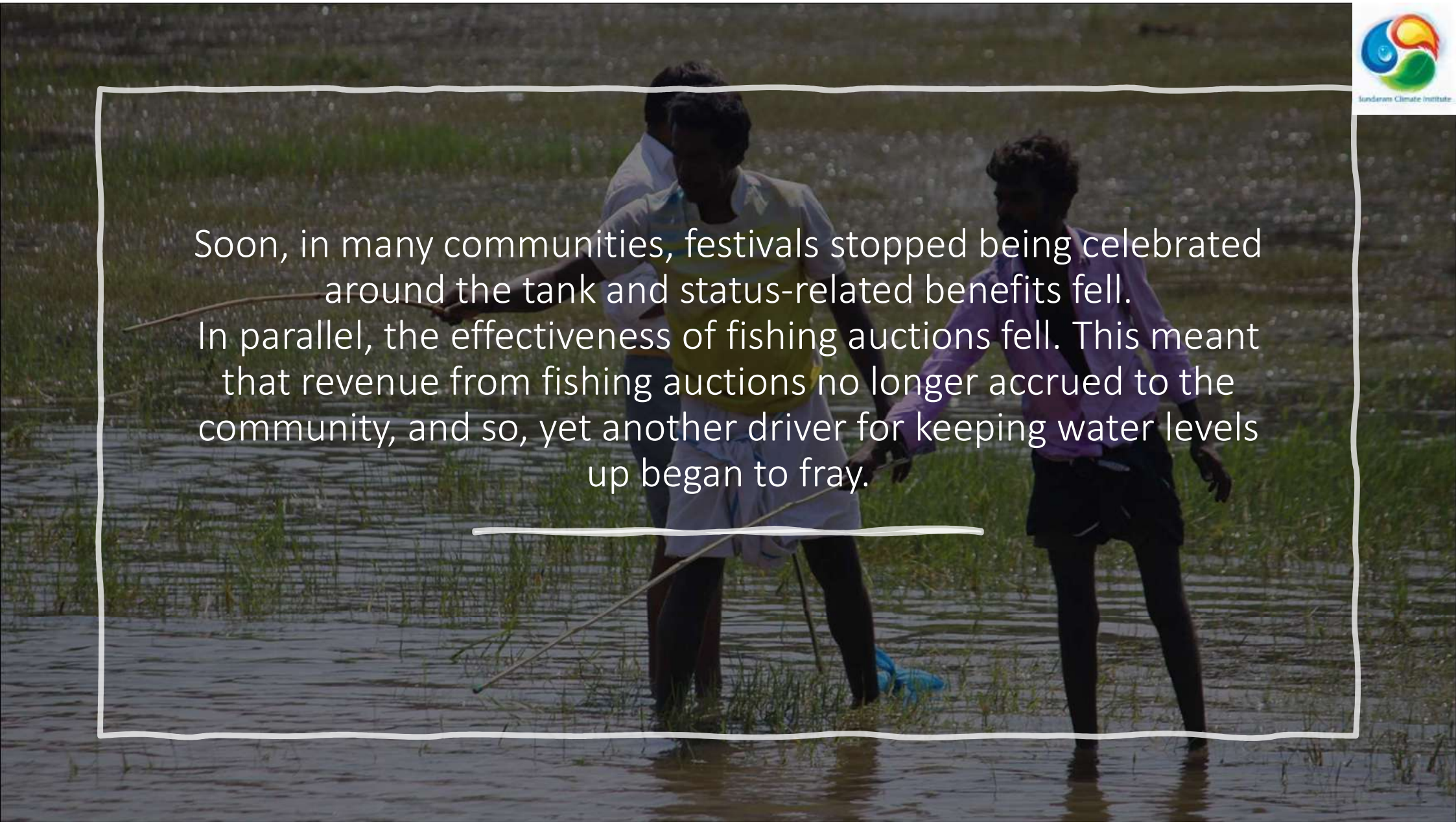
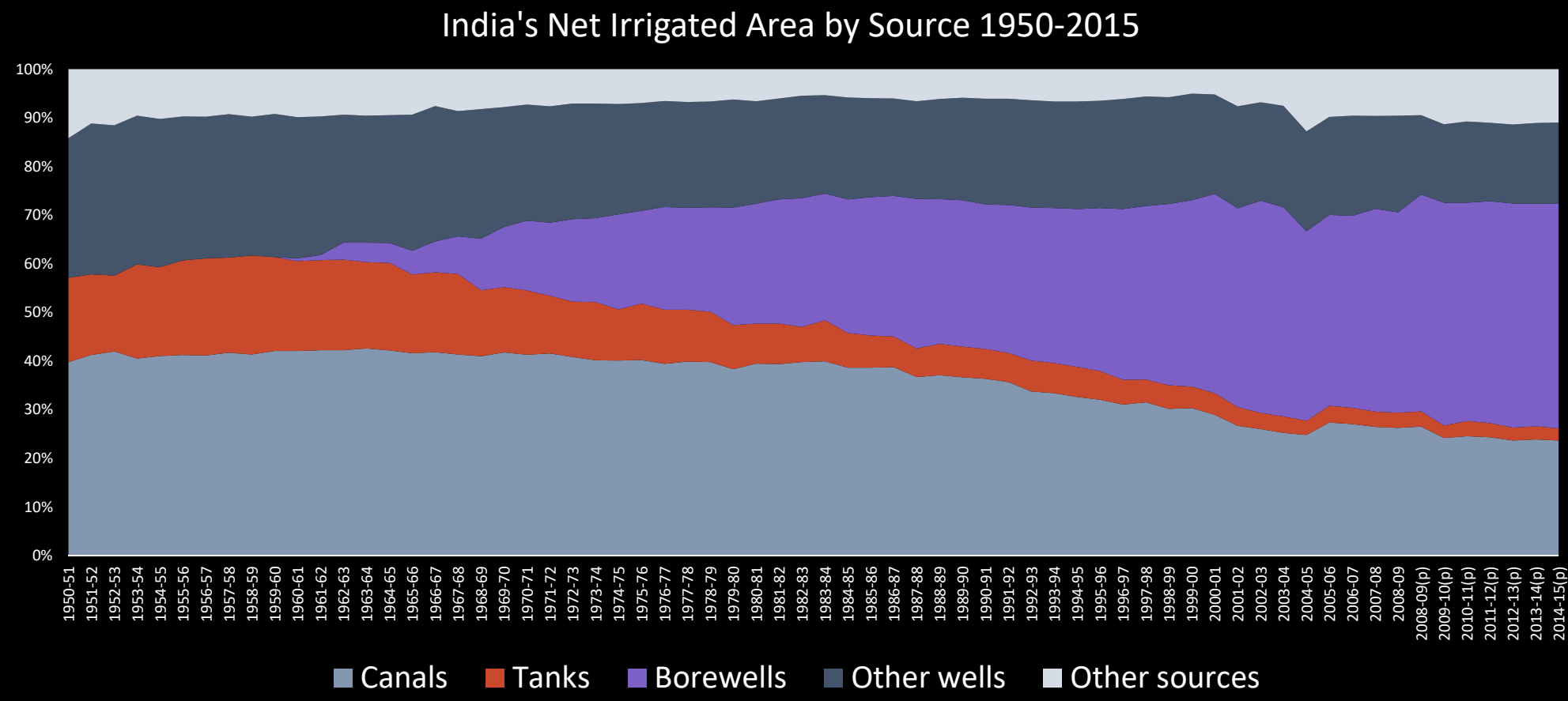
Administrators with different incentives from the community took over tank maintenance.

As water management moved away from the community, tank administration became another file on a crowded desk.


Soon, in many communities, festivals stopped being celebrated around the tank and status-related benefits fell.
In parallel, the effectiveness of fishing auctions fell. This meant that revenue from fishing auctions no longer accrued to the community, and so, yet another driver for keeping water levels up began to fray.

