# Infrastructures with a Pinch of Salt:

## Comparative techno-politics of desalination in Chennai and London

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by


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# DECLARATION

I, Niranjana Ramesh confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

# ABSTRACT

Infrastructures, being technological networks that form the structural and social scaffolding of cities, have been symbiotic with modern urban development. Building on their socio-technical character, this thesis seeks to understand the technological mediation of political formations and environmental knowledges that shape notions of urban sustainability. It takes as its point of departure the construction of reverse osmosis desalination plants to augment water supply in two cities across the global South and North – Chennai, India and London, UK. It uses the analytic of infrastructure to excavate the complex reasons as to why and how desalination plants came to be built in these cities.

Over a period of 10 months, oral and documentary narratives were gathered from institutions, professionals and citizens involved in water supply and access in the two cities. Based on a comparative reading of these texts and ethnographic field notes, the thesis focuses on the state and engineering practices as significant determinants of urban techno-natures. It demonstrates that infrastructures provide a mode of articulating statehood through mediation between technology, nature and society. It traces how engineers and other water professionals, through their everyday work, socialise those water systems, cultivating popular environmental knowledges. Finally, through a narrative of the contestations faced by the desalination plants, the thesis shows that urban infrastructural transitions give rise to distinct political formations.

As water becomes infrastructure engendering technological practices and shared knowledges over which political relations are forged, there are clear differences in how this is materialised in Chennai and London. Using Chennai as the point of reference to frame the themes and issues through which to explore the London case, the study identifies within those differences potential starting points for theory building from the global south.

# ACKNOWLEDGEMENTS

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As I wrote out and scratched many expressions of my appreciation for Shyam, my oldest friend, husband and now, partner in academic adventures, he looked over my shoulder and said "It's okay, you don't need to come up with more words after all this to thank me. It's time to get some sleep now." And so, there are literally no words to describe my gratitude for that total comfort he has given me over these years.

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# 1. INTRODUCTION

In July 2010, the opening of a seawater desalination plant in Chennai, the capital city of the state of Tamil Nadu on India's south eastern coast, was a big event. The state Chief Minister (CM) inaugurated the plant in the company of some of his trusted ministers and civil servants. As a journalist covering urban infrastructure and development for a daily newspaper, I was dispatched to report on this event to Kattupalli, the island 30 km to the north of the city where the plant was located. The media delegation did not get to see much of the plant that day as the presence of the CM took the press briefing in the direction of the political agenda for urban development and the role water projects were to play in that. The Spanish company Befesa, which had built the plant, was however keen to showcase its technological achievement and so arranged another visit at a later date for the benefit of the media. This time, the questions turned to sustainability of desalination – could Chennai afford this expensive technology? How much energy did it consume? Where would the power supply come from? Would this make Chennai a sustainable city or destroy its ecology? What message did this convey about Chennai to cities in the rest of the world?

It is worth noting that urban infrastructure or development hadn't yet become a regular topic of coverage in newspapers and so, most of the journalists present covered either politics or technology or water, which has its own news 'beat' in Chennai. Their questions, however, echoed some of the concerns raised around the world about the increasing use of desalination technology to address water scarcity and sometimes, fuel urban development. The interaction that ensued said nothing about whether these issues had been considered at all during the planning and construction of the desalination plant. Journalists did their job in asking the questions they were expected to ask and the answers followed an official script. Since my paper wanted a long feature on this rather than an immediate report of the plant's inaugural I had the opportunity to explore the project further in the following days with a wider range of actors – engineers and bureaucrats working in urban water supply, environmental activists, planners and politicians. What emerged from this was a picture of seemingly parallel registers of infrastructure development where policy objectives such as sustainability remained separate from everyday engineering practices that shaped urban infrastructure. But they responded to highly contextualised environmental subjectivities and contestations among urban residents, who negotiated with and participated in infrastructure making in myriad ways.

This study was, subsequently, born out of the interest to pursue this line of enquiry further and develop a nuanced understanding of how urban infrastructures come to be conceptualised, built, used and contested (Amin 2014); and how they interactively shape urban political and ecological formations. It, therefore, responds to recent calls in urban geography to look to the 'city's fabric', which includes the materiality as well everyday life of cities, as an important site for theorising processes of urban change and enable a grounded understanding of what the urban might mean (Gandy 2014, McFarlane 2008a, Koch & Latham 2017). By engaging with urban infrastructures as a set of materials, systems and practices mediating socio-natural relations, it aims to excavate the contingent ways in which multiple urban imaginations, techno-environmental knowledges and political claims come together in an arc of urbanisation.

Contemporary urban infrastructures have been implicated in discourses of globality because of the circulation and exchange of technologies and technical expertise between cities influencing their development (Björkman & Harris 2018). Simultaneously, urban water supply systems around the world are embroiled in a policy trajectory where the lukewarm performance of structural adjustment policies in the 1980s and privatisation in the 1990s was followed by an ostensible move towards community or environment centred models of water management. Cities have, hence, been increasingly expected to adopt and share novel technologies and decentralised governance of water infrastructure in a global drive towards environmental sustainability (Chasek et al 2013). Reverse osmosis desalination is one such mobile technology that has found its way into a wide range of water supply systems around the world following unexpected geographical circulations (Swyngedouw 2013).

In the same year as Chennai, London in the UK also opened a desalination plant as a climate-resilient back-up for any unexpected shortfall in its supply network. It drew water from the tidal Thames and so desalinated brackish water rather than seawater, and was reported widely as the first large scale desalination plant in the UK.[1] Its opening had however been delayed by a planning challenge by the then Mayor of London, questioning its environmental impact and contribution to urban sustainability. Reverse osmosis desalination was an energy intensive process that distracted from the urgent need to fix the city's massive leakage problem, he had contended. Urban sustainability had thus been a universal rubric on which the desalination project was evaluated across the global North and South, despite their significant differences. Chennai has never had a continuous universal water supply system, its network instead delivering water to households for a few hours in a day or fixed days in a week. Buildings and households have storage tanks in which water could be filled from various sources, including the public network and then piped for everyday use. While London has had such arrangements in the past even after the early 20th century universalisation of its network, the size and extent of its network presently means that it effectively requires continuous flow to run it. Regulatory backing and successive historical investments in the infrastructure have ensured that, for the most part, the average resident can simply open the tap for reliable water supply any time of the day. Yet, the global circulation of technologies, knowledges and urban imaginaries amidst cities has culminated in the parallel building of a very similar infrastructural addition in both cities, sparking similar doubts about its benefit to the urban ecology as well.

Urban theory, as Aihwa Ong (2011) contends, has tended to explain these interconnected transnational processes in cities as a singular condition defined in

[1] Thames Water opens first large-scale desalination plant in UK. *The Guardian.* 2 Jun 2010. Available at: https://www.theguardian.com/environment/2010/jun/02/thames-water-desalination-plant
Salt water plant opened in London. *BBC News.* 2 Jun 2010. Available at: http://www.bbc.co.uk/news/10213835

terms of epochs – of capitalism or environmentalism. In other words, globality has often been equated with universality in urban theory. This is true of, for example, the thesis of splintering urbanism (Graham & Marvin 2001) which frames a universal narrative of privatisation and global capital fragmenting networked infrastructures and disintegrating cities. The deviation from the 20$^{th}$ century Northern experience modernist infrastructure building was equated to a splintering of the very idea and form of the urban. But, what does the incursion of a technology like reverse osmosis desalination in cities around the world mean for their ecology and sociality? How does this infrastructural form come to be built in a city and why does it provoke suspicion and contestation or acceptance and socialisation? How does this contingent and layered journey of infrastructure-making shape technological and environmental knowledges in the city? Finally, are there any common themes or patterns at all that can be observed across the urban infrastructural experience? In order to address these questions, this thesis places the study of Chennai's water infrastructure alongside that of London in a 'comparative gesture' (Robinson 2011) that scholars have argued is 'only natural' to the study of cities (McFarlane 2010, Nijman 2015).

The formulation of urban comparison as a theoretical manoeuvre and methodological technique was motivated by the need to decentre urban theory from the Euro-American axis and move towards a more global urban studies that built theory from the experiences of burgeoning cities in Asia and Africa (Robinson 2013, 2014). When urban researchers started seeking out cases in the global south, they focused on issues of 'development', choosing comparative studies on the basis of developmental and regional commensurability (Robinson 2014). While the specificities of the southern urban experience have indeed been instrumental in formulating contextually reflexive theories like urban informality (Tuvikene et al 2017), Roy (2014: 17) cautions that "to assert the global south as a signifier of theory requires constant vigilance" for the assertion could slip into essentialism of cities in provincial categories while leaving claims of universality built on Northern cities intact. This phenomenon is also common, for example, in studies of southern environmental politics, which are inscribed in a binary of traditional and modern knowledges or local and global technologies (Greenough & Tsing 2003, Sinha et al. 1997).

So, this thesis follows from Roy's (2014) suggestion to pay attention to 'worldliness' or practices of 'worlding' in cities, whereby the socio-technical knowledges and the political cultures that make up urbanisation are simultaneously situated and interconnected with a variety of material and imaginative geographies. The comparative project here starts by recognising that reverse osmosis desalination or other novel technologies circulating between cities today may not represent a paradigmatic shift in the process of urbanisation; or an essential conflict between the global and local. But, their geographical spread allows for an engagement with the 'embeddedness in multiple elsewheres' (Mbembé & Nuttall 2004: 348) of cities, not least through the techno-environmental knowledges and subjectivities enlisted in the work of making infrastructures. In taking this approach, the cases here present possibilities for 'cross-pollination' (Furlong & Kooy 2017) of concepts, inspirations and theories from each other than reveal similarities and contrasts as such. This is because they constitute, in the global categories of the urban, two 'most different' cities (Robinson 2011) – that is, cities of different geographical, developmental and cultural trajectories that would not usually be grouped together, even if there are any similarities in governance mechanisms.

## 1.1. The Case Studies

Chennai's long nearly unbroken coastline, shaped as much by the construction of harbours, ports and roads as by geo-climactic features, is unlike any other major city in India. It runs the length of the city from north to south broken only by three river estuaries – Kosasthalaiayar, Cooum and Adyar – and is used extensively for leisure, fishing and harbour activity. The spectacular Marina beach (see Figure 1) with its vast sands forms the central feature of this coastline and is lined with important institutions of government and education (Arabindoo 2010). With the sea visible blue under the blazing sun all along its doorstep, then, it is little wonder that successive governments in Tamil Nadu[2] have always had an eye on harnessing it for drinking water supply. The city had experimented with desalination before in smaller discrete projects; and reverse osmosis membranes, the type of filtration technology used in desalination plants around the world now, were in widespread use for household water purification. But, the Kattupalli desalination plant, more popularly known as the Minjur plant after the wider area in which it was located, generating 100 million litres of water per day (MLD), was the first time a large scale desalination plant would feed into the public water network. The network's total capacity then came to only about 600 MLD, depending on rainfall and other factors (CD10), for a city of 8 million residents[3]. In 2013, another desalination plant was opened at the southern periphery of Nemmeli, adding another 100 MLD to the network. This move was criticised by environmental activists who argued that the region's ancient but fast deteriorating system of tanks and canals could instead have been rehabilitated to replenish the city's annually recharged ground and surface water sources. This, however, hasn't

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[2] A note on names: When India became independent from British rule in 1947, it retained the structure of colonial presidencies as States until 1956, when they were reorganised on a linguistic basis. The colonial Madras Presidency became Madras State in 1947, reduced in size in 1956 losing territories to the newly created states of Kerala, Karnataka and Andhra Pradesh. The state was renamed Tamil Nadu meaning Tamil Country in 1969. Tamil is the language spoken by the majority in the State. Chennai is the capital of Tamil Nadu.
The city of Chennai, ever since it originated from colonial settlement in the 17th century, has been known by two names as Madras and Chennai. While the authenticity of its two names is hotly debated and has also been theorised as an indication of the city's dual spatial and social character (Neild 1979, Arabindoo 2006), most Tamils have recognised both names and used them interchangeably. Over time, Madras became its official name at least in English, whereas it was acceptable to refer to it as Chennai in some Tamil documents. In 1996, however, the city was officially renamed Chennai.
So, in this thesis, the city is called as Chennai unless the name 'Madras' is required to refer to its existence in a specific time period or to an institution that hadn't changed its name in 1996: for eg., 'colonial Madras' or 'Indian Institute of Technology Madras'. Most State institutions did change their names in 1996 from say 'Madras Metropolitan Development Authority' (MMDA) to 'Chennai Metropolitan Development Authority' (CMDA). The main institution of concern here – Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB), however, is known widely by its shortened form 'Metrowater' and even finds a place in the utility's official communication. So, after the first reference, the thesis uses the name Metrowater to refer to this organisation.

[3] INDIA STATS : Million plus cities in India as per Census 2011. 31 October 2011. Available at: http://pibmumbai.gov.in/scripts/detail.asp?releaseId=E2011IS3

stopped plans to construct two more desalination plants – of 400 MLD and 150 MLD each to the south of the city (CD10), thus doubling the volume of supply.

**Figure 1: View of Chennai's iconic Marina beach from the State Planning Commission offices.**
**Source: Fieldwork photo.**

Networked water supply in Chennai is sourced mainly from a system of four reservoirs – Poondi, Cholavaram, Redhills and Chembarambakkam – which are fed by rain and the numerous tanks and canals surrounding them (see Figure 2). There were also two projects executed to draw water from far away - the Krishna river 488 km to the north in the neighbouring state of Andhra and Veeranam lake, a reservoir for overflow from the river Cauvery, 228 km to the south within the state of Tamil Nadu. The public water utility in charge of this is called Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) or Metrowater for short. Metrowater supplements this system with water drawn from well fields in Thiruvallur to the north west of the city and aquifers along the southern coast, either piping them to one of the reservoirs or directly distributing them through water lorries.

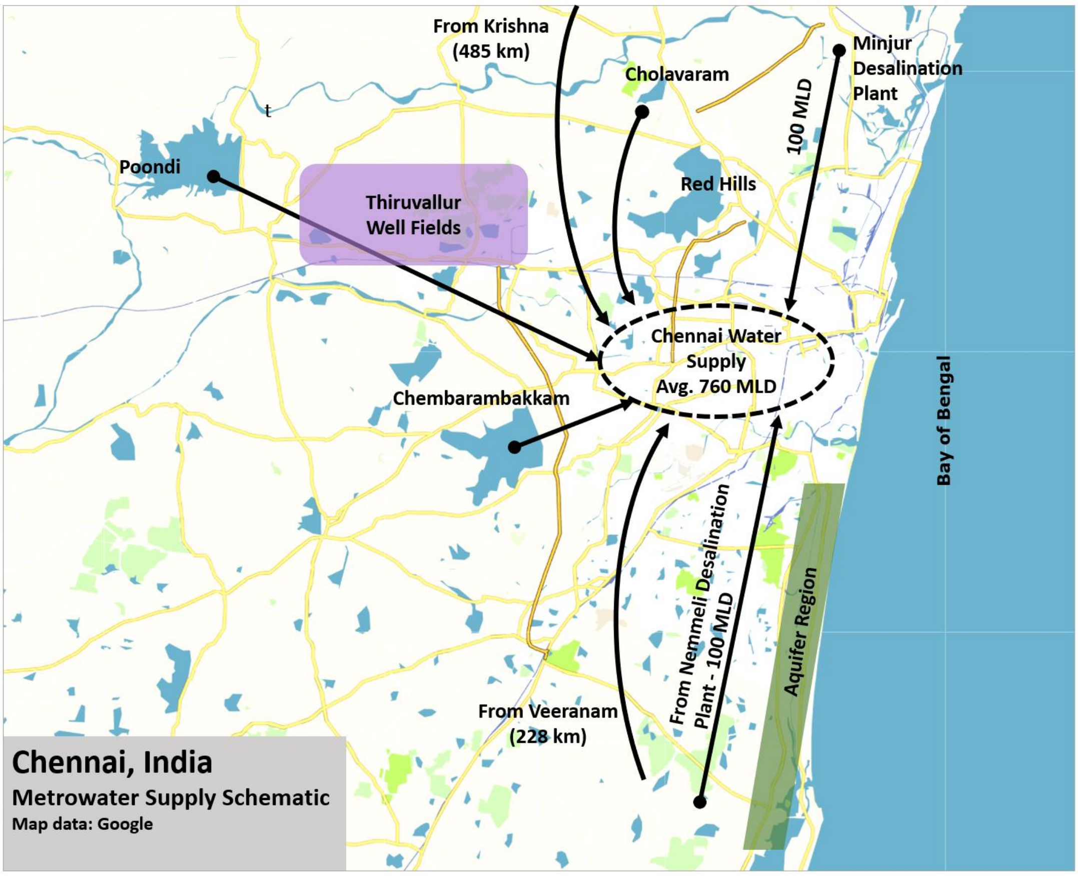


**Figure 2: Chennai Metrowater Supply Schematic.**
**Source: Compiled from Metrowater website and research data.**

Residents further supplement their Metrowater supply, if they have one, with groundwater pumped from their backyards and water sold in plastic cans or by private lorries ferrying from the hinterlands. This disparate water access mechanism means that there is almost no data on how much the total water consumption of the city is. But, a household survey conducted for an academic project (Srinivasan 2008: 268) estimated that an average household used groundwater for 46% of its needs and piped supply from Metro Water for 30%. 19% was met by public hand-pumps, 2% each by public taps and tankers. Private water vendors accounted for 2% in tanker form and 0.7% as packaged water. This thesis' focus is on Metrowater and its networked infrastructure; but it situates its analysis and ethnography in this ecology of everyday water access where engineering practices and environmental knowledges are mutually shaped by multiple waters and the socio-technics of mobilising them.

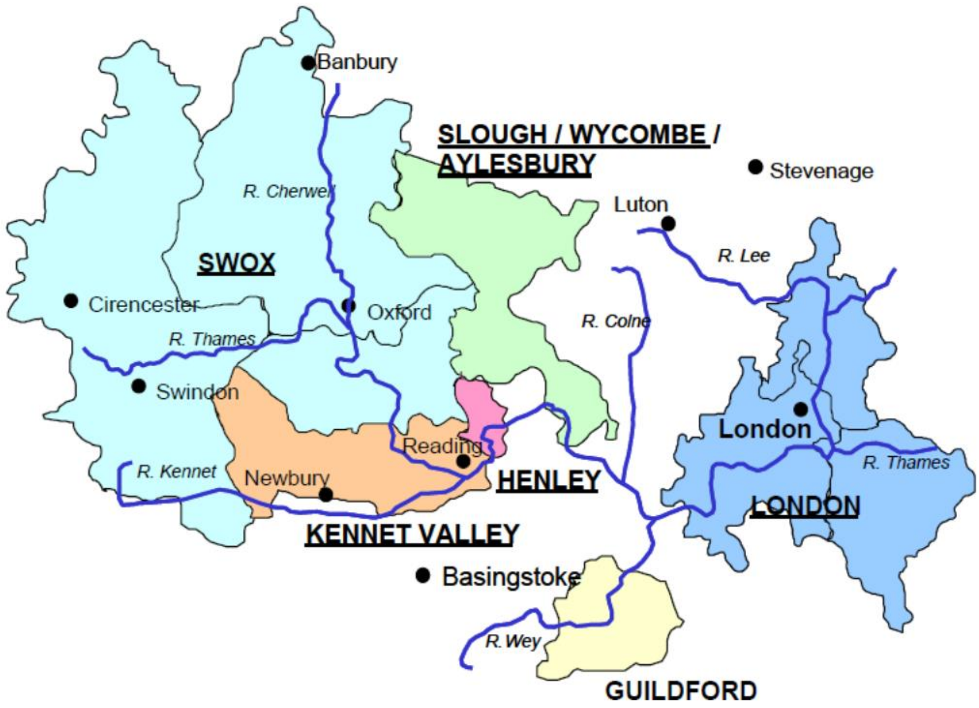


**Figure 4: Thames Water Supply Areas.**

**Source: LD8 (Thames Water, 2014. Final Water Resources Management Plan 2015 – 2040).**

London's water supply, in the post-war years, has been firmly tied to national water policy and regulation. Even after water management was privatised in England and Wales, the regulatory framework put in place influenced the direction taken by the water companies. The city is one of the zones in the Thames basin (see Figure 4), whose water supply and sewerage are managed by the private company named Thames Water. The company supplies a total volume of 2.6 billion litres per day through "94 water treatment works, 26 raw water reservoirs, 308 pumping stations, and 235 clean water service reservoirs."[4]

The river Thames here plays a similar topological role to that played by the sea in Chennai. Over the years, its meander and flow have been shaped by the embankments, locks, barrages and bridges, as well as more recent commercial and residential development, that have been instrumental in the making of London as a

[4] See: https://corporate.thameswater.co.uk/Media/Facts-and-figures

city. Consequently, the river has held strategic importance and sustained political interest (Kelly 2018). In the history of this river heavily mediated by technology and government, the desalination plant on its tidal parts at Beckton in east London presented a divergence for two reasons. Firstly, this is the first time since 1855 that water from the tidal Thames was allowed to be fed into the drinking water supply. The Metropolis Water Act 1852 enacted to ensure quality of the water supplied by the many water companies then, had prohibited abstraction of water from the tidal reaches of the Thames, defined as downstream of the Teddington Weir in West London (Jones 2013: 83-105). In the same decade, following the Great Stink of 1858, when industrial pollution and human waste dumped in the river lead to disease and death in the city, sophisticated sewerage systems were built separating waste from water supply, effectively reducing the risk of waterborne diseases. This biotechnical achievement of the city is still considered legendary (see Figure 3) and has lead to this centralised mode of handling human waste an ideal to be aspired to by many cities around the world.

The Beckton desalination plant, officially called the Thames Gateway Water Treatment Works (TGWTW) however, building on the efficacy of reverse osmosis filtration, abstracts brackish water from the outgoing tide on the Thames, upstream of its own sewage treatment works in Beckton, so that the water has as less of salt and waste content as possible.[5] The second divergence from previous water works is that this plant was explicitly positioned as a defence against climate vagaries in the future. Thus, it echoes what Matthew Kelly, historian of British environmental policy observes about the Thames Barrier:

> "…did not seek to improve living standards or economic effectiveness, but to counter the existential threat nature posed to London." (Kelly 2013: 206)

Thus it was an interesting turn of events that opposition to the desalination plant by the then Mayor of London called it a "retrograde step in UK environmental policy."[6]

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[5] See: https://www.thameswater.co.uk/Help-and-Advice/Water-Quality/Where-our-water-comes-from/Thames-Gateway-Water-Treatment-Works

[6] London Assembly, 2007. Seventy-Third Mayor's Report to the Assembly – 18 July2007.

The planning and construction of the desalination plant in London, thus, stands at a clear intersection of strategic national regulatory policies and the technological mediation of the environment[7].


**Figure 3: A caricature illustrating the horror of 'The Great Stink' in 19th century London.**

**Source: Wikimedia Commons/ Public Domain.**

*Caricature published in Punch at the time of the "Great Stink". The River Thames introduces his children – diphtheria, scrofula and cholera – to the city of London, showing some understanding that the river was a danger to health.*

[7] A note on terminology: The framework of water privatisation and regulation governing London are specific to England and Wales. However, water expertise in the city is identified as 'British' and not as 'English and Welsh'. The UK Central Government is sometimes referred to as the British Government here. London's local government is comprised of the Greater London Authority (GLA) headed by the directly elected Mayor and the elected London Assembly. It normally has limited impact on the city's water supply, except for the case of Mayoral contestation discussed in one of the chapters.

## 1.2. Thesis Outline

The empirical methods this project has adopted and the arguments the thesis presents are guided by the following connected research questions:

How does the conceptualisation and construction of water infrastructure shape subjective knowledges about the urban environment? What can this process tell us about the technological mediation of political relations in cities?

These questions are explored in the two cities discussed above: Chennai, India and London, UK, with the reverse osmosis desalination plants they opened in 2010 as a common point of departure. In both cities, the socio-materiality of water as a thing essential to life and intertwined in their cultural histories has played a part in determining their infrastructural development. There was, thus, a process by which water became infrastructure.

Chapter 2 engages with water's historical trajectory through a review of academic literature on its multiple ontologies. It explores the origins of water's persistent connections with ideals of modernity and traces the gradual unravelling of this ideal by a range of interconnected political and economic events around the world. In geography, theories inspired by political economy and structural analysis have been dominant in studying this change and so, the chapter delves into them in some depth. Such a theoretical approach however presents considerable limitations to studying the multivalent processes that this thesis aims to understand in order to achieve its research objectives. So, the chapter arrives at a theoretical framing that draws on interdisciplinary studies of infrastructure that pay specific attention to the technological mediation inevitable in urban water supply systems. Chapter 3 identifies this as an infrastructural epistemology using which it arrives at a methodological approach to conduct empirical research in the two cities. It devises a research design that puts to use the interconnectedness of infrastructure and the range of people and materials involved in its coming into being. Describing the fieldwork process and challenges in each city, the chapter identifies the significant differences in the outcome from the two cities and develops a thematic analysis of the data collected. It draws on the idea of an ‘experimental comparison’ proposed by Lancione & McFarlane (2016) to identify potential theoretical starting points for further investigation. The rest of the chapters in the thesis are structured around the themes identified here.

Chapter 4 builds on the idea of the state that was prevalent in the data as a significant determinant of water infrastructures in both cities. But, the forms that the state takes and its everyday articulations are distinct in the two cities, which the chapter explores as separate narratives. It traces a broad outline of how reverse osmosis desalination plants came to be built in two vastly different cities across the global South and North. In doing this it explores how the conceptualisation of water and hence, the natural environment, was constantly reconfigured by technologies of governance or state-making. In Chennai, the long history of a distinct cultural politics combined with the consistent welfare populism of the state inscribes water with a political vibrancy. In turn, the institutional structures that have recently emerged to support urban development and the building of complex technological projects are populated by a patron network of administrators whose personal connections drive the techno-politics of infrastructures. In London, where water’s privatisation has seemingly rendered its politics static, there emerges a narrative of shifting conceptualisations of water as multiple objects, the mediation of which constitutes the regulatory state. A narrative of the state’s articulation through urban water governance also offers a historical background to understand the overall mechanism of building water infrastructure in the two cities. It functions as the context to delve into the everyday practices of engineering and water management that the next two chapters delineate.

Chapter 5 and 6 are both interested in the constitution of techno-environmental knowledges through practices of infrastructure-making. To this end, they engage with engineering and techno-managerial practices involved in facilitating water supply in Chennai and London. Findings are presented through distinct themes making different but interrelated arguments in these two chapters. Chapter 5 analyses engineering practice as constantly negotiated between compartmentalised individual identities, using this premise to draw out the relationalities of urban imaginations and shared knowledges constituting engineering expertise. It proposes that technological mediation of urban natures can be understood as osmotic, in order to explore the constant negotiation and unequal agencies involved in the process. In Chennai, a networked system of everyday water access is built through the affective labour of engineers and the techno-environmental knowledges they share with the local residents. London's engineers, on the other hand, assert their expertise in the global forum of water infrastructure development, by mobilising the legacy of the city's history and colonial imaginaries. Based on these accounts, the chapter develops a view of infrastructures as an ecology of practice, which works in banal ways to constitute shared ways of knowing urban materiality as well as socio-technical forms of othering.

With this relationality of infrastructure as its overarching framework, chapter 6 investigates the epistemological diversity of engineering disciplines involved in making urban infrastructures. In Chennai, while the multiple epistemologies are apparent in different functions of city-making and even occupy distinct institutional roles, in London, there emerges a calculative framework of risk and resilience that attempts to reconcile these multiplicities. Since recent processes of infrastructure-making that have adopted discrete technologies and novel institutional arrangements have been seen as fragmenting and splintering the very urban fabric, this chapter attempts to address the question of whether certain technologies of approaching urban infrastructure-making are more divisive than others and what exactly does cohesion mean in these cities.

Chapter 7 builds on the idea that urban infrastructures are public affairs no matter their ownership structure or indeed their capability to fragment or generate urban sociality, to narrate an account of how they were constitutive of distinct political formations in both cities. In Chennai, it is the socio-material environment of the city's long coastline that present a challenge to littoral development including desalination projects; whereas in London, the newly created Mayoral office presents the possibility for a political challenge because of the individualised power of discretion it allows into the planning process. The chapter uses these two cases that technological projects, even in their goal of anti-politics, hold the potential to spur an organic politics that cannot be reduced to a pre-existing set of contestations.

In summarising the conclusions of the thesis, chapter 8 acknowledges the limitations presented by the comparative framework of the study. Investigating complex infrastructural projects using ethnographic methods across vastly different geographies requires inevitable compromise on the depth of engagement with both cases and the possibility of generalisable findings. Instead, since the comparative methods were framed as 'experimental', this chapter discusses how some of the themes identified in the empirical chapters present an opportunity for further research.

# 2. SOCIO-TECHNICAL MEDIATION OF WATER: INTERSECTIONS BETWEEN THEORY AND HISTORY

## 2.1. Introduction

> "…water as such is an unrecognizable object...water is anything but singular, it is a multiple object…" – Samer Alatout (2010)

The above statement could simply refer to the physical state of water: as a liquid, it is recognizable only by the form of its container or carrier – as river, sea, lake, tap water, bottled water and so on. It could equally mean that water takes multiple meanings based on the environment in which it exists; the social context in which it is used; the power structures which shape its course; the cultural context which determine the nature of its use (Strang 2004). Water, then, carries with it a narrative of the geography in which it exists, allowing its interdisciplinary study as the 'object of enquiry' (Gandy 2011). This chapter explores some of the possibilities offered by water's 'multiple ontologies' (Barnes & Alatout 2012) for versatile conceptualisation and how they can be used to understand nature-society relations in cities. In urban areas, water is one of the inevitable ways in which the idea of the natural environment and how humans relate to it are formulated, whether it is through technologies and economies of water access or the cultural imaginations and idioms of power that accompany its use.

It has not always been evident that the term infrastructure could be an analytical category to critically approach these socio-natural relations. Urban water systems came to be termed infrastructure only when they achieved seamless networked flow, and the term then was little more than a descriptor of the material network that enabled the urbanisation of nature. Urbanisation, in these studies, has largely been understood as a 'conquest' or 'metabolisation' of nature through circulations of power, knowledge and capital. The first part of this chapter will explore this imaginary, where networked, centralised and universalised water supply came to represent the 20th century ideal of modernity. The second part of this chapter will look at the unravelling of this ideal and the emergence of an array of discourses like the right to water, privatisation, market environmentalism and community participation. Conceptual preoccupations over this period included commodification of an ostensible natural resource and the privatisation of an accepted public good.

In Geography, this binary view of water as a commodity or resource and public or private good was bridged by the framework of Marxist urban political ecology (UPE), which has since been the most influential and overarching approach to the study of urban water systems. It conceptualised water as a 'hybrid' of social and natural actors metabolised through the circulation of capital, knowledge and power in the city. The notion of 'flow' and 'circulation' which are central to this theoretical framework, present significant limitations to water supply in the global south as this chapter will elaborate in its third part. This is not because of the absence of capitalist circulatory technologies, institutional structures or networks altogether in southern cities, but because of their continuously negotiated working, which from a UPE point of view is deemed 'fragmented' or 'fractured' circulation. The canon of infrastructure studies that has emerged recently through interdisciplinary interactions between Geography, Anthropology, STS and Sociology, however, focuses on the socio-technical work that goes into the making of an infrastructural system (Carse 2012), whether it is steel and wire electric grids or the 'social infrastructures' of health or education. Therefore, rather than offer a theoretical framework to apply to the cases here, infrastructure offers an epistemology of approaching the relationship between nature, technology and society in a grounded manner.

This thesis is concerned with water infrastructure in two very different cities across the global South and North, and how they relate to the global through their practices and imaginaries. But, as the roughly chronological review of literature in this chapter will show, colonial rule in the South and later, Euro-American influences in postcolonial development mean that water supply systems and their governance have long been globally connected, although this does not imply universal patterns or outcomes. While the broad sweep of literature presented here also serves to demonstrate the interwoven development of theory with history, it is important to keep in mind that contemporary urban water infrastructures may be shaped by ideas and events from multiple spatio-temporalities. After all, unlike in theory, the everyday access and use of water as a physical 'thing in the world' (Helmreich 2011) often simultaneously straddles several imaginaries, contradictory discourses and flexible techniques of governance (Baviskar 1997, Valverde 2011).

## 2.2. Conquest of Nature

> "The design, use, and meaning of urban space involves the transformation of nature into a new synthesis." – Gandy (2003: 2)

The dominant ideal of urban modernity is one where the networks that carry resources around the city remain invisible and follow a seamless circulatory logic of flow. The imagination of metropolitan life is 'predicated on the technologies of the underground' (Pile 2001: 269), which are in turn linked to the idea of the 'conquest of nature' in industrial Europe and North America. This, according to Maria Kaika (2005) is evident when the networks breakdown, revealing the 'unnaturalness' of the "intricate set of technological networks that transformed it [water] from a natural element into purified, commodified drinking water" (p. 4). The project of urban modernity, she argues, may be traced to the 17th century when the possibilities and attitudes towards the 'taming of nature' were coming together (p. 12).

### 2.2.1. Negotiated modernity

In the 17$^{th}$ century, the first system to pump water against gravity and supply to homes at a price had been built in Germany and then, in London (Tomory 2014). Before then, a conduit carrying water through gravity to the City of London was in place and 'water bearers' worked for some well-to-do houses fetching water manually from public sources. By the end of the 18$^{th}$ century, demand for convenience in obtaining water had already given rise to water companies delivering piped water inside homes (Jones 2013). The next important landmark in the journey of water infrastructure was the industrial revolution through which the city was fast becoming a site of deplorable living conditions, while its rivers became the source of disease and death (Kaika 2005). In response to this, in the later part of the 18$^{th}$ century, a sophisticated system of underground water supply was developed in

London, Paris, Berlin and New York (Gandy 2004, Salzman 2006). Of course, the process wasn't as seamless and straightforward.

