

# A ‘Chennai’ in Every City of the World: The Lethal Mix of the Water Crisis, Climate Change, and Governance Indifference

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## Abstract

The prevailing water crisis and problem of climate change demand a review of the developmental activities conducted by State of Tamil Nadu. While ascertaining a system to address the crisis can be daunting, integrated approaches, such as those that use technology, are fundamental to identifying and evaluating options for sustainable solutions.

This paper explores the water–climate nexus through the case study of Chennai, the capital city of the state of Tamil Nadu in India. Climate change has influenced the behaviour and patterns of floods, brought about incessant rain and led to a shift in the monsoons. In addition, changes to the climate have resulted in a shortage of drinking water in Chennai. There is a concomitant problem of a large and increasing population. These elements warrant a discourse on law, humans and technology. In Chennai, the indifference and denial of political leaders have resulted in failure, and unsustainable measures to address the water crisis have been implemented. The intervention of the Supreme Court of India relating to a mechanism to deal with a water-sharing arrangement between the states of Tamil Nadu and Karnataka in the last few decades has been unsuccessful. None of the proposed solutions were based on incorporating technology, which is a major oversight.

The resultant consequences of water use and the complex mix of social factors surrounding the vulnerable population are addressed in this paper. The effect of the water crisis on women and the agricultural workforce is illustrated to argue for greater and more imaginative governmental intervention. The paper concludes with a discussion of the need for a holistic approach to climate change and the ongoing water crisis that invites better interventions, particularly in terms of technology, to address the crisis and avoid a situation in which groundwater will be critically degraded by 2030.

**Keywords:** Climate change; water management; climate emergency; India.

## I. Introduction

This paper argues that achieving water and climate security for all in terms of governance mechanisms and solutions by courts that create challenges is necessary. These challenges, particularly those that relate to vulnerable populations of a metropolitan city, must be addressed through the lens of technology. The failure of mechanisms, not just those of the courts but also those of the legislature and actors responsible for monitoring and enforcement, is examined in this paper. This argument is addressed in three sections. The first section argues that the crises of water, climate and poverty have profound effects on the population, focusing specifically on Chennai city, the capital of Tamil Nadu state in India. The history of the cyclic effect of the monsoon with periodic droughts and floods<sup>1</sup> and the non-uniform pattern of rainfall and deficient rainfall even in normal years in Chennai have paved the way for water shortages that have not been adequately addressed since ancient times. From ancient to modern times, efforts to address the water crisis have been replete with mistakes and have carried the burden of large loans for

<sup>1</sup> UNDP, India Country Report. See also Editorial, “Cycle of Extremes”; Lok Sabha, “Discussion regarding Flood and Drought Situation in Tamil Nadu and Other Parts of the Country.”



developmental activities, including the construction and maintenance of dams.<sup>2</sup> The solution to the problems surrounding droughts and water shortages can be understood through government and court action and inaction.<sup>3</sup> This is explored in the second section, which argues that the central and state governments and the Supreme Court of India have failed to adequately address the water crisis in Chennai. Government leaders have indulged in climate change denialism, which has resulted in delays to the implementation of viable solutions to the crises of water and climate and created associated problems of poverty. Such delays have typically resulted in unsustainable development that has failed to balance socioeconomic needs with ecological sustainability. The water-sharing regime imposed by the Supreme Court of India has also failed by not facilitating mutually amicable solutions and not satisfying all parties involved in the dispute. These failures on the part of state agencies have had disproportionate effects on women and agricultural workers.

In the context of the inefficiency of state agencies and the associated problems of poverty, the third section argues for a holistic developing world approach to reframe how to think about water, poverty and climate issues. In the context of climate change and the water crisis, this section considers some viable solutions that stem from failed governance, the courts and the continued natural calamities that have resulted in the water crisis. The analysis in sections one and two of this paper explores several growing inequalities, such as the widening gap between the rich and poor and leaders' denial of the inhumane conditions and problems that predominate. Such problems mean that, at present, humans cannot prosper equally, and the issues must be addressed with localised and internalised solutions.

## II. Water, Climate and Poverty

This section argues that the crises of water, climate and poverty have profound effects on the population—specifically the population of Chennai city, the capital of Tamil Nadu state in India. A history of droughts and floods in Chennai have paved the way for water shortages that have not been adequately addressed since ancient times. From ancient to modern times, efforts to address the water crisis have been replete with mistakes and have recently carried the burden of large loans for developmental activities from the World Bank, including for building dams.<sup>4</sup>

According to a Government of India report, 21 major cities in India may have already run out of groundwater by 2020.<sup>5</sup> Climate change has accentuated environmental issues with changes in monsoon patterns, heatwaves and groundwater depletion. Problems of drought and famine add to the problems associated with unplanned cities and the unprecedented and unauthorised expansion of cities.<sup>6</sup> More closely associated issues include constraints in water conservation infrastructure, including water reuse and recycling, rainwater harvesting systems, wastewater treatment and the incorrect use of water conservation measures. On a global level, the World Bank estimates that climate change will push 100 million people under the poverty line by 2030, with the greatest effects felt in non-industrialised areas.<sup>7</sup>

Issues surrounding groundwater have persisted even following the *Chennai Metropolitan Area Groundwater (Regulation) Act of 1987* (hereafter 'The Groundwater Act'), which regulates and controls the extraction, use and transportation of groundwater as a result of water scarcity due to consecutive failure of the monsoon. The Groundwater Act contains provisions to keep 'a tab on the types of well, their exact location, the devices used for lifting groundwater, the purposes for which it was used, the quantity of groundwater used, the vehicles used for transporting the water and the licenses to be obtained for such transportation' (section 4). However, this law does not address water protection, specifically allocating and regulating the use of water among various claimants.<sup>8</sup>

Water problems in Tamil Nadu are not a new phenomenon. During the reign of Narasimhavarma Pallava (680 AD), Kanchipuram—a district next to modern-day Chennai—suffered continuously without rain for three years. The Pandya kingdom located in and around Madurai is also recorded as having suffered from drought-induced famine for 12 years.<sup>9</sup> As far

<sup>2</sup> Cullet, 'India: Evolution of Water Law and Policy', 159. See also Morrison, 'Archaeologies of Flow'; Naz, 'Water Management'.

<sup>3</sup> Kathpalia, 'Water Policy and Action Plan for India 2020'. See also Cullet, *Water Law, Poverty, and Development*, 181. Improvements have been noted in the 2017–2018 period and are attributed to the United Nations Sustainable Development Goals (SDGs), based on responses from water sector officials, academics/researchers and people from civil society/user groups, as mentioned in Ahmed, 'Water Governance in India', 2071.

<sup>4</sup> Dorcey, *Large Dams*. See also Goodland, "Viewpoint"; International Rivers, "The World Bank and Dams"; Preet, "Articulating a Vision."

<sup>5</sup> NITI Aayog, *Annual Report 2017–2018*.

<sup>6</sup> Chennai has lost many lakes, over which construction has been allowed in the last 100 years, from Mambalam to Nungambakkam. See Ge, "From Floods to Drought."

<sup>7</sup> NITI Aayog, *Annual Report 2017–2018*.

<sup>8</sup> Cullet, "Patchwork Laws."

<sup>9</sup> Sastri, *Foreign Notices of South India from Megasthenes to Ma Huan*, 18.

back as between the third and first century BC, ancient Tamil poet Thiruvalluvar<sup>10</sup> wrote in one of his couplets that rain had preserved the world, signifying the importance of water. Tamil Nadu has experienced several devastating famines, with one of the most severe in the year 1781.<sup>11</sup> This famine affected nearly all the districts of Tamil Nadu and resulted in the deprivation of basic needs and mass deaths.<sup>12</sup> It further led to large-scale migration within Tamil Nadu to less-affected districts until the end of the famine in 1784.<sup>13</sup> Another major famine occurred in 1790, though it was confined to the northern districts of Tamil Nadu. Unlike the 1784 famine,<sup>14</sup> during which there was government assistance, on this occasion, there was mismanagement, maladministration and frequent plundering, which aggravated the gravity of the famine. Nearly a century later, the 1876 famine-affected Madras Presidency (as it was called then) resulted in vast barren tracts across the country.<sup>15</sup>

Ancient Tamil literature details famine-like conditions in the state lasting three to 12 years.<sup>16</sup> Historically, segregation under the caste system resulted in concepts of purity around water, with the untouchable caste (Dalits) deprived of access to water, particularly from wells. Higher caste dominance is seen over various water sources, such as rivers, ponds and wells at the source or higher point, such that lower caste communities do not pollute the water sources. The Society for Promoting Participative Ecosystem Management and the National Conference of Dalit Organizations state that ‘water is used as a weapon to control and subjugate excluded communities’.<sup>17</sup>

An attempt to resolve the water crisis was made during the British era in India in 1876 when a small tract of land was taken over to build a tank at Puzhal, an agricultural town at the northwestern edge of present-day Chennai. Over time, its capacity was increased to 3,300 million cubic feet from its original 500 million cubic feet to accommodate the demands of a growing city. Renamed the Red Hills reservoir, the tank was the first of many centralised water projects in Chennai.<sup>18</sup> There were also proposals to tap water from the Kosasthalaiyar river, 160 km from Chennai, which involved constructing a masonry weir across the river and diverting the water to Cholavaram—a British plan to address the water crisis.