The rise of the borewell made wealthier farmers less interested in tank maintenance



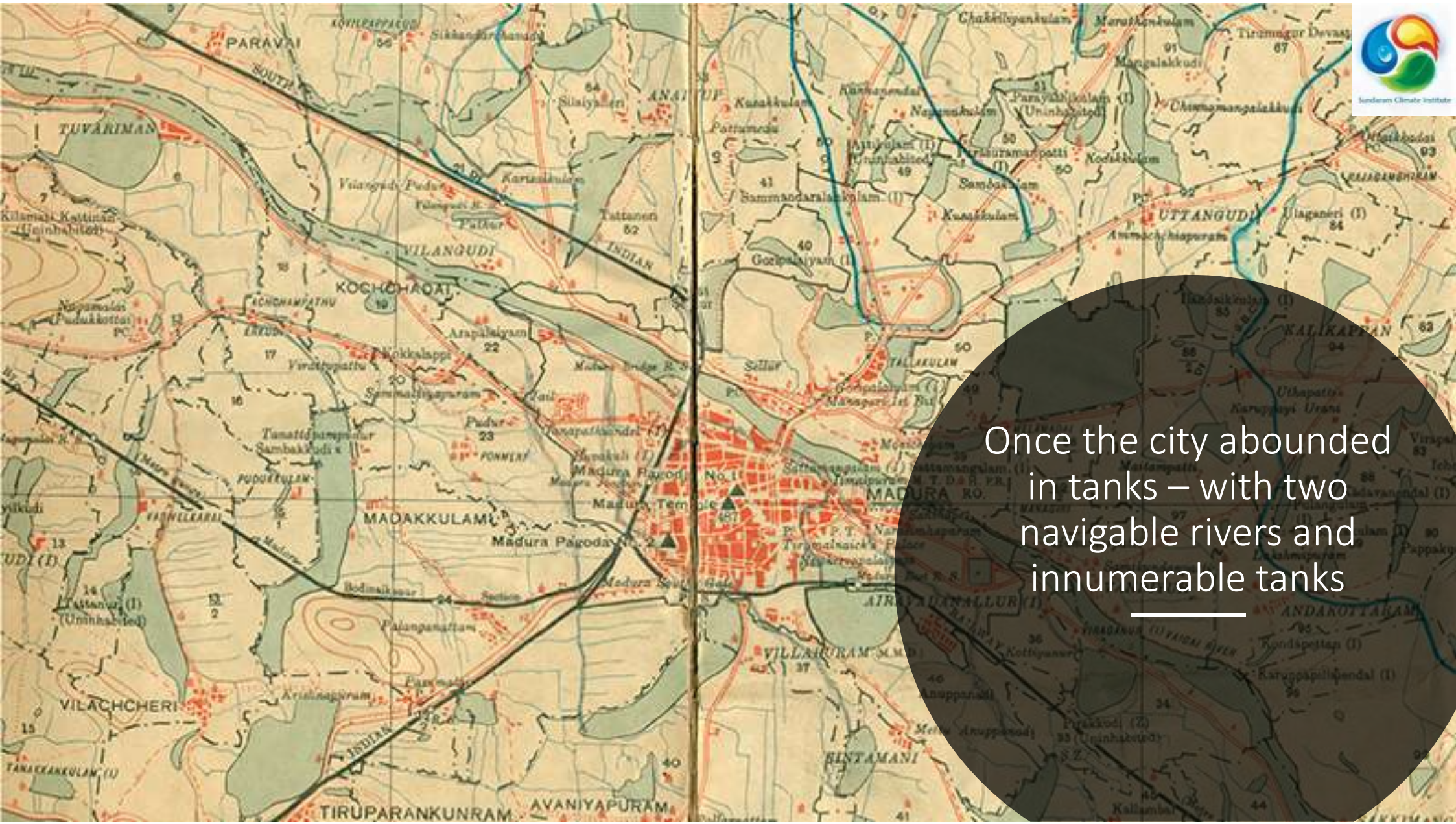
Source : Net Irrigated Area by source (Directorate of Economics & Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India), Statistics Handbook of India

Since wealthier farmers typically played an important role in tank maintenance, the tank system suffered when they lost interest...

Urbanization increased land scarcity, which made tanks valuable as dry land.

- In crowded cities, tanks became more valuable as empty land. Especially when a tank is dry/filled with waste or sewage.
- Feeder channels were especially vulnerable to encroachment. When they were encroached, downstream tank (s) dried out. Unmaintained sluices, or channels blocked with waste, also caused tanks to dry out.
- Changing land use patterns with less green cover around a water body meant tanks could not recharge groundwater levels as effectively.
- The people living around a tank in a city did not form a community that depended on the tank, and without watchful local guardians, many tanks disappeared.

We found this pattern manifest in Madurai, as it has in many other cities across India…

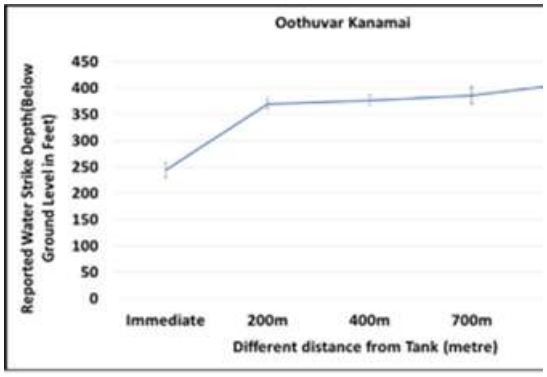

PARAVAI
TUVARIMAN
VILANGUDI
KOCHCHADAI
MADAKKULAM
Madura Pagoda
MADURA
UTTANGUDI
VILACHCHERI
TIRUPARANKUNRAM
AVANIYAPURAM
VILLAPURAM
KALIKAPPAN
ANDAKOTTAKAM
Once the city abounded in tanks – with two navigable rivers and innumerable tanks

Today, Madurai's tanks have been sacrificed for urban growth and its rivers are replete with sewage

Many tanks have disappeared

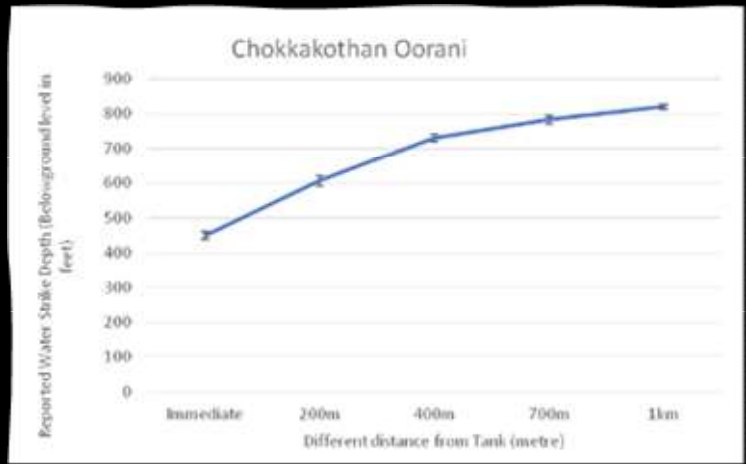
Replaced by offices, courts, housing and schools

Or have become filled with sewage and clogged with waste. For example, Oothuvar Kanmai is now called “Sakkadai (Sewage) Kanmai” by locals



Even as Oothuvar Kanmai has gone from ‘hero' to nuisance, it still manages to recharge surrounding ground water levels

Other tanks may disappear altogether, like the “Chokkakothan oorani”. Which is a shame, because encroached as it is, this small oorani (drinking water pond) still recharges local groundwater



"We own this land it is my ancestral property … the court has served the ordered … we are planning to convert it into a marriage hall or a swimming pool."

Unprotected, it is ripe for takeover by private interests

Summary – How did we get here?