Repeated attacks of deadly infections like Cholera, in the 19th century, precipitated investigation into water supply and sewerage mechanisms of the city. The slow and contested acceptance of bacteriology over the 'miasma theory' was accompanied by the meticulous and controversial construction of the celebrated Victorian underground sewers in London (Jones 2013, Hamlin 1992), creating a 'hygienist' and 'hidden city' (Gandy 2004). A similar process in Philadelphia initiated water infrastructure reform in North America (Melosi 2000). This result, Gandy (2004) argues, cannot be contained within the narrative of 'heroic urban history' because the discourse of purification and moral reform that emerged could be attributed more to pre-modern religious sensibilities than to a progressive modernity per se (Jones 2013). Similarly, Haussmann era Paris, considered the 'epitome of modernity' was squeamish about letting human waste be carried in its great sewers. It resisted the onset of modernity in bathroom plumbing systems and struggled to rework its pre-modern beliefs about bodies and washing (Gandy 1999). Culture and religious morality existed in a continuous tension with capitalist industrial development, with any of all those factors influencing the outcome that we have come to know as inevitable modernist progress now.

The London water supply system was one of the last to be centralised and municipalised in Britain. When cities like Manchester, Liverpool, Glasgow and also Hamburg outside Britain had municipal water supply, London's system was comprised exclusively of private corporations (Tomory 2014). The 'network' was a cacophony of pipes and connections criss-crossing the city, with adjacent homes often getting their piped water from completely different sources and companies (Jones 2013). Further, Joseph Hillier (2011: 37) argues, "It was not obvious that the constant system was better than the intermittent" which was prevalent until about 1870. The question of public or private, universal or differential, free or paid water supply preoccupied the London water sector for much of the late 19th century (Hassan 1985). There are accounts of this chapter in London history that portray a triumph of the welfare state over profit minded private companies (Porter 1998); and there are counter accounts that credit the private companies with rational thinking in the face of political pressure (Hillier 2014, Sunderland 2003).

The eventual centralisation and municipalisation of London's water supply was, however, effected by a series of exigencies rather than an exclusively public health concern or profit motive (Hardy 1991; Gandy 2004). That the Victorian sewers and water supply systems were technologically capable for their time and have served the city well has lead to such a system becoming a 'normative expectation' for urban water supply (Hillier 2014). A parallel process of negotiation between state, society and private companies in evolving notions of water supply was observed in the 19th century in North America as well (Carroll 2012). What had till the 20th century been multiple 'waters' – water associated with different usage cultures and belief systems like mineral waters or well and piped waters - became 'essentialized' into a single monolithic commodity through networking and municipalisation (Hamlin 2000). But, the narrative of the inevitability of modernity, Marxist geographers have argued, is not merely a matter of simplifying history but a deliberate construction meant to trivialise water for the citizens of the global North (Kaika & Swyngedouw 2000). This 'accidental'[8] flow of modernity did not quite continue into the colonial cities.

The colonial governments, which built roads, railways, bridges and municipalities, were not as keen on leaving their mark in the colonised cities with universal, public water supply. Apart from the technical, economic and financial difficulties 'inherent in the production of the bacteriological city' (Gandy 2004: 368), the coloniser lacked interest in the intangible long term benefits accrued by universal and public water supply and sanitation as opposed to the direct trade links generated by transport infrastructure and the revenue necessity of administrative structure (Kaika 2005). Writing about the West-supported development of Greece, which at the turn of the century was in terms of political status more a part of the 'orient' than Europe, Kaika (ibid.) points out that the relative invisibility of underground pipes compared to

[8] Michael Hebbert (1998) contends that London came to be the city it is today 'more by fortune than design' – stressing the ad-hoc, extraneous and evolutionary processes that shaped the city than visionary planning. Such a history, far from diminishing the city, gives it an organic and longer standing character, he posits. The same argument seems appropriate for the water supply systems that we've come to know as normal and necessary today.

mighty bridges privileged transport infrastructure. The project of modernising Greece, she contends, was the Western world's way of legitimising its democratic roots. So, infrastructure was definitely a modernising tool; but, water systems weren't the best exhibits of this modernity.

### 2.2.2. Fragmented legacy

The 'infrastructure crisis' that cities in the global South face today, thought to be temporary gaps in connectivity that would be overcome by planning, can be traced, in part, to:

> …the legacy of an incomplete modernity which rested on a brutal distinction between "citizens" who could lay claim to potable water and mere "subjects" who were left to make do as best they could. (Gandy 2004: 368)

The fracturing of the colonial body politic was in contrast to the cities of England or Europe, which, albeit class divided, depended on a 'militant working class to function effectively'. Culturally distinctive and a fragmented working class continue to be a feature of the cities of the global South. In the 19$^{th}$ century, Indian colonial presidencies were undergoing rapid industrialisation and urbanisation much like their counterparts in England. One such industrial city – Coimbatore, incorporated as a municipality in 1866 – required water supply desperately as it was fast becoming the centre of cotton mills and trade. But, the many projects devised for the city were dropped because of the high capital expenditure requirement (Saravanan 2007). Perhaps as a rebuke to the colonial government's short-sightedness, it was after the construction of the first basic water supply system in 1931 that the textile economy of Coimbatore and the nearby Tirupur picked up at an unprecedented pace (ibid.).

A similar narrative is told by Bombay's water infrastructure history; despite the city's rapid industrialisation, only basic water supply systems were constructed, without even a filtering mechanism. Combined with the city's poor sewerage management, epidemics of deadly diseases like cholera were frequent and unmitigated (Klein 1986). The political fragmentation mentioned above protected not only the coloniser but also the local elites from such devastation (Lewandowski 1975), creating segregated 'sanitary' and 'contaminated' cities (McFarlane 2008b). The moral economy that drove much public health initiative in London, while very much present in Bombay or Madras were far less disturbed by the inequalities because of the easy 'othering' of the unsanitary bodies (ibid.).

The effect that colonial administration had on Indian rural or agricultural water management, on the other hand, is much more contested. Debates focus on two issues – whether there really was a clean break between 'traditional' water management and colonial planning; if that were indeed so, whether the shift was beneficial or devastating to Indian ecology and life. The vagaries of the Indian monsoon have always required engineering intervention from farmers and communities, who built systems of canals and tanks or a pattern of wells adapted to local conditions, in order to store water for the drier seasons and in the rainshadow regions (Naz & Subramanian 2010, Sengupta 1985). Colonialism introduced, in the words of Rohan D'Souza, a:

> "distinct hydraulic paradigm…which involved fundamentally realigning land and water in new sets of social, political and ecological relationships." (D'Souza 2006: 625)

Arguing that pre-colonial Indian society had 'a significant technical sophistication' in building irrigation systems for agriculture, Naz & Subramanian (2010), nevertheless, deem them essentially village level community organised organic projects; a view shared by the 'new traditionalists' of the present day environmental movement in India (Sinha et al 1997). This strand of environmentalism (see Agarwal & Narain 1997) contends that the traditional community managed systems worked on an inherently conservationist wisdom which was deliberately or ignorantly destroyed by the technical and administrative changes brought about by the British and the post-colonial administration (Mosse & Sivan 2003, Sinha et al 1997). The hegemony of 'Western' science, strengthened by colonialism, has also been blamed for the lower status accorded to traditional knowledge in post-colonial development (Sengupta 1985).

On the premise of a 'quantum leap in irrigation' during the colonial era, as Naz & Subramanian (2010) put it, there have been debates on whether this change was beneficial to Indian agriculture, introducing a creative disruption (Stone 2002) or if it wreaked irreversible devastation on the Indian landscape (Whitcombe 1971). The colonial government has been held responsible for the 'decline' of the tank irrigation, especially by enacting the *Kudimaramat* or 'voluntary labour' act, which is considered simply euphemism for 'forced labour' (Mukundan 2005, Naz & Subramanian 2010, Sengupta 1985). But, this argument ignores the forms of coercion and power structures in the village communities which ensured a steady source of low-cost labour to maintain the canals and tanks (Sinha et al 1997). If the coloniser's tactics failed to maintain the canals and tanks, it only means that their exercise of power was less effective than village hierarchies in coercing labour.

The management of tank irrigation systems become important for urban water supply today as such tanks continue to serve south Indian cities like Chennai and Bangalore. Irrespective of the merits of the 'traditional' practices or the 'modern' systems introduced by the colonial regime, the idea of a paradigm shift between the two periods of history has been challenged. Nicholas Dirks (1986) suggests that cultural continuity among Indian societies and the peculiar British understanding of those continuities meant that the colonial regime changed far less than it lead us to believe. "Colonialism is no longer considered the great watershed it once was thought to be," he writes (p. 307). The image of an unadultered pre-colonial community devastated by colonial rule may itself be an orientalist construction, influenced by our own post-colonial politics, reason Mosse & Sivan (2003). The first Prime Minister of independent India, Jawaharlal Nehru, arguably betrayed his own post-colonial assumptions in unveiling his modernist project of building dams and bridges as the 'temples of modern India'.

### 2.2.3. Temples of Development

Lauding large dams as 'temples' of the newly independent India represented Nehru's vision of a state that was unfettered by its traditional past and whose 'religion' would only be modernism. However, he is reported to have regretted using that catchy term to refer specifically to large dams, which would soon become highly contested[9]. The quote's popularity, nevertheless, informs us of the imagination of modernity and development that prevailed in post-colonial India's planning sensibilities. It was this imagination that was at work in the handling of water resources, primarily for irrigation and hydro-electric power generation.

The primary shift observed in water projects from the colonial to the post-colonial period in India was from ground water to surface water and consequently, from hydrating dry plains to harnessing flood waters (D'Souza 2003a). As Ramaswamy Iyer (1998: 3198) puts it in his historical review, Indian water policy at that time was guided by the idea that surface water that flows into the sea is simply 'wasted'. For this reason and a matrix of factors including the Fabian socialist Nehru's influence, the rise of the United States as a global power and the awe it inspired through its Tennessee Valley Authority damming project, the seduction of technology to a new-born nation aspiring for food security, and the sheer boldness of mega-infrastructure, large dams became symbolic and strategic in the blueprint for development and water management in independent India (D'Souza 2003a, Bottrall 1992).

This was a phase that the countries of the global North had gone through in the early parts of the 20th century, and the countries of the South were following in their post-colonial phase (Biswas & Tortajada 2001, Kaika 2005). As Karen Bakker (1999: 210) reasons:

> "…large-scale water development is a 'peace time' resource, whose development is dependent upon an international perception of internal political stability."

The term that she uses for mega water projects, 'hydrodevelopment', not only conjoins water with development but also references the short form for hydro-electric power - that is 'hydro'. Development of nations as well as the power of generating the modern amenity of electricity was codified in water. The word 'water resources development', Iyer (1998) points out, is indicative of the planning attitude

[9] Guha, R. (2005). 'Prime Ministers and Big Dams', *The Hindu*. Available at: http://ramachandraguha.in/archives/prime-ministers-and-big-dams.html

towards water – to harness water using technology for the development of nations. Building dams represented building nations (Kaika 2005, Roy 1999), but not for long. The welfare state and its function of engineering large scale water infrastructure would be put to test in the 70s and 80s, following a series of controversies on water quality in the global north and a series of protests against large dams in the global South.

## 2.3. Volatile water

Post-war years in Europe, North America and Australia saw the emergence of water quality, closely following efforts at fluoridation of public water supply. In the wartime, addition of chlorine to water as a method of disinfection had been established, despite the negative association of chemicals as potential weaponry in destroying enemy bodies. Interestingly, at least in the UK, fluoridation initiatives carried the agenda of saving on dental health costs for the National Health Service; savings were sought to be achieved in one welfare service by public investment in a different welfare scheme. But, attempts at fluoridation by municipal authorities in London drew protests on overreach by the welfare state, infringement of democratic rights through 'compulsory medication' and the nexus between chemical companies and government (Jones 2013, pp. 140-160; Wright 2009). It was also the time when the post-war consensus of Keynesian planning was coming apart, thanks to the oil shocks and stagnation of economic growth in the 70s. With legacy infrastructure that hadn't caught up with growth, disruptions and failures in water supply had started becoming common (Rydin & Thornley 2003, Wright 2009). Even then, the policy response was the Water Act 1973 which consolidated the previously local council governed water supply into Regional Water Authorities (RWAs) directly under the national government (Bakker 2001, Buller 1996). The RWAs were also in charge of overall water resource management in their respective basins, in contrast with the act of 1963 which had separated these two functions especially to avoid conflict and ensure environmental protection (Jordan 1977) . In this situation, Rachel Carson's (1962) *Silent Spring*-inspired environmentalism started playing a part in public discourse (Jones 2013, Rydin & Thornley 2003: 52).

The introduction of European regulations on water quality brought to the fore a lack of such directives in the existing British policy framework. Public trust in tap water started waning, especially as indignant responses to European directives on water quality emphasized the non-fastidiousness of the British rather than assert existing safety measures (Wright 2009). The tensions in the British policy position was eventually sought to be settled through the privatisation of the RWAs in 1989, encouraged by the Reagan-Thatcher wave of market economics and the privatisation of other public services as well. One of the unique characteristics of the water sector in Britain today – complete privatisation including ownership of assets but with a complex and heavy regulatory framework – can be seen as a consequence of the simultaneous spread of neoliberal ideology and increasing pressure on environmental regulation from the European community (Rydin & Thornley 2003: 59). Meanwhile, large dams and mega water projects were increasingly becoming controversial in the global South.

Even in the Nehruvian era, when high modernism was said to have prevailed unfettered by political opposition, dam construction wasn't as prolific as it is thought to be; the country's complex administrative framework and more importantly its federalism slowed down planned projects with inter-state riparian disputes and local-national jurisdiction differences (Khagram 2004: 1-12, Wood 2007: 56-87). Organised opposition to individual large dams had started from affected villagers even in the 1940s, sometimes under the leadership of local units of the Congress party, which would come to plan these projects in independent India (Khagram 2004: 36). But, it wasn't until the 1970s that a sustained movement putting forth a persistent critique of the modernist project itself emerged, with the Silent Valley project in Kerala and the *Narmada Bachao Andolan* (Save the river Narmada campaign) in the north west. Significantly, these movements were not localised but rather transnational and pressurised international funding agencies to withdraw support for the dam projects concerned (Khagram 2004, pp. 33-65; Wood 2007).

The influence of *Silent Spring* (Carson 1962) and the ensuing American environmentalism was felt even in India, especially as the then Prime Minister Indira Gandhi, for all her other excesses, was known for her progressive views on nature and conservation (Greenough 2003). One of those excesses, the 'Emergency' which suspended civil rights for two years, had brought to the fore political activists not aligned by ideology but by principles of humanism or Gandhian thought. It is these ideals that guided the movements against big dams and environmental activism, in general (Wood 2007: 132). Dams, which submerged thousands of villages in the process of ensuring water security and energy sufficiency, came to be called 'tombs' rather than 'temples' (D'Monte 1985). Even though the modernist project of building mega-dams stood discredited, the idea of engineering water infrastructure or what D'Souza (2003b) calls 'supply side hydrology', even at a large scale and cost, is still prevalent in policy and practice. The latest example is the massive river-linking project or the inter-basin water transfer that had been shelved but revived in the early noughties (Misra et al 2007). That the cities are far from reaching a target of universal networked water supply (Gandy 2008) and that the groundwater reserves that have served them well so far are getting depleted or polluted (Naik et al 2008, Rodell et al 2009, Somasundaram et al 1993) legitimises these projects.

Rather than deem mega-projects fundamentally flawed, blame has been placed on the way they have been implemented by a flawed centralised state and attention turned to the governance of water (Mollinga 2005, 2008). This turn in water policy coincided with the advent of the Reagan-Thatcher neo-classical economics or what we've come to know as neoliberalism, which constructed a lasting critique of the welfare state. Consequently, the past two decades have seen the emergence and critique of four interconnected discourses on water supply – privatisation, right to water, market environmentalism and community management. Importantly, these ideas were now increasingly global more than defined national governments.

### 2.3.1. Changing beliefs

Given the growing acceptance of 'state failure' in managing water, especially in the global south, international development institutions and local governments advocated that private corporations take up urban water provision – a move for re-privatisation (Bakker 2007, Goldman 2007). The United Nations Millennium Development Goal (MDG), which adopted in 2000 to "Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation"[10], also proposed private sector involvement, since financing those goals required a global flow of private capital (Winpenny & Camdessus 2003, Kurian 2010). Supply side solutions and mega-projects which prepare for a growing demand are still justified based on this discourse (Bandyopadhyay et al 2002, Vedachalam 2012). Goldman (2007) posits that the MDGs actually represent a goal to capitalize access to water, making hundreds of millions in the global south 'dependant' on private companies for their water. The surprising consensus at the turn of the century on privatisation of water across governments, he argues, cannot be explained by straightforward economic or technical rationale. It takes a slow bureaucratic and political process of working with local governments, NGOs, think tanks, civil society organisations and media to bring about an ideological acceptance of the private corporation as the ideal supplier and manager of water (ibid.). This process, as Karen Coelho (2010) observes, was called 'reform', ostensibly referring to a corrective process aimed at the erring state institutions which had failed in their mandate of providing water to citizens. This had started not with outright transfer of ownership to the private but with a change in the institutional structure of urban water authorities, which became autonomous executive bodies severed from the elected governments.

In practice, it may not actually matter whether water resources are managed and households supplied by a state department or a private corporation. As has been pointed out by researchers studying the global south, universality and social equity were never realities even under public water supply; it is often the case that commoditised water is available free of cost, if informally, to the urban poor while public water remains inaccessible (Anand 2011, Loftus 2005). The language of commodification or commoditisation has also been found to be inadequate as the very act of abstracting water from the environment and supplying it in consumable form through pipes, buckets or trucks are acts of commoditisation (Bakker 2007, Page 2005). If commodification is supposed to refer to the commercialisation of water, that is quite independent of the private or public nature of the supplier (Castro

[10] UN Millennium Development Goals, available at: http://www.un.org/millenniumgoals/bkgd.shtml

2008). What is of concern, as Erik Swyngedouw (2009: 40) puts it is the "corporatization of water service delivery companies and the imposed requirement for profitability and 'full cost' recovery". It is in response to this that 'right to water' campaigns started up around the world, arguing that the treatment of water as an 'economic good' was fundamentally at odds with this basic human right (Bakker 2007).

The special 'human right' status to water is predicated on its un-substitutable necessity for human life and the requirement of water as a pre-requisite for other rights like food and life. Theoretically, it has been built on the framework of Amartya Sen's (1999) influential capabilities approach, which advocates the provision of basic infrastructure to all in order to ensure human freedom (Mehta 2006). This freedom, according to Sen, translates to development. In its basic goals, then, right to water echoes the United Nations' and other development agencies' views on water provision. This, in effect, is not really incompatible with privatisation. Nor does it challenge even commercial pricing sufficiently for there is no conceptual dissonance in guaranteeing rights to an economic commodity, especially when it happens to be a natural resource. Unsurprisingly, the UN, development agencies, national governments and private companies have found it unproblematic to engage with this campaign and co-opt them into their own goals (Bakker 2007). Sultana & Loftus (2012) mount a critique of the 'right to water' framework on two counts. One is its focus on the 'individual' and neglect of social inequalities and structural injustices in water access, quality and quantity. The second is its unwitting anthropocentrism disregarding the 'rights of water' (ibid.).

In an attempt to balance the concerns of 'right to water' and 'rights of water', the water sector has turned to what has been called by a variety of epithets such as 'market environmentalism' or 'neoliberalising nature' or 'green neoliberalism' (Bakker 2005, Goldman 2007) in the global north and south. The main problem, according to this doctrine, is the presumption of water to be a 'free natural resource'. If users did not have to pay, at least very much, for their water, they would not hold it in any value and hence lead to its scarcity, the logic of this argument goes (Goldman 2007). The market is purported to be the most effective allocator of resources;

hence, pricing mechanisms and efficient technologies are expected to take care of sustainability of urban water supply (Bakker 2005). Differential pricing was advocated as a means to ensure that water wasn't wasted by consumers and to penalise over-use. Based on the assumption that the urban poor would never consume large quantities of water, such a pricing was expected to bring about social equity too (Rogers et al 2002).

Critics have pointed out that this, in fact, meant augmenting supply only for those who can pay for it and that hasn't stopped the depletion of water resources in peri-urban areas (Coelho 2010, Janakarajan et al 2010, Ruet et al 2007). In one of the most well-known cases of water access, the constitutional 'right to water' in South Africa was ruled to be unaffected by a differential billing mechanism of the water supplier, which disproportionately affected poor and black communities (Bond 2012). Market environmentalism trumped right to water or as Bakker (2001) argues, efficient distribution has replaced equitable access as the goal of modern water supply. But, in the two decades since she concluded so, the dogma has been slowly unravelling in favour of community management or decentralisation of water supply.

### 2.3.2. Disrupting binaries

The global push for privatising water management and supply was premised on the private sector's capability to pump finance capital into large scale infrastructure, which was deemed necessary to meet the MDGs and connect millions in the global south to networked flow of water. However, it became increasingly clear that private companies did not have a record of investing of their own accord in long term infrastructure, especially in the water and sanitation sectors (Armentia & Cisneros 2009, Hall & Lobina 2006). Private companies, despite being free to charge for water supply and recover the 'full cost' incurred to them, were discovering that it was just not a service that could be profitable (Swyngedouw 2009). They were certainly not achieving development goals of universal water access (Prasad 2006). The private sector was becoming unwilling to invest in water and the public sector incapable of doing so (Gandy 2011).

In this situation, campaigns that voiced for a ‘community’-centric water management became better heard. This campaign is many pronged insisting on varied strategies like decentralisation of physical and administrative structure (Baviskar 2004), community participation or stakeholder engagement in large scale projects (Bandyopadhyay et al 2002), community managed small scale projects or full-fledged community ownership and planning of water use (Morse 2000). Importantly, these strategies are also expected to work towards the objective of ‘sustainability’, which the previous phases of civil engineering for quantity and chemical engineering for quality have overlooked (Barraqué 2003). In this formulation, the dichotomy between the progressive ideals of equitable water access and environmental conservation is bridged, at least in theory. Apart from re-opening questions of whether water is a resource, right, commodity or public good, it also brought forth the question of what exactly was meant by community.

In the global south as well as the north, centralised schemes of water management incorporate local level ‘stakeholder’ participation. These stakeholders can range from resident welfare associations to global water policy think tanks and they arguably do not necessarily espouse democratic ideals and even circumvent elected bodies (Baviskar 2004, Page 2003). The stakeholder consultation or participation process works more for the purpose of reinstituting a public character to water which is managed and supplied as a commodity by private or corporatized utilities. Whether the participating bodies truly represent the ‘public’ is debatable and that is why defining the concept of ‘community’ becomes important. Anxieties about the community are heightened when it is not just a participating body but the owner and manager of water resources.

Building on Elinor Ostrom’s (1990) work on the ‘commons’ as a model for sustainable resource use and the moral argument of collective solidarity, case has been made for community owned and managed water resources from across the world (Bhasin 1997, Nemarundwe & Kozanayi 2003, Potkanski & Adams 1998). Within the UK, the case of Wales is well known for its restructuring of privatised industry into a consumer cooperative (Morse 2000). But, this, Bakker (2003) argues, is in line with the previous policy of commercialisation as it takes water farther from public and democratic accountability. Equally, the pitfalls and inequalities of community come in the way of an ideal commons. Lyla Mehta (2001), controversially, picks the Kutch region in Gujarat, a potential beneficiary of the Sardar Sarovar Dam protests against which have transformed much of the debate around mega water projects in India, to demonstrate the inequities built into traditional and community managed systems.

The idea of community, Mosse (2008) contends, is often based on a flawed ideal of pre-industrial harmony rather than a progressive process of collective mobilisation. Additionally, it may simply be a prop in the continued withdrawal of the state, leaving citizens to their own means. Community engagement then becomes a one-size-fits-all prescription and fails to be a truly socially engaging project (Mosse & Sivan 2003). Insistence on community management and opposition to centralisation, Page (2005) writes, further little more than a narrow 'parochialism' that precludes possibilities of meaningful inter-regional ecological collaboration. In other words, it is a social strategy which doesn't take into account the genuine ecological contingencies of water management and supply.

As Bakker (2008) argues, the community management discourse has certainly disturbed the binary of public and private or commodity and resource that dominated water management debates. It widens the scope of conceptualising water in more than simply economic terms, bestowing cultural and symbolic meanings through the construct of community. But, the model still follows a managerial approach to water, advocating a change in human ownership as panacea to ecological and political issues that cloud the water sector. The objective of such a model, or even the debate between private and public water provision, is to arrive at the best method to supply water to societies, preferably in an equitable and sustainable manner. Much of the narrative above was also drawn up with this focus, albeit considering not just techno-natural factors (Srinivasan 2008), but including social and political factors, in what Mollinga (2008) calls a 'political sociology' framework of water resources management. Political analysis is only a means to the end of management of water resources.

So, for example, Govind Gopakumar (2009) argues that politics is strategically important to public-private partnerships in water management; in the same vein, Sridharan (2008) finds specific local political reasons why community management of water resources wouldn't work in particular locations and Coelho (2010) finds that bureaucrats and engineers in public water authorities find ways to subvert the goal of universal water supply. Urban water supply issues are conceptualised on a case-by-case with attention to the role of politics. In a way, the Marxist theory of Urban Political Ecology (UPE) is only formalising these piecemeal studies; but what it does is also offer a standard way to theorise urban water, even when there are no problems or issues to be addressed. It pays attention to politics, not in the specific local sense but in a structural sense, placing water in this ecology of politics and other urban processes. UPE jettisons questions of water management strategy and method in favour of examining water projects, events and processes as a part of the larger rubric of the metabolic city. The following section will explore possibilities and limitations in this theory.

## 2.4. Political Ecology

The term political ecology refers to a tradition of simply going beyond the techno-natural processes usually associated with the study of nature, an aspect of which is water, and paying attention to the forces of society and culture on the environment. As anthropologist Kirsten Hastrup (2013: 60) points out: "People are never simply placed in the environment, they actively interfere with it, and increasingly so." While the statement seems fairly evident, the need to make it arises from the arguably Western, post-industrial revolution practice of thinking about nature and culture as fundamentally different things (Anderson 2003, Gold 1984). Alienated from the natural environment by the city and industrial technology, popular imagination of nature came to be constructed by romantic poets and pastoral artists of the era (Gold 1984, Mitchell 1994).

Nature became an external thing, not a part of society, but to be conquered by man (Gold 1984). This conception of nature as a homogenous thing usually referred to in the feminine form and as the diametric opposite to human civilisation, has been, rightly, criticised as racialized and gendered (Merchant 1980, Wade 1993). The environmental movement in the 1970s brought questions of nature to the doorstep of everyday living and a radical rethinking of this nature-society relationship began. This occurred partly in response to the continued calls for ‘preservation’ of nature by society, sustaining the notion of human separation and power from society (Castree & Braun 1998).

Political ecology, far from being a ‘single body of theory’, as Paul Robbins (2012: 1) puts it, is: “…a number of independent trains of thought colliding in the field, leading to a remarkable synthesis in the late 1980s.” This section will go through a couple of key trains of thought that have resulted in the political ecology tradition as we know it today. While urban political ecology (UPE), developed by contemporary Marxist geographers, has been at the forefront in dealing with water issues in cities around the world today, it is the result of a long history of engagement with ecology and the environment in the 20th century, in the disciplines of sociology and geography. The following section will take a brief detour from water and dip into this history.

#### 2.4.1. Human natures

Literary critic Raymond Williams (1976: 219-224) famously problematized the concept of nature by simply observing that it was ‘perhaps the most complex word’ in the language. Etymologically exploring the word ‘nature’ as it has been understood over time, he made a case for a social understanding on nature rather than its acceptance as a given truth. Further, drawing attention to the place of man (sic) in nature, he pronounces, “…the idea of nature contains, though often unnoticed, an extraordinary amount of human history” (Williams [1972] 2005: 47). This resonated in an era when the effects of human ‘pollution’ of the environment were beginning to be painfully felt.

In the 1990s, when the idea of conserving nature had taken root all over the world, the pioneering works of art historian and literary theorist W J T Mitchell (1994) and anthropologist Barbara Bender (1993) further strengthened the social construction of nature thesis through their landmark texts on the politics of personal experience and socio-cultures that influence our subjective understanding of nature. While these arguments were powerful in contesting romantic notions of pristine nature and its preservation, they weren't addressing the issue of nature's influence on society. In other words, they challenged the politics of environmentalism of the age but not the environmental question itself. Doing that required a shift in the tenets of sociology, which also took place in the 1970s.

"When public apprehension began to be aroused concerning newly visible environmental problems," write Catton & Dunlap (1978: 43-44), sociologists lost out to biologists in 'highlighting the precariousness of the human condition' because they had been trained in the world view of the human exceptionalism paradigm (HEP) which did not acknowledge that the human was not only a part of society but also of the natural world around. The tools used to consider the social environment were influential paradigms like Marxism which were found to be inherently anthropocentric and took for granted the abundance of natural resources or the human capability to generate abundance. Culture was deemed capable of conquering nature. So, Catton & Dunlap (1978) introduced the 'new environmental paradigm' following the then short tradition of environmental sociology, which initially engaged mainly with environmentalists and their impact on society (Morrison 1973) or used environmental issues to consider traditional sociological questions like class and inequality (Burch 1971).

The total separation of social processes from nature had been a response to the racialized scientific paradigm of the late 19th and early 20th centuries (Hannigan 1995, Foster 1999), including social Darwinism and biogeography, which assigned ecological factors to the global geographical inequities of the time (Anderson 2003). It was aided by economic and scientific advancement in the Western world, which enabled society to live without worrying about its environment (Foster 1999). However, later accounts of environmental sociology reconciled the apparent lack of environmental considerations in classical sociological theories.

John Hannigan's (1995: 5) comprehensive book on the discipline begins with the acknowledgement: "the three major classical sociological pioneers – Emile Durkheim, Karl Marx and Max Weber – arguably had an implicit environmental dimension to their work." This was lost in translation in the derivative works done by their American interpreters, he (ibid.) writes. Catton & Dunlap's (1978) attempt at ushering in a 'new environmental paradigm' did not catch on and sociologists preferred to look for environmental cues in the classics. Marx's concept of metabolic relationship, they discovered, pointed in the right direction.

Catton & Dunlap's (1978) distinction between the anthropocentric and the eco-centric would have made little sense to Marx, contends Foster (1999), because he was always referring to the dialectic between man and nature; it would not have occurred to him to centre his theory on one or the other. Marx famously criticised the construction of the London sewers, exclaiming: "In London . . . they can do nothing better with the excrement produced by four and a half million people than pollute the Thames with it, at monstrous expense" ([1867] 1976: 195). He was also responding to the devaluing of human waste as agricultural manure, thanks to the cheap import of Peruvian guano (bird droppings); thereby making the construction of water based sewerage systems acceptable for the city of London (Penner 2013: 240-3).

Marx's theory on the modes of production deals not only with class but also with materials. In other words, it is not a theory of social relations only. It equally addresses human-nature relationships too (Buttel 2002). This relationship, he called, the 'metabolic interaction between man and the earth' (Marx [1867] 1976: 637) and capitalism was slowly destroying it. Foster (1999: 380) argues that the concept of 'social-ecological metabolism' was central to Marx's 'entire theoretical approach'. Allan Schnaiberg's (1980) concept of 'treadmill of production' was neo-Marxist in its critique of the forces of capital working to reproduce themselves at the cost of the environment. Environmental sociology has, subsequently, embraced Marx's metabolism in its study of the sociological processes affecting human beings and nature (Dickens 2000, Clark & York 2005). It may be noted here that the divide between society and nature or nature and culture still stays, even though the human is now accepted to be a part the natural world and a concrete theory has been evolved to study the relationship between them.

### 2.4.2. A response and an agenda

The emergence of a specific theory of political ecology indicates the existence of an apolitical ecology before it (Robbins 2012: 7). As discussed earlier in the chapter, there was a predominantly neo-malthusian strain to ecological studies and policies, which built a narrative of resource scarcity owing to rising populations, particularly in the global south. This argument, while appearing scientific, failed to account for the vast inequalities in access to and consumption of resources between small enclaves of wealthy populations and the global poor. It failed to account for the economic, social and political reasons why certain sections of the population couldn't gain access to resources while others living in similar bio-geographical conditions could (Robbins 2012: 8). In short, the natural limits argument was not merely apolitical, but also unjust. It ignored questions of environmental justice and in doing so, was 'implicitly *political,* since it holds implications for the distribution and control of resources' (Robbins 2012: 9). Those implications were often anti-poor and resisted redistribution of power and wealth.

In response to this, political ecology was formulated as a theory with an agenda, 'to think morally about a relationship we had assumed was purely instrumental', as Low & Gleeson (1998: 1) put it. They center questions of distributive justice not only for the purpose of dealing with resource inequality but with environmental degradation as well: "The question of justice *within* the environment is enfolded in the question of justice *to* the environment" (ibid.: 18). Moreover, since political ecology begins with a critique of global systems of inequalities, its analysis is automatically capable of accommodating studies at varying scales – from the village or city to nation states and international relationships (Gezon 2005). It is for this reason that Bryant & Bailey (1997) refer to the theory itself as third world political ecology, although distinct from a first world or global political ecology. The focus of this approach are the regions historically subjugated not only by global capitalism but also by ongoing state-led interventions which could destroy their environment and pressurise people dependent on it.