Before independence, in 1941, a drinking water reservoir was constructed in Poondi, near Chennai. The next year, a dam was built at the Kosasthalaiyar river, at the point at which the Cooum river split off as a distributary. The flow of the Kosasthalaiyar was diverted to the Poondi reservoir and from there to Chennai, resulting in disruptions and further water shortages. Added to these problems were continued deficient rainfall and droughts. Three consecutive years of deficient rainfall from 1968 to 1970 and the drought conditions of 1966, 1967, 1979, 1982, 1983, 1985, 1986, 1987, 1989, 1992, 1999 and 2000 posed a variety of problems. The droughts that occurred from 1977 to 1991 resulted in recurrent drinking water shortages in major parts of the state.<sup>19</sup> The heavy floods of 2005 and 2006 resulted in a draft 20-year master plan with the Chennai Metropolitan Development Authority, which stated that the failure of major rivers and other drainage systems led to floods.<sup>20</sup> The severity of the drought in Tamil Nadu was the result of aberrations in rainfall, overexploitation of groundwater, low reservoir levels and drought-prone soil types.<sup>21</sup>

As of 2018, all four reservoirs,<sup>22</sup> all three rivers, the wetlands and the Buckingham Canal in and around Chennai are dry, except for a few small exceptions. Major concerns include a lack of proper desilting and dumping of sewage in water bodies. An increase in population, thriving information technology (IT) and automobile sectors and the real estate boom have also resulted

<sup>10</sup> Dates of birth and death unclear. Speculations are that he flourished in circa 1st century BC or 6th century AD India. See Mageswari, “Contemporary Social and Cultural Relevance,” 1266.

<sup>11</sup> Sami, “Famine, Disease, Medicine and the State in Madras Presidency (1876-78).”

<sup>12</sup> Menon, “The Carnatic Debts,” 10. See also Selim, “4 Things You Need to Know.”

<sup>13</sup> Maharatha, “The Demography of Indian Famines.”

<sup>14</sup> Babu, “A Study of the Factors,” 3.

<sup>15</sup> Lardinois, “Famine, Epidemics and Mortality,” 454.

<sup>16</sup> Nathan, “Droughts in Tamil Nadu.”

<sup>17</sup> Fatah, “In India, Water and Inequality are Intertwined.”

<sup>18</sup> Gupta, “Urban Floods and Case Studies Project.”

<sup>19</sup> Chandrasekar, “Rainfall, Drought and Agricultural Output.” During the 1966 drought, there were two consecutive weeks of severe drought, but no moderate droughts occurred during the kharif season. In 1967, there were three consecutive weeks of severe drought conditions followed by three weeks of moderate drought. In 1979, chronic drought occurred, with nine consecutive weeks of severe drought followed by moderate drought, and a similar situation occurred in 1982. The droughts of 1986 and 1987 were also chronic and significant for Tamil Nadu and India. In 1999, the state experienced more significant declines in monsoon rainfall, affecting crop production, mainly groundnut and cotton.

<sup>20</sup> CDMA, Second Master Plan for Chennai Metropolitan Area, 2026. Volume 1. Introduction.

<sup>21</sup> Murugesan, “Drought - No Stranger to Tamil Nadu,” 3.

<sup>22</sup> Puzhal, Chembarambakkam, Sholavaram and Poondi in the outskirts of the city are dry. See Express News Service, “All Major Reservoirs.”

in the encroachment of land rich in biodiversity, such as the Pallikaranai marsh, stressing the land and accentuating water scarcity.<sup>23</sup>

Financial assistance to the Tamil Nadu Government to begin construction of a new Veeranam project to supply water to Chennai came from the World Bank in 1993.<sup>24</sup> This project draws 190 mld of raw water from the lake, completes conventional treatment and organises the conveyance of the treated water by pumping over a distance of 230 km to Madras (as it was then called) city for distribution.<sup>25</sup> The major aims of the Veeranam project were to make source improvements, such as desilting and lining the lake, completing restoration, raising the bund of the lake, removing a portion of shoal from near the inlet point of Vadavar and widening the Thotti Voikal inside the lake. Other improvements related to the raw water intake and pumping stations nearby at Sethiathope, Vadakuthu and Chendur. Improvements were also to be made to water treatment plants and the pumping station at Mangalam and the transmission main from Sethiathope.<sup>26</sup> After two years, the government of Tamil Nadu changed. The new government (Dravida Munnetra Kazhagam [DMK]) decided to shelve the project,<sup>27</sup> fearing that it would lose the upcoming elections if it were to take up the project.

Climate change has increased the effect of the water crisis,<sup>28</sup> thereby resulting in an increased dependency on the corporation water that the city supplies, which arrives only once every 15 days for a limited period.<sup>29</sup> In recent years, there has been a spike in prices and discontinued service.

A United Nations (UN) report stated that water demand will double supply by 2030, affecting the lives of hundreds of millions.<sup>30</sup> Another UN report warned that ‘depletion of biodiversity and water resources and degradation of marine and terrestrial habitats have brought the planet to the brink of ecological collapse’.<sup>31</sup> Unlike threats to land, such environmental threats are not perceived as serious, and this reflects in a disconnect with people’s nature.<sup>32</sup> This disconnect is capitalised on by governments and private profiteers, who exploit crises with socially oppressive and big-budget projects, such as desalination and the interlinking of rivers.<sup>33</sup> Such projects have resulted in the salination of water through hand pumps, with adverse effects on aquatic life due to waste, including dirty water and trash rejects, being dumped by the factory. The ecology has also been affected by desalination projects built on marshlands. Affected villagers now have to rely on external sources for water (private bottled water) and food (non-availability of fish). The impudence of the so-called developmental work has paved the way for the setting up of two more desalination plants: a 150-mld DSP plant funded by Germany’s KfW and another 400-mld plant with Japanese support.<sup>34</sup> A third is currently on its way.<sup>35</sup>

The 150-mld DSP plan includes a seawater intake facility with a reverse osmosis (RO) section, post-treatment section and brine discharge facility. A water transmission system has also incorporated the pre-treatment steps. The RO system uses water from the pre-treatment using a filtered water pump. Post-treatment, the limestone system is used to handle easiness before the water is delivered to consumers. The water quality is adjusted with NaOH to maintain a positive Langelier Saturation Index. Disinfection is conducted with chlorine.<sup>36</sup> The product water transmission pumps at the DSP transports the desalinated water through water transmission mains, water distribution stations and networks. A brine header (from the RO trains) is connected

<sup>23</sup> Ge, “From Floods to Drought.”

<sup>24</sup> The earlier project, in 1967, had also failed. See details at <https://cuddalore.nic.in/tourist-place/veeranam-lake/>.

<sup>25</sup> “Environmental Assessment of Second Madras Water Supply Project New Veeranam.”

<sup>26</sup> “Environmental Assessment of Second Madras Water Supply Project New Veeranam,” 33, 38.

<sup>27</sup> The previous Chief Minister Jayalalithaa (AIADMK) accused the DMK of shelving this project for political reasons and out of fear that it would fail just like the original. See “Jayalalitha Slams DMK for its Failures.”

<sup>28</sup> UN Water, Water and Climate Change. See also Garthwaite, “The Effects of Climate Change on Water Shortages.”

<sup>29</sup> Ge, “From Floods to Drought.”

<sup>30</sup> Molden, Water for Food.

<sup>31</sup> Brondizio, Global Assessment Report.

<sup>32</sup> Latour, Down to Earth.

<sup>33</sup> Padalam, Sulerikattukuppam, a fishing hamlet one hour’s drive from Chennai, is another solution-impacted community. Until 2011, the villagers had consumable sweet water accessible from shallow hand-pumps. This changed during construction of a 100 million litres per day seawater desalination plant to supply water to the IT corridor in the city’s south. The dunes that sustained the subsurface water were levelled, and the running of massive pumps to level the foundation throughout the day for months saw the freshwater flow from the surrounding sands into the deep foundation pits. Over time, the structures built into the sea for plant construction caused sea erosion.