- Once upon a time, Madurai's population understood and respected their water, and its intense seasonality.
- To balance supply and demand, they built and maintained their tanks.
- Sadly, the rise of the borewell and the disconnect between the community and the tank has led to the demise of Madurai's tanks and made Madurai water-insecure.
- People's attitude towards water has changed – once water was respected and was everyone's responsibility. Today, most persons, when asked what they see as their responsibility in managing water, struggled to produce an answer.

Contents

The SCI 4 P – path to water resilience

PARTNER

PRIORITIZE

PREACH

PROSPER

Partner and Prioritize

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We can think of acting in 5 steps: Partner, Understand, Prioritize, Act & Evaluate

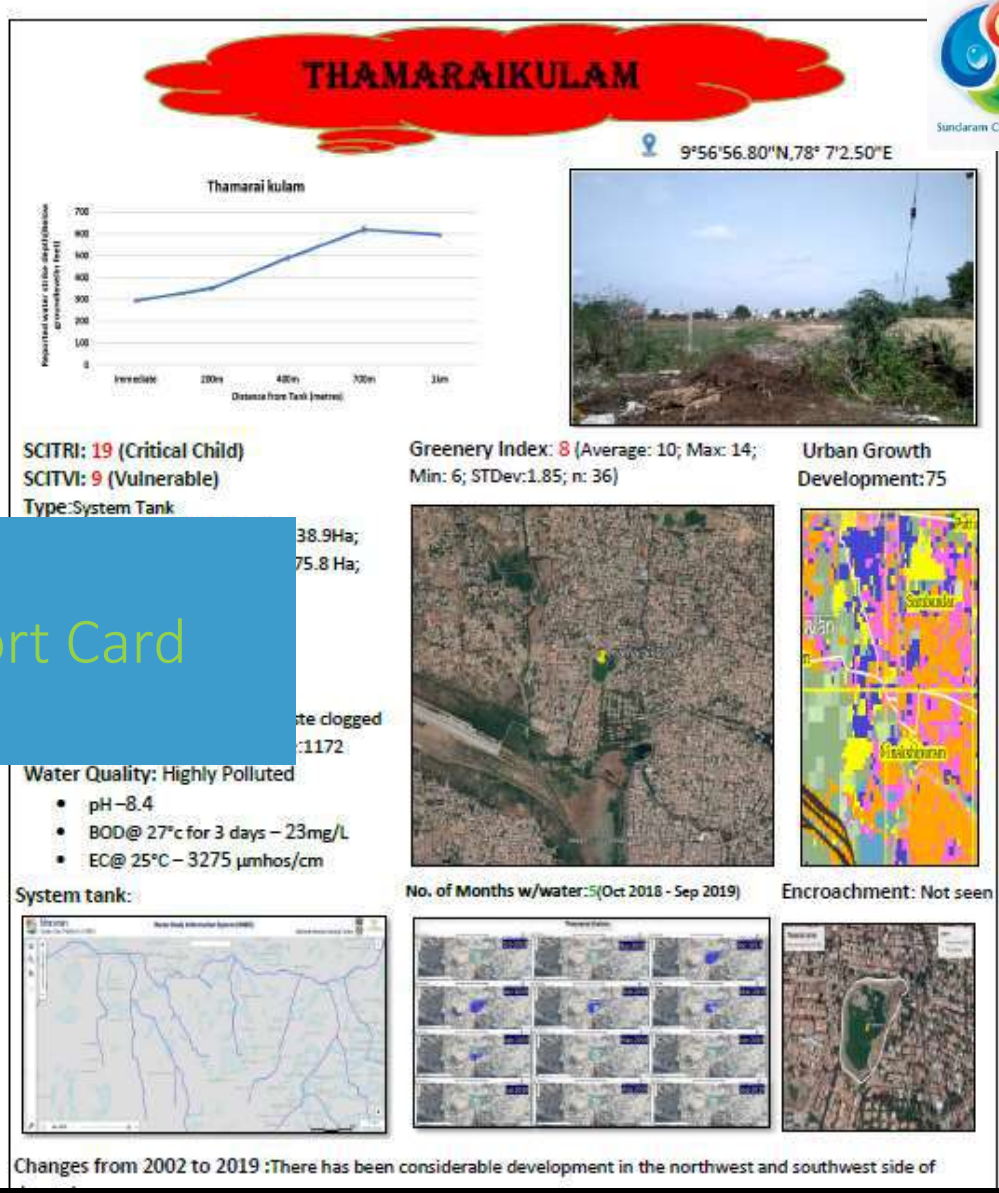
Rejuvenating a tank requires partnership – between the community, government agency responsible for the tank, research organizations that can help understand what is wrong, implementation organizations that can build community support and rejuvenate a tank and funders who can help catalyse the process.

To prioritize we need to understand…

Understand: Tank report card	Prioritize
⑩ Which tanks are vulnerable? ⑩ Where is the groundwater running out? ⑩ What needs to be done to make a tank functional?	⑩ Focus where the need is highest: where groundwater is running out ⑩ Begin with the most vulnerable tanks