There are also broader definitions that bring within the fold of political ecology any study that applies the principles of political economy to questions of ecology and resource management (Blaikie & Brookfield 2015). They encompass the range of studies sparked by the coinage of the term in the 1970s by anthropologist Eric Wolf and journalist Alexander Cockburn, as a way to think about environmental degradation through the lens of resource access and control (Peet & Watts 2004: 6). But, they also share the common thread of discussing the dialectic between humans and nature in Marxist terms (Blaikie & Brookfield 2015, Forsyth 2013). Based on a materialist reading of Marx, political ecology builds on the hypothesis that: "the way humans interact with the world of natural objects provides a "base" upon which law, politics, and society are founded" (Robbins 2012: 46).

Political ecology's connection to Marxism doesn't end there. In the words of Alain Lipietz:

> Political ecology, like the Marxist-inspired workers' movement, is based on a critique – and thus an analysis, a theorized understanding – of the "order of existing things." (Lipietz 2000: 70)

So, even if the objective of the study is not a political agenda of distributive justice, its disciplinary history involves a critique of the status quo. So, political ecology is, at once, a theoretical approach and an activist movement. Perhaps, the most controversial aspect of the theory is Robbins' (2012: 12) statement that it carries a "normative understanding that there are very likely better, less coercive, less exploitative, and more sustainable ways of doing things." Vayda & Walters (1999), one of the strongest critics of the practice of political ecology, find this presumption problematic and leading up to a populist environmentalism that always opposes projects connected to wider economic systems, in support of local or community-led to solutions.

Further, they lament the neglect of ecological considerations by an excess weightage given to political factors by political ecologists. Even the politics that is considered, they argue, often is only tangential to the environmental issue at hand and does not affect ecology directly. Political ecologists, according to them, in their counter-agenda to cover the gap in traditional ecological scholarship, have over-estimated the role of politics in environmental change. Their criticism, often considered unsubstantiated or unwarranted (Walker 2005), has nevertheless been followed by some refining and redefining of the political ecology tradition (Paulson et al 2003).

One such redefined theory specifically built for the context of the city is urban political ecology (UPE). It did not emerge as a response to Vayda & Walters' (1999) critical article. But, crucially, it theorised nature and society as both being 'hybrid' and not entirely distinct from one another. This added a whole new dimension to the traditional political ecology school of thought; additionally, it gave equal agency and importance to political and ecological factors, at least in theory.

### 2.4.3. Urban ecology

The term 'ecology', originating from a biological, environmental and geographical context, has, in the case of political ecology, also come to mean the 'interconnectedness of political relations' (Forsyth 2013: 3). Those political relations in turn are comprised of the interactions between various political systems with society and the physical or natural environment. So, 'ecology' could be used to refer to the complex interrelationships between the myriad of actors that form an environment – the physical and social actors. This concept was used in the urban context way back in 1925 by the Chicago sociologist Robert Park. In his formulation of what he called a human ecology of the city, he used the biological model of 'web of life' to study social interaction in the city (Park [1925] 1984). The city was said to have its distinct ecology comprised of infrastructure, people and its modes of production. Park's colleague Ernest Burgess, with whom he published the influential text *The City* and put forth the concentric zone model of city planning and analysis, proposes that urban growth be thought of as: "resultant of organization and disorganization analogous to the anabolic and katabolic processes of metabolism in the body” (Burgess [1925]1984: 53).

Decades later, Marxist scholar David Harvey (1993: 28), by remarking that ‘there is in the final analysis nothing *unnatural* about New York City” and calling the city a ‘created ecosystem’, brought the ecology metaphor back into use. He argues that cities comprise a ‘second ecosystem’, the deterioration of which, even if for the purpose of getting back to nature, would be an ecological disaster as well. Urban Political Ecology (UPE) is built on this thesis of urbanisation of nature, which in turn evolved from a critique of the fetishization of nature in modern cities. Swyngedouw & Kaika (2000) trace a historical capitalist and western tendency to idealise a pre-urban natural and ecological past, vilifying the city as an ‘underbelly’ of humanity; whereas, in practice, nature is the dark and monstrous thing sought to be domesticated and controlled for the benefit of the urban. This world view has spawned the imagination of what Gandy (2003: 9) calls an ‘ecological city’, some of its features being:

> “…an aesthetic predilection for the ‘urban pastoral’ rooted in nineteenth-century romanticism and a belief in the ‘curative’ and ‘regenerative’ powers of nature; and an elision between the ecological world view and a critique of modernist thought and design.” (Gandy 2003: 9)

This imagination is rooted in the lack of appreciation for the social and physical processes that go into constituting an urban ecology and a view of nature as only a commodity. Swyngedouw & Kaika (2000) posit that nature is commodified in that it is transformed through social and cultural processes and introduced into market relations. But, the process being as efficient and invisible as it has become now (Carse 2012), the commodity has become the only form in which nature is recognised and fetishized. As a political project to make visible the process through which nature is transformed into the city, urban political ecology proposes the study of the city as ‘a process of transformed nature’ (Kaika & Swyngedouw 2000: 121). The urban here is actually a process more than a place and it is nothing more than transformed nature; this essentially fuses nature and the urban and posits that ‘nature’ is not something found outside the city as a commodity, but is a part of what makes the city work and exist.

In this framework, water is clearly 'emblematic'. Water is undeniably a part of nature. It is often sought out by city-dwellers for leisure and relaxation, within and outside the city. But, it is also a life-sustaining essential element that has been commodified for ages now for the convenience of consumers. It lives a double life – in household taps as a mundane everyday infrastructure and in rivers, lakes, rain and floods as a force of nature that is a source of beauty, pleasure, awe and danger. Conceptually, water is an apt subject of study for political ecology, especially given UPE's concern with flows or circulation.

Urbanization, while attempting to 'render cities independent from nature's processes', in fact, ended up tying them into a 'socio-spatial continuum' (Kaika 2005: 5). That 20th century 'temple' of modernity – the dam, for instance, connects the city to natural resources essential for its existence - water. It also weaves the city together with the vagaries of the natural environment in which it exists, including droughts and floods. This connection happens through 'flow'– of water, electricity, transport, people and the material networks that carry this flow like pipelines, roads, underground tunnels etc. It is the 'flow' of nature, or rather, the capital and labour involved in creating hose flows, that makes 'nature as infrastructure' (Carse 2012). UPE characterises these flows as circulations.

### 2.4.4. Circulations and metabolism of hybrids

Metabolism, as we saw before, has been a defining principle of political ecology. Its original meaning being the bodily functions that sustained respiration, the word came to refer to the bio-chemical interactions between organisms and their environment even in the 19th century (Swyngedouw 2006). In the writings of Marx, the organism was the human being who used labour to interact with and transform the environment. In UPE, the environment is not necessarily the natural environment but the 'created ecosystem' of the city which involves everything from the flow of money into high value businesses and the flow of electricity in the grids to the flow of garbage from homes to landfills. These flows have a circular logic. But, the word 'circulation' in UPE derives from the industrial revolution notion of circulating money and material generating further wealth. Hence, Swyngedouw (ibid.) writes:

> In the process, 'circulation' became less and less identified with closed circular movement, but identified with change, growth, and accumulation….Accumulation is dependent on the swiftness by which money circulates through society. ( Swyngedouw 2006: 111)

It is not difficult to see the similarities with Edwin Chadwick's formulation of circulating waters for the city of London. High volumes and rapid circulation were necessary in keeping the circulation alive and in turn, keeping the city adequately hydrated and sanitary (Hamlin 1992). Circulation, for UPE, is metaphor and hypothesis, that the flow of water resembles and follows the flow of money. So, the urban is a metabolic process of circulations. But, what is the urban comprised of? What is the nature of the materials and organisms involved in these metabolic processes and circulations? They are all hybrids, argues Swyngedouw (2006), none of them being completely natural or social, all of them being a combination of the two.

The concept of a 'hybrid' comes from the influential actor network theory (Callon 1987), which is built on the premise that the human and the non-human elements in society, the animate and the inanimate, the social and the scientific – are all hybrid 'actants' in a societal network of production and reproduction (Latour 1991). The actants:

> "…whether natural or social, could at any moment redefine their identity and mutual relationships in some new way and bring new elements into the network." (Callon 1987: 93)

So, water, pipes, supply infrastructure, the water authority, the household user – they are all hybrid actants in that they are a combination of physical and social elements. Their make-up is not a constant and is continuously changing depending on the biophysical and social situation at hand.

The project of actor networks came about as a way of introducing the non-human element into sociological study, on par with human and societal actors. The non-human 'agency' is critical to ANT and less important is the notion of power that one kind of actors could have over others. UPE uses the idea of hybrids to describe the 'heterogeneous' make-up of the metabolic processes that produce urban water networks; but, stresses the need to consider role of power in socio-ecological relationships as they are never 'neutral' (Swyngedouw 2006).

### 2.4.5. Possibilities and limitations

One of the significant contributions of UPE is its work on the growing acceptance of water scarcity, especially in cities, as a matter of fact. Deconstructing this 'fact', Kaika (2003) explores how a major water scarcity that affected Athens was used to establish an idea of 'nature as threat' and the need to take 'emergency' measures to deal with it. The measures ended up benefitting the interests of private capital. On the other hand, Giglioli & Swyngedouw (2008) show how a water crisis failed to precipitate any socio-natural changes owing to the entrenched hegemony of historical power relations. In a similar vein, Lyla Mehta (2003) argues that although water scarcities are partly natural and partly social phenomenon, the actions and processes that follow scarcities are largely politically motivated.

These examples, which repeatedly present ecological crises as socially constructed, are indeed vulnerable to the criticism of Vayda & Walters (1999) that political ecology is really only politics with not much ecology in it. But, Nik Heynen, one of the early proponents of UPE finds it problematic that political ecologists are criticised for not taking ecological issues seriously "due to the common failure of ecologists to take urban issues seriously" (Heynen 2003: 981). He argues that the study of urban environments necessitates an explicit focus on social processes because:

> Humans metabolize nature, as do other living organisms. However, economic, political, and cultural processes govern human metabolization. Most dominant within these processes is capitalism. (Heynen 2003: 981)

UPE, interchangeably called Marxist UPE, is unabashed about its economic determinism, from the primacy it accords to the circulation of money over other social processes, to its analysis of environmental change through the prism of private capital. As Gandy (2003: 23) puts it poetically about the formation of what is considered one of the world's 'most modern' cities, New York: "The landscape of upstate New York has been sculpted into a life-sustaining circulatory system through the interaction of flow of water and the flow of money." When the very premise is of capital's power to shape human and natural flow, it would be a paradox to refer to the agency of all the 'hybrid' actors and the ecology they comprise.

Amita Baviskar (2003), studying environmental change in Delhi, finds that, in her case, it is neither ecological forces nor financial powers that direct it but the cultural imagination of local residents. She calls for a rejection of the economic determinism of political ecology and more research on the cultural politics of natural resources. Donald Moore (1993) puts forth a similar criticism of political ecology, arguing that the 'macrostructural bias' that it carries, blinds it to the possibilities of micropolitics and cultural construction of natural resources. This bias is evident in the assumption of 'invisible' infrastructure alienating urban residents from the socio-natural processes that produce their environment. In the cities of the global south, to which political ecology is supposed to be particularly relevant, infrastructure is hardly hidden and seamless. There is constant interaction with natural elements, like soil, water, floods and drought, although rapid urbanisation is changing these interactions (Coutard 2008).

Alex Loftus (2009) contends that Harvey's theory of 'accumulation by dispossession' fails to take into account the outcome of water privatisation across the global south, which is that water companies are finding it very difficult to profit from their business. This is important because much of the Marxist political ecology of water critiques the neoliberal logic of privatisation of water utilities. Loftus proposes a Foucauldian or Gramscian approach to political ecology; to theorise the urban as a socio-natural process and study the circulation of power rather than that of capital (ibid.). He also undertakes a feminist political ecology of water, where the power relationships in the domestic and the neighbourhood setting are studied (Loftus 2007). This study is about gendered labour and gendered circulation of money – very much Marxist themes – but at the micro-level and gender, not money, as the causal determinant.

Given political ecology's long history with Marxist ideas and its preoccupation with capitalism as a prime mover of society's relationship with nature, a reworking of the theory eliminating this economic determinism leaves only tenuous and fragile links with the disciplinary tradition. A crucial point Loftus makes in his 'rethinking' of political ecologies of water is:

> "Another implication of the production of this late capitalist waterscape is that non-human entities such as water meters, flow limiters and money acquire an alien power over people's lives." (Loftus 2009: 964)

Water meters and flow limiters are technologies of water that are becoming common in methods of governance, the apparatus of the state and hence, in society-nature relationships. The tools that UPE offers are inadequate to deal with this. Technology can only be one of the hybrid actors in the framework; UPE deals with this actor only through its ties with capital. Classical political ecologists assert that there is something distinctive about the capitalist character of or the power of money in socio-natural relations (Castree 2002). But, the chronological review above of the debates and discourses surrounding water, from the 19th century 'bacteriological' cities of Europe to the holy dams of post-independence India and the market environmentalism of the present, shows that water has repeatedly been at the point of intersection between science, technology and government. Technology has had an equally distinctive role in socio-natural water and where technology and water are involved, governance and government come into the picture. Since the first rounds of privatisation of water utilities started in the 1970s, studies of water have also focused on the role of private capital to the neglect of the state which continues to exert its influence on the sphere.

Marxist studies on the environment and nature have been opposed to the role of technology in environmental action, partly because technology has been co-opted by the market as its tool for environmentalism (Mol & Spaargaren 2000). But, technology itself does not easily fit into the traditional categories of right and left. This makes the position of the state or government also ambivalent in the interaction between water, technology and society. UPE's macro-structural bias and political economic backing make it ill-equipped to deal with a multi-faceted state as well (Giglioli & Swyngedouw 2008). Consequently, the state becomes a monolithic entity in UPE's formulation. So, the state's interaction with society through the technologies of water requires an approach that goes beyond political economy. The following section will argue that a socio-technical view of water will achieve this purpose best.

## 2.5. Technical, material and political

Apart from technology's interconnection with labour and capital, it is very much capable of affecting the everyday experience of water and planning for water supply in unpredictable and unintended ways (Latour 1991). Technologies and engineering have always had a role to play in the management of water and other resources (Mosse & Sivan 2003). But, with the rise of the environmental movement in the 1970s and plans for environmental mitigation, the role of technology has become a matter of contention and debate, exemplified by the debate between the 'technologically optimistic' (Hannigan 1995: 194) ecological modernisation theory and environmental sociology, which calls for a "fundamental reorganisation of the core institutions of modern society (the industrialised production system, the capitalist organisation of the economy and the centralised state)" (Mol & Spaargaren 2000). Inclination to use technology has also been criticised as depoliticising (Swyngedouw 2007) whereas the practice of using of technology has often lead to new forms of political contestation (Subramanian 2009, von Schnitzler 2008).

In this context, it is productive to think of water and nature as not just socio-natural but also socio-technical (Bakker 2012). The technical need not necessarily be an external technology but also the flow of water engineered to fulfil a purpose (Mosse

& Sivan 2003). The material properties of water make such engineering uniquely possible. The materiality of water itself becomes a technical mediator.

Traditionally anthropology has engaged with the material cultures surrounding water. It is based on the premise that landscape is "the symbolic environment created by a human act of conferring meaning on nature and the environment" (Greider & Garkovich 1994) and investigates the cultural meaning of water or a natural environment to the particular society. Veronica Strang (2004), undertaking an exploration of the material cultures of water in the midst of the environmental movement, suggests that society creates a cultural space around water, which is not subject to rational argument or action. Numerous studies have been done, along these lines, on the cultures of bottled water use (Opel 1999, Wilk 2006). The focus of these studies is on the meaning foisted by society on water or other materials associated with it like bottles, pipes or river-banks. They don't consider the active materiality of water or the related artefacts themselves.

There has now emerged a strain of anthropological and geographical work that, borrowing from science and technology studies, looks at the active mediation of water by technological artefacts. They emerged as a response to the critique of 'commodification' in water anti-privatisation protests; their objective is to complicate the relationship between water, governance and society by looking at particular forms of commodification (Wagner 2010). These forms are created by mediating technologies – like water bottles, pumps, pipes or desalination plants. The studies in this cannon – on household plumbing (Orlove & Caton 2010), bottled water (Hawkins & Race 2011) or water meters (von Schnitzler 2008) – lead to an analysis of macro-structures and issues like governance, sustainability, politics and race.

The socio-technicality of water embodies structural and cultural politics concerned with its supply and use; it also generates some of them. As von Schnitzler (2010: 9) puts it, anthropology of water is: "is always already also an anthropology of the (techno-) political projects through which water is mediated and that it in turn mediates." This approach, which is by no means restricted to anthropology but is adapted in geography, history and environmental studies too, suggests a politics specifically connected to the technologies that mediate water and go beyond material culture's view of water as a cultural symbolism. It also transgresses the Marxist tendency to place water as an actor that is manipulated by capital. In other words, water, as a socio-technical element, is not an 'inert resource' and not merely a 'backdrop to conflict' (Bakker 2012). It is bestowed with an active materiality and function in biological and social life that places it at the centre of governance and politics (ibid.).

Its physical properties – like pressure, leaking, flow – are metaphors for how access to water is decided by a negotiated notion of informal citizenship (Anand 2011, Coelho 2006). The kind of heavy infrastructure required to withstand the vagaries of water in excess and scarcity, comes to represent metaphorically and practically, the dense web of politics and governance required to sustain the infrastructure and the power it projects (Bijker 2007). Studies of technologies of water have frequently discussed the role of the state in the socio-technical process. Technology and water are both subjects in which the state usually has political and strategic interest. A water pump could play a role in state formation just as a large dam could (Barnes 2012). In turn, the state uses water technologies to exert its power and influence (Jones 2012, Selby 2003). Gandy (2004) and Kooy & Bakker (2008) have shown how water's close connection to bodily hygiene and the technologies employed to achieve that were used historically by imperial governments to project civilizational superiority and to exercise social and racial discipline.

The disparate set of studies, from which the socio-technical conceptualisation of water is drawn up above, present a platform on which to build a study of technologies of water. They also indicate an opportunity to theorise from below the relationship between water, technology and society. The socio-technical conceptualisation of water is relatively recent and the studies in that tradition do not follow a single theoretical approach. This opens up the possibility to use the unique materiality of water in a framework of the politics of technology.

## 2.6. Conclusion

"Do we live in water cultures?" asks Wiebe Bijker (2012: 624) in an article on the conceptual benefit of studying society through the lens of water. Of course water has always been a necessary part of all societies and cultures. There is no particular reason why this would be the era of water culture. What Bijker refers to is the eclectic range of topics that an academic study of water was opening up for pursuit. "…societies will be better understood when the role of water is the focus of analysis," he goes on to argue (Bijker 2012: 625). This chapter has attempted to see what water has revealed about societies over the past hundred or so years. It has also looked at how societies have viewed water over the time period and critically considered those conceptualisations of water.

19$^{th}$ century Britain was in many ways the epicentre of transformative ideas on water and its role and utility in urban life. From there emanated the ideal that a centralised, municipalised and networked supply of piped water represented a clean and hygienic urban modernity. The primacy of engineering in water management was also solidified in Victorian London and passed on to colonial and post-colonial nations. While war time Europe encouraged chemical interventions to purify water, the post-war Keynesian welfare states and post-colonial governments encouraged public investment in large scale water infrastructure. Water infrastructure represented an avenue for development and nation building.

All of that, however, started unravelling in the 1970s with the withdrawal of the state, rise of environmentalism and the growing influence of international non-governmental aid. Water was increasingly at the centre of the private vs public debate, which opened the conceptual dilemma of whether water was a commodity or a common resource; should it be free or paid for? When privatisation of public water utilities failed to achieve the desired results in many parts of the world, community management became widely discussed and advocated. Water became the poster-child of the commons. These developments were analysed by Marxist political ecologists who considered capital as instrumental in shaping socio-natural relationships.

Of recent, the central role of capital has been challenged by studies that take technology as the mediator between water and society. These studies also re-center the role of the state and government in the process and allow for an exploration of macro-structures as well as micro-politics. Water, in this case, is socio-technical, in that it is mediated by technology. It possesses an active materiality that shapes and is shaped by the technologies and socio-political processes. Water is at the nexus of technology, society and the state.

# 3. METHODOLOGY - REFLEXIVE ETHNOGRAPHY

## 3.1. Introduction – Infrastructure as ontology and epistemology

> "That is invariably the case in the East; a story always sounds clear enough at a distance, but the nearer you get to the scene of events the vaguer it becomes." - George Orwell on *Shooting an Elephant*[11]

Orwell's experience above of approaching an elephant may be familiar to anyone with a fieldwork component in their research. In contrast to the clarity of an academic hypothesis and meticulously prepared research schedules, the field is all blunt edges offering no easy starting point and more questions than answers. Interviews, on the face of it, are full of long-winded answers and contradictory narratives not addressing the question one started out with. Orwell's conclusion about this being the case in the 'east', presumably, is only because that's where he had encountered an elephant ever. My case studies were located in the global South and the North, but offered a similar experience in terms of muddling my hypotheses with discursive data and abstract narratives that often defied clear causation and the neat compartments of sustainable and unsustainable practices that media reports portrayed.

Yet, this is the promise of opening the 'blackbox' of infrastructure (Latour 1999) – using its incredible complexity to unravel the minutiae of urban life while embracing its utilitarian pragmatism that may not confirm to grand narratives. To stretch the elephant metaphor further, a closer look at different aspects of infrastructure is bound to reveal contradictory features not tallying with the overall narrative one expected to find or started out with. How then do we make sense of infrastructure? Is it more valuable to conduct a close ethnographic study of one piece of equipment (De Laet & Mol 2000) or is it important to abstract the whole structure into maps and documents which could then become the researcher's data (Carroll 2012)? Do its

[11] Available at: http://orwell.ru/library/articles/elephant/english/e_eleph

materials and form tell a story about the social environment they function in or does the behaviour of institutions and engineers explain the way they came to be built.?

These questions are complicated by what Brian Larkin (2013), in his seminal article on the politics and poetics of infrastructure, calls their ‘peculiar ontology’ of being “things and also the relation between things.” Focusing on the relations is often a study of the social and institutional environment that they are produced in, while an interest in their materiality or ‘thing-ness’ involves zooming into their constitution of particular events and social relations. However, scholars in geography and anthropology have found ways of straddling this duality and attempted to address the mutual constitution of infrastructure and their environments in their methodological undertaking. Epistemological and ontological musing on infrastructure can be traced back to Susan Leigh Star’s (1999) enduring work detailing an ethnography of infrastructure. She lists nine defining qualities of infrastructure, including ‘embodiment of standards’, ‘built on an installed base’ and the oft-repeated ‘becomes visible on breakdown’, assuming the norm of working infrastructure being something that fades into the background, invisible for all practical purposes. This has, of course, been shown to be an untenable definition as scholars working in the global South have pointed out that infrastructures can be vital and affective in their visibility. Calling infrastructures as ‘lively’, Amin (2014) has, in fact, argued:

> “Nothing is more striking than the visibility and sound of housing, sanitation, water and electricity, streets and landscapes in the making. The unfolding infrastructure is the object of attention, the frame of values and affects, the grid of neighbourhood, and the matter of wellbeing, sociality and struggle.” (Amin 2014: 143)

Indeed, empirically rich accounts of infrastructure are often those that focus on its use and acculturation, whether it is roads in Peru (Harvey & Knox 2015) or co-existing networked and household water systems in Tijuana, Mexico (Meehan 2014). While both these studies focus on specific infrastructural objects – one highway project in the case of Peru and three distinct systems of water use in the case of Tijuana – and ask the same kind of questions, they draw from different methodological traditions. Harvey and Knox (2015), who are anthropologists, stick to their disciplinary practice of ethnography; Meehan (2014) uses what she calls household surveys, which are really in-depth interviews at the household level, in conjunction with historical data and documentary evidence. Exploring the use of infrastructure has also lead to the examination of so-called ‘informal practices’ in the global south and how they constitute everyday regimes of rule and authority (ibid., Ranganathan 2014). These studies, in drawing out a ‘sociotechnical coexistence’ (Furlong 2014) have been useful in challenging the predominance in STS-inspired studies to focus on Large Technical Systems (LTS) of the kind Star (1999) started out with.

Star’s (2002) concern was primarily with information systems which work as substratum to a wide range of other processual areas like biomedical research, employment data and insurance claims. Contending that this underlying data is infrastructure in much the same way as pipes and power lines are urban infrastructure, she makes a case for a methodological approach based on the study of large informational data sets, like transaction logs or technical specifications, in order to ‘scale up traditional ethnographic sites’ and pay attention to the ‘effect of standardization or formal classification’. As she points out, it is not exactly possible to learn much out of “using fieldwork to stand and watch people punching keys and looking at screens.” (p. 108). In some ways, a seawater desalination plant, which is certainly no LTS, is similar. It is usually a series of tanks followed by an assembled structure of filters that continuously perform the function of reverse osmosis to output water free of its mineral and hence, salt content. Largely an automated process, there is little activity that is happening in the plant to inform the ethnographer of the social or material constitution of cities. Consequently, studying textual information generated around the desalination project, as in the London case, has often been more enlightening than ethnographic practices of interviewing and observation. But, the study of infrastructures needn’t be a choice between immersive observation into its ‘making’ or analysis of textual and numerical datasets about them.

It can be about the human work involved in their production, maintenance, use and socialisation (Carse 2012). As Star & Ruhleder (1996: 115) argue, "Analytically, infrastructure appears only as a relational property, not as a thing stripped of use." So, for instance, roads are mobility for drivers, problems to be negotiated for canal diggers or the pedestrian, and variables to be incorporated for the city planner. Centring the human-technology interaction, this approach leads the investigation into the kind of work most associated with technological systems – engineering. Given infrastructure planning and construction often spans national territories and global flows of capital and knowledge, Larkin proposes a method for their study as whole systems where:

> "…ethnography might need to be conducted in government centers far from where the actual roads are constructed and might take into account politicians, technocrats, economists, engineers, and road builders, as well as road users themselves." (Larkin 2013: 328)

The thing about urban infrastructure is that their development and functioning are symbiotic with the cities in which they are located, cities themselves being intensely networked systems bringing together global, local, technological, social, governmental and engineering processes in everyday habitation. Cities are a "world thick with infrastructure" (Latham & Wood 2015). So, ethnography here needn't be far away from where the infrastructure is, but can take into account the urban ecology – its affective materiality, everyday life, custom and public culture – as observational input, even while recording governmental or engineering practices and related documentation. In other words, it is possible to see infrastructures 'like a city' (Valverde 2011).

Framed against totalising analyses of spatial organisation, like networked infrastructure planning for example, as technologies of discipline, Mariana Valverde's (2011) approach of 'seeing like a city' pays attention to the pragmatic ways in which legal and governance techniques are often more 'flexible, contradictory, and fragile' than expected, thus 'undermining' themselves and succeeding in executing a particular political agenda only by 'highly contingent reasons'. The flexibility or contradiction in a given planning document could, of course, be there by design and aid in achieving its political intent. Nevertheless, the epistemology of 'seeing like a city' doesn't presuppose that technologies of governance are necessarily tied to a political agenda. Translating this to the study of urban infrastructures would mean that plans and policies for their construction would have to be considered alongside the contingent situations in which they came or failed to be built. They can be conceptualised as relational infrastructures of urbanisation, supporting material infrastructures as well as the socio-political imaginations that they inspire (Picon 2018). While not so perfect a phrase as 'conduct of conduct', infrastructures of infrastructure building would come close to explaining an articulation of power, scientific or otherwise, in cities drawing on contingent assemblages of urbanisation rather than governmental rationalities. That infrastructures can be both the foundation as well as the outcome, the cause as well as effect, is after all what makes their unique ontology (Larkin 2013). To this, it can be added that infrastructures are process as well as project, as the following chapters will attempt to establish.

It is no surprise then that the complex urban character of infrastructure has naturally required interdisciplinary approaches and mixed methods that have characterised recent studies, especially in cities of the global South (see for eg. Björkman 2015, Usher 2018). A key figure that emerges in this body of work that can broadly be called the ethnography of infrastructure is that of the engineer. It takes seriously Latour's (1987) call to follow engineers through society, as they go about socialising scientific knowledge in building and maintaining technological networks, their practice serving as conduit between state and society, and simultaneously constituting a structure of rule. Conceptualising engineering as a 'hybrid socio-technical profession' (Bell et al 2011), these studies have been adept at showing how infrastructural projects are:

> "…provisional and contingent achievements that demand constant attention to maintain their connections, performances and parameters." (Harris 2013: 358)

Study of engineering knowledges are nothing new to geography or any form of spatio-political analysis, of course. They have frequently been associated with modernist practices of nation-building, rationalisation of space and control of populations, a phenomenon comprehensively historicised by Mitchell (2002) in his theory of the rule of experts. It is no co-incidence that many of these accounts of engineering modernity (Gandy 2008, Swyngedouw 1999) are set in the early 20th century in Europe or in the colonies, for the success in setting up networked systems in several European cities at the time had indeed brought to the forefront the giddy possibilities offered by engineering. However, there has been another strand of work, which complicates the modernising function of engineering by focusing on the theme of negotiation that dominates building and working of infrastructures. As historian Martin Reuss (2008), based on his work for the U.S.Army Corps of Engineers, asserts, “engineers often spend more time negotiating than building.”

The negotiation itself has long been a function of engineering, though, as essays detailing the conflict-ridden construction of the London sewers have shown (Dobraszczyk 2008); with Hamlin (1992) even arguing that there was a distinctive group of engineers who wanted to follow an ‘anti-systems’ or decentralised approach to the London project. Interestingly, India’s sprawling metropolises appear to have been particularly inspiring to researchers studying the socio-technical role of engineers and their negotiated work (Anand 2011, Bjorkman 2015, Coelho 2006, Harris 2013, Ranganathan 2014). All five scholars cited here combine ethnographic methods of interviewing and observation with the reading of policy and project documents, accompanied by the inevitable inhabitation of infrastructure (Latham & Wood 2015) that comes with living in the city. These ethnographies are characterised by visual cues (Harris 2013, Ranganathan 2014) and personal interactions which reveal different things about urban infrastructure than the study of engineers in the global north or colonial cities (Gandy 2008, McFarlane 2008a) relying on exhaustive documentation and meticulous correspondence, often sourced from historical archives.

This difference in approaches to studying infrastructure in the global South and North became clearer to me through the course of my own fieldwork. While the Chennai case offered little in terms of published reports, correspondence or policy documents towards my analysis, there was opportunity for plenty of personal interactions followed up with proper interviews with officials at various levels and functions of the water governance apparatus. Additionally, the visible and multi-faceted nature of water supply in the city meant that I could draw on visual and even auditory cues as observational data; living in the city during the course of the fieldwork, I inhabited this infrastructure, engaging with its complexity and everyday practicality at the household level. Having lived in the same city before, but returning now after spending a few years in London, this experience constituted affective materiality that played a part in the critical lens I took to my analysis. So, the ethnography in Chennai was immersive and multi-sensory, and based almost entirely on personal interviews. In London, I was able to find plenty of published reports and documents relating to the desalination project and water management in general even before I embarked on fieldwork. But, there was very little scope for personal interactions or interviews following that. In many cases, the very availability of documentary material became reason to be denied personal audience with several officials. The limited access I was afforded in researching London's water system may have, of course, had to do also with my positionality as an immigrant woman of colour, attempting to do social research on organisations that worked ostensibly in the realm of the technological and the scientific.

Further details on how fieldwork was carried out in the two cities will be elaborated in separate sections in this chapter. But, before that, I will briefly sketch the research design and the rationale for it below.

## 3.2. Research design – following connections through

The study of infrastructures, as the brief review above has shown, have benefitted from applying ethnographic tools (Star 2002). The analytical techniques of ethnography, however, can be used in examining textual material as much as in personal interactions or field notes. A combination of the epistemologies of STS, geography and urban studies has shaped a versatile interdisciplinary method for the study of urban infrastructures that turns the intense complexity of cities into its source to excavate documents, individual accounts, institutional practices and socio-material relationalities. This thesis is interested in the kind of knowledges and political formations that emerge around the construction of water infrastructure in cities. To this end, it uses the desalination plants built in Chennai and London as a recent infrastructural transition through which ecological, engineering and political processes could be explored in the cities.

Both cities had a unified water supply and sewerage organisation, which – a quasi-public utility called Metrowater in Chennai and the private multinational company named Thames Water in London – exert a powerful imagination of legacy, technological work and everyday domestic utility. They were, naturally, a key site of research, but not the sole or necessarily the most significant actor in the construction of the desalination plants. Following the trail of planning, regulation and consultancy leading up to the construction of the desalination plants resulted in a network of institutions, professionals and political influences - like political parties in Chennai and the Mayoral office in London – that were mapped out to be potentially tapped into during the course of fieldwork. Thus, the fieldwork was structured as a process of following engineering work through the city. That is, I would start with individuals in the water company and follow up on their institutional connections with other professionals or associate and opposing agencies in the construction of the desalination plants. This follow-up could be in the form of documents to be referred or a personal interview, usually. The vast number of institutions that are involved in the everyday practice of building, maintaining, using and socialising water infrastructures necessitated this network approach. But, they also reflected the fundamentally relational nature of engineering work and infrastructure making in cities.