<sup>34</sup> Supply and Sewerage Board, Republic of India Preparatory Survey on Chennai Seawater Desalination Plant Project.

<sup>35</sup> Lakshmi, “Work on Third Desalination Plant.”

<sup>36</sup> More information about desalination pretreatment can be found at Lenntech, “Desalination Pretreatment: Seawater Chlorination.”

to the discharge pit to receive neutralised wastewater for dealing with effluents from the wastewater tanks. Lastly, effluents are discharged from the DSP to the discharge pit to the sea through discharge pipes.<sup>37</sup>

Desalination plants affect wetlands and the groundwater-rich agrarian sprawl of the Chennai Corporation, which includes the Chennai District (or Chennai Core City) and part of the districts of Thiruvallur and Kancheepuram.

The disconnect between public policy and the role of actors is relevant in managing and inducing law and technology in the case of droughts, water shortages and erratic rainfall. The problem of city water supply pertains to the equity that involves different sections of the population. A scarcity of water and food affecting disadvantaged populations aggravates infectious disease rates. The poor are on the receiving end of weak health systems, poor infrastructure, reduced technological capability and scarce resources to adapt to climate change and the water crisis. The usual slow state response to droughts has resulted in the poor being entirely dependent on groundwater, which has emerged as a depleting source. High-priced water from private tankers, particularly in Chennai,<sup>38</sup> and the lack of rainwater harvesting systems in Chennai<sup>39</sup> have resulted in widening gender inequities as women line up for hours to fill their pots with water, with the responsibility for water collection for the household falling solely on them.<sup>40</sup>

The effect of this is the persecution of refugees and migrants in their countries, and the large numbers are small compared with the volume of environmental refugees and immigrants who come from neighbouring countries due to natural calamities and rising sea levels.<sup>41</sup> The crisis has resulted in water being transported from the outskirts to Chennai. This has caused livelihood problems in the villages<sup>42</sup> and has drained water resources in the outskirts, resulting in a drop in the water table or the complete drying up of underground water. The remaining surface water has been either completely neglected or encroached on. This has also resulted in the dislocation of people from villages to cities, with a lack of opportunities in villages resulting in more people migrating to the city, creating a new lack of jobs and resources (including water) in cities, dislocating people from cities to villages. These social problems put a strain on both villages and cities.<sup>43</sup> Further, they threaten the rights of women, most notably rural women in developing countries, who are vulnerable to climate change. Women as the primary caregivers also experience an increase in their workload due to the water crisis and climate change that, in turn, affects the children through the absence of women at home to provide care. When mothers must leave the home to work due to the water crisis, the responsibility falls on teenage girls, who are taken out of school to look after younger children or conduct household chores.<sup>44</sup> The psychological influence of climate change and the scarcity of water is more significant for marginalised individuals, with signs of distress being common.<sup>45</sup> The disproportionate effect of climate change on marginalised people and the consequential effects of this on these populations in terms of social and environmental justice are significant.<sup>46</sup> Research in India has shown that global climate change is likely to worsen the effects of droughts in the years to come. A relationship has been found between the occurrence of drought and farmer suicides.<sup>47</sup> These problems must be addressed, with solutions to the water crisis requiring immediate attention and sustained results.

### III. Government and Court Response to the Water Crisis

The solution to the concerns surrounding droughts and water shortages can be understood through government and court action and inaction. The failure to adequately address the water crisis in Chennai by the central and state governments and the Supreme Court of India is explored in this section of the paper. Climate change denialism, which has led to a delay in the implementation of viable solutions to the crisis of water and climate and a failure to balance socioeconomic needs with ecological sustainability, is also addressed in this section. The water-sharing regime imposed by the Supreme Court of India has also failed by not

<sup>37</sup> "400 MLD Sea Water Reverse Osmosis Plant (Desalination Plant) Project." See also Supply and Sewerage Board, Republic of India Preparatory Survey on Chennai Seawater Desalination Plant Project.

<sup>38</sup> The Wire Staff, "Private Vendors Increase Prices." See also TNN, "Tanker Water."

<sup>39</sup> Raghavan, "Rainwater Harvesting." See also Fong, "Leveraging Rooftop Rainwater Harvesting"; Thirumurthy, "Over 40,000 Buildings"; Karunanithi, "Why Chennai-style Rainwater Harvesting Doesn't Work."

<sup>40</sup> Trivedi, "Responding to Day Zero Equitability."

<sup>41</sup> Brown, "Migration and Climate Change." See also Basu, "Water Scarcity and Migration"; Iceland, "Water Stress."

<sup>42</sup> Janakarajan, "Urbanization and Peri-urbanization," 51.

<sup>43</sup> Janakarajan, "Urbanization and Peri-urbanization."

<sup>44</sup> See Koolwal, "Access to Water."

<sup>45</sup> O'Brien, "Drought as a Mental Health Exposure," 181. See also Willox, "Examining Relationships," 169.

<sup>46</sup> Hayes, "Climate Change and Mental Health," 28.

<sup>47</sup> Deshpande, "Suicide by Farmers in Karnataka." See also Sarma, "Is Rural Economy Breaking Down?"

facilitating mutually amicable solutions. These failures on the part of the two public agencies, the government and the court, unduly affect women and agricultural workers.<sup>48</sup>

The World Water Assessment Programme ([WWAP] 2003), while acknowledging that the water crisis is essentially a crisis of governance, states that ‘the weaknesses in governance systems impede progress towards sustainable development and the balancing of socio-economic needs with ecological sustainability’.<sup>49</sup> Governance to curb climate change and ease the water crisis must imbibe the actual mechanics of wielding influence and social change. Leaders’ perceptions influence public policy, and there is space for using strategies, particularly in focused practical dimensions.<sup>50</sup> In the context of climate change and the water crisis, the large-scale implementation of strategies by the general population makes it the epicentre for the argument of influence and action.<sup>51</sup>

During Prime Minister Narendra Modi’s first term in office in 2014, he stated that the climate has not changed—rather, our habits have changed, and this change in habits is what is responsible for the destruction of the environment. Prime Minister Modi made his comment in response to a question on concerns about climate change by a school student.<sup>52</sup> He has held a second term from 2019 and has not issued a rectification since. Former US President Donald Trump opted out of the Paris Agreement, an international treaty on climate change,<sup>53</sup> stating that he did not believe the climate change report submitted by his government. Inaction by ‘climate quietists’ who state that ‘everything will be all right in the end’<sup>54</sup> has resulted in the overlooking of viable solutions to the crises of water and the climate.

India’s position on the Paris Agreement as an Intended Nationally Determined Contributions, with a submission made to the United Nations Framework Convention on Climate Change in October 2015, states a commitment to cutting the emissions intensity of the country’s gross domestic product by 33–35% from 2005 levels by 2030. India included in its submission that the requirement to achieve its 2015–2030 goal was 2.5 trillion USD.<sup>55</sup>

The former Chief Minister of Tamil Nadu, Edappadi K. Palaniswami, downplayed the scarcity of water in June 2019, dismissing associated reports as an exaggeration by the media and the opposition.<sup>56</sup> In the same period, S. P. Velumani, the state minister of Tamil Nadu for the municipal administration, claimed that the alleged drought and water crisis was a rumour.<sup>57</sup> This indifference by leaders reflects the absence of a common world for them and a lack of thought to the common man. This denial has led to new forms of injustice and inequality strung together by contradictions present in the climate change debate of the different effects of the crisis on the rich and the poor.<sup>58</sup> Other notions of wealth and accessibility are intertwined with this argument and are bound up with the issue of economic growth and the state of the environment.<sup>59</sup>

The question of whether drought is real as opposed to a rumour affects the implementation of mechanisms to work for recovery, avoidance, tolerance and escape that become the consequence of inaction. For example, the Tamil Nadu state government initially refused water offered from the neighbouring state of Kerala to recover from the drought based on the notion that the drought was not real,<sup>60</sup> before finally beginning to accept help from other states after it was too late.<sup>61</sup> Neither of the two prominent political parties (All India Anna Dravida Munnetra Kazhagam and the DMK) has taken measures to protect wetlands and floodplains in recent decades, with periodic accusations from both parties that the other has pledged people’s interest for their political survival.<sup>62</sup>

<sup>48</sup> Jain, “Women Bear the Burden.” See also Division for the Advancement of Women, “Women and Water.”