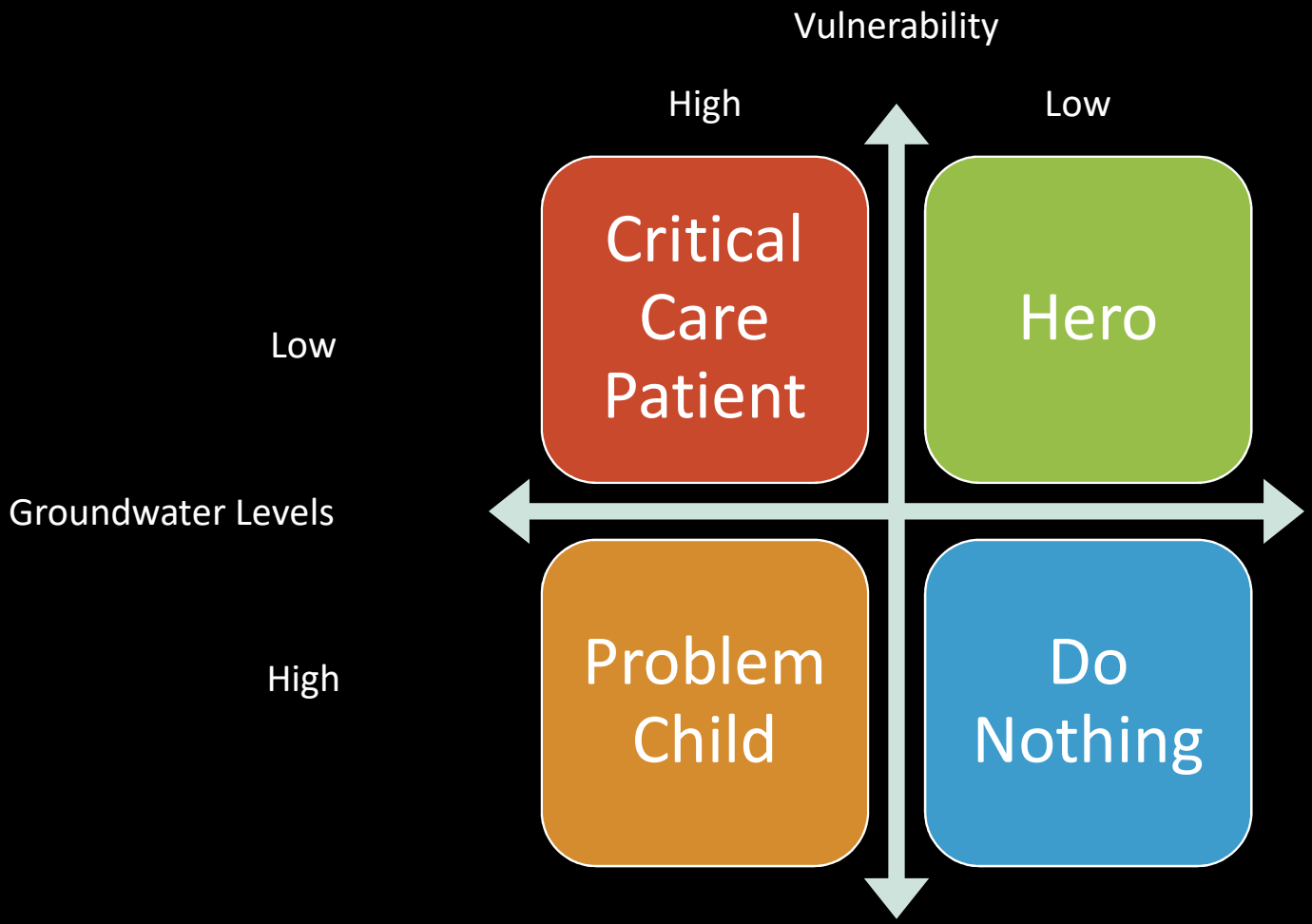
Understand: what must be done

Tank Report Card

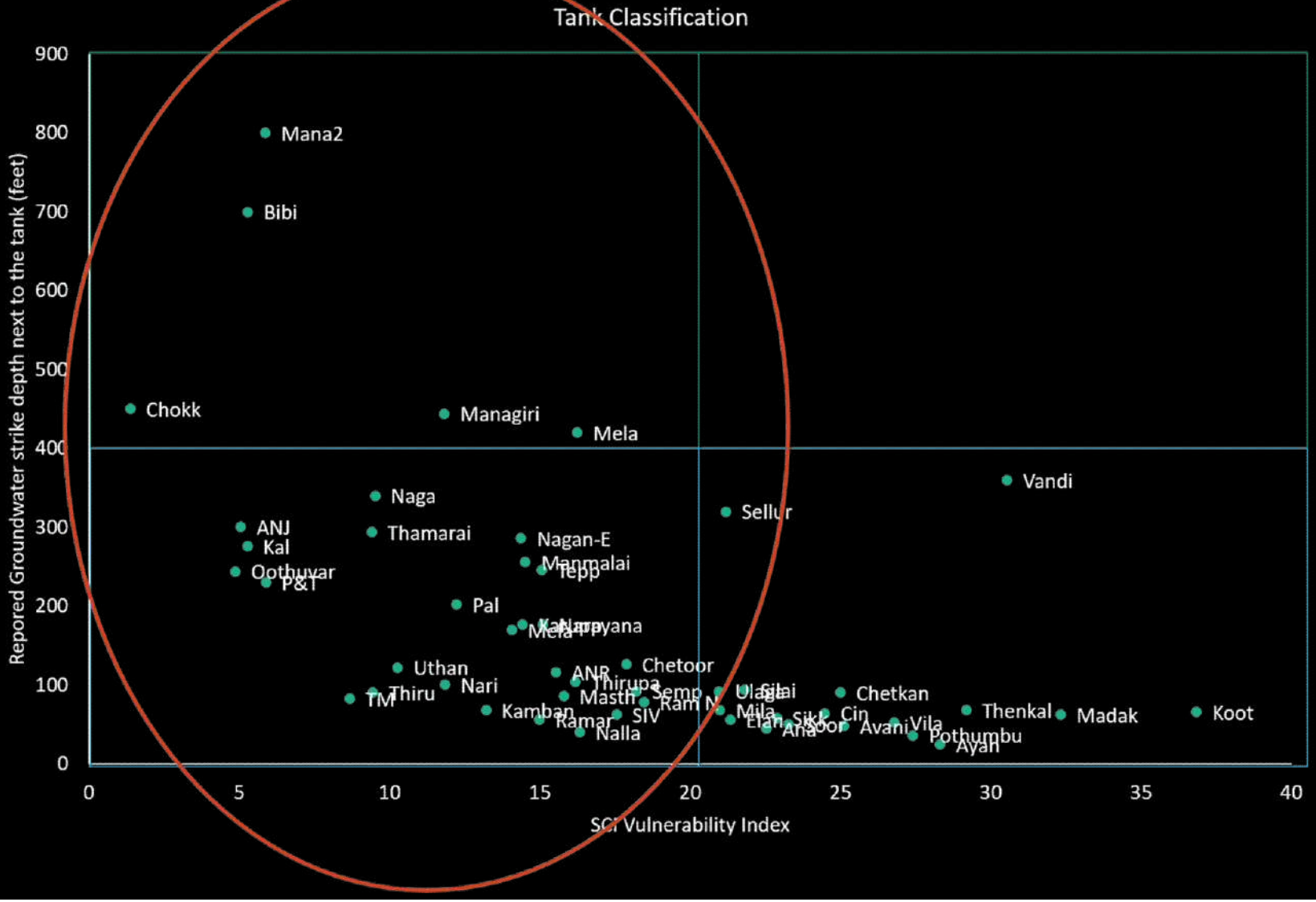


Our tank report card is a health card for a tank: looking at encroachment, surrounding groundwater levels, seasonal water levels, inlet condition and quality. Using our data-driven analytics, we assign a rating that rates a water body as functional or vulnerable to drive action.

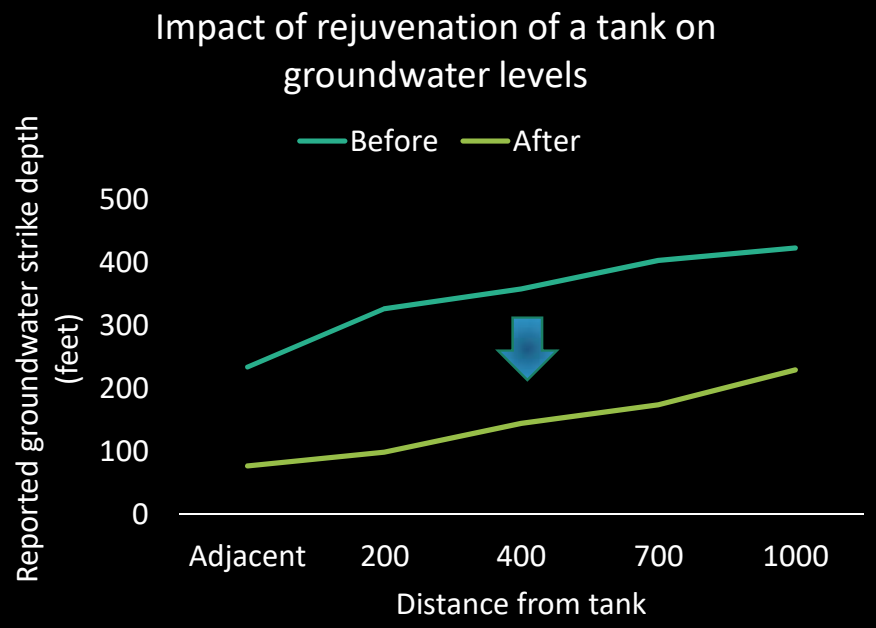
Prioritize: Where and How to Intervene



Prioritize: Focus on the critical care patient and problem children first



Act & Evaluate: Recheck groundwater levels to ensure that rejuvenating a tank has built up local water resilience.