In Chennai, the desalination plants were also linked physically and in popular discourse to other hydro-social engagements, like the prevalence of reverse osmosis purification units in households or the coastal commons as an ecological resource for the city and its historical fishing communities. So, I followed these leads as well, conducting interviews with private sector engineers designing reverse osmosis units for residential and office buildings; and with coastal activists and residents. In

London, on the other hand, the desalination plant was linked back over and over to the regulatory and planning regimes for water in the UK. Even research and development within Thames Water only came up upon questions specifically directed towards a former head of research in the company; engineering or water management expertise too were seldom discussed except in international trade or development conferences. Water engineering and management, then, emerged as a network of practices and social relations in both cities than as entrenched belief systems, knowledge or as calculative technocracy.

In using ethnography to trace these connections, McCann & Ward's (2012) techniques to study policy assemblages and what they term a 'mobile' urbanism have been highly useful. Rather than the traditional ethnographic idea of a 'bounded' site, they argue that it is important to adapt techniques of 'following' to do empirical justice to the theorisation of cities as relational and assembled. This has precedence in anthropology's use of multi-sited ethnography to bridge the discipline's founding binaries of 'local' and the 'global' (Marcus 1995). So, the techniques of 'following' usually applied to transnational movement of people, including experts (Larner & Laurie 2010), can also be applied to ideas, things and indeed policies or technologies, all of whose movements could also be interconnected. But, in following infrastructural development in Chennai or London, it would be unrealistic to practice immersive observation in all the institutions and sites it networks through. This is where interviews, which are considered 'staged' and 'scripted' encounters in traditional ethnography, become a particularly useful way of getting access to powerful individuals and institutions who are not used to being in the social researcher's gaze (Peck & Theodore 2012). Thus, in adapting to Geography's shifting concern towards agents of what Ananya Roy (2012) calls 'middling modernism' and 'cultures of circulation', the critical value of different ethnographic methods are also altered.

'Following' the 'things, metaphors, stories, and conflicts' relational to the desalination plants (McCann & Ward 2012), 90 interviews were conducted in Chennai and 35 in London, some of them repeated ones with participants who were inclined to interact further. They were all anonymised using a simple coding of C1, C2, C3 (see Appendix I-C) and so on for Chennai; and L1, L2, L3 (see Appendix II-C) and so on for London, the numbering being largely random. Since my participants' professional capacity was often as relevant to the argument as their comments, any interview text cited is always preceded by a brief introduction to who said them throughout the empirical chapters. Typically, interviews lasted half an hour to an hour; in Chennai, the interactions always gave me an opportunity to observe the work, and professional and social interactions of my interviewee before and after the interview. In London, interviews usually came with reading assignments – documents and articles that the interviewee referred to and recommended I look up for further details. I have coded these using the same logic as that used for interviews with CD1, CD2 etc. (see Appendix I-B) referring to documents for the Chennai case and LD1, LD2 etc. (see Appendix II-B) for London. I also attended a conference, two trade events and two social gatherings in Chennai; and four industry workshops in London. I have coded these along with field observations as ethnographic encounters with codes CE1, CE2, CE3 etc. (see Appendix I-A) referring to Chennai, and LE1, LE2 etc. (see Appendix II-A) referring to London. The list of ethnographic encounters in Chennai coincides with the list of institutions that had been mapped out while laying out the research design, whereas in London, it is the list of documents that reflects the set of institutions involved in water management. That is, my encounters with institutions of water governance was heavily mediated by published documentation in London.

For most part of interactive work in the field, recording proceedings was either futile or not allowed, except in a small number of interviews in London. So, much of my research material is in the form of copious hand-written notes, some recording exactly what was being said and others jotting down the content of each sentence, along with significant gestures, sounds and keywords. My experience working as journalist in Chennai came handy in this mode of gathering research data. The politics and implications of this will be explored while explaining fieldwork in each city in further detail below. But, from a methodological standpoint, this meant that I was already interpreting oral and visual communication even at the time of interviews and other field activities.

Mediation of primary sources by the researcher is, of course, inevitable given that their very presence and positionality are capable of altering the kind of information conveyed. By the same token, whether the researcher is positioned with a recorder, a camera or a pen and notepad could influence the direction the interaction takes. Irrespective of whether I was permitted to record conversations or not, I always carried my notepad with me, given I needed to make field notes wherever possible. The 'sites' where I conducted fieldwork varied widely between the staid offices of Metrowater and government agencies, offices of private companies attempting a swankier look with white walls, cubicles and glass doors, conference or business centres located at the urban peripheries, fishing villages in Chennai and busy cafes in London. There was inevitably a lot of movement during fieldwork and limited time and space to set up ideal interview conditions. Thus, even recorded interviews sometimes had too much background noise, making my written notes quite valuable. In order to minimise the layers of interpretation that eventually goes into my transcribed records, I digitised handwritten notes at the end of each day; this also allowed me to add details I remembered from a particular meeting and juxtapose interviews with field observations for the day

In Chennai, almost all my interviews were held in Tamil, which however always has a smattering of English in them. So, my notes followed the speech format by code-switching between the two languages. My daily exercise of note-taking and transcription, then, also allowed me to translate according to context and tone of speech. So, for example the word 'sustainability' would always be referred to in English, with just one of my interviewees, a Marxist environmental activist, attempting to coin a Tamil equivalent. Words like 'engineer', 'technology', 'infrastructure' and 'supply' fell in the same category. If the Tamil words for them were used, which was almost never, the meaning changes ever so slightly and this would be noted in my transcripts in case it became relevant to my analysis. 'Engineer' in Tamil, for example, would literally be someone who works with 'materials'; and 'technology' would be 'industrial technique'. The most significant difference was between the Tamil and English words for the water company: in English it was the Water Supply and Sewerage Board, but became the 'Drinking Water Board' in Tamil, more accurately reflecting the specific concerns of water supply in the global south. Even though conversations were entirely in English in London, my interviewees' speech was peppered liberally with jargon, abbreviations and technical terms, which consequently featured more in my analysis of London than Chennai.

The following sections will describe the fieldwork process in the two cities, its challenges and how my methods adapted to those. Despite an ideal of infrastructural ethnography involving unfettered access to sites of engineering and following engineers wearing hard hats, the reality of infrastructure making, especially within grey government offices, is different and needed a lot of compromise and reflexivity in my methods. The clear differences in the way I was best able to engage with water infrastructure in Chennai and London altered my analysis and comparative framework, which will be discussed in the final part of this chapter.

| Chennai Fieldwork Details | | |
|---|---|---|
| **Interviews** | | **Total 84 interviews** |
| Metrowater | Engineers: 14, Administrators and others: 4 | 18 interviews |
| Private Water Sector | Engineers: 7, Consultants: 3, Managers and others: 5 | 15 interviews |
| Government Institutions | Dept. of Environment, Chennai Corporation, Former Mayor,Public Works Department,Municipal Administration and Water Supply Department | 13 interviews |
| Coastal Residents | Adyar Estuary, Kattupalli (Minjur), Nemmeli | 13 interviews |
| Water Users | | 9 interviews |
| Non-Governmental Organisations | Care Earth Trust, Coastal Resource Centre, Human Rights Advocacy and Research Foundation | 9 interviews |
| Others | | 7 interviews |
| **Documents** | | **Total 20 documents** |

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| London Fieldwork Details | | |
|---|---|---|
| **Interviews** | | **Total 39 interviews** |
| Thames Water | Engineers: 3, Consultants: 2, Administrators and others: 3 | 8 interviews |
| Private Water Sector | Engineers: 2, Consultants: 12, Water Managers: 10 | 24 interviews |
| London Government | Former Mayor, Policy Researcher, Sustainablity and Resilience Manager | 3 interviews |
| Others | | 4 interviews |
| **Documents** | | **Total 32 documents** |

**Table 1: Details of Fieldwork in Chennai and London.**

## 3.3. In the field

### 3.3.1. Chennai – 'information drought', but conversation rich

Location: Metrowater, Office of the Managing Director (MD).

Time: Early in the fieldwork, Week 3.

> *"Write a letter addressed to the officer and leave it with us. We'll pass it on to him."*
>
> *"Will you then contact me over phone with an appointment time?"*
>
> *"Sure."*
>
> *"Or I could check with you tomorrow. What's the direct line here? You know I could email you the request letter – that way, you can just reply to the email."*
>
> *"No no, better write a letter on paper. We can't be sure of emails."*

Writing a letter of request to interview was a ritual repeated throughout my fieldwork in Chennai. Any government office I turned up at, I was met with the instruction: "write a letter". I would sit at the desk of a secretary or colleague to the official concerned and write a brief explaining my project and what I expected out of the interview. I couldn't just carry copies of a pre-written template as the request would have to be tailor-made to the specific official not only in terms of his role in the water supply system but also in terms of his temperament and relationship to his subordinates. There was even an occasion when my hand-written letter was typed out for me by an office assistant, correcting for what he considered the right way of addressing his boss with a request like mine. The emails I had sent in advance were not of any consequence either.

This wasn't simply a techno-phobic bureaucracy clinging on to the formal practices of an older era and its archaic hierarchies. After all, government offices had routinely started co-ordinating activities on WhatsApp groups and have been taking to Twitter to publicise their work. Emails may have arguably been a mode of formal communication that was less used in Chennai's institutions of water governance. Yet, the letter-writing demonstrated the deliberate employment of the cultural idiom of deference to perform the authority of the state. Having been a journalist from a newspaper going in and out of Metrowater a few years back, there was a marked difference in access with the change in my positionality. The way the institution presented itself to a reporter in the city and a student from abroad speaks for the process of boundary-making between state and society.

The process of drafting the letter outside the door of each potential interviewee meant that the office staff were involved in it. Typically, whenever I approached an engineer or administrator of some seniority, there would be a secretary or office assistant who would look for ways to turn down my request. In other cases, the officers themselves would ask for a letter to keep in their records. The first few interactions of this kind ended up being hostile because I was taken aback by their obvious desire to keep me at bay. But, I soon learnt that the initial wariness was followed by a mellower response from the secretary, who would lower his voice to advise me on how best to write the letter or approach the concerned officer so that he is amenable to respond and not refuse participation in my project. The micropolitics of these interactions also affirmed to me the value of my methodology – to engage with the everyday practices of infrastructure-making by drawing from ethnographic techniques of observation and interviewing. Sometimes, the means of collecting information said more about the politics of urban infrastructure than the actual data collected. It enabled me to observe work carried out in government offices, movement of people between and within them, and the subtext of official titles and hierarchies – who deferred to whom? What kind of files and maps were visible and how did they circulate around?

Chennai's water supply system, unlike London in the UK, wasn't a part of a national or even state-level uniform system of water governance and policy. In fact, in policies relating to water or urban governance in Tamil Nadu, Chennai was always afforded an exemption or a separate section. This meant that the set of institutions that could be influencing water supply were spread far and wide, or take unexpected forms, like the Tamil Nadu Water Investment Company (TWIC) or the local panchayats where the desalination plants were built. In order to navigate this institutional plurality, I adopted the method of 'following' connections, which has snowballed into my dataset. But, most of these institutions were either directly under or associated with the Tamil Nadu State Government, which Coelho (2004: 57) points out, had "a reputation for extreme paranoia about releasing information to the public."

This was indeed my experience in attempting to access any documentation or even information that was officially supposed to be published, for instance, the annual reports of Metrowater or the environmental impact assessment for the desalination plants. After repeated attempts to access some of these key documents, I had a decision to make about the kind of information I sought to obtain. The documents, some of which I eventually did get to see, might contain some clues about how exactly decisions related to desalination came to be made, whereas relying on what engineers and other professionals in the water sector told me in interviews and informal conversations would mean that I was getting to know their experience in working with water infrastructure. I decided that the latter was indeed valuable material on its own, considering that several of my interviewees were keen on talking discursively about various aspects of their work life, which painted a richly complicated picture of technocracy in Chennai.

However, the official channels for interviewing key decision-makers and project engineers in Metrowater or other agencies didn't materialise until halfway through the fieldwork. So, I took a leaf out of the methods in which water users often accessed bureaucracies for their civic issues – by contacting neighbourhood level officials like area engineers and ward councillors for Metrowater and the city Corporation. There were also two key NGOs who worked occasionally on water issues; they were able to put me in touch with Government engineers who they had found to be keen on engaging with socio-ecological issues of water in the city, within or outside the framework of their jobs. So, I started meeting those engineers in their area offices, from where neighbourhood level distribution was co-ordinated. While this told me little about the desalination plant itself, it said a lot about how water infrastructure was spatialised and materialised in the city. But, some of those engineers also happened to be posted in projects and planning before their current role in distribution, and so were able to discuss their participation in the recent wave of infrastructure building for Chennai's water supply. The neighbourhood level ethnography and attending conferences or trade events enabled me to also contact private sector engineers working with membrane technologies (of which reverse osmosis is one) as consultants and as building contractors installing household purification and recycling systems. What became clear through this initial part of my fieldwork was a wide range of engineering knowledges and roles that shaped the city's socio-natures and environmental subjectivities in myriad ways. Even the project managers and administrators that I later interviewed officially often came from engineering backgrounds.

Throughout the fieldwork, I had to keep adapting my strategy to fit with the circumstance and office situation at which I met people; so, handwritten notes became the most flexible form of recording data in this 'on my feet' approach to fieldwork. It was also a necessity in the second part of my fieldwork, which consisted of formal interviews with higher level bureaucrats in several Government agencies including Metrowater and other water management companies. Audio recording was uniformly denied in all these places; but the interviewees were keen to ensure that my notes were accurate and so, allowed me the time to keep writing as we spoke.

Both desalination plants in operation in Chennai were under the control of the private company that built them. The Minjur plant was planned and built by a private company called IVRCL which formed a consortium named Chennai Water Desalination Limited (CWDL) with the Spanish companies Abengoa and Befesa for the purpose. Their agreement with Metrowater constituted what is called a Design-Build-Own-Operate-Transfer or DeBoot model of public-private partnership. That is, Metrowater purchases water from the plant for a period of 25 years at the end of which the plant transfers to it. The Nemmeli desalination plant was built by VA Tech Wabag, an Indian infrastructure company that started its life as the subsidiary of the

Austrian company Wabag, but then was cut off from its parent business which it eventually acquired resulting in what its website calls a 'reunification of the Wabag group'[12]. Their work on the Nemmeli plant was an EPC contract that simply involved a fixed-term contract to build and maintain the plant, with its ownership remaining with Metrowater. The plant was thus funded by Metrowater with assistance from the Tamil Nadu State Government and the Indian Central government (CD8, CD9). Since my ethnography focused on engineering practices in the city, it was simply impractical to pursue any interaction with engineers or other actors in the Spanish companies. IVRCL, by the time of fieldwork, had sold their stake in the plant, leaving only Wabag whose engineers still worked on the Nemmeli desalination to recruit as participants in my research. I was, however, able to use the local network of engineers to contact the plant manager at Minjur who could then let me visit the plant on her discretion.

The spatiality and multiplicity of water infrastructure in Chennai meant that I could use the city as my 'site' to explore networks and stumble upon connections and participants during the course of my fieldwork. This fostered informal connections even though my positionality was firmly fixed as an outsider – a young(er) student from a university abroad – interacting with engineers who shouldered much responsibility in running the city. Yet, I would call potential participants on their phone for interviews and be invited over for a cup of tea, as long as I guaranteed anonymity, right away or within the week. My participants also took interest in my work wanting to know what I had gathered so far, what this has told me about Chennai and the sociology of its water infrastructure. This gave me the opportunity to discuss the wider discourses on water management and their opinions on them. This was in contrast to the London experience.

### 3.3.2. London – Outside the sites of infrastructure making

As a student at a central London university that does consultancies and internships with London's resource governance, I had a few institutional leads to begin fieldwork

[12] See: http://www.wabag.com/the-company/history/

in London. I started by participating at an international innovation workshop on sustainable water infrastructures held by UCL's department of Civil Engineering. This workshop invited industry professionals, including from Thames Water, and included a field visit to the Beckton Desalination Plant as well as the pilot Recycling plant that was built during the 2012 Olympics. Subsequently, scanning UCL's events calendar opened up several occasions to meet professionals in water governance with the aim of setting up further interviews. I also signed up for industry events in the city, two of which were very productive since they were focused specifically on water management in London and involved networking with the very engineers and consultants who were involved in planning for the Beckton desalination plant.

Yet, these interactions developed into a longer conversation or an interview in very few cases. Sometimes, the workshops themselves and the discussions that happened in them were informative on their own. They provided insight into the matters of concern over which networking and exchanges happened between engineers, consultants and other resource managers. Building on the contacts I developed during this networking phase, I started emailing officials in Thames Water, the regulatory agencies and consultancies involved with the desalination project, exploring ways in which I could engage with them for my research. I would propose an interview or an informal conversation in their office so I could observe processes of decision-making and planning as I visited them. But, of all the interviews I conducted, only two were held in a working office, both in Thames Water's headquarters in Reading.

Partly because Thames Water was located outside London, most of my interviewees preferred to meet at a café or a meeting venue, like an office at UCL. These were the category of conversations that despite the recording, had too many external disturbances in the audio, leaving me relying on my notes to fil up the gaps. Interestingly, many of the interviewees in London were more comfortable with the recorder than with my persistent note taking. I expected to follow up on these meetings with a reciprocal visit to their offices, which was met with much lesser enthusiasm on their part. Engineers and professionals in London, unlike in Chennai, seemed to be not used to the idea of answering lay questions about their work, much less being the subject of social enquiry. This, however, did not make them open to this novel exercise. I was constantly directed to published documentation and industry reports for questions on the everyday work that influenced approaches to water infrastructure in London. The availability of these documents, often in abundant volume but not always addressing the concerns of social research, became a block beyond which conversations didn't proceed far. They also made meetings or interviews an exercise in my participant explaining to me how things worked, often addressing what they saw as my positionality of being a 'researcher from India'. Once they had 'given' me the document or the information I asked for, there was nothing further to discuss.

I approached the Greater London Authority (GLA) through its elected members and researchers, as that had been a site of contestation against the desalination plant. It also has committees for various functions of urban governance, including sustainability and resilience. Here, too, documents and reports were readily available even before I could get a chance to explain my research objectives. That I was given access to textual material by various sources – they were in any case usually available online with some diligent searching – did not, however, mean that it was possible to easily find any kind of information one was looking for. For instance, the public consultation in which then Mayor Ken Livingstone had given strong evidence against the desalination plant and Thames Water's priorities was all but impossible to find. Requests to Thames Water and the GLA only redirected me towards each other. At one point, I was also told that they had made it available online and it was up to me to find it, despite clear messages in their online archives that older material tended to be taken down. Finally I stumbled upon it in the cached archives of the Newham Borough Council, to which the planning application was originally submitted.

Another case was that of Thames Water's older resource management plans, a statutory document that water companies in England and Wales are required to publish every five years. They are meant to be publicly available, but the company shelves the older plans, understandably because they are so extensive and voluminous. After being told by several sources that the plans were already made public and so, I should be able to access them, I finally requested for the plans as a customer and got them sent to me by the company's customer service. Eventually, as in the Chennai case, I had a decision to make about what sources I would turn to and how I would use the fieldwork experience to direct my research.

In delineating their method of 'following' for a mobile theory of urbanism, McCann & Ward (2012) make a distinction between following people and following documentary evidence, the former being a way of way of observing practice and the latter of policy. In London, the reluctance of people to permit an observation of their practice left with me no option but to go the document route. Even ethnographic 'meta-data' i.e. field notes that describe the 'relational situations' in which policy or practice happened, were more extensive in Chennai thanks to meetings and document collection happening mainly outside the spaces of infrastructure making in London. This is reflected for instance in the long list of ethnographic encounters (CE1, CE2 etc. - see Appendix I-A) cited in Chennai, in comparison to London, where it's the documentary sources that form a longer list (LD1, LD2 etc. - see Appendix II-B). It soon became clear that the nature of data gathered in Chennai and London were very different. Coding published documents and conference discussions brought up planning jargon and abstractions of infrastructural complexity rather than the processual narrative of the formation of networks and agencies that emerged in the Chennai case. These 'certain differences' (McFarlane & Robinson 2012: 767) between the two cities determined how they could comparatively interact with each other.

## 3.4. An experimental comparison – shall the twain meet?

Since the research data from Chennai was clearly far more extensive and ethnographic than that from London, and there were obvious limitations to comparing them as two separate case studies, I started thinking one city through the other (Robinson 2016a). That is, while considering a particular theme or problematic in one city – for example, climate resilience, it was useful to think about the form that this theme might take in the other city. It was also an exercise in eliminating a normative ideal of what water infrastructure was supposed to be, and consider why one city did not do things the way the other city did. For example, my experience with timed water supply – for a few hours per day on specific days of the week – and the separation of drinking water from other water in Chennai inspired the question of why London would not consider doing that in emergency situations. To put it in other words, what actions were taken to make sure that London's water supply always remained a system of continuous flow for 24-hours a day every day?

My grounded ethnographic experience in Chennai frequently made it the city that I thought London through, thus inverting the traditional reference point of the city from the global North. This was also a function of the fieldwork design, which privileged an interactive ethnography often used to study states and systems in the global South, but less in the global North now. The epistemology developed at the beginning of this chapter and my previous research experience in Chennai had drawn me towards this method. But, using the same rubric in London prompted me to reflect on how methodological decisions were made often by the kind of information that a city made available to researchers; and how these decisions, in turn, determined urban theory that has for a long time "divided between analyses of wealthier and poorer cities in the wake of developmentalism." (Robinson 2016b) Thus cities of the global South came to be centres of 'southern theory' (Tuvikene et al 2017) that focused on the 'the specificity, distinctiveness or even uniqueness of cities beyond the West' (Brenner and Schmid, 2015: 161).

This thesis, in placing Chennai and London under a similar epistemological and methodological rubric, has attempted to avoid the binary of 'universalism' and 'particularism' and instead engages in what Lancione & McFarlane (2016) have called 'experimental comparison'. In this form of urban comparison, the goal is not to arrive at a paradigmatic urban theory based on the comparison; nor is it to focus on the differences as an argument against urban theory. Instead, "it is an effort to reveal at the same time 'interconnected trajectories' (Ward, 2010) and differential patterns." (Lancione & McFarlane 2016) Such an approach to comparison is experimental because its outcome is the development of "devices to orient further critical reflection on the specifics of the cases." (ibid.) The dialogue between the two cities here, thus excavates in each of them, processes that might not have been obviously visible in a singular case study or through the lens of established theory.

By using a contextualised method of thinking, a set of themes that could be observed in different forms across the two cities was developed. Then, the textual material was coded again for descriptions of how the themes played out in Chennai and London. Tracing themes through the data, however, was a multi-step process. The fieldwork method followed a logic of connections and movement of people and things; so, the research data emerging from it could not be detached from the personal and situational context in which it emerged. A senior bureaucrat's account of infrastructure development differed from that of a contracting engineer on a building project not only in content but also in the agency it carries. So, once the codes were established, the occurrence of specific themes were referenced with the source it came from. These source-theme combinations were then listed out and rearranged to trace a narrative of how the processes concerned materialised in the two cities. This was far from a neat list, and was more of trial and error of messy story arcs into which other accounts would then fit in, shaping an analytical chapter. In the data from London, the source mattered lesser because much of the research material was from official documents. In the end, the London case was more useful as a comparative exercise to excavate further out of Chennai than as a standalone study. But, the themes identified in London certainly present possibilities for further research, as the outcome of experimental comparison (Lancione & McFarlane 2016) is expected to be.

The four empirical chapters that follow are thus organised into four major themes that emerged from this analysis, and contain further sub-themes.

| Chapter | Themes | Chennai | London |
|---|---|---|---|
| 4 | Articulation of the state | Distributed agencies and individualised authorities built over socio-material formations, for which urban infrastructures form a key site of articulation. | A regulatory state for which water's ability to be governed makes it a key thing around which technoscientific government can revolve |
| 5 | Relationality of infrastructures | Infrastructural expertise built over shared knowledges between urban residents and engineers, who negotiated multiple commitments in their daily work | The figure of a British water expert constructed through urban imaginaries of London and its legacy and sustained by the practice of networking among water managers around the world |
| 6 | Epistemologies of water engineering | Multiple epistemologies following from the wide range of engineering disciplines that work on engineering – it is the interaction within this cacophony of voices that constitutes infrastructure | The multiplicity of knowledges that go into infrastructure-making sought to be reconciled by an overarching risk framework |
| 7 | Political contestation | Coastal development and a politics of environmental identities | Assertion of Mayoral authority by challenging the premise of water infrastructure planning from a discretionary position |

**Table 2: Conceptual themes of comparative analysis between Chennai and London.**

## 3.5. Conclusion

Uncovering the blackbox of infrastructure, as I discovered during fieldwork, was a lot less revelatory and a lot more exploratory than I expected. Rather than a tidily packaged box that demanded only the curiosity and time of a researcher to unravel, it was a complex network of things and people that responded slowly to picking and prodding. It was partly through the work of analysing and knowing the multiplicity of networks that there emerged the form of an infrastructure at all. Engineers and water managers did this work, and by following them, my analysis has mirrored this networked ontology of knowledge production as well. By doing this, I was able to broaden the scope of what we understand as infrastructures to the negotiated everyday practice that enables water access and distribution in Chennai. But, the differences in the kind of data I was able to gather in Chennai and London significantly shaped my analytical conclusions as well. The documentary evidence that dominates analysis in London, thus revealed actions of boundary-making and the establishment of expertise or governing authority, whereas the Chennai side of the story revealed distributed agencies and shared knowledges. Thus, the ethnographic basis of my methodology was better suited in Chennai where the work of infrastructure-making is visible in everyday practices and the city as the site of that process. The following chapters seek to encompass this divergence between Chennai and London within the structure and aims of the thesis by adopting the thematic structure outlined above.

# 4. MATERIALISATION OF THE STATE IN WATER INFRASTRUCTURES

## 4.1. Introduction

Six months after completing fieldwork in Chennai, when the city appeared to have taken a technocratic turn towards building modernist water infrastructure, there arrived a moment when analytical process seemed to fail in making the city knowable. Massive floods submerged many parts of Chennai over three days in December 2015, exposing its utter vulnerability and unpreparedness to hydrological whims.[13] The city lacked not only the technological infrastructure or engineering capability to deal with the floods, but also suffered from the absence of any coherent political or institutional capacity to respond to this hydro-social crisis. Its fault lines opened up, Chennai looked far from any transition towards techno-scientific or administrative modernity. At the same time, conducting fieldwork in London, consultants, engineers and policy documents informed me that London, which already had universal water supply and sewerage systems, was building further technological infrastructure in order to be resilient and infallible. Slow in fixing massive leaks in its pipes which lead to loss of volumes of water, the city could, nevertheless, afford to simply access further resources, even if through energy-intensive means, without suffering the devastating consequences like the floods Chennai faced for ignoring its floodplains. There was an ostensible story of contrasts between the global north and south; a disconcerting incommensurability in the way their infrastructures were imagined and understood.

However, as it usually turns out with research, complexities and patterns started emerging in both cases through what Meehan et al (2013) call a 'parallactic shift' in focus. A parallax is an optical phenomenon defining apparent change in the position of an object, caused by viewing it from different lines of sight. Meehan et al (ibid.) use this concept to explain their approach to objects as standalone forces shaping power, stressing that this is meant to develop a robust theory of objects in

[13] "A wrong call that sank Chennai". The Hindu. 10 Dec 2015. http://www.thehindu.com/news/cities/chennai/chennai-floods-a-wrong-call-that-sank-the-city/article7967371.ece

constituting power and not to discount the effect of social relations. Thus, the "shift is more parallactic than it is paradigmatic." (p. 2) A parallactic shift in this thesis, then, indicates a different position to view water infrastructure from, rather than a negation of the material differences between how water is accessed by citizens in Chennai and London, or how desalination, an energy-intensive technology potentially harming marine life, might be distracting from sustainability issues in the two cities.

Taking a cue from Ferguson's (1994) question about development schemes in Africa, this chapter sets out to ask what else such infrastructural projects achieve apart from ordering arguably unsustainable techno-natures. After all, Chennai Metrowater as well as Thames Water are aware of the long term maintenance and ecological issues with the water network in their respective cities, but are slow in tackling them. Desalination plants do very little to address massive leakage issues or loss of riparian systems which work to recharge the ground water table and drain the city. Yet, they face minimal opposition or political resistance to their plans. In Chennai, where water supply is closely connected to the elected Government (of the federal state of Tamil Nadu) – where two parties of similar ideological and policy persuasions alternate in power. The year after the floods was a general election when for the first time the ruling party was elected to power, despite the incredulous images of devastation transmitted across the state. Water, suddenly, didn't seem to be an electoral issue. Or the political role of water was changing. In London, despite the unique model of complete privatisation of water in England & Wales, water managers insisted that the desalination plant was built in response to government regulation.

Informed by empirical material, which points towards a narrative of shifting governance structures rather than policy debates on sustainability, this chapter will consider the mutually constitutive relationship between water infrastructure and the state. Karen Bakker contends that water is biopolitical because:

> "…modern governments seek to optimize both water resources and our individual water-use practices in order to secure the health and productivity of the population. This control is enacted through formal regulation, but also

> is self-policed through the cultural aesthetics of health and hygiene, ranging from entire bodies of water to individual human bodies." (Bakker 2012: 619)

But, what if it wasn't water that modern governance seeks to optimise, but rather the sustainability of the institution of governance itself? It is this structure of rule sustained through the governance of water that is identified as the 'state' here. The state is not necessarily a coherent reified entity comprised of professional politicians, publicly funded institutions or governmental actions. Here, it is a rubric through which to understand power relations in water governance across the global north and south. Water's materiality and the unpredictability of its embeddedness in the cityscape allow for little by way of precise control. Knowledge or the lack of it with respect to water's behaviour in the future necessitates planning and regulation, which makes it an object of governance (Carroll 2012). So, water wields its agency to shape the state because of its capacity to be governed (Meehan et al. 2013). Water infrastructures are, then, a materialisation of a specific kind of state power – techno-political in Chennai and regulatory in London.

The first part of this chapter (section 4.2) will explain the analytical approach it takes to understanding the state and its relationship to urban water. In both cities, there is a form of 'stateness' (Painter 2006) that is mutually constituted with water infrastructure. But, the specific forms this stateness takes are distinct as well as emergent. That is, the state is transforming and shifting along with urbanisation and environmental change in the city. The rest of the chapter is divided into a section on Chennai and another on London. Section 4.3 discusses the Chennai case in three further subsections. 4.3.1 explains how the multiplicity of institutions that govern water supply in the city occupy a geographical spread that gives insight into how the state is materialised in the city. The movements and interactions between people that establish the institutional structure of water management in the city, however, follow an interconnected logic of patronage and administrative welfare. 4.3.2. explains the importance of popular politics to the development of water access mechanisms in the history of Tamil Nadu; this history, in turn, can be used to understand the techno-political articulations of the contemporary Tamil state. 4.3.3.

follows a chronological order tracing how the idea for the desalination plant originated with the growing importance of Chennai and a broader urban agenda in the political and imaginative geography for Tamil Nadu. It traces the series of institutional interactions that achieved the construction of the desalination plant back to the logic of connections described in 4.3.1. Section 4.4. discusses the London case as one of technoscientific governance built around a governable object, which in this case in water. For this, it uses the concept of the boundary object drawn from science & technology studies (STS) (section 4.4.1.). In section 4.4.2 the shifting and alternating conceptualisations of water that have defined the regulatory path taken to govern the privatised water industry in London, is explored. Section 4.4.3 then uses two maps published by the UK Environment Agency to illustrate how these shifting conceptualisations have been instrumental in constituting the regulatory state as well as building techno-material infrastructures like desalination.

## 4.2. Assembling the urban state

In the late 1980s and 1990s, privatisation of urban water supply started in western Europe, from where successful companies started investing in water around the world, including major cities of the global south. This wave of privatisation was built on the premise of 'state failure' to provide equitable, efficient water access particularly to the urban poor, according to global developmental organisations led by the World Bank. The state, here, was equated to public institutions and elected governments that had largely been in charge of water supply as a public developmental necessity during the post-war and post-colonial years in the global north as well as the south – the so called 'state hydraulic' paradigm (Bakker 2003b). However, as delineated in chapter 2, this was followed by a 'strategic retreat' (Bakker 2013a) of private companies from water provision in certain unprofitable geographies, which were usually the very areas that the state had failed to provide for and privatisation was expected to address. The public sector then had to step in to sustain water supply systems around the world with the private sector settling in to 'shallow expansion' focusing on specific profitable technologies or projects, and liaising often with city authorities rather than national governments (Pierce 2015).

What emerged at the scale of the city is a complex apparatus of public and private institutions as well as professionals, in which the figure of the state was not easily discernible. This complexity was encompassed, instead, by the framework of 'governance' which also became a lens from which to analyse the inequities and problems of water supply to large cities (Bakker et al. 2008).

Yet, in Chennai and London, where the desalination plants are excellent examples of the private sector's 'shallow expansion' through discrete localised projects, there emerges a figure of the 'state', defined more by its idiom of rule than its position of public accountability or funding. London's water supply is part of the famous UK model of privatisation where water resources, supply and sewerage are entirely in private hands for effective management. Chennai's water utility Metrowater, though still a government institution is parastatal – a type of organisation that became popular during the 1980s following structural reforms in several countries (Bakker 2013b). Its management is tied to the Tamil Nadu State Government but its operations remain autonomous in theory and have largely been 'corporatised' for full cost recovery. But, their positioning in the public-private spectrum and the basis of their finances do not preclude these institutions from being a component in the apparatus of the state that is constituted with and through processes of urban water supply. The construction of techno-natures, sustainable or otherwise, then becomes an urban articulation of the state, in material and discursive form.