<sup>49</sup> UNESCO Division of Water Sciences, World Water Assessment Program, 30.

<sup>50</sup> Alasuutari, “Epistemic Governance,” 67.

<sup>51</sup> Partida, “The World is in a Water Crisis.”

<sup>52</sup> Indian National Congress, “PM Narendra Modi on Climate Change.”

<sup>53</sup> “Paris Climate Deal.”

<sup>54</sup> Latour, *Down to Earth*, para 3.

<sup>55</sup> Ministry of Environment, Forest and Climate Change, India’s Intended Nationally Determined Contribution.

<sup>56</sup> TNM Staff, “TM CM Palaniswami.”

<sup>57</sup> Special Correspondent, “Misleading Information.”

<sup>58</sup> See generally, Mendelsohn, “The Distributional Impact”; Steiner, “Climate Change is a Threat.”

<sup>59</sup> Brock, “Economic Growth and the Environment.” See also Grossman, “Economic Growth and the Environment.”

<sup>60</sup> Agamben, *What is Real?*

<sup>61</sup> Kaveri, “Kerala Offers.” The offer from the Kerala Government of about 2 million litres of water every day was accepted by Tamil Nadu on a later date. See also Press Trust of India, “Palaniswami Welcomes Kerala’s Water Offer.”

<sup>62</sup> India Today Web Desk, “As Tamil Nadu Reels.” See also “MK Stalin blasts AIADMK.”

At the national level, the Bharatiya Janata Party's 2014 election manifesto mentioned drinking water for all. However, government funding has been reduced for its rural drinking water program over the last few years.<sup>63</sup> The Bharatiya Janata Party's 2019 election manifesto made promises for a new ministry for water and a 'Jal Jivan Mission' to ensure piped water to households by 2024. Although the government has established a new ministry, critics are sceptical of its usefulness.<sup>64</sup> The 2020 budget allocations resulted in increased allocation for drinking water while reducing funds for water conservation purposes.<sup>65</sup> Issues that have not been taken up as electoral issues include the absence of initiatives to restructure water institutions and address reductions in groundwater, lobbying for large dams, the increasing footprint of the urban water sector and the decline of the state of rivers.<sup>66</sup> The circumstances of modernisation, whereby there is a conflict between modern humans and their surroundings and the effect of climate change, represent a state of war, albeit a phony war, seen as omnipresent by some while being ignored by others.<sup>67</sup> Donald Trump, then President of the US, ignored warnings surrounding climate change while pulling out of the Paris Accord, claiming that the threat of climate change applies unequally to nations. This meant he was unable to see the dangers of engaging in a war with climate change.<sup>68</sup>

Indian politicians endlessly politicise water issues by blaming the opposition party for the ongoing water crisis;<sup>69</sup> however, drinking and irrigation water is not an issue during election campaigning, nor do voting patterns reflect the fact that voters value these issues.<sup>70</sup> The Delhi state government is an exception to voting patterns; here, the electorate rallied around the central issues of water and electricity, and this resulted in the election of a non-traditional political party.<sup>71</sup>

As a consequence of inaction, in December 2015, the Chembarambakkam reservoir filled up and overflowed following the monsoon, which resulted in the opening of the sluice gates, sinking significant parts of the city.<sup>72</sup> All four reservoirs on which Chennai depends for its water supply are now dry.<sup>73</sup>

Concerns surrounding water scarcity and the distribution of resources resulted in the Supreme Court of India's decision to look for an ideal mechanism for water sharing between the neighbouring states of Tamil Nadu and Karnataka.

The distribution of water between the three neighbouring states of Kerala, Karnataka and Tamil Nadu has been an issue of contention from 1799 to the present. The Supreme Court analysed the issue of water sharing from the genesis of the controversy, starting from the Subsidiary Alliance Treaty in 1799 and the continued conflict between the three states. Over time, work was undertaken in the territory of the State of Mysore to restore the river; this was protested by the Collector of Tanjore in the Madras Presidency,<sup>74</sup> with continued insistence that the State of Mysore had the right to use the natural water forces flowing through its territory.<sup>75</sup> Thereafter, efforts seeking equal participation for any new reservoir work and irrigation were made by the States of Madras or Mysore on the river Cauvery by an agreement in 1892. A subsequent agreement in 1924 related to regulation of the discharge of water through and from the concerned reservoir was agreed to by the Mysore Government. Subsequent agreements were made between both states, before and post-independence, regarding the extension of irrigation areas, the covering of new irrigation areas and the need to avoid water use fluctuations.<sup>76</sup> However, none of these agreements resolved the water sharing and irrigation issues between the states, and, following numerous attempts to resolve the issue, litigation commenced. The most recent attempt at litigation culminated on 16 February 2018, when the Supreme Court of India delivered its verdict considering the drinking water needs of Karnataka in the face of an acute water crisis and widespread unrest in both states. The Supreme Court of India was unwilling to interfere in the orders of the Cauvery Water Disputes

<sup>63</sup> Venkataramkrishnan, "The Election Fix."

<sup>64</sup> Sengupta, "Can Ministry of Jal Shakti Save Indian Rivers?"

<sup>65</sup> Mathur, "Budget 2019."

<sup>66</sup> Thakkar, "A Story of Missed Opportunities."

<sup>67</sup> Latour, *Down to Earth*, 90.

<sup>68</sup> Latour, *Down to Earth*, 90: 'By pulling out of the Paris Accord, Trump explicitly triggered, if not a world war, at least a war over what constitutes the theater of operations. We Americans don't belong to the same earth as you. Yours may be threatened but ours won't be'.

<sup>69</sup> See, for example, Hanasz, "The Politics of Water Governance," 1.

<sup>70</sup> Ge, "From Floods to Drought."

<sup>71</sup> AAP, 70-Point Action Plan.

<sup>72</sup> Ramani, "A Wrong Call." See also Lakshmi, "Gates of Chembarambakkam."

<sup>73</sup> "Chennai Water Crisis." See also Subramani, "How Chennai Overcame"; Ministry of Jal Shakti, "1892 Agreement between Mysore and Madras."

<sup>74</sup> *The State of Karnataka by its Chief Secretary to Government v State of Tamil Nadu by its Chief Secretary & Ors. and State of Kerala through the Chief Secretary to Government v State of Tamil Nadu through the Chief Secretary to Government and others*, Civil Appeals 2453 and 2454 of 2007, Supreme Court of India, 50.

<sup>75</sup> *The State of Karnataka by its Chief Secretary to Government*, 53.

<sup>76</sup> *The State of Karnataka by its Chief Secretary to Government*, 62.

Tribunal, which made some realignments in water allocation. Tamil Nadu was asked to consider its underground water sources, and its share was reduced by 10 tmcft (one thousand million cubic feet).<sup>77</sup>

**Table 1: Quantity of water allocated to Karnataka and other neighbouring states by the Supreme Court of India in 2018**

State	Quantity of water allocated in 2018
Karnataka	284.75 tmcft (increased by 14.75 tmcft)
Tamil Nadu	404.25 tmcft (as opposed to 419.25 tmcft). Reduced water share from 192 tmcft to 177.25 tmcft received from the Karnataka, TamilNadu inter-state border, Biligundulu)
Kerala	30 tmcft (no change from Tribunal decision)
Puducherry	7 tmcft (no change from Tribunal decision)

Attempts to implement the Supreme Court of India's decision were met with protests, with the Tamil Nadu Government filing a contempt petition before the Supreme Court of India seeking action against the Central Government for 'willfully disobeying' the court's order.<sup>78</sup> This intervention of the Supreme Court of India for an ideal mechanism to deal with a failed water-sharing nexus between the two states of Tamil Nadu and Karnataka has been unsuccessful in recent, with technology excluded from any intervention.<sup>79</sup>

The Supreme Court's decision has had a wider range of repercussions, as the water crisis is non-linear and affects not only the shortage of drinking water but also the accessibility of clean drinking water. The crisis also affects regional conflicts over water access. Addressing this nexus should be the focus for any policy and technology change developed to adapt to or mitigate the effects of climate change. In this nexus, water projects, such as dams, are also a source of electricity development as part of post-independence structural economic reforms and have resulted in indebtedness through development loans from the World Bank and the Asian Bank.<sup>80</sup>

Implications of the court's decision are affected by the wealth divide, the water crisis and the associated problems of food and energy. A direct implication of governance impudence is that more people compete for fewer resources, with rising water prices due to scarcity. Such circumstances create a state of desperation, endangering civil rights, democracy and the rule of law. A UN Human Rights report pointed out that human rights may not survive such an upheaval.<sup>81</sup> In the context of extreme wealth inequalities in India,<sup>82</sup> with increased state inequalities in a few states in particular, including the state of Tamil Nadu,<sup>83</sup> the ongoing water crisis and the effect of climate change pose similar challenges to human rights.<sup>84</sup> Women, children and socially and economically vulnerable populations are most affected. Water problems are gendered, with women being traditionally entrusted with fetching water for the home from public water points.<sup>85</sup> Women often have to walk long distances and wait for many hours, depending on where the source of water is.<sup>86</sup> This has other repercussions, such as loss of education. When water availability is scarce, families can be forced to rely on unsafe water, which leads to disease and illness, death and higher infant mortality.<sup>87</sup> Women also lose out on agricultural employment, which creates livelihood problems. Such problems have been noted by women who report doing housework.<sup>88</sup> Other consequences of unhygienic water include ill effects on the unborn child when clean water consumption is sacrificed by women for other members of the family.<sup>89</sup>

The water crisis also stresses natural resources and the food supply.<sup>90</sup> This strain must be seen from the perspective of the population and natural resources. Population control measures, such as the two-child rule, have been put in place.