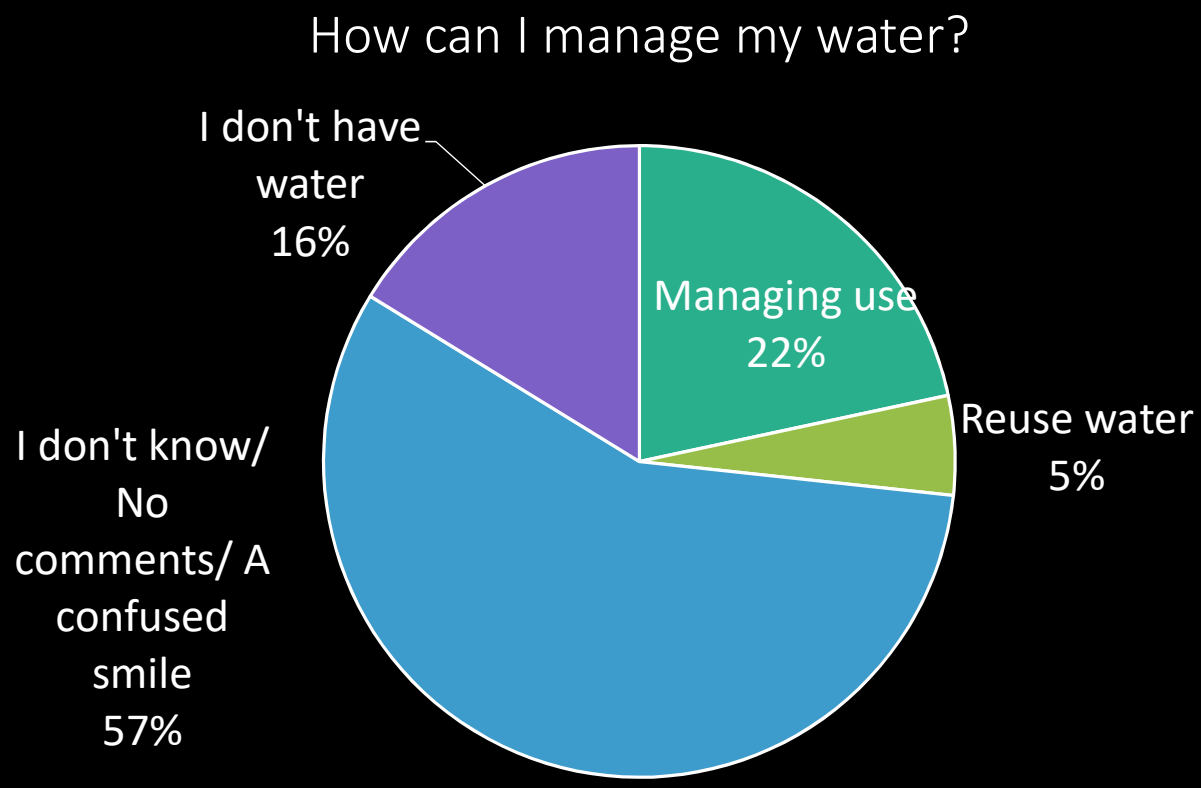


Many tanks can be rejuvenated into becoming functional: in this example, we studied the before-and-after groundwater levels of 19 tanks after rejuvenation, and found that groundwater recharge had improved significantly after rejuvenation.

Preach

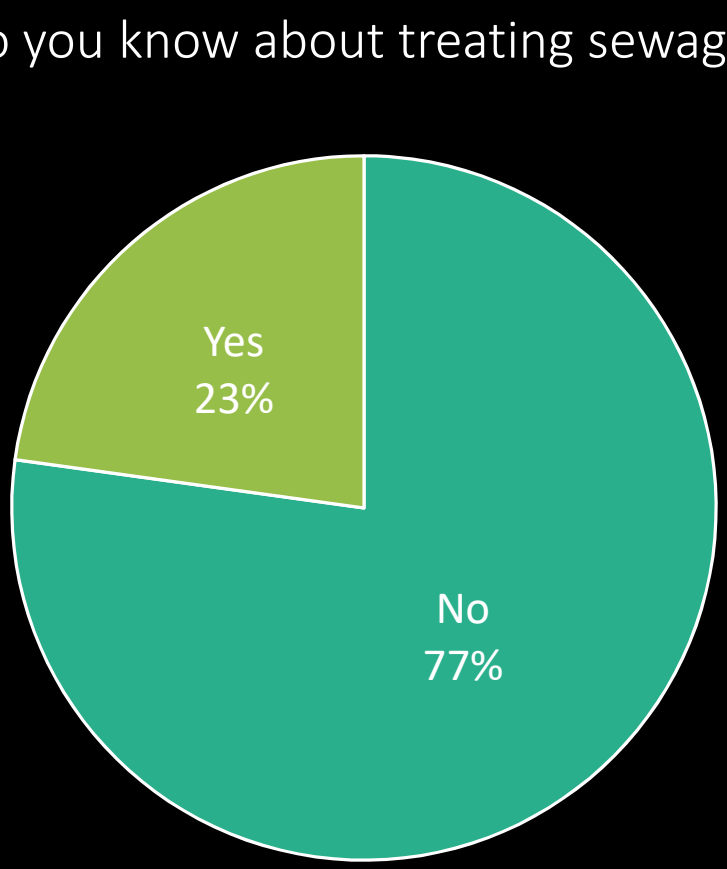
True change needs a change of perspective

Sensitizing students and communities on the role of citizens and the history of water is important because most respondents struggled to say what their role was in managing their water.