The biopolitical role played by water in the rationalisation of modern cities has been of widespread interest to urban scholars, who have focused on technologies and practices by which the relationship between bodies and space have been moulded in the exercise of power (Gandy 1999, Kooy & Bakker 2008, Osborne 1996). There isn't an ostensible state in these studies, but political technologies or governmental rationalities inscribed through an institutional apparatus. If Foucauldians were interested in power beyond the state and preferred to discuss the 'governmentalisation' of the state (Rose & Miller 1992) - the logic of operability on which modern government is built – for state theorists, this opened up a conceptualisation of the state beyond the institutions and acts of government.

Building on Foucault's observations on the étatisation or statisation (Barry, Osborne & Rose 1993) of society, the scope of analysis can be extended to the myriad forms and discourse that the state takes in everyday operationalisations of rule (Carroll 2009). Ethnographic explorations of the state have done exactly that in excavating rationalities of rule in practices of bureaucratic and social institutions, within and without the encompassment of the nation-state (Corbridge et al 2005, Ferguson & Gupta 2002, Sharma & Gupta 2009).

For Corbridge et al (2005: 10), who are concerned with how the subaltern see the state and work with it amidst reforms towards decentralisation and localised governance, "encounters with the state are produced by dispersed state agencies amid conditions of greater or lesser institutional scarcity." Ferguson & Gupta (2002) situate the state in the symbolic realm of 'cultural production' arguing that states are "constructed entities that are conceptualized and made socially effective through particular imaginative and symbolic devices." But, in cities, especially those that are political capitals or nodes in global economic flows, there is an abundance of institutions at the local and national scales. Yet, a similar ethnographic approach to studying predominantly public provision of urban water has been more useful in delineating informal and strategic means by which water access is negotiated between residents and water professionals (Anand 2011, Bjorkman 2015, Coelho 2006). All of this raises the question of what exactly the state is. If individual members as well as disparate institutions have been effectively implicated in the logic of rule, yet allowing for 'informal' practices to prevail in urban public works, then what purpose does the state or its conceptualisation serve? What distinguishes state from society and why is that important?

Outside the Foucauldian canon of governmental rationalities, there have emerged sophisticated understandings of the state that still recognise its dispersal in society; these elude a categorical grouping of their own because of nuanced differences in their approaches. A common theme they feature, however, is of state-making as a process of boundary-making (Carroll 2012, Das & Poole 2004, Mitchell 1991). It is consistent with the 'statisation' of society that the state becomes harder to pin down and for that very reason, the ways in which it is distinguished gains political significance. But this is not a fixed or uniform outline of the state. As Mitchell (1991) suggests:

> "…the elusiveness of the state-society boundary needs to be taken seriously, not as a problem of conceptual precision but as a clue to the nature of the phenomenon. Rather than searching for a definition that will fix the boundary, we need to examine the detailed political processes through which the uncertain yet powerful distinction between state and society is produced." (Mitchell (1991: 78)

Das & Poole (2004: 7) do fix this boundary at the rule of the law, which would then decide the "practices and spaces that were seen to form part of the state and those that were excluded from it." Whereas the act of making and sustaining that boundary produces the state's legitimacy for them, Mitchell argues that it is 'a mechanism that generates resources of power' (Mitchell 1991: 90).

The phrasing here is key - power is not accrued to the state as a reified entity, but is an outcome of the process, distributed among actors and institutions unequally. However, in attempting to bridge the 'agency-structure' conundrum of such a distributed mode of state-making, he conceptualises the state itself as only the "metaphysical effect of practices" that produces an appearance of structure (p. 94). This hypothesis, unsurprisingly, is not popular among scholars who have drawn from Mitchell (1991) for the state, if nothing else, is not an illusion (Painter 2006). Besides, the state, constituted through a shifting, continuous political process, doesn't have to be a fixed structure, even if only metaphysical. It can be materialised (Carroll 2012) or embodied (Mountz 2003) through the very processes that constitute it. The state isn't to be found as a separate structure elsewhere from the everyday life where it is experienced, but can be conceptualised as an assemblage of those very practices and things through which it is articulated.

Joe Painter (2006) calls this 'stateness' in his seminal article on the 'prosaics' or mundane practices and everyday discourse that add up to the widespread experienced effects of the state, which he observes in 'industrialised countries', but has been noted in the global south as well (Ferguson & Gupta 2002, Gupta 1995). What is uniquely significant about his theory, however, is the notion of 'prosaics', which is drawn from Bakhtin's philosophy of 'dialogism' and 'unfinalizability' to highlight "the unsystematic, the indeterminate and the unintended" (Painter 2006: 763) aspects of the state. Whereas Mountz's (2003) theory of embodiment attributes irrationalities to the humanity and belief systems of the state's employees, Painter (2006: 762) asserts that, often, it is a 'panoply of discordant voices' (citing Campbell 1996) that assemble around particular issues in time and space to 'effectuate' the state. When that issue is water, the agency and materiality of the substance and the technologies employed to access, use and manage it, are inescapable as ontology as well as analytical rubric.

Following from the growing body of work in STS and Geography that study power and rule as functions of materiality, Carroll (2012) writes the history of the technoscientific state in California, where water was a 'boundary object' (Star & Griesemer 1989) around which science and government were constructed. In 2009, he cast the study of the state as cultural analysis, where culture was triangulated as practice, meaning and materiality (Carroll 2009). The culture he was interested in specifically was of science and engineering or 'technoscience'; and how it socialised the idea or 'meaning' of the state into practice through material devices. In this way, the state was conceptualised as a 'particular kind of society' (Carroll 2012: 495). This framework accounted for material agency as well as human intent by allowing exploration of:

> "…how human intentions concerning problems related to water led to the design of various forms of material culture, such as levees, metering devices, and hydrologic maps, and how these became critical actants" (Carroll 2012: 497)

Whereas this classic ANT-inspired approach deems materiality to be an unintended consequence of human intention, Katie Meehan (2014) draws from object oriented philosophy to contend that water infrastructures are not 'power-tools' used by the state to exercise power, but are themselves 'well-springs of power". She shows through everyday infrastructures of water access how objects "both coexist with and limit state power, resulting in variegated geographies of institutional authority." (Meehan 2014: 215) However, through different philosophical routes, Meehan (2014) and Carroll (2012) arrive at identical conclusions about the state, with the former arguing that infrastructure building has not "so much centralized as *concretized,* cast in rebar and cement" state power (Meehan 2014: 223) and the latter deducing that the state "is critically built into and out of the environment."(Carroll 2012: 495). Fundamental to such an understanding of the state is the concept of 'technonatures' which, as previously delineated, refers to how ontologically 'non-humans of all kinds' are involved in the making of socio-natures and how the epistemology of such a world is 'technologically mediated' (White & Wilbert 2010: 6).

Techno-natures constructed by the intricate networks of urban water supply are found to be critical in constituting the state in Chennai as well as London. Their role as 'objects of government' is not dependent on the success of those constructions in ensuring social or environmental sustainability, but in assembling a structure of rule. As Whitehead points out:

> "While states have been criticised as either ineffectual, unjust, or even irrelevant managers of socio-environmental relations…[they] continue to play a significant role within a range of environmental issues at a number" (Whitehead 2008: 414)

Since the environment is understood to be techno-natural, the politics of state-making in them is techno-political. However, in the framework of technopolitics, instead of thinking of non-human materiality as a foil to human action, what if the state made use of the 'force' of objects in building its own spatiality and sustainability? For instance, as Pushpa Arabindoo (2017) shows in the case of the 2015 Chennai floods, the widespread circulation of the statistical term '100 year flood' and its conveniently literal interpretation by the government deeming the floods 'unprecedented' and a 'rarest of the rare' weather event, allowed for middle class environmental subjectivities about the ecological fragility of Chennai's urbanisation to be unchallenged. Thus, by skilfully converted the statistical abstraction of a '100 year flood' into popular political discourse and environmental knowledge, the unpredictability of water's force was constitutive of state power as much as its occurrence was caused by actions of society. This chapter finds that this is achieved through the daily work of the state and not just as response during exceptional events. Urban infrastructures and spatiality are constituted through constant negotiation between the state and unpredictable techno-natures, this unpredictability being part of how the state shapes its intent. If "our mastery of tools lures us into thinking we understand their total reality" (Meehan 2014: 217), the states presented here make no such claim, instead preferring to assemble and be assembled by infrastructures built on the unknowability of tools and techno-natures.

It is partly the handy use of the word 'assembling' that makes the Deleuzian vocabulary apt in the analysis of states that are constantly remade around urban socio-materiality. Unlike the 'actor network' or to use John Law's (2008) term 'material semiotics', which doesn't make explicit the intended action that leads to a provisional arrangement of human and non-human actors, the notion of the assemblage is easily imagined in the process of assembling. Typically, in the study of cities, assemblages are drawn from below – by illustrating grassroots movements and social formations that disrupt and modify central planning (McFarlane 2011). But, there is a case to be made for viewing the assemblage from above in order to attend to techniques of reterritorialization and scaling (Legg 2011), or a spatial re-assembling of state power (Allen & Cochrane 2010). There is role for deliberation in the assembling and that which is assembled holds potential to act as a whole, if only provisionally. As Ian Buchanan (2015: 385) argues, "the assemblage is purposeful, it is not simply a happenstance collocation of people, materials and actions, but the deliberate realisation of a distinctive plan."

So, the theory of the urban state this chapter sketches is not about a moment in history when a new stable formation has risen from the ashes of an old order. The state is, instead, conceptualised as an already emergent thing that is assembled and re-assembled through the techno-politics of water infrastructure.

## 4.3. Chennai: urbanisation of Dravidian hydro-modernities

### 4.3.1. Peopling institutional geographies of water

Metrowater, the utility in charge of water supply and sewerage in Chennai, is headquartered in a sprawling leafy complex at the head of one of the city's arterial and historically iconic roads – Mount Road (CE1). Built to connect the colonial bastion of Fort St George with St Thomas Mount, the highest point of the city in its then southern end, the 13 km road splits the length of the city centre into east and west; coastal and inland neighbourhoods. It has since been renamed Anna Salai in honour of C N Annadurai, a respected leader of the Dravidian movement whose political offshoots continue to rule the political discourse and governments in Tamil Nadu. Annadurai's statue also adorns the start of this road, while Fort St George continues to be the seat of the Tamil Nadu State Government, even though a massive complex meant to house the legislative assembly and secretariat was built nearby in 2014 (CE3). In a city prone to such political symbolism, the location of the Metrowater offices is not just a matter of hydrology. The office building itself is non-descript, with greying blocks of 7-8 storeys clustered in right angles housing neatly maintained but sparse offices facilitated with hastily added air-conditioning units. It used to be the site of one of the three sewerage pumping stations that served the colonial city and so the bylane in which it is inset is called 'pumping station road'.

The name, in its banality today invokes a fountainhead of stateness (Painter 2006) that is materialised through water infrastructure in the city. As a transmission engineer never tired of saying:

> "Whether water flows or not in the city, the back and forth between our MD [Managing Director] and the secretariat never ceases." (C15)

He used the Tamil word for secretariat which literally translates as 'executive headquarters', making his comment all the more insightful of the *action* of assembling the state that the movement of people and files did, aided by the proximity of the institutions. Twice, while interviewing the MD (C51), the researcher accompanied him on his short commute to the secretariat or walked him out on his way there. Such embodied work done to establish and sustain connections between different institutions governing the city, including its residents, frequently ‘peopled’ (Simone 2004) water infrastructure in Chennai, as the chapters here will demonstrate. Abdoumaliq Simone, employs the term ‘people as infrastructure’ to describe “a specific economy of perception and collaborative practice” (ibid.:408) that exists among marginalised urban residents to enliven and provide for everyday life in the city. While the infrastructures discussed here are not marginalised in any sense in Chennai, they demonstrate how the state and other institutions of ordering employ similarly provisional and informal practices of infrastructure-making. Much like with the concept of ‘informality’ which despite its origins as a way of understanding marginalised urban lives, has now been shown to be a feature of even ordering cities around the world (Tuvikene et al. 2017), the idea of ‘peopling’ is reinterpreted here to show how such techniques are used by urban actors at all levels, in order to imbibe political claims into material forms through flexible connections of people, objects and institutional structures. In this particular case, the close relationship between the Secretariat and the Metrowater HQ hinted at the inseparability of water from the elected government in Tamil Nadu, which is crucial to understanding the nature of the state’s articulation in Chennai.

It was in 1978 that for the first time an institution was set up to exclusively for the supply of water to the city, separate from other municipal functions carried out by the city Corporation. The Chennai Metropolitan Water Supply and Sewerage Act, 1978 (CD11) defines the institution’s mandate broadly:

> “An Act to provide for the constitution of the Chennai Metropolitan Water Supply and Sewerage Board, for exclusively attending to the growing needs of and for planned development and appropriate regulation of water supply and sewerage services in the Chennai Metropolitan Area with particular

> reference to the protection of public health and for all matters connected therewith or incidental thereto." (CD11)

Framed as a regulatory as well as planning organisation, Metrowater was to have on its board the Minister in charge of water supply, the Secretary to the Government and the Commissioner of the Chennai Corporation, among others. The Act also made it clear that "'Government' means the State Government" of Tamil Nadu, and not the Union Government in New Delhi.

This, however, is not the origin story one hears at Metrowater, which always traces its history further back to 1914, when Kilpauk Water Works, the then city of Madras' first water treatment plant, was opened. The water works complex, a red brick heritage building, continues to function as one of the city's three major water treatment plants and also anchors Metrowater's training centre, a quiet floor of seminar rooms surrounding a courtyard – like a school during vacation. A project engineer remarked wryly about the training centre:

> "That building comes alive only when the management decides that its engineers need to be trained by some international consultancy or the other. The last time we went there, it was a training session on RTI [Right to Information Act]. We learnt the different ways in which we could refuse to give out information, while still complying with the Act." (C14)

The training centre has hosted, among other topics, sessions on reverse osmosis, naturally, on water quality held by the UK company Severn Trent and on marine biodiversity. Metrowater's participation in these global circulations of knowledge and practices of governance, at a site where it draws on its historical legacy, is always accompanied by the mundane practices of movement and interaction through which it maintains its position as interlocutor for the Tamil Nadu State government. For example, the executive engineer in charge of the Nemmeli desalination plant was almost never to be found in his office on the top floor of the HQ but was away on site visits, even though the plant's operation and maintenance was contracted out to a private company and wasn't supposed to be supervised on a daily basis by

Metrowater. The 45 km distance between the two locations did not deter this movement but added to the importance of his work and position. He explained on one such afternoon, when he had returned from a site visit:

> “We have visiting dignitaries from other countries or cities all the time – today, it was the Israeli Ambassador. We couldn’t really let the private company show them around. Anyway, the minister would be visiting on such occasions, so, I would have to go at least for that.” (C48)

The private company’s view of the matter was however dismissive, with its Chief Technological Officer saying:

> “I’m not sure what Metrowater expects to achieve out of being in these visits. It’s not like they have the technical expertise for it. They are probably doing it only because the minister told them to.” (C13)

In any case, Metrowater’s role as simultaneously a part of the government apparatus as well as its interlocutor is acknowledged in both comments above. In fact, the waterscape of the city is criss-crossed by a such interlocutors, a multipicity of institutions that have varying effects on how water is experienced as an object of everyday use and a matter of concern (Latour 2004).

For one, Metrowater, the institution tasked with water supply and sewerage functions, has limited capacity to achieve the goals of ‘planned development and regulation’ listed in the Act that established it. This is because it does not have authority over any of the surface water bodies in its operating area, except the three reservoirs from which water supply for the city is drawn. The surface water bodies in the state fall under the 160-year old Public Works Department (PWD), which in 1971 gave birth to the Tamil Nadu Water Supply & Drainage Board (TWAD) that is now in charge of water supply outside Chennai. In 2008, a dedicated institution called the Water Resources Organisation was carved out of the PWD, primarily for river basin and irrigation management. But, as the organisation describes its relationship to water bodies:

> "Our State has got about 39,000 tanks out of which around 10,000 tanks are owned by Public Works Department. Out of 10,000 tanks, about 5,000 tanks are system tanks fed by riverine channel flows. The rest 5,000 tanks are rain fed tanks." (CD16)

Metrowater has to enter into an abstraction agreement with the WRO if it needs to draw water from one of these tanks, unless the tank has already been handed over to the Chennai Corporation to be rejuvenated or maintained as an ecological service. The Corporation is also in charge of storm-water drains, which are meant to flush the city of any stagnated rainwater and not mix with the sewerage pipes operated by Metrowater.

The WRO oversees an Institute for Water Studies (IWS) and a State Ground & Surface Water Resources Data Centre (SGSWRDC) in Chennai, both performing a research and documentation role. Using a combination of GIS and other field research methods, they produce 5-year reports on the state of surface and ground water resources by river basin (see Figure 5), apart from advising concerned departments on the viability of their schemes. However, according to one of the Joint Directors (JD) of the IWS:

> "In the last ten years, we have been terribly understaffed and underfunded. Our staff strength is only 56 where it is supposed to be 78, and I see no attempt to fill the vacancies or upgrade our equipment, all indications of the department closing down. But, things may be looking up soon for I gave a presentation last month to the Chief Minister, who says it's important for us to publish reports every two years now." (C23)

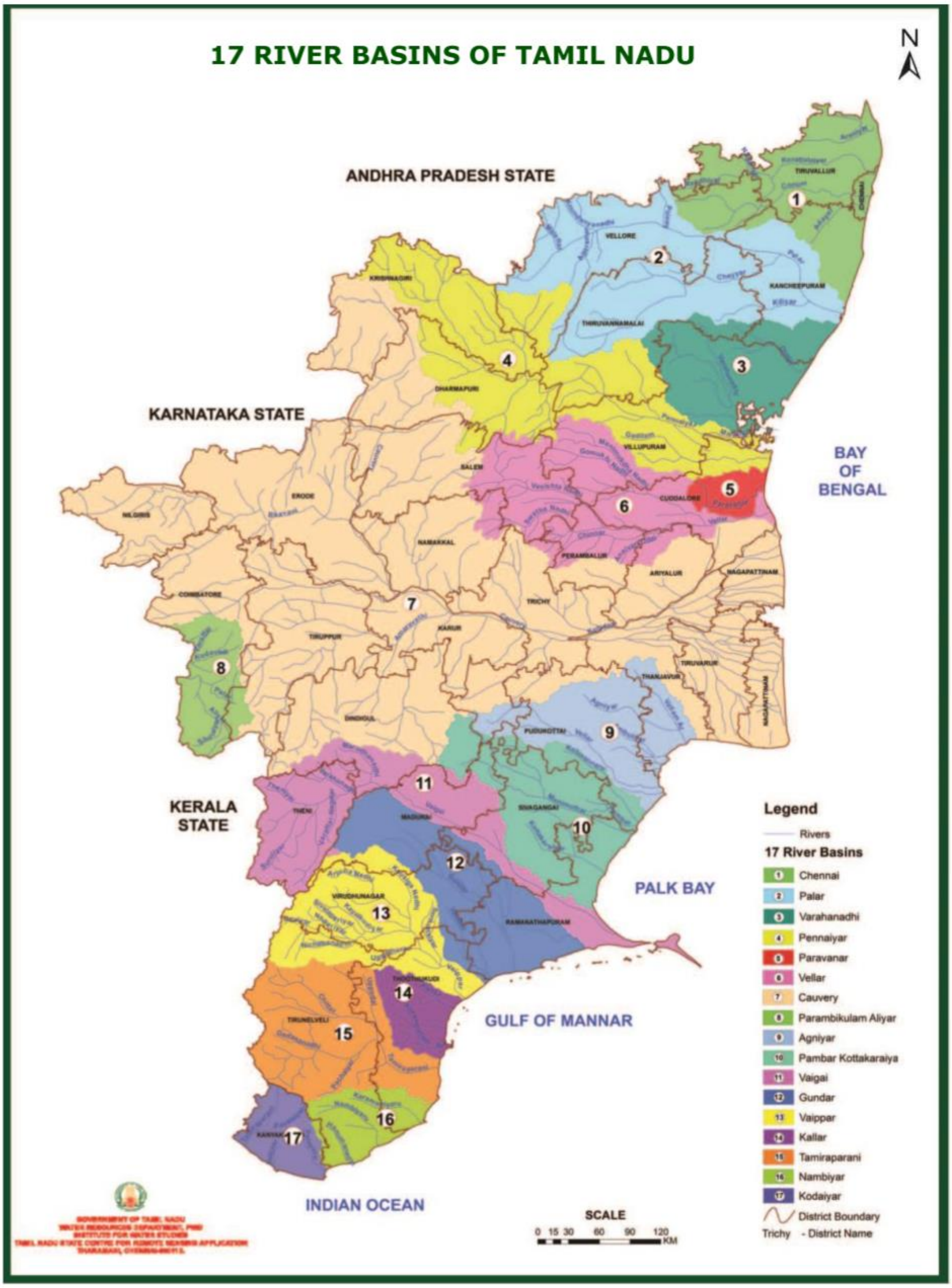



**Figure 5: Map showing river basins in Tamil Nadu.**
**Source: Public Works Department, Policy Note 2017-18, Govt. of Tamil Nadu (CD5, p. 196-197).**

This institutional plurality can be visualised in the form of infrastructure, involving mediation between other governmental departments, private companies and water users, contributing to the 'state effect' (Painter 2006) that is felt through the water supply network. The reason it is experienced as a 'state effect' and not mere bureaucracy has to do with how water infrastructures have always been implicated with the ruling government in Tamil Nadu and the relationships of patronage that structure its authority. A key feature of this framework is the curious figure of the 'institutional big man' who embodied a:

> "…notion of individuality and instrumentality that is central to the politics of South India and crucial to an understanding of the dynamic relationship that exists between action and organization in Indian society." (Mines & Goursishankar 1990: 761).

Contradictorily being "both a quintessential hierarchical man and an individual," (p.763) his 'constituencies' are comprised of the benefactors of his individual patronage. But, the existence of an institution and its hierarchy are necessary for the exercise of that patronage. Unsurprisingly, the example the authors give for such a figure is the late Chief Minister J Jayalalitha – a leader often casually dubbed autocratic, but whose authority, far from being absolute, derived from the convenient positions occupied by other institutional big men in her network. This kind of power structure requires 'satellite institutions' with their own officers (p. 764) reminiscent of pre-colonial kingship enacted through a "a shifting series of centers of different kinds of functions, connected with various interlocking networks" (Shulman 2014: 21).

These actions are more evident in regulatory institutions, newly set up in collaboration between the Union and State Governments. One such is the State Environmental Impact Assessment Authority (SEIAA) that was notified by the Ministry of Environment & Forests (MoEF), Government of India, in 2006 for the purpose of clearing what it called category B projects (of lower value or risk) at the state level (CD12). Since the Authority was at its core a 3-member committee nominated by the Union and State Governments, it is reconstituted with each electoral cycle, with trusted officers of each government appointed to those positions. Early in 2015, the SEIAA as well the State Coastal Zone Management Authority (SCZMA), an institution with a very similar mandate notified in 2012 (CD13), were in the process of getting dissolved and reconstituted. The outgoing Member Secretary of the SEIAA was the former head of Metrowater, who happened to have been at its helm when the desalination project was devised. When his retirement came about, he was appointed Officer on Special Duty, a way for partisan governments to keep their trusted bureaucrats around, heading the SEIAA.

The Tamil Nadu Environment Directorate (CE4), an executive agency under the Tamil Nadu Department of Environment and Forests, housed SEIAA and the SCZMP in a South Chennai building, and was also a top-heavy office with two directors and two engineers. According to a director:

> "We are here to carry out the Government's mandate, like preservation of specific lakes or conducting environmental awareness programmes. Apart from that, we deal mostly with environmental clearance for projects, sorting them into category I and II or A and B, giving clearance here if possible or passing it on to the concerned authority." (C45)

A Superintendent Engineer chipped in to allay any scepticism about the office's capabilities:

> "You should try visiting the central government MoEF. They get 500 applications per month and just keep clearing like clockwork. It's not unusual for some applications to be deliberately submitted when the SEIAA is dissolved so that it goes to the MoEF and gets cleared. But, some others prefer to keep the project in the state – so, they would plan it at just the limit for category B if possible." (C50)

The honour system they seemed to be suggesting was, in fact, a long nurtured network of individuals who had been patrons of each other's works and ideas, and developed similar interests in how public administration and urban development were to be conducted. They were the institutional big men who passed projects and applications around their network, crafting infrastructures of statehood, employing skills and knowledges from a generalist's rather than an expert's toolbox.

This kind of official can be found within the organisational structure of Metrowater as well. Take the position of the Engineering Director (ED), which is one of the three positions appointed by the Government, the other two being the Managing Director (MD) and Finance Director (FD). It has limited institutional authority as it's the MD who heads the organisation and is in charge of its flagship projects, which are then assigned to specialist divisions like with desalination. As the ED explained about other operations:

> "It is really the Treatment & Transmission (T&T) engineers who head operations and maintenance. I would be able to tell you about desalination if it came under the Planning & Design department, where I have some experience. But, when it was planned, the Superintendent Engineer at Contracts & Monitoring was seen as more efficient. So, it went to that department." (C36)

But, this ED had something of a coterie in Metrowater – his fellow commuters from his days in a southern suburb of the city called Tambaram. One of them explained:

> "He is a man of strong community. He really took interest in those of us who would travel by train from Tambaram and nurtured our ideas, giving us a leg-up where he could. He is like that at work too, always building personal connections." (C14)

Whether the personal connections amounted to much, he had tried to create value for himself in the institution by building up into someone the engineers could turn to against what they perceived to be a hostile management. It would be impossible to draw any direct consequence from his actions to Metrowater's current interest in improving water supply to the southern suburbs, especially given recent development in the city's south as opposed to the north . But, his network is a sample of the relationships of patronage that sustain spatial privilege and marginality. Another instance was a T&T engineer who insisted on helping me with writing a letter to the MD (something that Metrowater required before research could be conducted). There were usually people to be found waiting outside his office – representatives from resident welfare associations or other civilians who were there to talk about their water supply. Unsurprisingly he was from the south of the city and very interested in the growing residential suburbs there and their eclectic methods of accessing water.

The relations of power that legitimate the institutional big man are derived not from any innate authority of their position or character or inevitable kinship ties, though kinship, caste or origins may certainly enable the employment of strategic relations creating 'differentiated agents and positions' (Çalışkan & Callon 2010). So, technologies of government in Chennai are "concerned with the question of distribution, not simply of resources, but of agency" (Farias 2011: 370). For the Tamil state, the bureaucratic structures of government have, in fact, been useful in developing these networks of patronage, through a combination of personal and ideological connections as well a shared belief in the ideas of a modern developmental state. As Gopakumar (2009) puts it:

> "A primary way the Dravidian state has exerted its authority over Chennai has been by building the capacity to arrange society according to its ideology through a strong, efficient technocratic bureaucracy." (Gopakumar 2009: 116)

The 'Dravidian' character of the Tamil state that he draws attention to is significant in understanding why water is a political object in Chennai and how it contributes to state-making. The following section will sketch a brief history of the Tamil state built on the foundations of the early 20$^{th}$ century political movement called the Dravidian movement, and its encounters with Chennai's waterscape. In order to do that, the 2015 Chennai floods offered a typical illustration.

### 4.3.2. Whose project is it?

The December 2015 floods, while far from being unprecedented in their mere occurrence (Arabindoo 2017), were unusual in one way. They affected the affluent neighbourhoods in the southern parts of the city more than floods usually do. This was attributed to the Chembarambakkam reservoir whose floodgates weren't opened until it was inevitable, causing a sudden deluge. The news magazine *Frontline* wrote:

> "Tamil Nadu, traditionally a water-starved state, has a peculiar problem when it comes to water release from reservoirs, dams and lakes. Every single release is treated as a celebration by a section of people…Such water release details have, for about two decades, been decided by the Chief Minister. Each time a routine water release takes place, a press release is put out crediting the Chief Minister with ordering the release." (Radhakrishnan 2015)

In the delay caused by waiting for such a ritualistic opening of the Chembarambakkam reservoir on direct orders from the Chief Minister, the deluge became inevitable and unmanageable, the article implied. Portrayal of the Chief Minister as a ruling patron, especially in matters related to water, is hardly confined to agricultural rural regions in Tamil Nadu. Tea shop discussions[14] on water supply to Chennai and other cities, for instance, attribute credit or blame to water supply projects directly to the Chief Minister at that time. This partly has to do with the constant under-the-skin presence of the ruling party government in public and personal life. This is the state that instituted the midday meal scheme in schools, universalised the free and subsidised public distribution of rice and facilitated marriage or childbirth through various government schemes. As recently as 2013, it opened government run eateries selling food at negligible prices in major Tamil cities. What's interesting about these schemes is that they also carry in either their name

[14] "Tea kadai chronicles", The New Indian Express, 15 Dec 2016, see: http://www.newindianexpress.com/cities/chennai/2016/dec/14/tea-kadai-chronicles-1549060.html

or public artefacts like pamphlets, buildings etc., reference to the ruling party or more precisely, to its iconic leader.

The state in Tamil Nadu is routinely implicated with the practices, ideologies and leadership of its two major politics parties – the DMK and the ADMK. Both parties trace their origins to an early 20th century rationalist movement, now often referred to as the Dravidian movement, that mobilised Tamil linguistic and caste identity as an affective unifier. Two years after the older of the two parties, the DMK, won its first election in 1967, the Madras State, as it was then called, was renamed Tamil Nadu, meaning literally the Tamil nation. Literature, drama and poetry had played a key part in popularising the party's campaign and the Dravidian movement in general. So, it was little wonder that its prominent leaders were writers who enthusiastically used the growing medium of cinema to further their cause. One such writer was M Karunanidhi, who became Chief Minister when the DMK's founding member C N Annadurai died in 1969, and has continued to be the leader of the party till date. The first position that this five-time Chief Minister of Tamil Nadu held in 1967 was, however, Minister for Public Works, coveted for its charge of large water bodies.

For a long time, provision of water to cities as well as for agricultural regions was synonymous with the management of these public works – lakes, tanks, canals and irrigation systems among others. For the city of Chennai, this meant the construction of an additional tank called the Poondi reservoir and strengthening of capacity to channel and treat water from the existing sources – the Red Hills and Cholavaram lakes. The city also identified groundwater aquifers and well-fields from which water could be extracted for urban supply. An elaborate distribution system dividing the city into 12 zones with separate distribution stations for the north, south and central parts was developed at this time, and continues to be the foundation on which further capacity is added today. When CMWSSB was created in 1978 followed by a period of World Bank funded restructuring and development, it was more of such aggregated projects and incremental additions to the network that the organisation continued to do until the late 1990s. The World Bank appeared to have little to do with the two prominent large scale projects that were planned during that period – the Krishna Water Supply Scheme that involved bringing 15 tmcft (thousand million cubic feet) of water from the Krishna river 485 km north of the city; and the Veeranam Water Supply Project that involved channelling 180 mld of water from the Veeranam lake 228 km south of the city. The World Bank's implementation report for its Madras Water Supply Project II hints at why this was so:

> "Within less than six months of Loan Effectiveness the Tamil Nadu government that had negotiated and supported the project was voted out of office. The incoming government did not favor the project's selected bulk water scheme, the Veeranam scheme, but preferred an alternative solution, the Krishna scheme, to bring more water to Chennai." (CD14, p.2)

So, the loan amount corresponding to the Veeranam project was cancelled and the World Bank stuck to assisting in a general goal of "improvements to the sources of supply, treatment, distribution and conservation of water." (CD12, p.2) The credit to the Veeranam and the Krishna projects would go not to a global technocratic agency but to specific Chief Ministers.

The origins of the Krishna water project are usually traced to the 1956 re-organisation of federal states in the newly independent India, when the erstwhile Madras presidency covering much of south-eastern India was carved into majority Tamil-speaking Madras and majority Telugu-speaking Andhra states. The Krishna river flowed through three other states including Andhra but not Madras, which nevertheless appealed to the tribunal set up under the Interstate River Water Disputes Act, 1956 to allocate Krishna water for supply to the city of Madras (Nikku 2004). It is worth noting that Tamil Nadu, which has long portrayed itself as short-changed by riverine systems, is engaged in perennial riparian disputes with its other neighbouring states, Karnataka and Kerala, and these are potent political issues at the State level as well for the Union Government in Delhi.

It wasn't until 1976 that the states involved reached an agreement to transfer water from the Krishna to Chennai. The 1977 Tamil Nadu elections were, however, won by a breakaway faction of the DMK called the ADMK, lead by popular actor MG Ramachandran (MGR) who had been the public face of the DMK through the revolutionary roles he played in his movies. MGR, who continues to have a cult following in Tamil Nadu still influencing the electoral performance of the ADMK, never lost an election until he died in 1987. MSS Pandian (1989) calls it 'the MGR phenomenon' that mobilised 'subaltern consciousness' through the roles that the actor played in his films evoking Tamil ballads and folk tales that allude to historical characters. The official agreement to channel water from the Krishna river to Tamil Nadu through a series of canals was signed between Andhra Pradesh and Tamil Nadu in 1983 under the MGR government, and it thus became MGR's project. MGR, however, came to be remembered for the increased installation of public water pumps and distribution of free plastic pots for the poor, sparking popular political analyses about the ADMK's proclivity for paternalistic solutions as opposed to the DMK's preference for construction projects (C9). This also tallied with the fundamentally rural focus of the ADMK and the DMK's interest in urban development (Gopakumar 2009).