<sup>77</sup> *The State of Karnataka by its Chief Secretary to Government*, 62.

<sup>78</sup> Muruganandha, "Cauvery Management Board."

<sup>79</sup> D'Souza, "Nation vs. Peoples," 58.

<sup>80</sup> The World Bank, "Project Signing"; Asian Development Bank, "\$231 Million ADB Loan." See also Rich, "The Emperor's New Clothes."

<sup>81</sup> Alston, *Climate Change and Poverty*.

<sup>82</sup> Oxfam International, "India: Extreme Inequality in Numbers."

<sup>83</sup> Chadha, "Disastrous Inequality."

<sup>84</sup> Tallan, "Chennai's Water Crisis."

<sup>85</sup> Kulkarni, "Women and Decentralised Water Governance."

<sup>86</sup> Kulkarni, "Women and Decentralised Water Governance."

<sup>87</sup> Cronina, "Water in India."

<sup>88</sup> Janakarajan, "Urbanization and Peri-urbanization."

<sup>89</sup> Baker, "Impact of Social Capital."

<sup>90</sup> Mancosu, "Water Scarcity."



The solution for population control and city expansion lies not in forcing people out. Instead, land-friendly economic opportunities must be created for people willing to migrate out of Chennai. Disassociating the link between the capital city of Chennai and the exercise of power over its peripheral areas can be a way to provide the motivation to migrate to peripheral regions of the State of Tamil Nadu.<sup>91</sup> In the case of migration outside the city of Chennai, access to water cannot be guaranteed by access to land, as groundwater is not accessible.

Data collection and dissemination, along with the use of various forums, have raised people's awareness and, in recent times, have mobilised audiences.<sup>92</sup> However, climate variability, agricultural collapse, soil erosion and mass migration from the global south are bound up with issues of conflict and insecurity.<sup>93</sup> In future, this will result in a new categorisation of migrants and environmental refugees, leading to social and political tension.<sup>94</sup> According to a UN Expert, 'the world is fast approaching climate apartheid where only the wealthy can afford basic resources in the face of fatal droughts, famine, and heatwaves'.<sup>95</sup>

#### IV. Solutions and Road Map for Chennai

This section considers six viable solutions to the water crisis in the city of Chennai, focusing on solutions that can be implemented locally by policymakers to address the issues of water, poverty and climate collectively.<sup>96</sup>

Recommendations by the Chennai Metropolitan Development Authority in 2008 to avert floods in Chennai included converting the 'constraints in disposal of floodwaters into an opportunity ... for augmenting urban water supply through the creation of additional storage capacity, developing a network of open spaces to provide a green environment to be used as flood moderators and for preventing encroachments'.<sup>97</sup> However, the recommendation to identify 'areas where development other than those appropriate to use them as open spaces which have to be prohibited or severely restricted' has been criticised as being out of touch with grassroots realities and as having the potential to lead to a lack of participation from stakeholders in assessing the viability of the solutions.<sup>98</sup> The first solution to this problem is to address stakeholder participation. Strategies for stakeholder participation can be used to prevent conflicts, manage trade-offs, raise awareness and build intersectoral complementarities at the right scale.

The Sustainable Development Goals set by the UN in 2015 mention local participation and other governance goals related to water resources.<sup>99</sup> This is in sync with the Organisation for Economic Co-operation and Development's (OECD) principles on water governance adopted by 34 member countries and endorsed at the ministerial level. These principles call for 'promoting stakeholder engagement for informed and outcome-oriented contribution to water policy design and implementation'.<sup>100</sup>

Four levels of stakeholder participation are advocated: (1) information, (2) implementation, (3) involvement and (4) representation.<sup>101</sup> Stakeholders should include residents, particularly from the farming community and women. Evidence shows that the participation of women in the management of water resources has resulted in its success.<sup>102</sup> Certain mandatory criteria may need to be included at each of the four levels. Identifying the appropriate mechanism for engaging stakeholders according to the situation, such as the need to prepare for upcoming water crises, is crucial to the success of stakeholder participation.<sup>103</sup>

Identifying and including vulnerable stakeholders and understanding their interest and motivation for participating in the policy process would prevent the arbitrary selection of participants.<sup>104</sup> This selection would also assist in ascertaining remedies for

<sup>91</sup> Schatz, "When Capital Cities Move."

<sup>92</sup> The World Bank, "Raising Awareness."

<sup>93</sup> Roschmann, Climate Change.

<sup>94</sup> Bhattacharyya, "Climate Change, Migration and Conflict," 3.

<sup>95</sup> "World Faces 'Climate Apartheid' Risk."

<sup>96</sup> Partida, "The World is in a Water Crisis."

<sup>97</sup> CDMA, Second Master Plan for Chennai Metropolitan Area, 2026. Volume 1. Chapter 9.

<sup>98</sup> As mentioned in Comptroller and Auditor General of India, Report of the Comptroller and Auditor General of India. Flood Management and Response in Chennai and its Suburban Areas.

<sup>99</sup> Sustainable Development Goals, United Nations Development Programme.

<sup>100</sup> OECD Water Governance Initiative Thematic Working Group 1, Stakeholder Engagement.

<sup>101</sup> Arnstein, "A Ladder of Citizen Participation," 216.

<sup>102</sup> The recent Indian National Water Policy of 2012 acknowledges the importance of a women-centric water policy and infrastructure, considering the hardships caused to women as a result of water scarcity. Kholif, "Activating the Role"; Trivedi, "Women are the Secret Weapon"; The World Bank, "Promoting Women's Participation." See also Khandker, "Gender Perspective in Water Management."

<sup>103</sup> OECD Water Governance Programme, Stakeholder Engagement.

<sup>104</sup> See, for example, Boakye-Agyei, "Stakeholder Participation."

implementing the engagement processes; handling customers complaints; and related policy guidance on whether, when and how to compensate a given water reform or project.<sup>105</sup> One commentator pointed out that this also addresses various concerns of ‘absence of political will and leadership, the lack of time, staff and funding, weak supportive legal frameworks, resistance to change and reluctance to relinquish power, weak capacity, the lack of citizens’ concern and awareness, information asymmetry, fragmented settings, and the complexity of issues at hand’.<sup>106</sup> Working in collaboration with the national level, Metropolitan, Municipal and District Assemblies have sought to acquire information on improved tools for better water quality and quantity management, thereby providing a valuable contribution to this field.<sup>107</sup> Other aspects of sharing views and priorities help increase stakeholders’ willingness to pay, raise awareness on water risks and costs, foster co-production of services and policy, manage trade-offs related to water allocation and prevent or solve conflicts over water use.<sup>108</sup>

The involvement of stakeholders in water governance has seen success in India in civil society debates on the interlinking of rivers scheme by the Central Government, which was initiated after 2002. The involvement of public stakeholders included non-governmental organisations (NGOs), such as the South Asian Network on Dams, Rivers, and People, International Water Management Institute and the Centre for Science and Environment; water experts Mr Ramaswamy Iyer and Dr Jayanta Bandhyopadhyay; and formal interest groups, such as the National Civil Society Committee on Interlinking of Rivers in India and WaterWatch Alliance. There were ad hoc recourses used by interest groups to facilitate dialogues and pressurised governments to release documents and reports related to the proposed schemes into the public domain. This resulted in a critical evaluation of the detailed project report for the Ken-Betwa link by the National Civil Society Committee on Interlinking of Rivers in India, which found serious shortcomings.<sup>109</sup> A similar arrangement, resulting from stakeholder participation in Chennai, has been by NGOs and ad hoc interest groups. While these actions are important, they are not a panacea and must work collectively with other solutions, particularly in terms of the resources available, to facilitate widespread engagement.