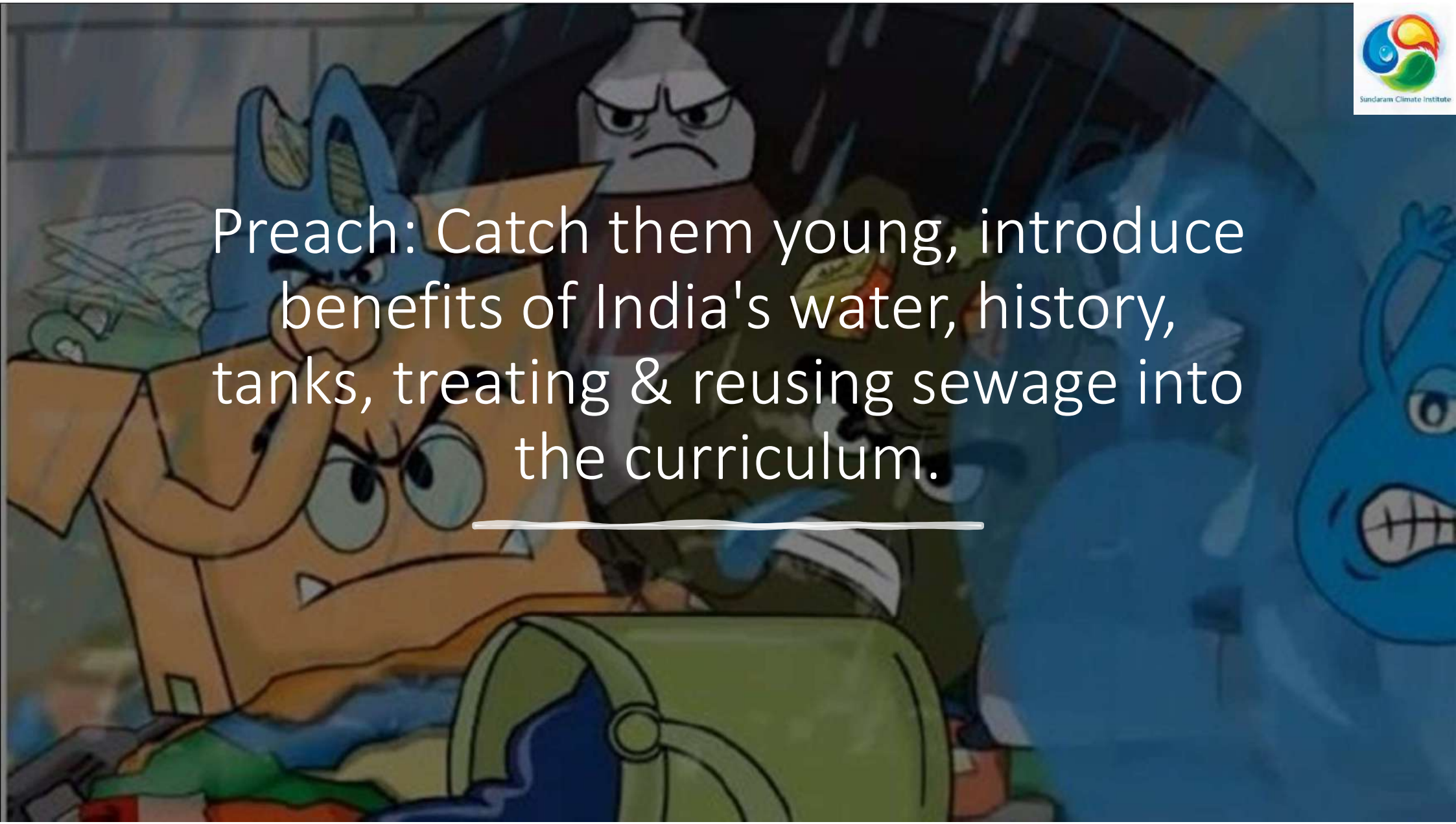


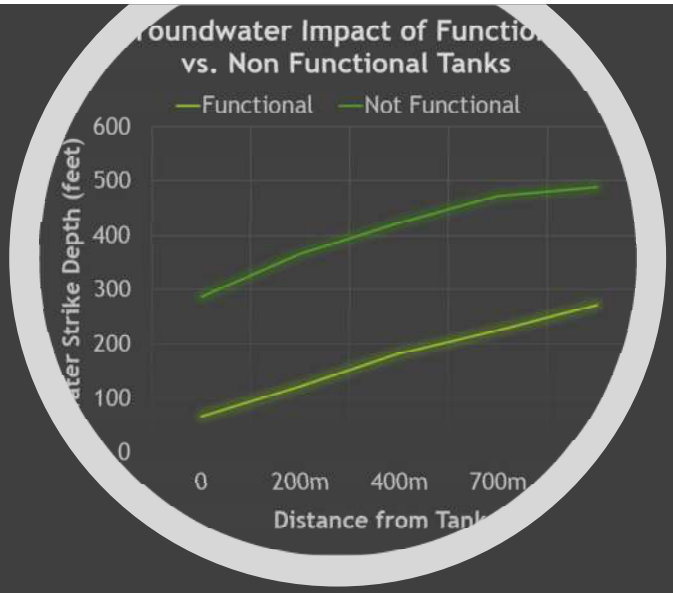
Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=2118)

Most households were unaware of treating & reusing sewage.



Source: Sundaram Climate Institute Waste & Water Survey 2018-21 (n=2118)


Preach: Catch them young, introduce benefits of India's water, history, tanks, treating & reusing sewage into the curriculum.



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Educate the community on the benefits of living next to a functional tank: Flood prevention & Groundwater recharge

Prosper: Tank Tourism and Sewage Treatment

The connect between tank and community is strengthened by regular, tangible benefits flowing from tank to community which is highlighted by storytelling and festivals. While this exists in some rural tanks, it is sorely missing in urban tanks.

Sustainable tank tourism allows tanks to provide jobs and stimulate local economy.

To tap the tourism income, a tank needs to be clean and contain water. Next, adequate infrastructure like a walking or cycling path, dustbins and seating or selfie-spots are a must. We found once a tank or a lake has such infrastructure, it can support tens to hundreds of livelihoods.

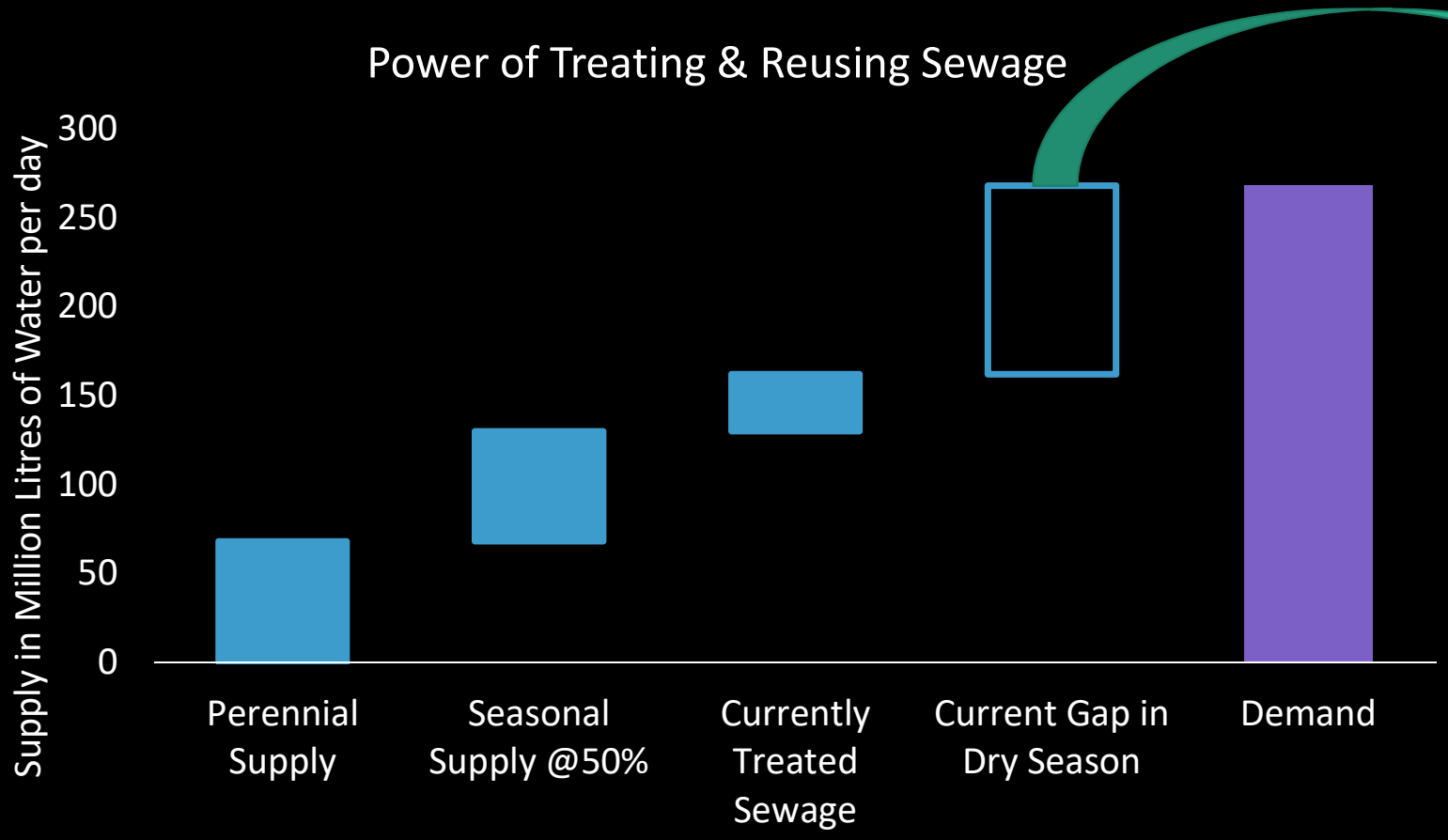
leveraged. Large tanks can become outright tourist destinations.

Tank Size	Potential	Intangible Benefits	Revenue (Rs. Lakhs per annum)	Direct Jobs	Enablers
Small (< 5 Ha)	• Walking • Park (*) • Performances (*) • Temple Festivals	• Community • Better Health • Groundwater recharge • Improving real estate values	< 20	1-2	• Water presence • Route storm-water drains into lake • Sewage Treatment • Clean surrounding (Dustbins) • Walking path • Seating • Lighting • Fencing & Greenery (*) • Wi-Fi hotspot • Selfie Spots • Drinking water
Medium (	• Walking	• Community	100	45	• Water presence

Once the community becomes vested in a tank's well-being, the tank will remain functional, making its neighbourhood water resilient.