These political priorities have arguably overshadowed the Master Plan drawn up in 1978 along with the creation of CMWSSB. This plan was updated in 1991 to take into account expected water from the Krishna, and then revised again in 1997 (CD18, p.). By then, following a power tussle after the death of MGR, Tamil Nadu had fallen into a pattern of alternately electing to power the DMK lead by Karunanidhi and the AIADMK, a faction of the ADMK lead by MGR's fellow actor and political heir J Jayalalitha. During this period, government projects accomplished under each government were aggressively 'branded' as a *Kalaignar* or *Amma* scheme after the popular honorary titles bestowed upon the respective Chief Ministers. 'Kalaignar', meaning artist, stood for the DMK leader Karunanidhi and 'Amma', meaning mother, stood for the AIADMK leader Jayalalitha.


**Figure 6: Publicity material for inauguration of Minjur desalination plant, Chennai. Source: IVRCL press release shared with researcher.**

So, the Minjur desalination plant, though initiated under the AIADMK regime was completed under DMK rule and was inaugurated by Karunanidhi (see Figure 6). The DMK, in turn, started the Nemmeli desalination plant which was completed under AIADMK rule and bears a plaque commemorating its inaugural by Jayalalitha. Contrary to the practice elsewhere of bottled water labelled with images of pristine mountains to assert quality, government-distributed subsidised water bottles in Tamil Nadu bear a picture of the Chief Minister, Jayalalitha in this case. The label drew legitimacy from the water rather than the other way around, for packaged water had long been in use in Tamil Nadu even when circulated in reusable cans of dubious appearance (see Figure 7).


**Figure 7: Packaged water in Tamil Nadu.**
**Source: Left - *The Hindu*/ THG Publishing Private Limited - 17 Sep 2013.**
**Right – Fieldwork photo.**
*'Amma' government-distributed subsidised water bottles in Tamil Nadu ( left) and commercial water can (right).*

This continued until 2016 when the latter died, leaving her party further split and the DMK under the *de facto* leadership of Karunanidhi's son M K Stalin. It is this trio who have shaped Chennai's waterscape in the past three decades not only through the projects and schemes that bear their name but also through the elaborate networks of authority and distributed agency that their governments have nurtured. Stalin, who had been politically active since the 70s and was elected to the Tamil Nadu Legislative Assembly in the 80s from a constituency in central Chennai, became the city's first directly elected Mayor in 1996. The previously ceremonial office of the Mayor had been abolished in 1973, but was reinstated in 1996 by the DMK government which had itself been elected after a long hiatus that year. The move was prescient of the role the city was to play in the state's polity and political economy and placed infrastructure development, albeit mostly of transport, at the forefront of the urban agenda (Arabindoo 2006, Gopakumar 2009). Although this agenda is mostly linked to a range of road construction, it also initiated the Chembarambakkam water treatment plant, a significant addition to Chennai's water infrastructure. Designed with 'French assistance', construction on the plant, however, began only in 2005 and was completed in 2007, in time for inaugural by the DMK Chief Minister Karunanidhi, elected in 2006. The plant's capacity is 530 MLD, meant to treat water from the Krishna river, but it supplies around 150 MLD depending on water level in the Chembarambakkam lake. Figure 8 gives a timeline of the developments in water infrastructure for Chennai described so far, and their firm association with the political party in power at the time.

The story of how Chennai got a desalination plant in 2010 arguably starts in 1996; unless you ask an AIADMK loyalist who would trace it to 2001. For the simple purpose of chronology, I start with 1996 and M K Stalin, the first elected Mayor of Chennai from the DMK. 1996 was the year that the city's official name was changed from Madras to Chennai, even though both names had been used interchangeably in practice and even in certain official documentation over the years. This, along with the *Singara* [beautiful] *Chennai* campaign launched by the Mayor, was symbolic of the city shedding its traditional image and instead, mobilising its social and cultural strengths to partake in neoliberal globalised flows of capital and technology (Arabindoo 2006). But, the ensuing infrastructural development also revealed micropolitical relations that were rooted in the social, historical and material conditions of the city. But, before we get there, the rapid urbanisation that Chennai underwent in the following years and the accompanying plans for massive upgrades to its infrastructure and less so, to its water supply system, needs to be set in context.

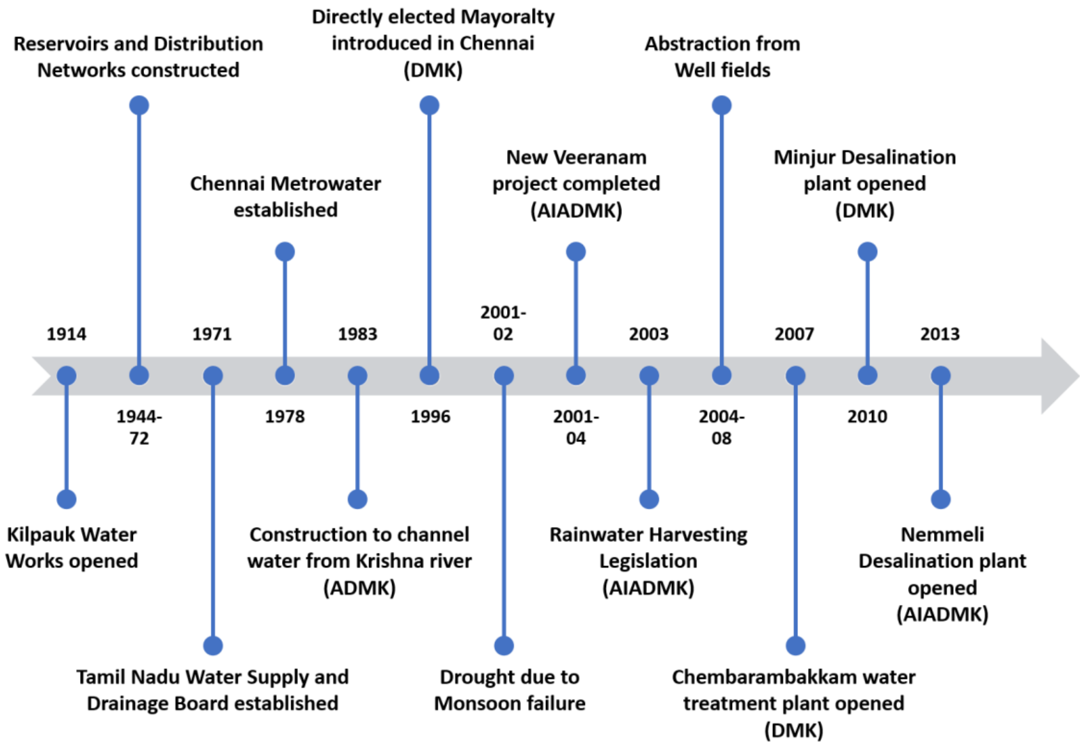



**Figure 8: Political entanglements of water projects in Chennai – A timeline**
**Source: Developed by author.**

That the power and reputation of a leader is both asserted and dependent on their ability to assure water supply has been a theme since pre-colonial times in Tamil Nadu. Historical anthropologists have provided detailed accounts of a particular system of water engineering involving a network of tanks and canals that dealt with seasonal monsoon rains by using the natural gravity of landscape to facilitate flow and storage of water (Kent 2013, Mosse & Sivan 2003, Stein 1980). Of these, David Mosse's (Mosse & Sivan 2003) focus is explicitly on the state, addressing the orientalist construction of pre-colonial India as a republic of villages, free of or lacking the intervention of a state. Arguing that the state then was as involved in everyday life as it is today, he establishes that the water network and the idioms of kinship, authority and law associated with it were technologies that "supported supra-village authority and control around water allocation" (ibid.: 64).

It is the idiom of authority itself and the negotiated nature of its control that is of interest to us here:

> "…kings build tanks to mark acts of bravery or to reward the religious wisdom which guides it. Indeed, in the founding of kingdoms and villages alike, warrior prowess and religious merit are linked to the bringing of water. However, water and land are not resources for Maravar warriors to hold and enjoy, but rather to rule through granting them further to communities…" (Mosse & Sivan 2003: 65)

The elaborate process of granting material rewards in exchange for more or less nothing except respect or gratitude, which eventually ought to translate as power, is the relationship of patron and client that many accounts of south Asian society and state describe (see Pillavsky 2014 for an overview). In some accounts, the patron-client transaction is a subversion of democratic modernity (Kochanek 2000), even if it might indeed complement and enhance electoral democracy and state service delivery (Sadanandan 2012). It is also detected as a feature of neoliberal governmentalities, where cutback of state resources is accompanied by indirect but politically connected modes of service delivery (Bear 2015, Björkman 2015). As Piliavsky (2014: 3) points out, patronage and clientelism are often used as euphemism for corruption in the Anglophone media, indicating an incomplete or perverse modern state-formation. But, the Indian democratic state has time and again proven to be a highly sophisticated machine (ibid.) defying stereotypes of oriental despotism or village republics, especially in agrarian societies with complex hydraulic works (cf. Wittfogel 1953).

In fact, the splintering of social groups and their diluted loyalties to temple, state and locally powerful warriors in pre-colonial South India, could be understood as an organic mode of checks and balances to authority:

> "Legal conceptions in religio-political traditions were relativist regarding the nature of rules, rights, and legitimacy, and these widely accepted conceptions hindered political authorities from developing absolutist, centralizing control." (Price 1993: 495)

In postcolonial India, the Dravidian movement happened to be adept at using visual and literary media to project itself as the natural representation of this ‘subaltern consciousness’ (Pandian 1989). Rather than being a radical movement offering a clean break from a hierarchical past, then, the Dravidian state shows signs of continuity in its curious mix of patronage and distributed agency as the mode of exercising statehood. It helps to keep in mind that the mobilisation of Dravidian nationalism in post-colonial India drew on ancient Tamil literature and sought to actively reclaim the logic of Tamil cultures, if only imagined. The parallels between contemporary Tamil polity and pre-colonial rule are, hence, not literal. Nor is this a culturally essentialist account of an unchanging society. Not even pre-colonial Tamil Nadu was unchanging, as Mosse & Sivan (2003: 65) demonstrate how the continuously changing and physically shifting settlements of the region over two centuries made its ecological as well as social engineering vulnerable to military conflict with colonial armies at the end of the 18$^{th}$ century. Tracing patterns in the political technologies and cultures used across widely different historical periods enables an understanding of the assembling and reassembling capabilities of power.

The historicisation offers a framework from which to critique contemporary urbanisation processes in Chennai in its own terms, avoiding ‘universalist propositions’ (Chakrabarty 1992: 351) of modern cities, states and their sustainabilities. While Chennai is certainly undergoing some rapid change and rewiring of its global networks, it’s worth noting that its encounters with technology, global capital or neoliberal urbanisation are preceded by a history of similar encounters.

### 4.3.3. Urban articulation of the state

Visiting a high ranking politician in Tamil Nadu, like a former Mayor of Chennai, is a bit like a attending a noble’s court (CE7). He is surrounded by a select group of party members, his advisers and fellow politicians of lower ranks. They are all clad in regulation crisp white shirts and matching *dhotis*, with an occasional woman in a *saree*. There are also other outsiders – media persons or representatives from citizen organisations - waiting impatiently for their turn to speak to him. The politician, in this case, spends a substantial amount of time with each visitor; but his meetings are conducted in the middle of this assembly of trusted people. Even by these standards, M K Stalin's inner circle, which was at one point formalised as a 'core committee' during his time as Mayor was legendary. A colleague of his explained:

> "He also started a co-ordination committee to liaise operations between Metrowater, Libraries, Fire Service, Slum Board etc. That is, after all, the kind of work the Mayor is empowered to do. It is not like he is directly in charge of water supply or transport. But, he can, as elected representative of the people of Chennai, work with agencies to make public services better in the city. This, however, is possible only if it is the same party in power in the State Government as well. The Mayor can co-ordinate only if there is co-operation from Government Institutions, which are of course allied always with the party in power." (C60)

The constitution of the Mayoral office in 1996, for all its global outlook, was also seemingly designed to encourage the culture of the 'institutional big men' and their relationships of patronage. Other cities like Bangalore were constituting formal agencies to further the urban development agenda as a government-private sector partnership (Sami 2013). In Chennai, the City as well as the State Government preferred networks established at a personal level. It was in Stalin's 'core committee', which was different from the official co-ordination committee, that the idea for desalination is said to have emerged (C25). This committee was mostly a mix of industrialists and civil service officers and did not exactly consist of experts on urban development or infrastructure.

In fact, both the DMK and AIADMK governments were in the practice of nurturing their trusted civil service officials, who would be posted to key administrative roles or assigned to head flagship projects when each party was elected to power. A change in the elected government is always accompanied by news of not just the ministers assigned their portfolios but also of change appointments to important public institutions like Metrowater, or posts in the Secretariat.

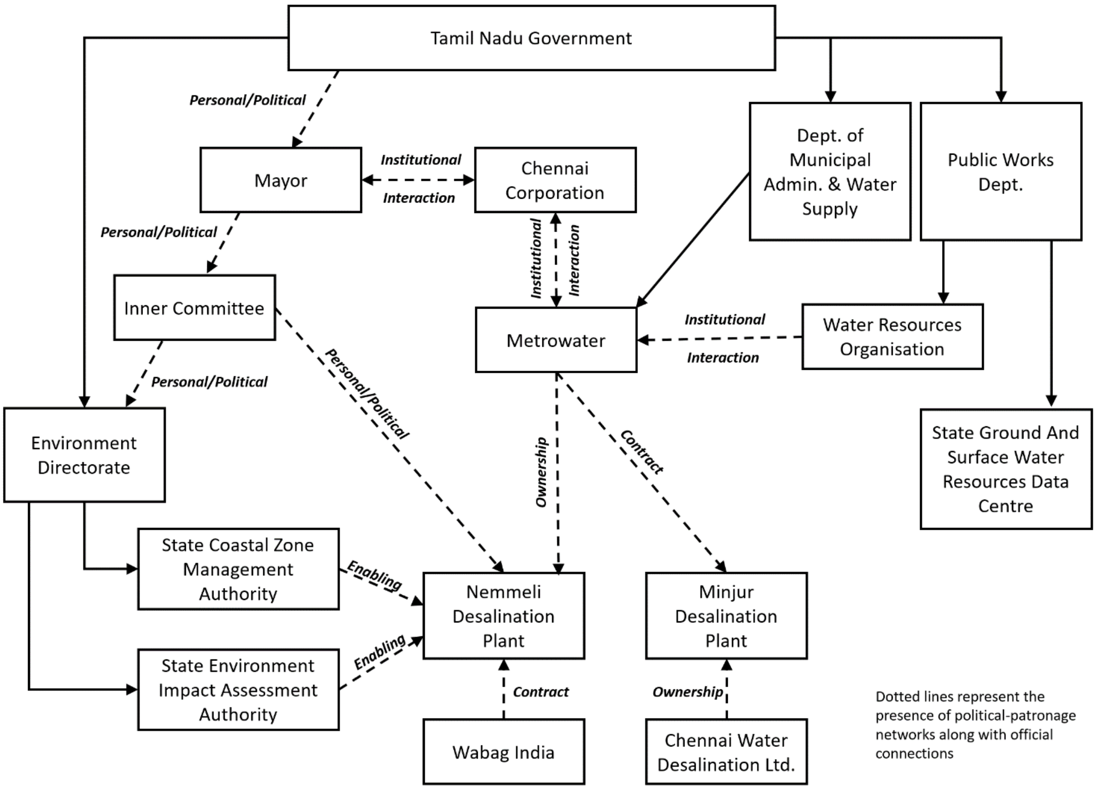



**Figure 9: Chennai Water Infrastructure – Institutional Flows.**
**Source: Developed by author.**

The most trusted of these are assigned advisory or consulting roles after their retirement or become part of the party leader's planning committees, like Stalin's above. In any case, both parties, founded on ideals of social justice and distributive welfare, have a fairly all-encompassing approach towards governance and aim to reach the widest possible beneficiaries in their programmes, at least as an ideal. Figure 9 illustrates the array of institutional connections determined by the official structure of urban governance as well as sustained by the distribution of personal patronage networks. Andrew Wyatt (2013) describes this as a combination of 'clientelist' politics and 'programmatic' policies leading to universal populism. Civil service officials, then, suffer no ethical dilemma in their job of executing universal schemes, despite maintaining loyalty to specific parties. A senior bureaucrat in the Government Secretariat reasoned:

> "The institutional arrangement in Chennai is very similar to say, Bengaluru or Hyderabad. The universal wisdom then was that the creation of a strong

Mayoral authority will help in urban development. But, it soon became evident that that was a silver bullet and a Mayor cannot be easily vested with much power, nor can he do everything on his own. People expect politicians to be responsible for their everyday services here – if something goes wrong, he's directly to blame. So, every leader needs trusted advisers who can work the machine to get things done." (C65)

Stalin's core committee, however, doesn't seem to have taken the desalination idea much further, for, by the time it actually materialised in Chennai, it was under the auspices of the AIADMK ruled State Government in 2001, as small scale 0.1 MLD installations adjoining settlements of the urban poor along the coast.

2001 was a landmark year for water projects in Chennai because of the consecutive years of monsoon failure that had depleted the city's ground and surface water sources[15]. As with urban water shortages, the scarcity was compounded by lack of tools to preserve water from the rainy days as many parts of the city were built over historic lakes and marshlands meant to preserve water. This also meant that the city depended significantly on the groundwater that it had built over, drawn using borewells to sustain its everyday life and growth. The network supply accounted for only a few hours of supply on alternate days or a couple of days per week. When the ground and surface water sources dried up in 2001, presented an opportunity for drastic measures to address these issues. Plans that had been brewing for a while and techno-legal methods that might have been more difficult to implement at other times could be hastened to completion now, not least because they would also be accomplishments of the government then in power – the AIADMK under Chief Minister J Jayalalitha. From a 2002 Metrowater policy note listing all the projects completed that year:

"The status of city water supply and the Contingency plan for managing the acute water crisis was reviewed by the Hon'ble Chief Minister in detail on 11.6.2001. In order to tackle the grave water situation and acute drought, it

[15] "Chennai's water woes", The Hindu, 05 Jun 2003, See: http://www.thehindu.com/thehindu/mp/2003/06/05/stories/2003060500290100.htm

> was decided to adopt a multipronged strategy with immediate measures to attend to the day-to-day needs and long term measures for a permanent solution to the water problem facing Chennai city." (CD14, p. 1)

The immediate measures consisted largely of bringing water in from distance sources by road and rail. Water was drawn from as far south as Erode (400 km) to distribute about 70 MLD in Chennai through lorries, stationed tankers and widely installed stand pumps. The more long lasting effect was however the drilling of deep borewells and identification of well fields in the hinterland, which continue to send water in lorries to sate Chennai's increased thirst today. This has also become the situation against which new projects are assessed or justified:

> "RO desalination costs 54 paise/litre compared to 13 paise for other surface water sources. But, what RO is expected to replace is transport of water in lorries from far away, which costs on an average Rs. 1.2 per litre. For Metrowater, this is not a profit enterprise, but public service. So, they are only going to see if it fits into their budget." (C38)

> "Any treatment plant is worth-it, even if it's only an addition of 10 MLD. 18000 litres per lorry. 10 million divided by 18000 litres per lorry would be 500 lorries per day." (C13)

> "In 2001, water was brought in from Neyveli [200 km] at the rate of Rs. 2200 per load in lorries and trains – that's literally money down the drain. We were looking for a more reliable and sustainable source which is when desalination came into the picture."(C48)

In 2001, the first step was, however, small scale desalination units for the urban poor:

> "Metrowater has taken a considered decision to focus on fishermen's colonies and aggregations peopled by the economically disadvantaged groups. Since these areas are located close to the sea and suffer from lack of potable water, resulting in major health related problems…a beginning has

> been made situating two Reverse Osmosis Plants one at Ayodhya kuppam and another at Kasimedu kuppam in Royapuram." (CD14, p.5)

These units have now been closed, but, the other long term measures stay. The plan to draw water from Veeranam lake, dubbed the New Veeranam Project, was initiated and construction completed in 2004, although supply never touches the planned 180 MLD owing to fluctuations in water levels in Veeranam lake, which is also the local source of irrigation. It is still often referred to as a 'lifeline' to the city, along with the Krishna Water project, even though their actual contributions to the piped network in terms of volumes are never known. Metrowater only releases figures of its reservoir levels, not how they were filled. As a water researcher in one of the city's development institutes said:

> "It is engineering projects like Veeranam that save politicians in times of crisis. Metrowater engineers do not seem to know of this enormous political power they hold, though. Even though people may be getting their everyday water from lorries, it is seen as a messy method. Veeranam on the other hand is something that the state did for them." (C52)

The Secretary of the Municipal Administration & Water Supply (MAWS) department of the Tamil Nadu Government, a politically important department to which only the most trusted bureaucrats are usually appointed, said:

> "For Krishna water, we have to ask Andhra. For Cauvery, we ask Karnataka. Veeranam was water from within Tamil Nadu. But, even that is not Chennai's own water source, of course." (C65)

Yet, at the time, it wasn't the Veeranam project that created ripples in the city's hydro-politics, but a more unexpected initiative – rain water harvesting (RWH). The dramatic implementation of the RWH programme became the stuff of legends and fed into a growing middle class environmental subjectivity in the city (Arabindoo 2011).

In 2002, a municipal ordinance mandating rainwater harvesting in all buildings became an amendment to the Chennai Metropolitan Area Groundwater (Regulation) Act 1987 which gave buildings a year to comply. When the approach of the deadline in 2003 saw poor compliance, the act was amended again giving buildings just one month to implement rainwater harvesting systems or face disconnection of water and sewerage services from the utility. That is, buildings had to add fittings to their plumbing to channel any rainwater collected on their rooftops to the ground, and make adjustments at the ground level for the water to be able to seep under. The impact that this law actually had on groundwater levels is disputed (Arabindoo 2011), as it's difficult to measure whether any increase in groundwater levels is due to this programme or the subsequent years of healthy and even heavy rainfall. But, the widely publicised follow-up on the law and its punitive rather than incentivised implementation was a landmark in the urban articulation of the Dravidian state.

Rain water harvesting soon became something of a matter of pride for middle class residents across the city and allowed for an environmental subjectivity that could be reconciled with their urban lifestyle. It was also considered a communitarian initiative because installations enabling seepage of water into the ground improve the groundwater table for everybody, not just that particular household. By the same token, enough number of buildings would have to do it for it to be effective. Combining a strict legal framework with the city's proclivity for technological installations, as evidenced by its widespread adoption of borewells and household reverse osmosis purifiers more recently, RWH became a model to aspire to irrespective of its results. The MAWS Secretary at the time, who had come from a long and memorable stint as MD of Metrowater, retired in 2010, but was appointed Officer on Special Duty soon after. An AIADMK loyalist and a confidante of its leader Jayalalitha (she resigned her post when Jayalalitha died in 2016), she was at the forefront of government action enforcing the RWH rules. Seated in her top floor office overlooking the vast sands of the Marina beach, she explained:

> "When we said, 'be a good boy and do it', it failed. Only the 'Do it or else…' approach worked. I tried implementing an RWH condition for new buildings

> to get a water connection when I headed Metrowater, but wasn't able to achieve much. With political backing, though, I was able to achieve the same thing, with the penalty that buildings would lose their existing Metrowater connection if they didn't comply!" (C61)

What made it work, according to her, was the 'political will' that mobilised party machinery to accomplish this for their 'Amma', the respectful moniker by which Chief Minister Jayalalitha was known. She was 'agencing' the autocracy of the AIADMK party structure to make what she thought was a necessary urban governance programme work. Had she been responsible for initiating the desalination plants the city now has as well?

> "No way! It is the kind of project engineers think up. What we need is decentralised technology, like the small RO units set up in 2001. Metrowater perhaps thinks it will lose its importance if it enable widespread conservation efforts and decentralised initiatives like RWH. But, they have to realise, in the longer run, that's the only way to avoid total public disillusionment with them. They, after all, operate within a political framework and cannot afford public discontentment at their hands." (C61)

Nevertheless, plans for a large scale reverse osmosis desalination plant was already underway then. An Austrian company named VA Tech Wabag pitched desalination projects in Mumbai, Gujarat and Chennai in 2003 according to the company's public relations officer (C74). But, Metrowater engineers remember discussions about commissioning a desalination plant in the late 1990s, before the 2001 elections and the change of government.

> "The MD had called for a few project engineers to start working on a proposal and so we did. But, it was close to the 2001 elections and what with the drought as well, our proposal never saw the light of the day." (C14)

In any case, before VA Tech Wabag's plant opened at Nemmeli to the south of the city in 2013, there was another desalination plant that had opened in Minjur to the north in 2010. This plant was built like any other factory amidst the heavy industries of north Chennai by a private infrastructure company named IVRCL which formed a consortium called Chennai Water Desalination Limited (CWDL) with the Spanish companies Befesa and Abengoa to plan and build the plant. Metrowater entered into a purchase agreement with them[16].

> "It was an international company that built it and they seemed to prefer the planning and financial freedom of executing the plan on their own. It worked out for us because we were new to the technology and could learn from this one before launching our own plant." (C48)

In infrastructure governance parlance, it's called the Design-Build-Own-Operate-Transfer or DeBOOT model of public-private partnership, where the public institution offers a concessionary deal to the private company to take the risk of investing. In this case, the compulsory purchase agreement and Tamil Nadu's relatively low electricity charges were to have helped.

The Nemmeli desalination plant, on the other hand, involved all the institutions discussed above and more. It is Metrowater's own plant, built on a traditional EPC or Engineering-Procurement-Construction model and further extended as a Maintenance contract as well. The detailed project report (DPR), which is the initial planning document, is always prepared by an external consultant in such large projects. In this case, the same consultant who worked on the Veeranam project, MECON ltd., a Government of India undertaking formerly known as Metallurgical & Engineering Consultants, prepared the DPR.

> "We couldn't very well decide that the government wants a desalination plant at this site, so we will build it there. MECON, being a public institution, is a trusted consultant. Metrowater has better experience in water treatment than them, obviously. So, our engineers had a difference of opinion in terms

[16] See: http://www.ivrcl.com/desalination.php

> of what kind of filters should be used in the plant. But, these technical objections were taken as insubordination, like a political objection."(C14)

There had been other technical disagreements, but none of them challenging the premise or need for desalination itself. For instance, a scientist from the National Institute for Ocean Technology (NIOT), a Union Government institution that researches thermal desalination (as opposed to reverse osmosis) in its south Chennai campus, was in the advisory committee for the Nemmeli plant:

> "Metrowater is taking the right step in aggressively expanding its supply – the city needs it. But, they have been hasty, I don't think they gave enough thought to the brine discharge mechanism or long term maintenance. Thermal desalination is inefficient and that's why it's environmentally safe. But we need to conduct more indigenous research on that. I don't think weighing reverse osmosis against rainfed sources is a fair comparison. It is too simplistic to say city's water supply can be met if it gets enough rain." (C55)

The NIOT, backed by the Union Government's Department of Science & Technology has been experimenting with solar powered desalination in southern Tamil Nadu, tidal powered desalination in Kerala and small scale reverse osmosis units in village schools. A similar, if a more business oriented and larger scale profile can be seen in Tamil Nadu Water Investment Company, which is promoted by the Tamil Nadu Government and IL & FS, an infrastructure financing corporation. After planning a treatment & recycling system for the textile manufacturing hub of Tirupur in western Tamil Nadu, the company was contracted to conduct 'feasibility studies' for desalination along Chennai's southern coast, and then to prepare DPRs for water distribution systems in 26 municipalities across the state. Its latest project is the upgradation of water supply & sewerage for a city in Maharashtra, a state in north-western India.

Infrastructural development in the public sector has spurred an inter-governmental trans-regional economy of expertise in matters of governance, as evidenced by Metrowater's and NIOT's showcasing of their desalination projects to public administrators from California and Florida (C8, C55). Despite activists and environmentalists decrying the mismanagement of Chennai's coastline, Tamil Nadu Environment Directorate's mapping of the coast has attracted interest from other states:

> "We spent Rs. 3 crore [30 million] on coastal zone mapping, covering everything - mangroves, sand dunes etc. Only the turtles were left out. Seeing this, West Bengal & Maharashtra want to do the same thing. They've approached us and Anna University." (C50)

There emerges the picture of an infrastructural state here (see Figure 9), which, using the institutional and technological means available, builds elaborate interconnected systems – of governance or material utility – thus sustaining a framework of rule as well as firmly materialising itself into geographies of urbanism. Irrespective of the ideological or other differences, both the DMK and AIADMK, when in government, wanted to be seen building things. Material outcomes were concrete ways in which their stateness could be asserted. Just as much as there might have been a shallow expansion of the private, there was also an expansion of the state, cast in institutions and infrastructures. As the MAWS Secretary at the time said:

> "We did RWH and that was a good thing. Lakes and tanks that we have neglected so far have to be rejuvenated. But, do you really think as a government, it is responsible for us to tell people 'collect your own water and pump it out of the ground for your use'? In the end, networked supply is more efficient and we haven't even covered half the overall consumption in the city yet." (C65)

Private companies that work with Metrowater or the Tamil Nadu government, thus, are ambivalent about their work. As the Chief Technology Officer at Nemmeli said:

> "With Metrowater, everything has to pass through high command before we can go ahead with whatever the plan we proposed is. They make sure we can complete the project without trouble – they help with getting a power

connection or planning approval - but that means we have to put up with the eccentricity that is Tamil Nadu politics.” (C13)

In what way did the elaborate network of institutions and their quasi-governmental status help in achieving this infrastructural state, though? The feasibility studies done by TWIC to choose a site for a desalination plant in southern Tamil Nadu give a clue. The study lists a set of parameters based on which the assessment was done with a simple Yes or No against each site. So, there is ‘availability of land close to sea’, ‘will the seabed sediment affect the quality of intake’ ‘water quality – does it require extensive pre-treatment’ etc. Where the factors are more complex, for eg. ‘geology of seabed’ or ‘acceptability from a social/environmental point of view’, they are still answered with a simple Yes or No, thus selecting the site with the most number of Y’s against it (CD2). Another example of this is the detailed project reports (DPRs) submitted for environmental clearance with the TN Directorate of Environment (CD3). After elaborate details like geological maps of the district including the seabed, tide details, rainfall and humidity charts etc., this is how the section on the plant’s environmental impact reads [the section is reproduced here (see Table 3) rather than attached as the authors of the report did not permit a copy, but consented to reporting/writing about it]

Far from developing a technical or administrative expertise, what the DPR demonstrated was a unambiguous contribution towards the building of the plant. The elaborate network of institutions and administrators were themselves an infrastructure enabling the construction of material projects and the hence, the ‘concretization’ (Meehan 2014) of stateness (Painter 2006).