As Chennai is a temple city, a second viable solution would be to revive temple tanks.<sup>110</sup> In previous centuries, the water stored in tanks attached to temples known as *kovilkulam* was designed for the ritual baths of the deity. This water was also available for devotees to wash their hands or feet in or to engage in a holy dip before entering a temple. The temple tank was the focal point of several Hindu religious festivals, such as the *theppam* or float festival, for offering prayers to one’s ancestors and meditating on the banks. Successive rulers of ancient Tamil Nadu underscored the importance of the temple tanks.<sup>111</sup> The temple tanks were generally structured with corridors and flights of steps around them. The presence of intricate inlet chambers brought water to the tanks from streams or rivers, and outlets carried away the excess water. Some temple tanks have natural springs in their bed and others have a well that can be accessed when the tank is dry. These arrangements and careful planning ensured that temple tanks would always have water, even when all other sources had dried up.<sup>112</sup> However, over the course of time, the tanks fell into neglect, and water conservation via the tanks did not form part of the plan for modern-day Chennai. The tanks were left unattended and, unless they were maintained by private temple trusts for religious purposes, are now stagnant water bodies.

Increased water demand, land fragmentation and changing land-use patterns explain the neglect of the temple tanks.<sup>113</sup> An effective community system that can explore water sharing and accountability, involving different responsibilities, as in the case of the traditional irrigation institutions, is needed.<sup>114</sup> There is a further need for a legal basis for implementing guidelines to resolve the problem of the transfer mechanism, particularly with the extent of coverage, authority and liabilities. Regulatory authorities are required to address issues of standards and rights with mechanisms designed to ensure effective accountability for accessing roles and responsibilities, along with monitoring mechanisms and penalties. For regulatory mechanisms to be effective, there must be a capacity to enforce agreed standards and impose sanctions for noncompliance. Finally, there is a need

<sup>105</sup> Boakye-Agyei, “Stakeholder Participation.”

<sup>106</sup> Boakye-Agyei, “Stakeholder Participation.”

<sup>107</sup> Akhmouch, “Stakeholder Engagement,” 204.

<sup>108</sup> UN Water, *From Vision to Action*.

<sup>109</sup> Pasi, “Rethinking Water Resources Management.”

<sup>110</sup> Krishna, *Ecological Traditions of India*.

<sup>111</sup> Special Correspondent, “Temple Tanks.”

<sup>112</sup> Alaguraj, “Temple Tanks,” 138.

<sup>113</sup> Mosse, “Rule and Representation.”

<sup>114</sup> These might require legal support to make them viable, as can be seen in countries like Spain, Japan, Chile and the US. In Mexico, however, despite a changing and chaotic legal framework, informal or non-official irrigator organisations and horizontal agreements do exist. See, Palerm-Viqueira, “Are Visible and Strong Legal Frameworks.” Examples of such systems can be seen in other countries like Indonesia, based on local wisdom. See Rejekiingrum, “Institutional Development.”

for constant review to adapt to unforeseen challenges.<sup>115</sup> Regulations governing access to the tanks mandate that Irrigation District management are a stakeholder in participation.

Giving control to the local community could address the existing vague responsibilities of ownership of the tanks as common property held by the community, as well as issues of control, which could be resolved by involving institutions at the village level and those surrounding the villages, such as NGOs. Involving the local community can be a factor in decisions made at appropriate levels, from manual work, to inspecting the tanks, to addressing deterioration or damage.

Water bodies surrounding these temple tanks can then serve as an important focal point for maintaining the hydrological balance of the area by keeping in control the microclimate of the area. These tanks, if made functional and in working condition, could be used to preserve water at the surface and ground through percolation after the rainy period for later use in the area. The temple tanks can be used not only to store water for future public consumption but also to recharge other water bodies nearby as self-standing tanks. These tanks could also protect the residential areas against flooding that often follows heavy rains during recurrent spells of cyclones in South India, including in Chennai. With nearly 40 temple tanks in Chennai, this could represent an effective measure for addressing the water crisis.

Storing water in water tanks carries concerns of water pollution and health problems if the water is used for potable water purposes, such as drinking water. This water will need to be treated, and operational monitoring, management plans, documentation and communication will be required. Health-based targets will also need to be developed, along with the introduction of a system assessment and design, with fixed health-based targets and surveillance of the drinking water quality.<sup>116</sup> There should also be consideration for technology that can be used once the initial volumes of groundwater and water allocations are used from these tanks.<sup>117</sup> Automated cleaning of tanks is also essential to retain the portability of water, along with water treatment measures.

Temple tanks have been revived to a large extent in Tamil Nadu, and they are used for water storage in the state's districts.<sup>118</sup> Such efforts must continue to be implemented in the remaining temple tanks. Efforts to revive temple tanks in Bhuvaneswar, Orrisa, have also been successful, with the need to combine history and geography being advocated.<sup>119</sup> Siltation of the temple tanks and the dumping of public waste into them are major causes for concern, and both these issues require special attention when reviving temple tanks.<sup>120</sup>

The third solution involves using innovative methods to address water wastage by water tankers, which is the primary mode of transporting water in India. Private and public tankers are used to transport water to areas facing water shortages. These water tankers leave a trail of water on their way to the destination—a similar problem experienced by oil tankers to which a solution was found. Arguments against seeking a solution for water tankers are based on the notion that oil is more precious than water; however, the validity of such arguments are doubted by the reality of the situation of severe water scarcity. Tighter regulation about water wastage and spillage through water tankers is needed. Technology must be used to ensure safe water for potable use through water tankers, along with the regulation of the transportation of potable water. One solution for the state is to partner with the innovators and patent holders of relevant technologies.<sup>121</sup>

The World Health Organization has found that water tankers can be used to transport water to areas in need during the initial phase of an emergency. The use of tankers to transfer water is, however, expensive and relatively time consuming, though not to the extent of alternative solutions, such as bottled water, whereby empty bottles are discarded. There is also a need to avoid scuffles near water tankers when dispensing water directly; water should be off-loaded to storage tanks rather than having people collect water directly from the tanker. A storage tank connected to communal taps could be a better method for ensuring that water tankers are effective. Communal taps, however, require infrastructural commitments by governments. Additional issues associated with water tankers, including locating filling points close to a delivery point and ensuring the presence of a good drainage point near every filling point, must also be considered. The water tankers themselves must be well maintained, with regular cleaning and disinfecting of storage tanks. Water infrastructure that can deliver water to households, while costly for the government, could improve the supply of potable water. Such measures should be implemented without transferring the

<sup>115</sup> Jiménez, "Unpacking Water Governance."

<sup>116</sup> WHO, Guidelines for Drinking-water Quality.

<sup>117</sup> UNCTAD, Water for Food.

<sup>118</sup> Ganesan, "The Temple Tanks of Madras," 1.

<sup>119</sup> Khanna, "Temple Tanks in the Landscape."

<sup>120</sup> Khanna, "Temple Tanks in the Landscape."

<sup>121</sup> See, for example, Indian patent number 202017007855, titled "Apparatus and Method for treating Silica-Containing Water," and Indian application number 202147033923, patent application on "System for Purifying Water by Recrystallization and Heat Exchange Devices (deviants) for the Implementation Thereof." This application is pending the grant of patent.

costs of water infrastructure to low-income households. The frequent use of water tankers could also damage poorly constructed roads due to the use of heavy vehicles for transportation—an issue that must be assessed before initiating water transportation. Suitable modifications to water tankers should also be considered for water dispersion to multiple families and a method for addressing water wastage during water transport sought.

Private tankers in Delhi have filled a large portion of the gap between supply and demand, which has added to the capabilities of government-run tankers. However, a downside of this is the emergence of the so-called tanker mafia. An alternative would be to improve areas linked to the water supply, such as fixing pipe leakages and installing individual motors for consumers.<sup>122</sup> Regulation in the form of capping the price of the water cans and ensuring that water is potable for use is also required.