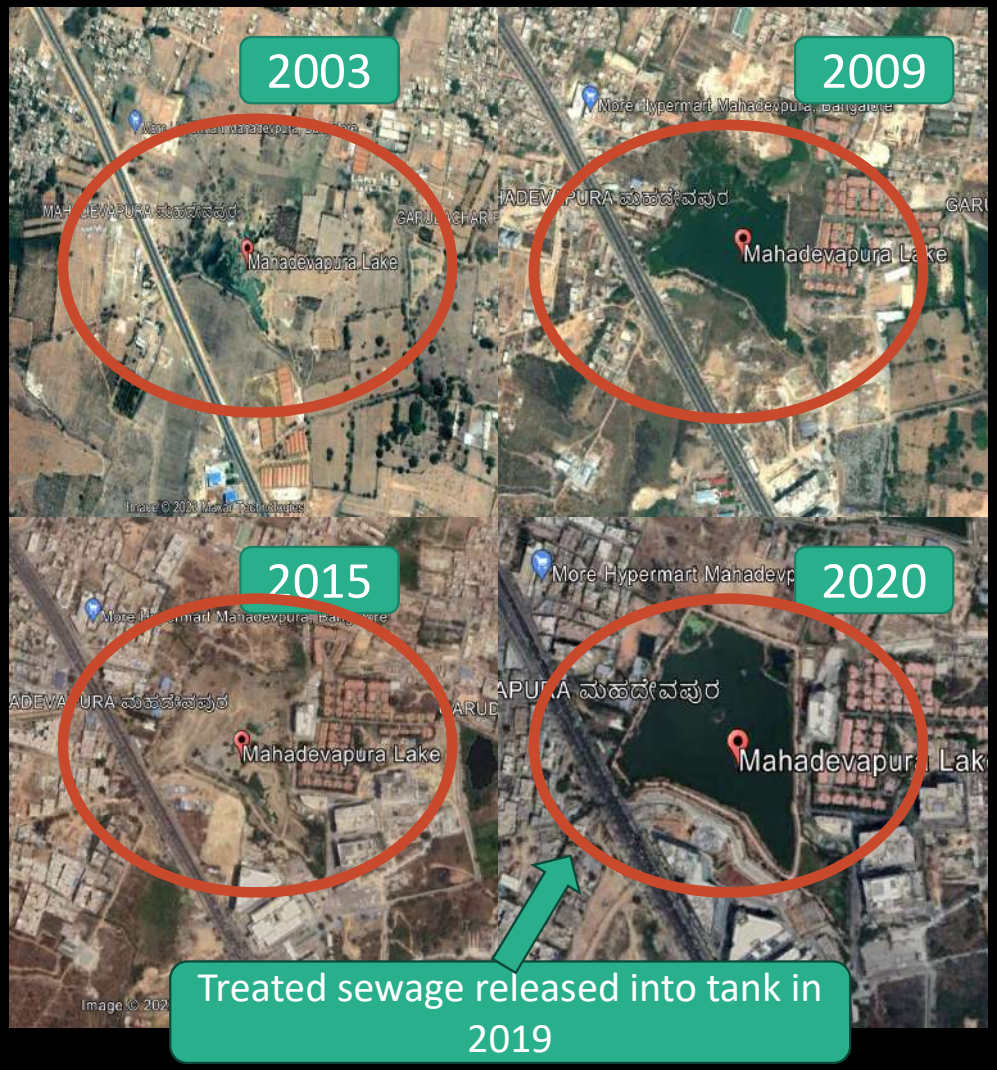

Decentralized Sewage
Treatment can also significantly
improve city water resilience

Water supply is at its lowest in the summer. Treating & Reusing sewage can help alleviate summer water scarcity.



This Gap can be met by treating half of Madurai's generated sewage.

Source : Tamil Nadu Urban Flagship Investment Program (Tranche 2) – Dedicated Water Supply Scheme for Madurai Municipal Corporation from Mullai Periyar River at Lower Camp; June 2019 prepared by the Madurai Corporation for the Asian Development Bank. Sewage treatment capacity and Actual treated taken from National Inventory of Sewage Treatment Plants, Central Pollution Control Board, March 2021; Sewage generation assumed to be 75% of water demand.

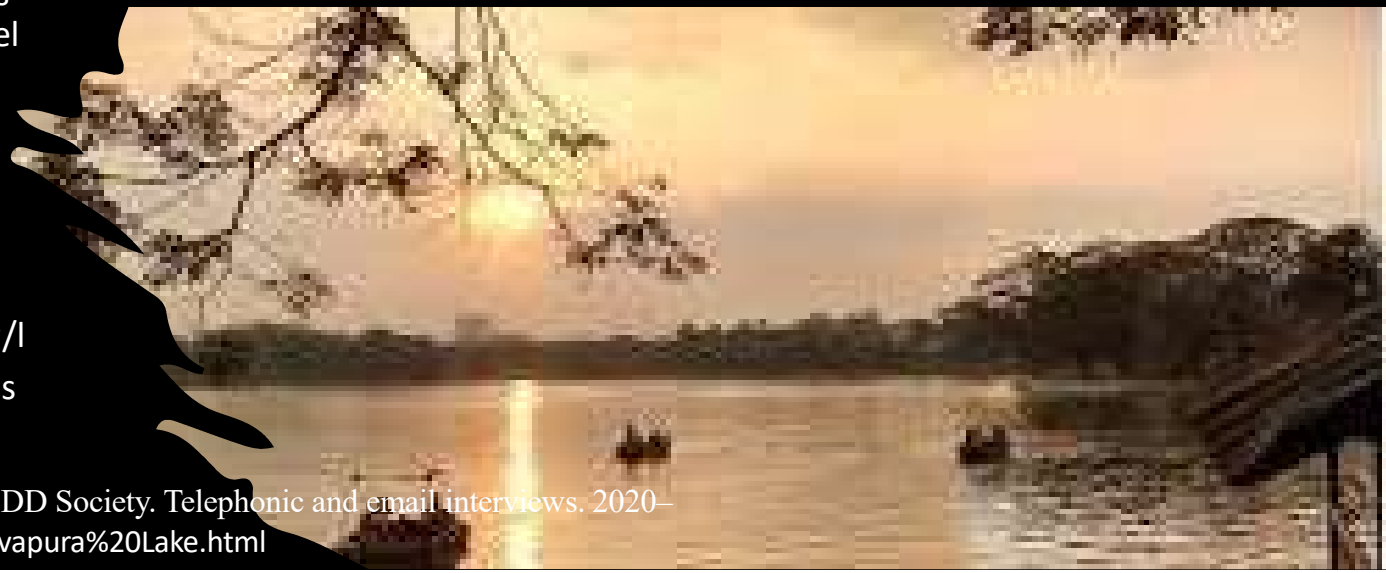


Some may feel queasy about directly using treated sewage. A workaround is to replenish tanks with treated sewage that can then recharge surrounding groundwater, which can then be used by households. This has been done successfully in Bengaluru in a public-private partnership.