In the past decade, the official area of Chennai city has been expanded dramatically, ostensibly for the purpose of improved planning and infrastructure provision in the hinterlands into many parts of which the city had already grown. In January 2011, 4 months before the Tamil Nadu State assembly elections, the then DMK government announced that the Chennai Corporation would be expanded from an area of 176 sq km set in 1978 to 430 sq km, by incorporating smaller local bodies like town and village panchayats into the city limit.

| | | |
|---|---|---|
| Land use proposed | : | Others (that is, not residential, commercial or industrial) |
| Water required for project | : | - |
| Whether the site is near backwater, estuary, creek or lagoon | : | No |
| Alternate sites for environmental consideration | : | Not considered |
| Current land use | : | N/A – not agriculture, homestead, forest, fallow, mangrove, orchard, marshes, sand dunes |
| Any breeding or nesting ground | : | No |
| No. of trees cut | : | None |
| Trees cut | : | N/A |
| Dredging | : | No |
| Any Sand dunes removed | : | No |
| Cutting/Cleaning of Mangroves | : | No |
| Not near | : | National park, marine park, sanctuary/tiger reserve/elephant reserve/turtle nesting ground, Coral reef, mangroves |
| No cyclone affectation | : | - |
| Point of final discharge | : | No |
| No population to be displaced | : | - |
| No cyclone affectation | : | - |
| Point of final discharge | : | No |
| No population to be displaced | : | - |

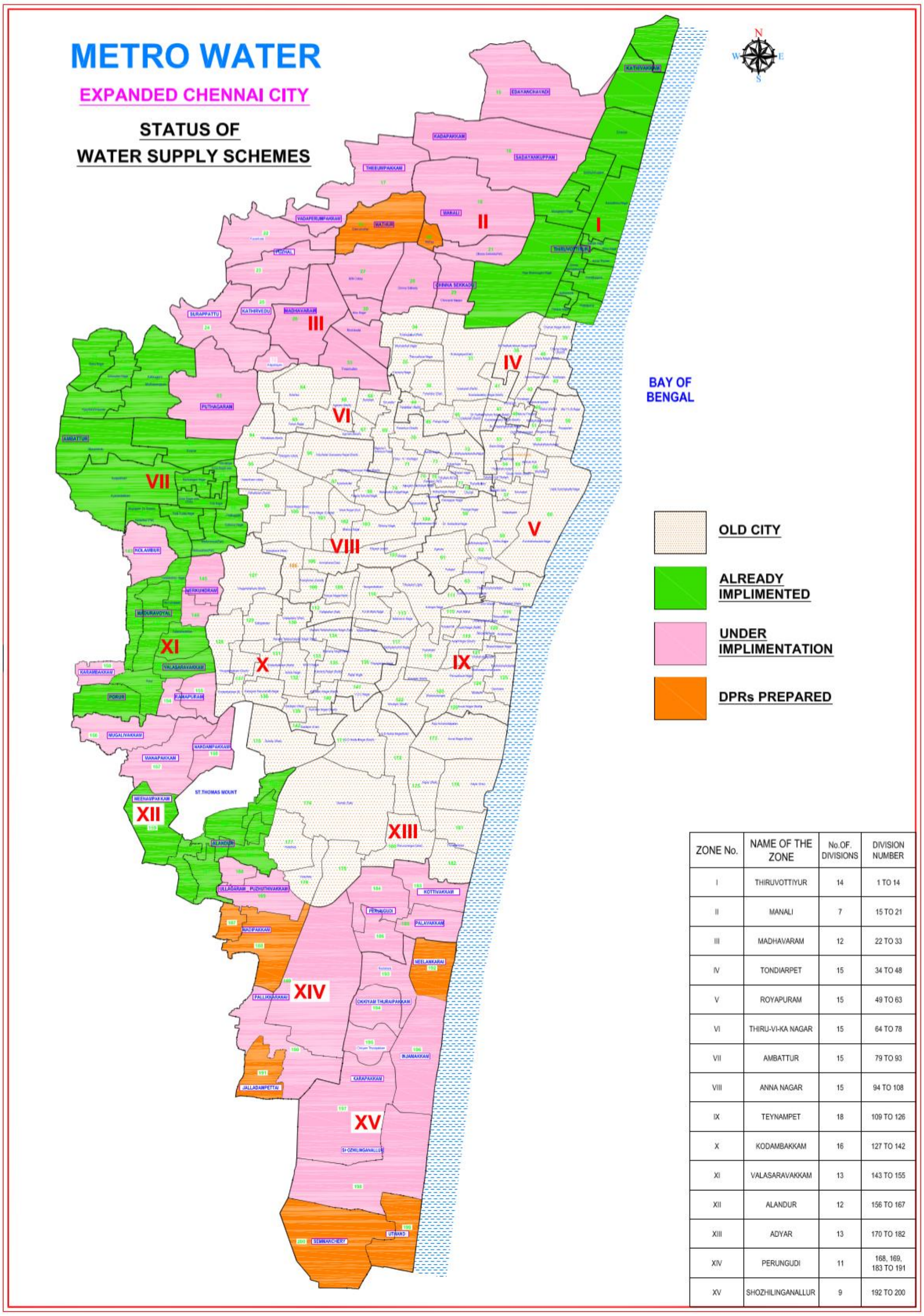
**Table 3: Excerpt from the Detailed Project Report for environmental impact assessment. Source: Data collected from field notes.**

At the same time, the Chennai Metropolitan Area, which is the area that comes under the Chennai Metropolitan Development Authority, the para-statal institution that does master-planning for the city, was increased to 1189 sq km. While the opposition party then contested the move claiming that a large city administration would compromise on governance and public delivery, the expanded city corporation was dramatically renamed 'Greater Chennai Corporation' by the AIADMK lead government in 2016, following other cities in India like Bangalore and Mumbai. Often the infrastructural funding cities could obtain either from the Central Government or international agencies were proportional to their size making the expansion a rational political economic move. As a senior politician put it:

> "The city was expanded in order to get funding from JNNURM[17] or other aid agencies. Large cities had an edge in terms of appealing to investors as well as the Union Government's priorities. At that time, Chennai was the smallest in terms of actual corporation area, while Bangalore, Delhi, Hyderabad had all expanded their limits already." (C60)

In a case of cyclical reasoning, this also became the rationale for increased infrastructural development in the public as well as the private sector (C23, C36, C48, C75). In 2018, Chennai became the largest city in India by increasing its metropolitan area seven times to 8878 sq km (CD4). If the 2011 expansion was any indication, the city is all set to become the stage for more of the infrastructural state (see Figure 10 for a map of Metrowater's plans to expand its water supply along with the city).

[17] JNNURM - Jawaharlal Nehru Urban Renewal Mission




| ZONE No. | NAME OF THE ZONE | No.OF. DIVISIONS | DIVISION NUMBER |
|---|---|---|---|
| I | THIRUVOTTIYUR | 14 | 1 TO 14 |
| II | MANALI | 7 | 15 TO 21 |
| III | MADHAVARAM | 12 | 22 TO 33 |
| IV | TONDIARPET | 15 | 34 TO 48 |
| V | ROYAPURAM | 15 | 49 TO 63 |
| VI | THIRU-VI-KA NAGAR | 15 | 64 TO 78 |
| VII | AMBATTUR | 15 | 79 TO 93 |
| VIII | ANNA NAGAR | 15 | 94 TO 108 |
| IX | TEYNAMPET | 18 | 109 TO 126 |
| X | KODAMBAKKAM | 16 | 127 TO 142 |
| XI | VALASARAVAKKAM | 13 | 143 TO 155 |
| XII | ALANDUR | 12 | 156 TO 167 |
| XIII | ADYAR | 13 | 170 TO 182 |
| XIV | PERUNGUDI | 11 | 168, 169, 183 TO 191 |
| XV | SHOZHILINGANALLUR | 9 | 192 TO 200 |

**Figure 10: Chennai Metrowater – extension of water supply to the expanded city. Source: Metrowater website. chennaimetrowater.tn.nic.in**

## 4.4. London: regulatory state

### 4.4.1. Water as boundary object

> "I advise companies and utilities on water sustainability all over the world. But, when I get home, I'm unable to get my daughters to use lower pressure on their showers. I had to finally buy a low flow shower head to force this behavioural change." (L20 - Sustainability Consultant, London)

It has been over forty years since London's municipal water utility called the Metropolitan Water Board was restructured into a quasi-public institution called Thames Water Authority, and subsequently, privatised in 1989 as Thames Water (Jones 2013, Pearce 1982). The privatised entity was initially part of a massive engineering company that expanded into water markets in North America and Europe, but was then sold off to a consortium of investors lead by an investment fund, which, in turn, has transferred to a consortium of pension funds[18]. This period roughly coincides with the disappearance of a popular political discourse on water in the city. If it can be detected at all, it is only in gendered, domesticated forms as articulated by the consultant above. Possible contamination of water during the wars or the subsequent controversy over fluoridation (Jones 2013, p. 140-160) were emotive issues, involving political intervention. Hydrological contestations, to be sure, continue to shape water policy and politicise it elsewhere in the country, especially in the north of England. But, in London, deficiencies in water supply or sewerage are framed as building issues to do with faulty plumbing or old fittings, and seldom treated as a city-wide or infrastructural problem. While some of them are raised occasionally in consumer forums and water companies are blamed for hosepipe bans in drought years[19], the political value of water in urban public discourse appears to have largely diminished.

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[18] The Metropolitan Water Board was established in 1903 to unify nine different water companies supplying water to London. It was restructured as a quasi-public authority in 1973 called Thames Water Authority and subsequently, privatised in 1989 as Thames Water. (See Pearce 1982, Jones 2013). The company was bought in 2001 by the German utility group RWE and then sold to Kemble Water Holdings, a consortium controlled by the Australian investment fund Macquarie Group in 2006. Kemble Water Holdings is now controlled by a set of pension funds from all over the world.

[19] See http://utilityweek.co.uk/

Except with specific interest groups, usually landed agriculturalists, water is hardly the kind of vibrant political object that energy or housing or transport is in the UK, much less in London. Critique of water supply or governance seldom make for important political statements or reported news. All of this has lead to the water sector becoming a frequent example of the 'retreat of the state' that is said to have begun with the privatisation of various sectors under the Thatcher government in the 1980s (Oliver 2007). The privatised water sector, since, has certainly come to be financialised and embraced a 'post-political' concern with environmental efficiency and risk mitigation rather than spatial or distributive issues (Allen & Pyke 2013). But, the absence of familiar forms of antagonistic politics or resource struggles by itself does not mean an absence of politics altogether (Barry 2001).

In the past nearly thirty years, privatised water management in England and Wales has hardly been a static phenomenon, with a range of regulatory models and institutions developed to govern this industry; and the water industry, in turn, undergoing a restructuring to protect its own financial interests. Throughout this period, the water sector as a whole – the water supply companies, their consultants and contractors, and the regulatory institutions – has produced a number of political objects in the form of reports, maps and material infrastructures (Barry 2002) in response to ostensibly hydrological and climate events. The desalination plant constructed in Beckton was one such hydro-social artefact in the Thames Valley, meant as back-up only during times of drought and as preparation for a future afflicted by climate change. Hence, it is referred to as 'future-proofing' (LD33) rather than as 'drought-proofing' or 'weather-proofing' which were terms sometimes used in Chennai. But, that wasn't all the difference between the two cities.

Thinking London through Chennai, a crucial difference in the environmental subjectivities of the two cities comes up. Both cities turned towards an energy intensive technological solution in response to a drought situation, mediating this decision making process with political artefacts like posters and speeches in Chennai; and reports and maps in London. But, whereas in Chennai, 'stateness' was established by an elaborate network of individualised agencies with political affiliations thus ‘peopling’ (Simone 2004) infrastructures with a multitude of actors, the technopolitical process in London works on the basis of water as a boundary object (Star & Griesemer 1989) around which a system of government is evolved between regulatory and private institutions. The boundary-making also serves the additional purpose of demarcating the line between state and society; experts and citizens; technoscience and everyday water use. This is, of course, a continuous process giving rise to different political formations and environmental knowledges. In these distinctive hydro-social assemblages, the difference between the ‘means-ends-necessity’ (Arabindoo 2011: 112) pragmatism of Chennai and the infrastructural excess (which does not necessarily mean perfection or abundance of water supply) of London cannot be discounted. The 24-hour-on-tap supply of water in London itself, then, acts as a boundary marker (Mitchell 1991), with those who know how the water gets there on one side establishing a structure of rule or ‘stateness’ (Painter 2006) and those who just turn the tap on the other.

In the following sections, the STS (science & technology studies) concept of the boundary object will be used to critically look at a specific set of reports and maps leading up to the construction of the desalination plant. These are not documents related to the plant per se, but reports that were circulated in the wake of the successive years of drought and the environmental regulatory response to it in the noughties. But, before we get there, what is a boundary object and how is it different from any object of governance that enables a structure of rule? The term boundary object was coined by STS scholars Star and Griesemer (1989) in their quest to understand how scientific work usually achieved results in consensus over a wide range of people and things. They identified “a 'central tension' in science between divergent viewpoints and the need for generalizable findings” (p. 387) by deviating from the myth of a scientific breakthrough and of consensus being a natural outcome. Understanding this from the perspective of objects that normally inhabit multiple social worlds, they ask: “how can findings which incorporate radically different meanings become coherent?” (p.392). The idea of a ‘boundary object’ that can aid in achieving this consensus or coherence thus starts to take shape. Boundary objects, according to them:

> “have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation.” (Star & Griesemer 1989: 393)

This, however, is a vague definition that in its most popular form is applied in arguments of social constructivism (Bijker 2001, Harvey & Chrisman 1998). Besides, the ‘multiplicity’ of water (Barnes & Alatout 2012) and its range of social roles has already been widely commented upon. How, then, is the concept of the boundary object useful? Star (2010) has later clarified that this ‘interpretive flexibility’ is only a fundamental building block over which the concept of the boundary object can be developed primarily to reveal the ways in which various groups working on the object juggle its forms to arrive at a workable conclusion. That is, more than the characteristics of the object, it is how it’s contested back and forth in an attempt at resolution among groups of professionals or social groups that is of interest. Specifically, this section benefits from a close reading of Carroll’s (2012: 489) take on the role of water as “an object at the boundary between science and governance.” He shows how the construction of water as a resource enabled the Californian state to come in contact with the idea of scientific governance, generating “new discursive, organizational, and material forms in both realms, which in turn stitches them together.” (ibid.).

In the case of London, this process can be observed in the mechanism of environmental regulation, which, as the following section will show is a particular articulation of the state. The creation of a regulatory framework after water privatisation, as we shall see, enabled the British state to consolidate its authority over water systems throughout the country and work with various forms of expertise in discursive ways that might nevertheless be a vehicle to push a political agenda. The result:

> “is not scientific government, but a technoscientific state formation composed of a complex set of continuously contested and shifting interconnections.” (Carroll 2012: 490)

### 4.4.2. 'Peckham Springs' to desalination – shifting conceptualisations of water

A 1992 episode of the popular TV series *Only Fools & Horses* featured *Peckham Springs,* a bottled water brand flying off the shelves of newly sprung organic food stores in London. It showed its lead character, south London wheeler-dealer Derek 'Del Boy' Trotter, merrily bottling tap water from his council flat, labelling it the aforementioned 'Peckham Springs'.[20]

> Del: *"We're doing nothing illegal, are we? Eh?"*
>
> Rodney (Del's brother & occasional conscience keeper): *"Nothing illegal…? Del, We're selling public water to the public!"*
>
> Del: *"Ah…this water used to be public. And then Maggie, she privatised it, didn't she?*
>
> *It now belongs to a board of directors and a load of investors. They sell it to us, we sell it on. We're only repackaging it."*

With its wicked wit and a cleverly packed plotline, the show managed to capture the neoliberal environmental zeitgeist of the era in the episode aptly titled *Mother Nature's Son*. In 1989, water in England and Wales had been completely privatised in that each of the river basins in these regions was sold to a single private company for management. These companies owned the assets, including the watery ones, in their basin. In this market, it was only in bottled water that there was scope for other entrepreneurs like Del Boy, for private companies were essentially monopolies in their respective river basins. Although privatisation was driven by the desperate need for investment in water infrastructure (however flawed the logic of expecting it from the private sector might be) in order to rectify falling water quality, one of its aims however was to make water a market commodity – a freely traded good whose pricing and quality reflected supply and demand in the market (LD1, p.11). This was

[20] 'Mother Nature's Son' (1992). Only Fools and Horses, Episode 11. BBC. 25 December.

in line with the growing wisdom of the era that the market could achieve the kind of economic and environmental discipline that states and user awareness couldn’t.

> “Water may be a gift of nature but it is also a commodity. In the economic sense, this is a good or service exhibiting scarcity; unlimited amounts are not available at zero cost. Even where water is plentiful it has to be treated and distributed, and wastewater has to be safely disposed of. These activities use up economic resources. In many - perhaps most - countries at all stages of development, water is scarce and is rapidly getting scarcer.” (Winpenny 2005)

As with any other commodity, then, water’s scarcity would increase its value and pricing, thus imposing efficiency and discipline among its users, leading to water conservation. This was the premise of market environmentalism (Bakker 2005). The image of Del Boy bottling water from his council flat shrewdly conveyed water’s trajectory from everyday object to a nationalised public resource to finally a commodity to be sold in the market. It showed how ‘council pop’ (Jones 2013) came to be an ecologically sensitive commodity.

In 1973, water supply and sewerage, managed by local councils in the post-war period, was nationalised, consolidating 200 supply authorities and 1400 sewerage works into 10 Regional Water Authorities organised according to river basins. This move “was driven by economies of scale, the engineering logic of integrated river basin management and an antipathy to local government” (Page & Bakker 2005). In London, however, water supply had been consolidated over the metropolitan area way back in 1903.

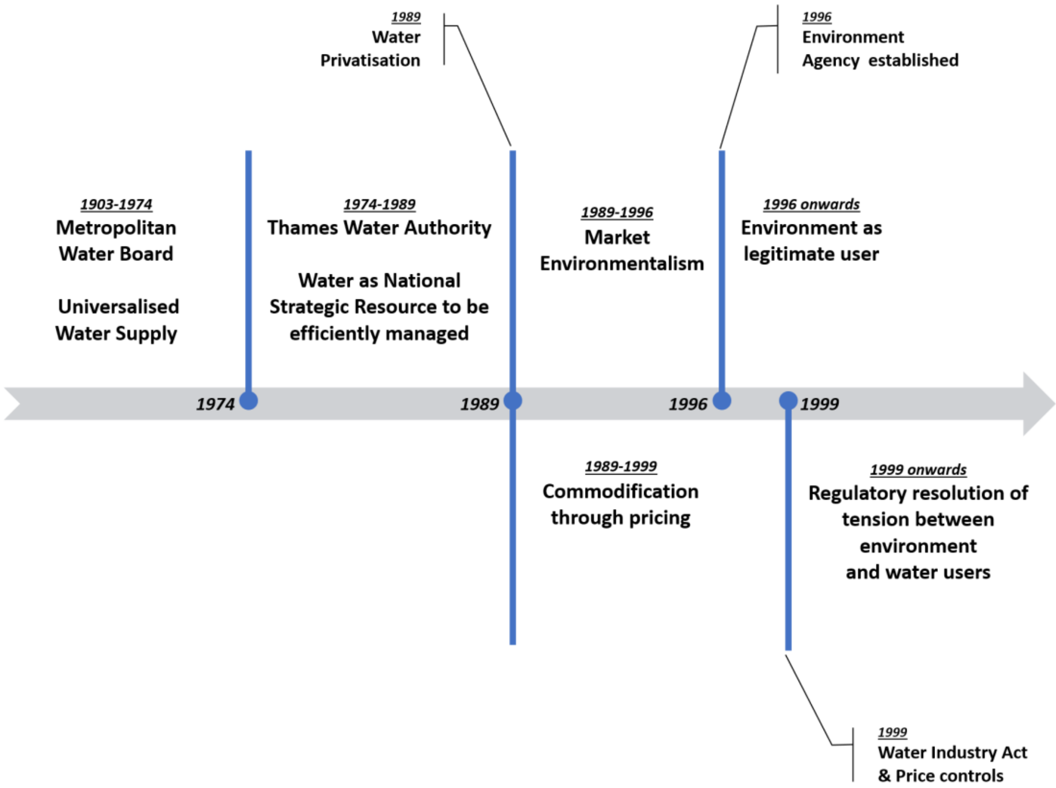



**Figure 11: Ontologies of water through history in London.**

**Source: Developed by author.**

So, the loss of local community control over water felt in other parts of England (Strang 2004) was less of an issue in the city. Structurally, nationalisation paved way for privatisation in 1989 by consolidating water management into river basins and prioritising cost-efficient water supply with an emphasis on demand management (Bakker 2001). (Figure 11 shows the history of restructuring of the water sector was accompanied by shifting conceptualisations of water, which will be discussed in the rest of this chapter.)

The key difference between the two time periods, then, was in terms of their distributive economics. Under nationalisation, water was framed as a strategic resource important for public health, which meant that regional and property-value based cross-subsidies were applied to ensure universal water supply of adequate quantity and quality, even if the goal was full cost recovery for water supply (ibid.).

As Page & Bakker (2005) further point out, this did not eliminate the influence of local politics or interest groups. Powerful land owners and industry groups, in particular, were able to lobby for specific exemptions or inclusions in water policy and its implementation. After 15 years of this arrangement, in 1989, the 10 regional water authorities were sold to private companies, effecting a complete privatisation of water management, with each basin to be managed holistically by a single private company. The market was supposed to take care of setting a fair price and ensure responsible use of a sensitive resource.

But, the initial years of privatisation of water are now remembered mainly for the sudden spike in the charges for water. In a report prepared for Public Services International, a global federation of trade unions, Lobina & Hall (2001) find that average price increase for the whole country as well as for only Thames Water was nearly 50%. Following widespread backlash from the popular media, including those generally backing the agenda of privatisation, market pricing was abandoned and a regulatory route was taken (Bakker 2001). New Labour's manifesto for the 1997 elections mentions water in the context of promoting competition in order to foster a successful and profitable business environment, but foregrounds the interests of customers and the environment:

> "Where competition is not an effective discipline, for example in the water industry which has a poor environmental record and has in most cases been a tax-free zone, we will pursue tough, efficient regulation in the interests of customers, and, in the case of water, in the interests of the environment as well. We recognise the need for open and predictable regulation which is fair both to consumers and to shareholders and at the same time provides incentives for managers to innovate and improve efficiency." (Labour Party, 1997)

The Labour government elected that year passed Water Industry Act 1999, two key features of which had a lasting impact on the evolution of the water industry in England: (i) It prohibited water companies from disconnecting service to users who hadn't paid their bills (ii) It imposed significant restrictions on metering of household water use except under extra-ordinary circumstances, or unless the customer wanted to be charged 'by volume'. Even this provision was meant for the customer's preference in case their volume of use did not match the value of their property, which was the existing method of charging. For good measure, the Act adds that customers who opt for billing by volume of use cannot be charged for the fitting of meters in their premises.

The result of this was that water charges continued to be billed on the basis of the value of residential properties, called 'rateable value', for the most part. These charges had to be approved by the Director General of Water Services, which became Ofwat, deriving from the Office of Water Services that supported the Director General, in 2006 (LD26). Ofwat is now constituted by a Board rather than the Director General, and conducts price reviews every five years on the basis of its mandate to "balance the interests of consumers with the need to make sure the sectors can finance the delivery of water and sewerage services."[21] This early focus on pricing continues to be the most significant restriction applied on the water sector, forcing water companies to plan for the least possible increments in investment, simultaneously protecting stakeholders and shareholders, from a business point of view (Ogden & Watson 1999). The institution representing the public to the industry – the Consumer Council for Water, formerly the Customer Service Committees – are on the side of the 'average customer' taking a majoritarian stand on keeping the prices down rather than argue for water conservation or distributive justice, as Page & Bakker (2005) point out.

This 're-regulation' of the water sector, in theory, thwarted the march towards market environmentalism, where pricing mechanisms that incorporate environmental costs are important to inculcate user discipline. Yet, the privatised water sector soon came to be known as a success story in environmental water management. The Department for Environment, Food & Rural Affairs (DEFRA) and the agency it sponsors to execute environmental regulation, the Environment Agency (EA), both announced at the turn of the century that the water management strategy

[21] See: https://www.ofwat.gov.uk/regulated-companies/price-review/

of the 90s under a privatised industry had achieved record quality in England's rivers and other water bodies (LD31, LD32) with a simultaneous improvement in drinking water quality as well (LD29).

This has been achieved by recoding (see Figure 11) water from its position as a strategic national resource to a 'part of the environment', argues Bakker (2005), perhaps the most consistent chronicler of the water sector in England:

> "The reconfiguration of citizens as consumers under market environmentalism has thus occurred in tandem with the representation of the environment as a legitimate user whose interests are to be balanced with—or even prioritized over—those of consumers." (Bakker 2005: 560)

What she refers to is the EA's role in issuing abstraction licences and approval for safe disposal of treated sewage. These licenses are issued by taking into consideration the level of stress a water body is under and whether it can afford to be extracted for human use. As the EA sets it out in its abstraction licensing strategy:

> "Abstractions over 20 cubic metres per day require an abstraction licence (with some exceptions). Whether we grant a licence or not depends on the amount of water available after the needs of the environment and existing abstractors are met, and whether the justification for the abstraction is reasonable." (LD25: 9)

The regulation, as the above statement shows, requires justification to extract water from the environment's use towards human use. So, the 'market' side of market environmentalism may have failed; but, this didn't mean that environmentalism had necessarily been a smokescreen either. While it may not have been possible to use pricing to effect user discipline and water conservation, the regulatory framework placed environmental use in the same plane thus changing the way water was conceptualised. In other words, water's multiplicity was put to use to alter industry approach to its management. It is usually assumed that commodification is desired by neoliberal states but is not achieved due to cultural or social plurality. But, what if states and indeed the private industry could benefit from the ambiguity of water and the ‘tacking back and forth’ (Star 2010) between water as a resource, a commodity and a part of the environment? This would constitute water as a boundary object around which regulatory governance could be built.

### 4.4.3. Two maps and the turn towards water multiples

During the course of the interviews in London, in contrast to Chennai, the colourful history of privatisation, politics and regulation almost never came up. However, discussions veered more towards the regulators and their models to approach to water than about the actual mechanics of water supply itself, even less specifically about the desalination project.

> “Ofwat’s job has always been to balance supply and demand in an industry which doesn’t have market competition and the commodity is one essential for life.” (L13)

> “The key to understanding the water industry in England and Wales is to understand Ofwat. When water was privatised, there was a need for companies to be regulated so they don’t provide shoddy service or overcharge customers. So, Ofwat was instituted.” (L17)

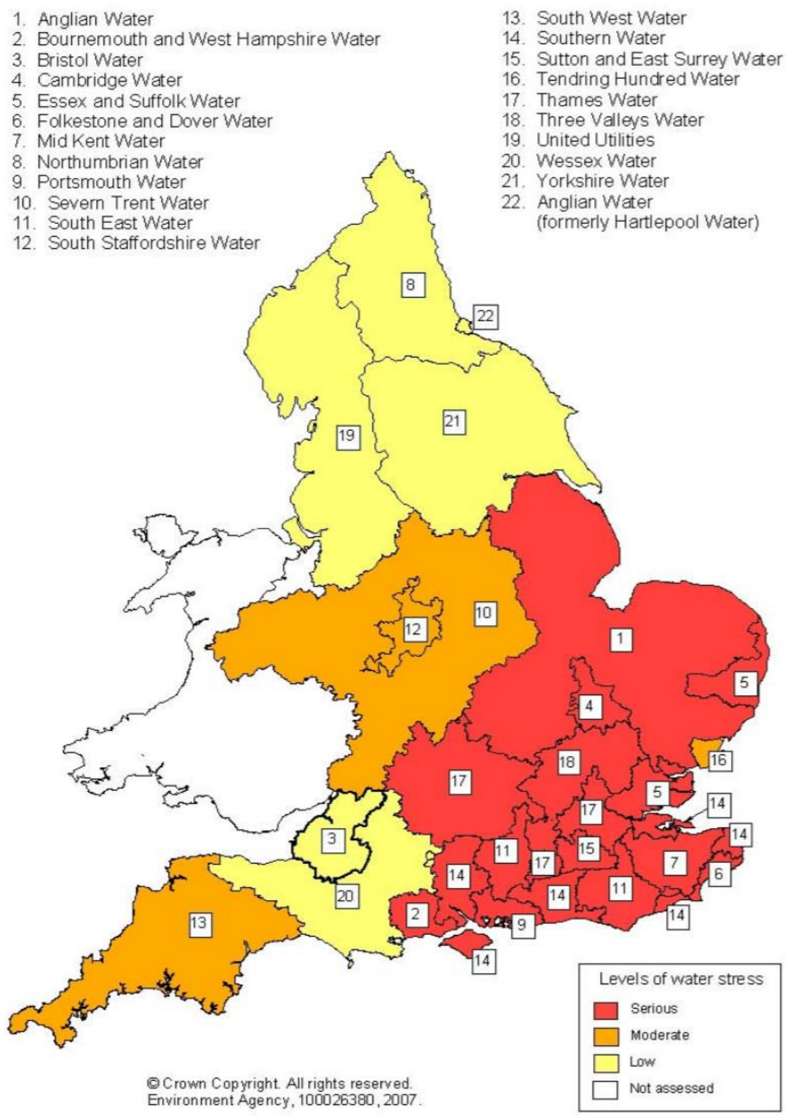
> “It’s not Ofwat’s job to protect water as a resource. It is their job to ensure our ability to supply water, to protect our resources (chuckles)” (L34)

By their resources, the respondent, a former engineer at Thames Water, meant finances and water, hence the chuckle. Understandably, Ofwat featured more prominently in response than the EA, since it was Ofwat that approved water companies’ pricing and their resource management plans, before it was passed on formally to DEFRA for final approval. In practice, Ofwat worked with water companies to ensure that their projects, like desalination for example, are workable financially and that they would be able to recover their expense through reasonable pricing. The EA’s major interactions with the water sector was in licensing abstraction and issuing permits for safe discharge of treated waste, clearly a more traditional regulator’s role. Yet, there was one report prepared by the EA which kept cropping up in discussions about the desalination plant. It was a classification of areas by water stress published in 2007 (see Figure 12), in response to the drought conditions the south east of England had started experiencing from 2004-06 (Marsh 2007).

The EA did not come into existence during the water privatisation of 1989, but rather in 1996, following the Environment Act 1995, passed in the same year that the north of England suffered a particularly severe drought. The EA was meant to replace a number of other institutions and so came with a wide range of functions including that of the National Rivers Authority, pollution control, fisheries regulation, flood defence and some aspects of harbours, navigation and conservancy. While the EA does not replace any executive or engineering functions like the statutory duties of the water companies to provide an essential service, it is tasked broadly with the mandate "to protect or enhance the environment." It was meant to be the agency that helped DEFRA make decisions about responding to drought, flood and other environmental events.

So, when the south east of England faced a dip in rainfall resulting in water shortages from 2004-2006, the EA, on request from DEFRA, prepared a report classifying areas in England by their level of water stress. This report contained a map that colour coded whole river basins according to the level of water stress they were experiencing; ad since adjacent river basins tended to share similar hydrological features, whole regions were coloured in blocks of yellow, orange and red. But, hydrology influenced only the report's estimated water availability; the other major factor it considered was actually household water use which it scored on the basis of volume. Higher the volume of per capita water use, the score contributed towards a higher stress level. Based on a three tier classification of 'low', 'medium' and 'serious', the whole of south east of England was marked 'seriously water stressed' in bright red in the map. This was picked up widely by the media, civil society and public interest groups[22].

[22] "Water metering plans put forward", BBC, 30 Jan 2007, http://news.bbc.co.uk/1/hi/england/6314091.stm




We have not carried out assessments and classifications for Dŵr Cymru / Welsh Water or Dee Valley Water areas because the request from Defra specifically relates only to England. Therefore, these areas appear white on the map.

**Figure 12: Map showing Water Stress Classification in England in year 2007. Source: Environment Agency Water Stress Classification 2007. (LD2, p. 5)**

The Consumer Council for Water (CCWater) responded as below to the to the EA report:

> "We agree that there should be some degree of coordinated water efficiency activity everywhere in England. We believe that this already happens to an

> extent as water companies have *a statutory duty to promote the efficient use of water by their customers*. There is a broad spectrum of water efficiency activities ranging from education programmes which should happen everywhere, to compulsory metering and supporting initiatives for this, *which should only happen in areas where it is more cost-effective* than other approaches to manage to the supply-demand balance." (LD30) (italics added)

The peculiarity of water regulation in England conscripted water users as both 'consumers' or 'customers' to be given a certain level of service, and also environmental subjects obliged to water companies' national duty to control their usage behaviour. CCWater straddles the line between water as a resource that needs to be efficiently used and a commodity that needs to be managed in cost effective ways and attempts to reconcile these two conceptualisations of water through the factor of user interests.

Water companies conceptualise levels of stress entirely through their ability to provide a certain degree of service or alternatively, the need to impose certain use restrictions. In fact, the latest EA National Drought Framework in 2017 (LD27) identifies three types of drought – environmental, agricultural and water supply droughts – of which the last one is rarer because supply systems are designed to deal with environmental adversities. Accordingly, water suppliers are required, by the Water Industry Act 1991, to prepare and maintain Drought Plans, updated every three years. Drought management measures usually span the three categories of (i) Temporary Use Ban (ii) Drought Order (iii) Emergency Drought Order (LD28). The first two categories involve restrictions on non-essential use, popularly known as hosepipe bans. Emergency drought orders have not been issued in the UK since 1976. This is because they involve withdrawing full service through some means and introducing limited supply, like through standpipes. In everyday parlance, this means that if drought effects cannot be mitigated through hosepipe bans, then people will have to be queueing in front of standpipes, a dramatic shift in access levels.

> "The shift is dramatic because our infrastructural doesn't have room for any in-between levels. You can't cut off supply for a few hours per day to

vulnerable populations like old people, hospitals etc. Retrofitting houses with dual piping for drinking and other water will be expensive and infeasible." (L33)

> "Standpipes, we have to admit, are a bogeyman. I mean, we have to use them temporarily when a main bursts or something. But, we wouldn't do it voluntarily as a drought measure." (L34)

So, Thames Water's decision to build a desalination plant was taken in the middle of the drought of 2004-06, with the spectre of standpipes ahead:

> "There was no one eureka moment when we took the decision. We were in the middle of level 2 [of the drought management framework], banning car washing and so on. We could see that if droughts continued into the next year, there would be certain areas without water 24 hours a day. Imagine if that happened in London, the capital city; now, imagine if that happened in the Olympic year!" (L13)

In this situation, Thames Water had four options to choose from. The first one was to build a reservoir in Abingdon in Oxfordshire, something that the company had wanted for a long time. But, it was fiercely opposed by a vocal group of local residents along with environmental groups for all the reasons that large reservoirs and dams are usually opposed for[23]. This group, while opposing a reservoir as environmentally destructive, however, recommend inter-basin water transfers and desalination as sustainable routes for the Thames Valley to take. This is what Thames Water ended up doing in building a reverse osmosis desalination plant on the Tidal Thames, to be used only in times of drought. It could also have built a waste water recycling plant using membrane technology very similar to desalination. The company has built a localised recycling plant in east London, which was used to supply non-potable water for use in the Olympic stadium. It draws its input from the northern outfall sewer, but is localised in that its output doesn't connect back to the networked supply.

[23] The Group Against Reservoir Development (GARD) challenges Thames Waters plans, see: http://www.abingdonreservoir.org.uk/

Thames Water's final option was to undertake massive leakage reduction in its Victorian mains, which it was anyway required to do by statutory and political obligation.

> "We had applied to Ofwat for mains replacement even in the 1990s, but they wouldn't approve the hike in cost and water charges that came with it. So, we applied for a twin track approach – mains replacement leading to a 250 MLD reduction in demand and a desalination plant for 150 MLD increase in supply. They approved this." (L18)

Drought hit England again in 2010-11 with two consecutive dry winters plummeting groundwater and reservoir levels. By then, the city's desalination plant was already fulfilling the company's statutory obligation of drought-preparedness. The drought ended in the summer of 2012 with record rainfall, after which there has not been a drought situation in the city yet (as of 2018). The desalination plant thus has never had to be used except to compensate for the odd abstraction problem from a reservoir or aquifer.