A fourth solution involves better reservoir management and infrastructure, along with a curbing of real estate work in and around lakes and flood plains. Water reservoir management has been conducted since the time of the Indus Valley Civilisation. In this civilisation, intricate systems of water harvesting and drainage were implemented in Harappa, Mohenjo-Daro and other sites. Sringerapur, near the modern-day Allahabad, had a sophisticated water harvesting system that used the natural slope of the land to store floodwaters of the river Ganga.<sup>123</sup>

Therefore, in addition to maintaining and sustaining temple tanks, a water resource management plan to identify seasonal tanks and ponds must also be designed. Water management plans should integrate pre-existing tanks and ponds with rainwater harvesting to enable the recharge of groundwater and collection of surplus water. An additional maintenance plan that inspects these structures, resources and the surrounding areas should also be drawn up to curtail negative developments and damage to and deterioration of the environment.<sup>124</sup> Systems of water harvesting are not new and are used in several countries, such as Sri Lanka.<sup>125</sup> A sophisticated planning system that allows sufficient floodway and water diversion zones and their enforcement is a viable option. However, when there is a lack of political will to address water scarcity and climate change, problems of enforcement will emerge.

In the context of climate change, reservoir databases must investigate the proportion of reservoirs with seasonal separations between flood and conservation storage. The changes observed in the amount of release and the distribution of habitats would help water management adapt to changing conditions.<sup>126</sup> This is an issue of managing dam operations for both flood control and water conservation and storage. These issues are becoming more pressing as climate change effects increase. This is a problem for countries with large seasonal changes and patterns of flood and drought. An example of this is the outcome of a class-action lawsuit in Australia relating to mismanagement of the Wivenhoe Dam and the Brisbane floods disaster, which led to a settlement of A\$400 million with the Queensland Government and SunWater, the dam's operator.<sup>127</sup>

In India, the Watershed Development Component project of Pradhan Mantri Krishi Sinchai Yojana constructed water harvesting structures that helped improve water availability in project areas. In Telangana state, in Gunjala—a tribal village of Tamsi Mandal under the Gunjala micro watershed—the Integrated Watershed Management Programme (IWMP-I/2009-10) addressed the problems of a very low groundwater table (below 300–400 ft), the unavailability of a reliable natural water source and the absence of any man-made water harvesting structures. Water-retaining structures, such as loose boulder structures (97), rock field dams (31), percolation tanks (2) and check dams (3) were constructed, with the project costing Rs.39.12 lakhs.<sup>128</sup> These measures improved the water harvesting potential of the watershed and increased the productivity of cotton (from 6.5 Q/acre to 10 Q/acre) and redgram (from 1.4 Q/acre to 3 Q/acre).<sup>129</sup> These projects have also been successful in certain districts of Tamil Nadu, including Dindigul, and could benefit other areas of Tamil Nadu.<sup>130</sup> These measures could allow more infiltration into groundwater storages by decreasing runoff and could, in the long term, contribute even more depletion of groundwater storage. Further, on the regulatory level, expansive planning for enforcing and implementing this top-level administrative suggestion is needed.

<sup>122</sup> Bansal, “Private Water Tankers.”

<sup>123</sup> Agarwal, *Water Conservation Techniques*.

<sup>124</sup> Kaptan, “Heritage Management of Temple Tanks,” 365.

<sup>125</sup> Abeywardana, “Evolution of the Dry Zone.”

<sup>126</sup> Hickey, “Improving Reservoir Management.”

<sup>127</sup> *Rodriguez & Sons Pty Ltd v Queensland Bulk Water Supply Authority Trading as Seqwater* (No 22) [2019] NSWSC 1657.

<sup>128</sup> Details can be found in an independent report: Ministry of Water Resources, *Best Practices of Ground Water Harvesting*. Similar initiatives can also be seen in the state of Odisha: [https://dolr.gov.in/sites/default/files/Odisha%20Batch%20I\\_opt.pdf](https://dolr.gov.in/sites/default/files/Odisha%20Batch%20I_opt.pdf).

<sup>129</sup> Rani, *Nutrition Security*, 28.

<sup>130</sup> Department of Land Resources, *Success Stories*.

The use of artificial intelligence (AI) for reservoir management and infrastructure is also part of the solution to the water crisis. Success stories using AI in everyday life include its use in the healthcare, energy and transportation sectors. However, in the water domain, AI remains underdeveloped.<sup>131</sup> One area of potential AI use is pipe bursts and resulting water wastage.<sup>132</sup> AI and machine learning can help create prediction models to detect pipe failures in pipes that have never failed before. This means predictions of pipe failure for the next few years can be made based on similar pipe failures, pipe characteristics and pipe surrounding characteristics (e.g., soil, density). This can be used to prioritise pipeline replacement.<sup>133</sup>

Use of AI approaches that incorporate strong learning capabilities and high computational efficiency to solve reservoir engineering problems can efficiently accomplish time-intensive tasks. One commentator suggests the hand-shaking protocol between AI and conventional systems be used to make the best use of both systems for reservoir management.<sup>134</sup>

The fifth solution in addressing the disconnect between developmental projects and climate change is addressing water-wasting aspects of unplanned cities. This solution takes into account roads, highways, flyovers, airports and high-rise buildings that are presently not sensitive to depleted water resources by incorporating planning based on water retention rather than drainage.<sup>135</sup> This necessarily entails large changes in planning assumptions<sup>136</sup> to address these development projects' current contributions to reduction in the water table,<sup>137</sup> as they are commonly undertaken on reclaimed water bodies.<sup>138</sup> The Intergovernmental Panel on Climate Change's 1.5°C special report identifies 'cities as a critical global system to accelerate and upscale climate action'.<sup>139</sup> This requires short-, medium- and long-term plans that should include working towards the reduction of risks from environmental hazards and building on local acquired knowledge to reduce disaster risk in urban areas. Recommendations include the need for accountability of city and sub-city levels of government and the importance of supporting civil society groups, especially representative organisations of the urban poor.<sup>140</sup> This can be effected with the support of technology and design (physical or material intervention), institutional support (addressing regulation, land markets and public investment on the development of informal settlements), rights-based concepts (based on the assertion of basic human rights assured by the Constitution of India) and structural discourses.<sup>141</sup>

Other recommendations include the need to reframe current and future urban development trajectories to consider scientific projections, innovative and inclusive visions of urban futures and design participatory arenas. This can be ensured by the use of adaptation solutions developed by public, private, community-based and informal actors, as well as international experts. This needs to incorporate climate-resilient investments and ensure international financial institutions, donors and private sector companies prioritise valuing and incentivising such investments.<sup>142</sup> The World Bank's work in urban development—which aims to build sustainable cities and communities through an urbanisation process that is green, inclusive, competitive and resilient and contributes to the Sustainable Development Goals—can be seen as an exemplar of this.<sup>143</sup> Four broad areas of the World Bank's work are enhancement of planning system and local capacity, strengthening fiscal and financing systems, promoting territorial and spatial development, and building resilience to disasters and climate change in the urban setting. The recommendations emphasised so far address the need for better design, planning and management of city assets and urban environments via strengthening planning systems and local capacities.<sup>144</sup>

One initiative already in place is the smart city mission, which is a government-driven pan-India effort for urban development. It was initiated in 2015 and selected 20 cities to address climatic shifts occurring in urban India as a result of rapid unplanned urbanisation and associated issues like overcrowding, lack of inclusive growth and planning, poor maintenance and lack of upgrading of old infrastructure.<sup>145</sup> Smart cities must ensure that water security is a cornerstone of their planning and

<sup>131</sup> Doorn, "Artificial Intelligence."

<sup>132</sup> Manikandan, "Burst Pipe"; Staff Reporter, "Precious Water"; Staff Reporter, "Leakage in Drinking Water Pipeline."

<sup>133</sup> Hatle, "Using Artificial Intelligence."

<sup>134</sup> Ertekin, "Artificial Intelligence Applications." See also Li, "Machine Learning"; "Artificial Intelligence-based Risk Solution."

<sup>135</sup> Rathi, Indian Urban Infrastructure Report 2020, 35.

<sup>136</sup> Rathi, Indian Urban Infrastructure Report 2020, 35.

<sup>137</sup> Ministry of Water Resources, Ground Water Scenario, 52.

<sup>138</sup> Dutta, "How Chennai Lost its Water."

<sup>139</sup> Masson-Delmotte, Global Warming of 1.5°C.

<sup>140</sup> Satterthwaite, "Adapting to Climate Change."

<sup>141</sup> Cirolia, "Overcoming the Disjunctures."

<sup>142</sup> Chu, "Unlocking the Potential."

<sup>143</sup> The World Bank, "Urban Development."

<sup>144</sup> The World Bank, "Urban Development."