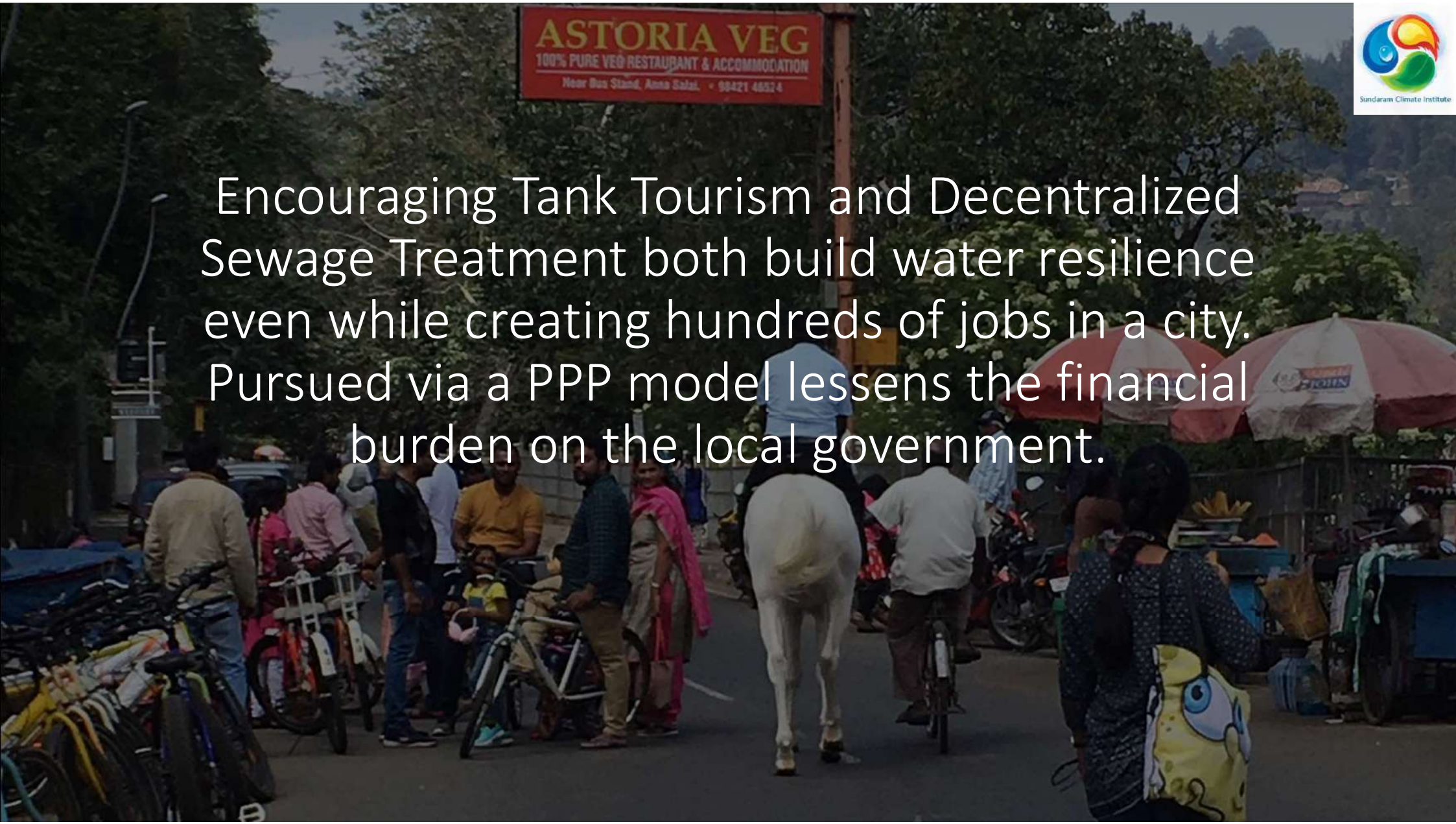
Source : Google Earth Images; P.G. Ganapathy, Senior Advisor, CDD Society. Telephonic and email interviews. 2020–21.

Using treating & reusing sewage to replenish seasonal tank water can improve a city's water resilience

- Mahadevapura Lake is a 26-acre lake located along the Outer Ring Road, Bangalore.
- Salient points
  - Rejuvenated through a PPP
  - Cost of the plant: Rs.2.01 Crore funded through CSR
  - Technology: Settler, Anaerobic Baffled Reactors (ABRI), Anaerobic Filters(AF) and Planted Gravel Filter (PGF).
  - Importantly, this tech choice means low OPEX;
  - Construction Period: 12 months
  - Start of Operation: March 2019
  - Design Capacity: 1 MLD
  - Influent Quality: BOD-200 mg/l & COD-400 mg/l
  - Expected Effluent Quality: BOD 30-20 mg/l (this is comparable to the existing water quality of many of the tanks in our study set)



Source : Google Earth Images; P.G. Ganapathy, Senior Advisor, CDD Society. Telephonic and email interviews. 2020–21. https://site.bbmp.gov.in/departmentwebsites/Lakes/Mahadevapura%20Lake.html



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Encouraging Tank Tourism and Decentralized Sewage Treatment both build water resilience even while creating hundreds of jobs in a city. Pursued via a PPP model lessens the financial burden on the local government.

Punya: Reconnect with the sacred nature of water.

Recommendations

Government

- PPP-model for tank rejuvenation: Partner with Private Institutions to rejuvenate tanks
  - Single window for tank partnerships
  - When possible tie in MNREGA with tank rejuvenation
- Encourage tank tourism in urban tanks
- Institute Tank Report Cards for all tanks. Update every year.
- Roll out a water curriculum for all school children
- Encourage universal metering.
- Value water appropriately
- Promote decentralized sewage treatment and reuse

Companies/ NGOS

- Fund Tank Tourism Projects
- Adopt your nearest tank
- Celebrate tank festivals/ encourage tank tourism
- Partner with government to rejuvenate tanks
- Treat & reuse your own sewage

Individuals

- Understand the importance of the tank in your water resilience
- Be conscious of your water
- Harvest rainwater & treat and reuse your sewage
- Adopt your nearest tank.

Our key recommendations: a tank report card, curriculum/community education, decentralized sewage treatment (tied to tanks) and tank tourism dovetail into many existing government schemes

5P	What to do?	Schemes
Partner	Create partnership between Government, community, NGO and Private Organizations (CSR/ Philanthropy/ Individuals) for rejuvenating water bodies including by treating & reusing sewage	Jal Jeevan Hariyali / Jal Hi Jeevan / Kudimaramath scheme / Jal Jeevan Mission (JJM) Atal Mission for Rejuvenation and Urban Transformation (AMRUT) Smart City Mission NPCA
Prioritize	Prepare "Tank Health Card" to find out which tank is most vulnerable to the community.	Jal Shakti Abhiyan (JSA) / Azadi ka Amrit Mahotsav / Mukhyamantri Jal Swavlamban Abhiyan / Jalyukt Shibar Sujalam Sufalam Abhiyan / Mission Kakatiya / Neeru Chettu /Jal Jeevan Hariyali / Kudimaramath scheme Jal Jeevan Mission (JJM) / Har Khet Ko Pani (HKKP) / Repair, Renovation and Restoration (RRR) Atal Mission for Rejuvenation and Urban Transformation (AMRUT) / Fifteenth Finance Commission (FFC)
Preach	Include water bodies, water history and the philosophy that water is everyone's responsibility in the curriculum and educate the communities across India	Jal Shakti Abhiyan (JSA) / Azadi ka Amrit Mahotsav //Jal Jeevan Mission (JJM)
Prosper	Create tank tourism to make tank more valuable to the community. Encourage decentralized sewage treatment and reuse. Experiment with wastewater markets and divert fully treated water into to a nearby water body to recharged ground water levels.	Atal Mission for Rejuvenation and Urban Transformation (AMRUT) Smart City Mission Urban Municipality Directions (e.g. BWSSB in Bengaluru)

Conclusions

- India's Urban Water Resilience Is Likely To Fall
  - Demand Rising: India's population is growing and getting wealthier, with households wanting the convenience and dignity of a flushable toilet at home. This means the year-round water demand in India's is set to rise sharply.
  - Supply Becoming Volatile: Meanwhile, thanks in part to climate change, Madurai's traditional sources of water will get more seasonal and more temperamental. Other sources like groundwater will likely fall due unbridled demand, while sewage treatment & reuse is still in its nascency.
  - This translates to the City water supply-demand gap rising sharply in lean water months
- Public Attitude towards water pricing & water as a voting issue place constraints on what solutions will work.
- Resilience building tools are in hand:
  - Indian cities like Madurai have two powerful weapons within their own control to build resilience.
    - Tanks are custom-made to bridge temperamental and skewed supply and demand
      - Functional tanks can recharge groundwater by 200 feet in their vicinity
      - Functional tanks depend on strong connect with community
      - Treating and reusing sewage can add to supply and reduce volatility of supply.
- The SCI 4 P framework can help bring back water resilience.
  - Partner & Prioritize to rejuvenate vulnerable tanks in groundwater stressed neighbourhoods
  - Preach – emphasize that water management is everybody's responsibility, stress the importance tanks and highlight the benefit of treating and reusing sewage
  - Prosper: Strengthen link between community and their tank by encouraging tank tourism to create local jobs. Decentralized Sewage treatment and reuse can also build water resilient.
  - Punya: Emphasize the good that come out of rejuvenating tanks and respecting water.

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