<sup>145</sup> Available at <http://164.100.161.224/content/innerpage/cities-profile-of-20-smart-cities.php>

implementation.<sup>146</sup> This can be achieved via incorporating water-sensitive infrastructure in the initial stages of planning and development of smart cities. There is a need to include advanced technologies (such as internet of things sensors and big data) for wastewater management, water quality monitoring, enhancing water distribution systems and leakage detection. Use of automated metering and smart power grids can optimise water consumption and reduce water losses. At the consumer level, smartphone apps linked to smart meters that allow consumers to check their water consumption in real time can facilitate automated billing/payment and aid consumers to address water loss by seeing water consumption per person/member of the family versus the ideal water consumption per person.<sup>147</sup> Leaks should be rectified as soon as possible, to minimise water wastage. The use of new technologies to reduce the volume of runoff, maintain stormwater and filter water by collecting or storing can be part of sustainable urban drainage systems to improve green space in the city. Sensor devices can aid in preventing water wastage in the proposed system for water supply management.<sup>148</sup> In addition, in Chennai, there is a suggestion to incorporate sensor-based surveillance for forecasting and warning of floods and tsunamis and water level monitoring. However, this is insufficient to predict disasters based on historical trends alone, as it precludes inclusion of climate variability over time and the increase effects of slow-onset events, such as the rise in sea levels and temperatures.<sup>149</sup>

In the planning of cities, there is a need to focus on initiatives that consider climate and disaster risks over time, as long-life infrastructure such as housing, roads, flyovers, water and energy transmission structures need to be able to withstand future stressors.

A concept of urban climate resilience that incorporates the challenges of water shortages is not new in India, with the adaptation of projects in various cities like Surat. For example, the Urban Health Climate Research Centre (funded by the Surat Municipal Corporation) was set up to address public health and climate change.<sup>150</sup> Another example is the Asian Development Bank's Urban Climate Change Resilience Trust Fund for Asia,<sup>151</sup> which has begun work on building resilience in an integrated manner in Mysore, Vishakhapatnam and Kolkata.<sup>152</sup> This includes district-level vulnerability and risk assessments to better define vulnerability<sup>153</sup> and inform urban resilience strategies.

However, challenges persist in a project-based approach to climate action, including resistance by city-level government agencies and gaps in strategies on the ownership of climate resilience, planning and budgeting. There needs to be a climate lens on key urban projects, whether area-based development or pan-city initiatives. Not having this could undermine the smart city mission in the long run.<sup>154</sup>

The link to the law can be provided by ensuring that an eco-housing certificate applies to all types of buildings (single-family residential, housing complex and apartment buildings), for which the building developer pays a fee and submits the proposal to the building proposal department at Pune Municipal Corporation. The eco-housing assessment criteria would be based on local environmental concerns. The building plan would be examined to ensure existing norms are satisfied, after which the proposal is handed to the respective cell for eco-housing certification. It is then sent to an independent third-party organisation that verifies the plan's compliance with the eco-housing criteria. Despite the full extent of the suggested reforms entailing major changes, including reorienting city planning in Chennai to reduce water table depletion, the reforms are justified and urgent. The reforms need to work with water law, planning law, engineering and financial systems to achieve the necessary structural changes of city planning for climate change effects.

For a certificate to be issued, several aspects of the following criteria would be considered: site planning, architecture, efficient building materials, energy-efficient lighting, solar water heaters, water conservation, segregation of waste and use of other innovative technologies. Rainwater harvesting, non-energy-intensive water treatment or recycling of sewage water, segregated garbage collection system, washrooms with dual flush systems, water meters and solar heaters are features that need to be included in a building. A point system would award an eco-housing score of one to five green stars. The more stars a building

<sup>146</sup> Vishwanath, "We must make Water Security."

<sup>147</sup> Sukhwani, "Role of Smart Cities."

<sup>148</sup> Priyal, "A Novel Method."

<sup>149</sup> Epstein, *Climate Change Futures*. See also Earth Institute, "Date on Past Climates"; Harrison, "Predicting Future Climate Change"; Chrobak, "We can No Longer Rely on Historical Data."

<sup>150</sup> See National Institute of Urban Affairs, *Surat Climate Resilience Strategy*. See also TARU Leading Edge, *Surat Resilience Strategy*.

<sup>151</sup> Asian Development Bank, "Establishment of the Urban Climate Change Resilience Trust Fund."

<sup>152</sup> Steinberg, *Inclusive Cities*.

<sup>153</sup> Ministry of Science & Technology, "National Climate Vulnerability Assessment." See also Indian Institute of Technology Mandi, *Climate Vulnerability Assessment*.

<sup>154</sup> Jogesh, "Climate Disconnect."

has, the greater its tax reduction. Rating systems can be a guide for house buyers to choose environmentally friendly houses, which will incentivise contractors to build eco-friendly houses.<sup>155</sup>

Certain OECD recommendations to address climate change and development that can be applied to Chennai depend on the capacity to make major investments and bring about long-term structural changes. These include strengthening urban transportation, building energy-efficient cities, setting regulations to directly incentivise green urban investment and establishing policies around investments to protect property rights. The OECD also suggests reviewing legislation related to municipal finance to ensure cities can access the necessary resources and establish and improve their creditworthiness for financing low-carbon infrastructure, among other initiatives.<sup>156</sup>

The last solution is the participation of people and their willingness to act to mitigate climate change. An individual's belief that there are actions they can personally take to address climate change and that now is the right time to act is crucial for complete involvement at the individual level. Individual actions like reducing electricity use, eating less meat, shopping from local markets, reducing consumption and hoarding, reusing and recycling as much as possible, planting trees, conserving water, developing awareness on individual vehicle and household emissions, and flying and travelling less can go a long way and make a difference in the long run.<sup>157</sup> International organisations such as UNICEF and UNESCO work with young people to elevate their voices on climate change through creative platforms, advocacy and participation at major United Nations summits. Better technologies will provide more cost-effective and smart solutions for people to adopt. If people feel that there are beneficial actions they can take and affordability means they have the resources to do them, this will increase their willingness to adopt mitigation measures. There are also the elements of adaptiveness and resilience that have arisen as a result of continuous disasters. Adopting individual behavioural changes relating to climate change into the law is a challenge. However, the positive changes resulting from the suggestions backed by law and technology can inspire hope at the individual level for progress to combat water shortages and climate change.

## V. Conclusion

There is a need to achieve water and climate security for all. This can be achieved via the governance mechanisms of legislators entrusted with the responsibility to monitor and enforce solutions by courts. Vulnerable populations face challenges that need to be addressed through the lens of technology. This is especially true for a city like Chennai in South India, which has a water crisis exacerbated by mistakes and the burden of large loans for developmental activities like maintenance of dams. Government and court action/inaction and climate change denialism by leaders have resulted in delays in the implementation of viable solutions to the water and climate crises, resulting in unsustainable development. Failures of water-sharing options have disproportionately affected women and agricultural workers.

Solutions to these crises from the perspective of a developing country require innovative government efforts through advertisements, competitions and corporate social responsibility activities to bring about much-needed awareness. The lack of public discussion and discourse in Chennai remains problematic. Similar water conservation and health-based campaigns have helped change public perceptions in the past. The requirement is to incorporate the neglected aspects of addressing water shortage before day zero—the day of complete lack of water, estimated to be India in five years if current trends are not changed.<sup>158</sup> The most pressing need is to address the lack of appropriate legal and regulatory measures to effect reforms necessary to avoid the worst-case scenarios of water scarcity (i.e., day zero). The reality of climate change and the water crisis is not simply something we do; over the past decades, it has become fundamental to who we are. Significant social changes are required to achieve the necessary levels of water conservation sans government intervention, especially with the existing disconnect at higher levels of government. Cultural norms cannot simply be legislated away, although strong corrective legislation is urgently required. Many of the shortcomings of governments are often given as the reasons why good policies do not work.<sup>159</sup>

There are many dimensions—scientific, technological, economic, social, political, ethical and so on—that need to be integrated to bring about an urgent change, especially since the challenges entail worsening social pressures and inequalities. Addressing these challenges requires new social movements that incorporate reduction of greenhouse gas pollutants, adaptation to new

<sup>155</sup> Friestedt, “Ecologically Sustainable Housing.”

<sup>156</sup> OECD, *Cities and Climate Change*.

<sup>157</sup> Ministry for Environment, *What You can do for Climate Change*.

<sup>158</sup> Yeung, “India has just Five Years.”

<sup>159</sup> Banerjee, *Poor Economics*, 345.

weather patterns and a push for a more just and equitable world. This should result in suitable political action that responds to the scientific consensus on climate change with new and existing technologies and proven economic incentives.

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