In 2013, the EA updated its method of geographical classification of water stress levels as well as its representation, publishing a new report with a map that looked mostly green (low water stress) with dots of red and orange (LD3). This report was prepared for the purpose of helping make decisions on compulsory metering, but it focused entirely on overall abstraction and its effect on water bodies in the basin. What it, in fact, depicted was the stress on specific water bodies rather than on entire basins or the catchment area of said water bodies. Unsurprisingly, this map did not become a popularly imprinted image.

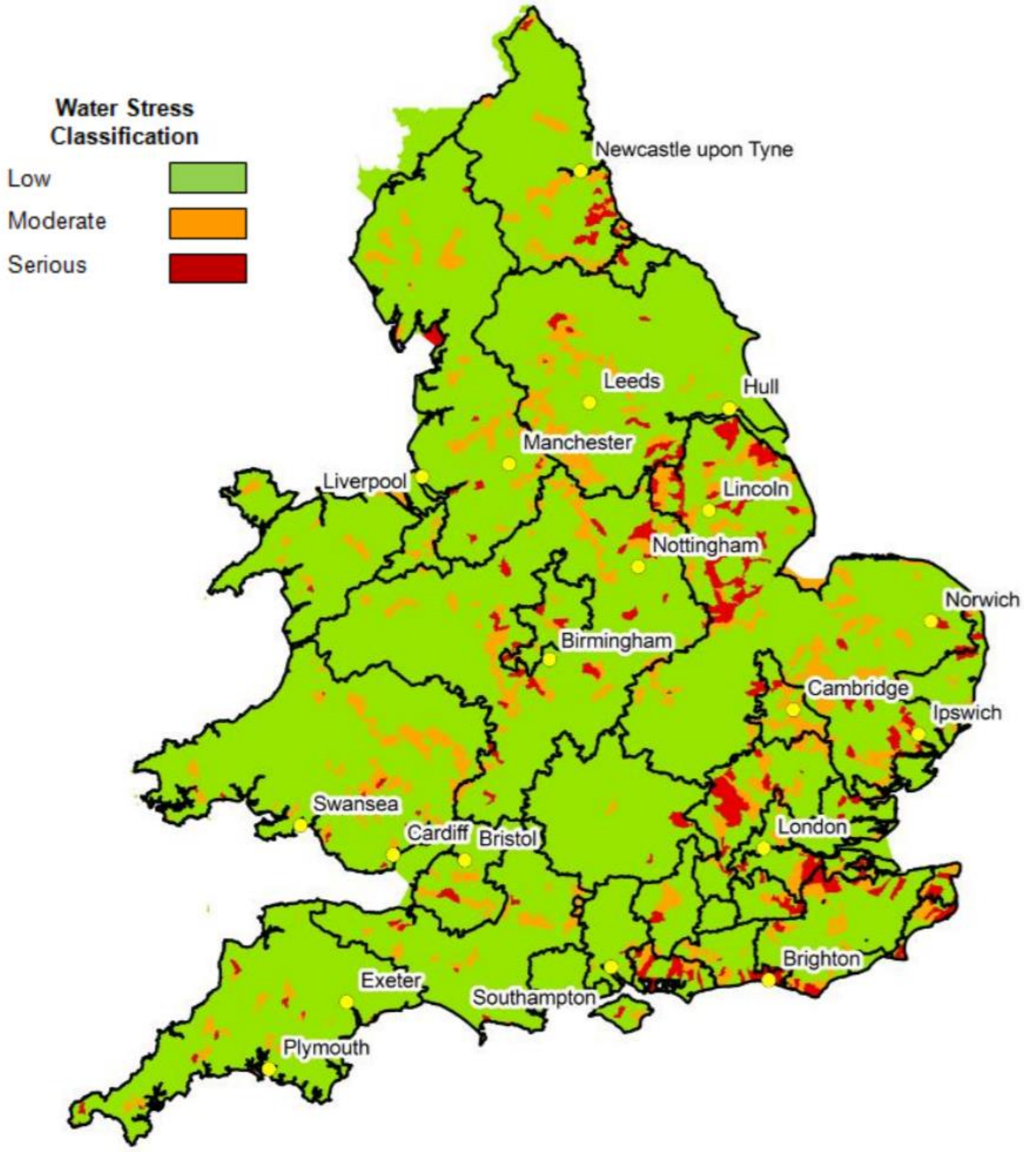



**Figure 13: Map showing Water Stress Classification in England in year 2013. Source: Environment Agency Water Stress Classification 2013 (LD3, p. 8)**

Bakker's analysis of the regulatory framework in the UK recognises that water has not been made legible through neoliberalisation and commodification, and that multiple cultures of water or 'waters' persist:

> "Although neoliberalization attempts to rescript water as an economic good, consumers' meanings and values of water do not easily succumb to messages of economic reductionism." (Bakker 2005: 545)

This is why she calls water an 'uncooperative' commodity (ibid.). But, as the documents and reports above have shown, it isn't only the users who ascribe multiple meanings to water; but the arms of regulatory government and indeed the water industry, juggle around multiple definitions of water in their textual encoding of the environment. The city's infrastructural growth has, in fact, diversified the water multiples leading to different purposes served by waste water, desalinated water, brackish water etc. Thus, the regulatory state in the UK does not attempt to commodify water despite its multiple existence, but through its variable and malleable conceptualisation. It is invested in the 'interpretive flexibility' (Star 2010) of water as that over which there can be 'tacking back and forth' (ibid.) between models of techno-scientific governance. This is what enables institutions and experts on water governance to exercise a form of 'stateness' (Painter 2006) through water infrastructure in London. In the consensus and evidence based politics of 21st century Britain (Giddens 2013), an essential substance like water becomes an ideal 'object of governance' through its boundary-making properties and its simultaneous ability to bring diverse views together in a necessary plan of action even if not in principle.

## 4.5. Conclusion

There was a clear difference in the way this chapter dealt with the political and institutional histories of water in Chennai and London. While the section on Chennai delved considerably into continuity of the political cultures and idioms of authority shaping hydrology in Tamil Nadu over a long time, the London narrative started only after the privatisation of the water sector in 1989 and stuck to the mechanics of governance since then. This is partly a function of my ethnographic methodology which achieved better results in Chennai than in London, yielding conversations of greater length and depth. But, it is also a reflection of the nature of the state and its articulation in the two cities. Even casual conversation or the beginning of interviews usually referred to the history of water projects and their politics in Chennai, whereas in London, there was little said about water before it was privatised. Even the Great Stink and Bazalgette's sewers were reserved for when the city's legacy was explicitly addressed. But, the absence of a visible political culture or its effect on public memory did not make the state absent in London.

This chapter has given a broad outline of how reverse osmosis desalination plants came to be built in two vastly different cities across the global south and north. Building on empirical material from the fieldwork, where almost every interview or conversation referred to the government or a state institution or the national regulation in the context of water supply in general as well as in relation to the desalination plants, the chapter turned to the idea of the state to frame its narrative. Water infrastructure in both cities is built and sustained through a complex interconnection between institutions of government, private companies, individual agents and political parties. It is the constantly shifting and emergent logic of this relationship that is called the 'state' or 'stateness' (Painter 2006). The term 'stateness' goes beyond the functionality of governmental institutions and the reification of their distinction from and control over society to consider how "everyday life is permeated by the social relations of stateness, and vice versa." (ibid.: 752) While this might indeed include political imaginaries and cultures that institutional practices could give rise to, water is a key element through which the state's presence is materially articulated. Water's inevitability and indispensability in everyday life makes it a useful object through which to study the constitution of 'stateness' across varying geographies. This, however, does not mean that there is a universal logic or structure of state power in relation to water. The 'social relations' that are recognised as the state in Chennai and London are distinct and emergent.

Water has always been a vividly political object in the history of Chennai and the Tamil state, which have evolved in a symbiotic trajectory of urbanisation and technological mediation of their social relations. As this chapter demonstrated, these relations have been 'peopled' (Simone 2004) by an elaborate network of authority and distributed agency mobilised over years of Dravidian politics and universal welfare populism. In tracing the succession of events and processes that lead to the construction of the desalination plant, this chapter has argued that the network is, in fact, socio-technical and constitutes the formation of what can be understood as an ‘infrastructural state’. This means that the urban form and its water supply systems enable the materialisation of the state in ‘concrete’ (Meehan 2014) forms in everyday life as well as in the more-than-material infrastructures of intent, agency and authority that characterises Chennai’s institutional set up. The seawater desalination projects are an attempt at gradual movement towards centralised and universal networks, which would presumably involve increasing and changing techno-political mediation, and so present an interesting tapestry on which to study emerging engineering practices and technical knowledges shaping urban environmental subjectivities. This is precisely what the subsequent chapters attempt to do.

In London too, the ‘stateness’ permeated by water supply and management can be termed ‘infrastructural’ but for very different reasons. Here, water acts as a ‘boundary object’ – a thing that inhabits multiple social words and enables working towards consensus across divergent disciplines and viewpoints (Star & Griesemer 1989) – between regulatory agencies, private companies and users, constituting the state through its ability to be governed. Through a review of academic literature and regulatory documentation, this chapter followed the back and forth in conceptualisations of water that have prevailed since it was privatised in 1989. The privatisation was expected to usher in an era of market environmentalism (Bakker 2005) by redefining water from a resource to a commodity that is subject to market pricing. In the final section, this chapter discussed two maps published by the EA, representing drought in very different ways, around the time of construction of the desalination plant. They showed that water’s multiplicity enables regulators and private companies to build a technoscientific mode of governance as well as material infrastructures around it. Since it is this mode of governance that that determines the universalised, centralised water supply to households, it becomes an ‘infrastructure of stateness’.

Susan Leigh Star, in a 2010 article that clarified the concept of boundary objects to sceptics and enthusiasts alike, argues that when the ‘interpretive flexibility’ of the object gets standardised between actors, “then boundary objects begin to move and change into infrastructure, into standards” (Star 2010: 605). While in the case of London, this process is evident in the attempt to model water use and supply using standard frameworks across regions, the reliance on connections and strong, if unstable, networks to achieve water supply in Chennai is instructive of the clear differences in the way the term ‘infrastructure’ is understood and practised in the two cities. Infrastructure does not have to be ‘standard’ in order to perform the functions of enabling and connecting that it is supposed to do. It could instead be a ‘structure of contact’ (Amin & Thrift 2017: 35) that sustains relationalities of power, knowledge and politics. These themes will be examined in the following chapters.

# 5. RELATIONAL INFRASTRUCTURES OF BANAL ENGINEERING

## 5.1. Introduction – the osmotic city

> "In the end, life comes down to electrochemical gradients. But we haven't yet found very effective ways of making what works for the cell work for society: harnessing the energy released by the equalization of solute concentrations." (Ball 2011: 344)

The techno-utopia to which science writer Philip Ball appears to be yearning above, is rendered in philosophical poetry, as if to defy the idea that science is the anti-thesis of culture; the rational logic emerging out of the ashes of the unexplained ways in which people used to deal with water and the natural environment in the past. It imagines a world where the electrochemical gradient that pervades organic life, like plant and animal cells or the meeting point of freshwater and seawater, can be put to use in generating power. This gradient, created by the difference in the molecular make-up of things, is usually navigated through the process of osmosis in nature. For example, when the earth is watered, the difference in the ratio of water to minerals between the soil and the plant's roots enables the absorption of water along with nutrients from the soil to the plant cells. This is osmosis. Similarly, when the river meets the sea, the difference in their salinity means that freshwater mixes into the sea rather than the other way around. The movement is actually effected by an ionic exchange and hence can be used to generate energy as Ball (ibid.) says above.

Technology, nature and culture are often squared off against each other as irreconcilable elements of the city. The nature-culture divide, however, has been bridged in geographical study through the concept of metabolism – of natural resources by circulations of capital, knowledge and power that drive urbanisation. In metabolic urbanisation (Swyngedouw 2006), technology is a tool and those who wield it are agents of capital or other power structures, crafting hybrid techno-natures (see chapter 2 for a detailed review of the literature on urban metabolism). Fantastic possibilities like the one imagined above might be just another techno-fix in this narrative. But, a critical study of the practice of technologically mediated resource access and use in cities throws new light on such imaginations as a hint of the negotiation between the categories of nature and culture that technologies mediate. Metabolism is far from complete or seamless in cities and circulatory technologies and networks have to be constantly made and remade to navigate the complex socio-materialities of everyday urban life. As Gandy (2018) has recently suggested:

> "In this sense the urban becomes a space of multiple possibilities driven not just by the logic of capital but emerging from a series of socioecological, technological, and ideological entanglements." (Gandy 2018: 98)

These entanglements, based on the metaphor of chemical gradients and the ionic exchange between them, can be imagined as 'osmotic'. An analytical shift from metabolism to osmosis in conceptualising the urban enables a nuanced understanding of the contested power relations and negotiated techno-politics that cities have historically engendered. This approach also opens up the sociology of knowledge production in the technological intervention of interest here – reverse osmosis desalination. Interestingly, it is also useful in a socio-ecological framing of leakage, a significant feature of urban water supply systems all over the world that a metabolic approach can only characterise as fracture or disorderliness (Coelho 2006, Giglioli & Swyngedouw 2008). When fresh water mixes and assimilates into saline water through a semi-permeable membrane, it is osmosis. Water passes through the membrane into the saline side because of osmotic pressure, caused by the difference in the concentration between the two liquids. In reverse osmosis (RO), external energy is applied to overcome this pressure, enabling a reversal of flow through the membrane from the saline to the freshwater side, leaving the minerals behind.

Thus, the city can be visualised as a series of semi-permeable membranes gently separating the categories of technology, the engineer, the urban resident, material structures etc. They are categories rather than distinct entities for they refer to overlapping hybrid thinking and practice sometimes inhabited by the same professional or institution. The semi-permeable membranes allow interaction between the categories enabling movement of things, ideas, identities, power relations and knowledge, ultimately reshaping the entities and their relationships. They also restrict certain flows potentially giving rise to or limiting conflict. Any discourse or knowledge emerging from this is not necessarily a convergence of various interests but a practice that seeps through the membranes of conflict and communication. This chapter is interested in the osmotic manner in which engineering knowledge and practice are mutually constituted with urban infrastructures in Chennai and London. It uses RO desalination, a seemingly precise techno-fix, as its point of departure to explore the negotiated nature of engineering, technology and expertise. It begins by detailing what RO is and how the difference between its electrochemical conceptualisation and its material technique can help in the understanding of engineering practice in the two cities. It raises the question of whether there is such a thing as an engineering approach to water supply, and if so, what that means for infrastructural transitions and politics.

So-called quick-fix solutions like desalination are contrasted against continuous maintenance issues like leakage in Chennai as well as London. But, as this chapter will show, RO and leaky pipes occupy a continuum of techno-natural interactions over which shared knowledges and relational infrastructures are established. In order to accommodate the inter-city and global relationalities of these infrastructures, the chapter adopts a thematic structure than deal with each city separately. Section 5.2. delineates how the gradient of agencies and compartmentalised identities exercised by various technical practitioners in water management become relational infrastructure, through shared knowledges and practices. Section 5.3 places the relational networks of water engineering in Chennai alongside those in London to explore hierarchy of knowledge flows globally and how a technology like desalination alters that. It then unpacks how expertise emerges from these multi-scalar interactions. Section 5.4 returns to the urban scale, tracing the global networks back to the city. By discussing leakage, an important issue in urban water systems that water companies are wont to ignore thanks to its technological dullness, the section lays out a spatial politics of engineering expertise in the city. The chapter will then conclude with a discussion on what engineering agency means and how it works with the structural elements of cities.

### 5.1.1. Working with pressure

Chennai and London are two cities that have battled the chemistry of salt and water for a long time. Close to the sea, with estuaries and canals drawing patterns over a range of porous and non-porous soil types, the biophysical make-up of the two contemporary cities encourage play between water and minerals. That they are vast urban agglomerations which have been growing steadily over the past 150 years or so, and more rapidly in the past two decades has only added salt to this petri dish. While Londoners figure out ways to remove limescale from their kettles, Chennaiites scrub their steel pots and buckets clean of salt deposits. Rust and clogging are a problem in pipelines, showers and household appliances thanks to mineral residue. Households have tried out various filtering mechanisms including charcoal and muslin cloth to improve water quality, protect appliances and make better tasting tea. Taps would have mechanical filters in place even before reverse osmosis purifiers and large scale desalination came to be prevalent. So, each of those sites of chemical gradation were also sites of technological mediation and hence, of techno-politics. As Barry (2017a: 13) puts it:

> "the chemical compositions of atmospheres, landscapes and bodies have become critical sites for politics, government, and everyday experience." (Barry 2017a: 13)

Seawater desalination arrives in continuity with this long line of filtration and mediating technologies between water, salt and people. Since technological mediation is inevitable to urban water access, professional water management is necessarily a technological practice, most commonly associated with engineering work.

Osmosis is usually represented by a U-shaped tube (see Figure 14), with a membrane dividing its base, separating the two solutions neatly compartmentalised in the two arms of the U. If the membrane allows solute particles to pass through, then the low concentration solution moves to the high concentration side, carrying dissolved particles with it, as it happens with plants absorbing water and nutrients from the soil. If the solutions are water with different mineral concentrations and the membrane is permeable only to water, blocking solute particles, then, water flows from the freshwater to the saline side until the concentrations of both sides are equalised, achieving system equilibrium.

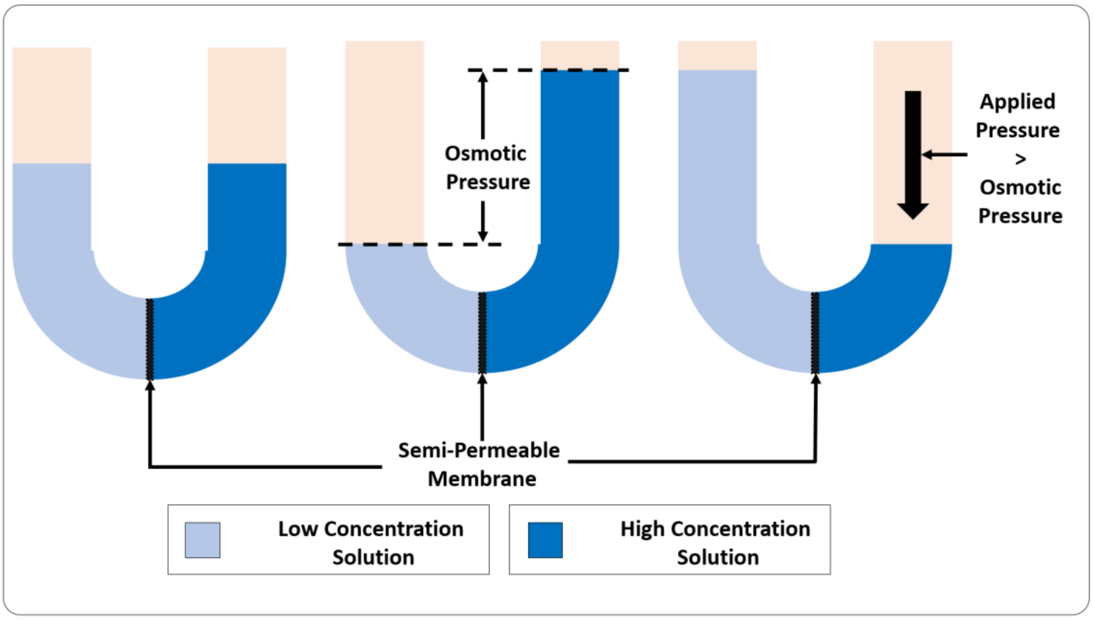



**Figure 14: Osmosis and Reverse Osmosis – an illustration.**
**Source: Developed by author.**

In the illustration, the difference in levels between the two sides represents the 'osmotic pressure'. This is the amount of pressure that needs to be applied on the higher concentration side to stop the flow of water through the semi-permeable membrane. In reverse osmosis, a higher pressure than the osmotic pressure is applied on the saline side to reverse the flow so that water flows from the saline to the fresh side, leaving the mineral salts behind the semi-permeable membrane. Reverse osmosis constantly fights the tendency of the system to move towards equilibrium by applying sufficient pressure on the high concentration side to reverse the pressure dynamic of the system. This is a widely known and understood process in households all over Chennai, where groundwater was pumped from backyards and purified using reverse osmosis purifiers, or simply RO as they have come to be called colloquially.

**Figure 15: Reverse osmosis filters at the Beckton desalination plant, London. Source: Fieldwork photo.**

It, however, was not the engineer's vision of reverse osmosis, as I found out while having to watch a half-hour video tutorial on reverse osmosis at an engineer's home in Chennai. It was quite important to understand that the desalination plant is comprised of a large number of membranes, possibly of varying vintage, he (C13) explained (see Figure 15). This is something critics (C43, C52) point out as a maintenance problem with desalination. The image conveyed by numerous engineers to me is of a roll of fabric, which are the membranes layered around one another in the form of a pipe filtering the highly pressurised saline water sent through them (C28, C40, L35). Since the water pressure exceeds the tendency of this high concentration solution to not flow, what emerges out of the membrane is water shorn of all its mineral content, some of which is responsible for salinity. So, the water obtained is nothing like the fresh water we are used to encountering. The latter is multiple and comprised of a wide spectrum of mineral concentrations and suspended particles. RO water is wiped so clean of any additional material, harmful or otherwise, that it is re-mineralised in order to make it taste close to what we are used to. The efficiency or superiority of a RO plant is thus not about the purity of the water output, but the proportion of water left behind as residue. In Chennai, about 40% of the seawater is left behind to be discharged. In London, since the water drawn is merely brackish and not exactly seawater, nearly 85% of the solution passes through. This outcome of desalination is also socialised at the household level in Chennai in terms of the difference in taste between purified RO water and piped water if available. The residue is often collected in buckets to water gardens or wash automobiles (CE19).

In engineering circles, water obtained from desalination is more accurately understood as a synthesis than as production or manufacture. Although we imagine a volume of water gushing through a membrane leaving behind impurities as in a sieve, the reverse osmosis occurs at a molecular level because of the electrochemical action of ions in the water. The membrane is permeable to these ions and not to the mineral ions. It takes repetitive iterations of the filtration process to achieve a steady stream of potable water, constantly fighting the system's tendency to move to equilibrium. If there wasn't attention given to the system, it would spiral into equilibrium, in a manner of speaking. So for an engineer, to achieve flow, equilibrium needed to be resisted. Maintaining a difference in pressure (Anand 2011) to enable flow was crucial to engineering work and thinking. But, is there such a thing as an engineering approach that is distinct from other approaches and attuned to a particular principle of pressure or precision? As the following sections show, there can be observed a clear set of practices of the water engineer in the two cities, but this is far from being an essential reflection of their orientation towards technological precision. They are, instead, an outcome of their negotiated position between the multiple membranes that compartmentalise their identities as technocrats, residents of particular geographies, political actors, expert professionals etc. Through gradual, repeated iterations of technological and political practice, an accepted framework for water supply is formulated.

### 5.1.2. The myth of the puppet engineer

> "A municipal water service is, like any other service, a relation among actors, a social exchange. Large engineering bureaucracies, however, tend to conceive of and portray their services as structured primarily by natural principles such as gravity, slope and depth, or by the imperatives of science and engineering. Pressure, scale, size and distance are presented as natural 'givens' – universal imperatives, free of history – and are invoked to explain the limits and parameters within which the service must operate." – Karen Coelho (2006: 497)

This academic critique is surprisingly common among bureaucrats and consultants managing water supply in Chennai today. Admonishing engineers for missing the people in their attention to hydrology and hydraulics, they've granted themselves a freer hand in managing water resources on a socio-economic basis. London's water supply is famously privatised and managed by the logic of cost recovery and environmental management. It is governed by a strict regulatory framework, which is what, several water managers asserted, lead to the construction of a desalination plant in Beckton.

In both cases the managerial intervention was deemed necessary because the then model of water supply and sewerage disposal was found to be oblivious to the economic and ecological issues that water flows are implicated in. Ofwat's (LD4) recent review of the water industry in the UK credits early 20$^{th}$ century private investments and regulated localised supply with achieving nearly 100% piped water supply, but follows it up by arguing that this was insufficient to deal with the pollution control and sewerage disposal needs of the 1960s and 70s. Based on the diagnosis from a Central Advisory Committee report on water (LD5), in 1971, that it was the separate and discrete handling of water supply and sewerage disposal by local authorities that was the problem, the Central Government proposed to plan for water on "an integrated river basin basis under a responsive management structure." (p.12) As the Ofwat report surmises:

> "This would allow each river and its tributaries to be regulated and managed to ensure discharges did not pollute water supplies. It would also ensure that abstractions did not put at risk river life and the enjoyment of river users." (LD4, p. 12)

As detailed in the previous chapter, eventually, the integrated water authorities were privatised in 1989, with further emphasis on economic and environmental management, even if there was no explicit rejection of engineering.

In Chennai, the 'engineering approach' was directly held responsible for then problems with water supply. Administrative officers in the Tamil Nadu state government claimed that engineers had, for a long time, focused only on finding ways to draw water from Chennai's hinterlands and failed to make any innovative progress in the city's water network. In line with policy and academic research (see for e.g. Baviskar 2004), administrators stressed the need for decentralised or community oriented water and demand management as opposed to the engineers' supply oriented approach. A retired official was almost apologetic about saying:

> "There are many passionate engineers in Metrowater and the Government, who believe in environmental management. But, by and large, the engineering ethos is to prefer large projects than decentralised or smaller ones as they are easier to manage." (C61)

The engineers, in turn, said that large projects were anything but easy to manage and that they did decentralised work every day. Yet, planning for bulk supply of water especially through one new technology or source was identified as an 'engineering ethos' that needed to be reined in for economic and environmental reasons. The UK water industry, after privatisation, was facing what a report commissioned by its trade union members identified as a private equity problem:

> "We are now down to only four companies, with most of them in the hands of private equity consortia, often foreign owned." (LD6)

That is, only four of the water companies in the UK were UK stock exchange listed companies, with the rest being multinationals or owned by private equities. The largest of them, including Thames Water, were owned by private equities from around the world with little interest in water engineering as a business, let alone as public infrastructure. Yet, the British water engineer continues to hold some authority as an expert and acts as a consultant for various projects around the world. This has been attributed to the uniqueness of the British water privatisation itself as an expertise that can be exported elsewhere (Larner & Laurie 2010). As I will show in this chapter, the sheer myth of historical British water engineering and the colonial networks it drew from sustain its position in global networks now. In fact, engineers in the UK do acknowledge that they are no experts in emerging technologies like reverse osmosis, recycling or even smart meters.

> "London has this legacy infrastructure and the entitlement that there's abundance of water! So, we never developed the kind of innovation or expertise that they did in Australia or Western US, where there are serious droughts." (L33)

However, this has not always been the case, as delving into Thames Water's organisational history shows. The company's interest in water technologies have had to do as much with its global ambition as with the ecology of water and its governance in the UK. Paradoxically, it is precisely because of the relative stagnation of infrastructural change in the UK that its privately owned companies reach outward and attempt to establish their expertise in the global water market.

The private sector in Chennai charges Metrowater with stagnation in its innovations, because its engineers had grown oblivious to cost, pricing and efficiency in water access and supply, with government support and subsidy. In a discussion on sustainability of desalination, one of the plant managers from the private company contracted with maintenance said:

> "Sustainability is in the hands of Metrowater – what the plant costs to set up or operate and what they charge the people are incomparable. How can it be sustainable then? The engineers don't have to learn new things. Whatever they decide to implement, they don't have to worry about costs." (C13)

He was an engineer as well, but like many others in the private water sector, he had spent a few years working in West Asia. His experience in Saudi Arabia, he claimed, informed his practice. He also held the title of consultant as he had taken it upon himself to learn and develop a managerial approach to water engineering. Metrowater engineers, on the other hand, had no reason to learn anything more than their limited supply framework and that stagnates them, he reasoned (C13).

Engineers from Metrowater, however, argued that they were of course keen to develop expertise on technologies and cutting edge tools in water management, but were seldom allowed the space to do so, thanks to the organisation's top-down decision-making. In fact, conversations with Metrowater engineers routinely started with lament against the management and its short-sightedness in terms of skill development and technological advancement within the organisation:

> "We were excited when the desalination project was announced – you know, some of us had worked on advanced filtration technologies before. We were keen on some ideas for pre-filtration treatment and had also started learning about bioreactors. But, I think someone must have told the MD [Managing Director] that ultrafiltration is the best. It sounds the best as well right calling itself 'ultra'. So, they just stuck to it and ended up finding the best contract for it basically." (C14)

A retired engineer who had hoped to be promoted into the management cadre said:

> "How does it make sense to make a civil servant the head of Metrowater? Their qualifications might be in arts or sciences. How are they to understand water engineering and appreciate our work?" (C12)

Karen Coelho (2010) attributes the restricted role of engineers to Metrowater's very origins as an autonomous institution constituted from the water supply and drainage functions of the municipal government in 1978. The newly set up authority was meant to be empowered to set tariffs, contract projects, access funding and take financial or project decisions without the partisan influence of local or state government. As demonstrated in the previous chapter, this is hardly the case. In terms of hierarchy as well as practice, Metrowater is answerable to the Tamil Nadu State Government. But, what the organisation ultimately answers to is a neoliberal rationality, Coelho (2010) argues, taking gradual, incremental steps, with the help of international agencies and consultancies. One of those rationalities was the increase in financial and managerial control over engineering functions and decision-making. There was inevitably downsizing of staff and freeze in hiring at various times through the 1990s. Even when engineers within Metrowater agreed that the reforms were necessary, Coelho concludes that it can only be because "…the rationales of reform had been so successfully internalized within Metrowater…" (ibid.: 6)

The understanding that these accounts offer of water engineering as a job in Metrowater and as an 'ethos' strips it of any agency except that of a machinic commitment to techno-solutionism. What kind of agencies do engineers, then, employ to work within this organisation that has apparently devalued them and a critical environment that sees them as puppets in the hands of a global, faceless ideology of neoliberalism? How does the management deal with an obviously disgruntled set of employees and what does this engineering-management divide mean for the sustainability of water systems? I expected to explore these questions in the annual meet up of the Society of Public Health and Environmental Engineers (SoPHEE) in Chennai on World Water Day. Engineers employed in Metrowater had founded SoPHEE as a professional organisation that also doubled as a social network.

The group, its members admit, is not very active. They do meet at least annually for World Water Day which falls on the 22nd of March and would I care to join them, they asked. And so, I turned up at a meeting venue opposite the iconic Spencer Plaza on Anna Salai for a gathering of engineers and their families. In a workplace culture that doesn't involve Friday evening drinks at the pub and allows days off mainly or only for child or elderly care, the World Water Day event was the office Xmas party of sorts. The event was catered by a not-for-profit called Poovulagin Nanbaral (Friends of the Earth), that describes itself as a 'people's welfare organisation' advocating a constructive scientific approach towards environmental, conservation and development issues[24]. One of their popular campaigns has been for the promotion of millets as a sustainable alternative to rice in Tamil Nadu, as they are said to be a less water-intensive crop. The food at the event eschewed rice in favour of millets and was delicious (CE21).

## 5.2. Compartmentalised professional identities

At the world water day event in Chennai (CE14), I learnt two important things about being an engineer in Metrowater: 1. Navigating complex and often apparently contradictory approaches to socio-natures becomes second nature when you straddle the job of supplying water to a rapidly growing city with general engagement in global environmental discourses. What appears contradictory, though, might also be thought of as an ontologically grounded and negotiated understanding of the techno-scientific abstraction of sustainability. 2. Engineers were not simply another component of Metrowater's leafy cool offices, along with the piles of papers, stacks of files and wooden cubicles. Meeting them outside their office where discussion often turned to millets, agriculture and water policy reminded me of the osmotic membranes which compartmentalised their identities, politics and profession, if often unsuccessfully or at the most, provisionally.

It was the year that Dr Rajendra Singh, winner of the Magsaysay Award for his work in reviving Rajasthan's tank and canal based water harvesting system and popularly

[24] See their website for details: http://www.poovulagu.org/

known as the ‘waterman of India’, won the Stockholm Water Prize. Much of the discussion in the event revolved around whether Metrowater engineers, collectively, can achieve a similar feat, thus preparing the city better for droughts and floods (CE21). However, as the guest lecturer, a development scientist, talked from the podium about Chennai’s tanks and canals, the engineer (C27) sitting next to me, whispered:

> “This is all very well. But, what about the continuous work we do on an everyday basis? We’ve reduced leakage from 25% to 7% in the past 5 years. Just because that doesn’t seem to generate exciting news…” (C27)

He was referring to Metrowater’s concerted leakage reduction project, which was much suspect thanks to imprecise data. In an odd similarity with its counterpart in London, Chennai’s water network is not metered and residents pay the water authority not for their use but for the value of their property, provided it actually has a Metrowater connection. This means that any calculation of leakage is based on extrapolation from a small measured area and may not reflect the network in all its complexity across the city (C7). Leakage in the networked pipes, interestingly, had not come up as a major politicised issue in Chennai, in the context of desalination or otherwise, unlike in London, where it repeatedly rears its head.

Metrowater had nevertheless decided to address the issue, however imperfectly. This has to do with the nature of Metrowater’s expertise and how that’s spatialised in Chennai. Leakage is a subject ridden with class and race connotations around the world as we’ll see. But, officially, Metrowater and Thames Water reckoned with it in ways that were reflective of the urban politics they were embedded in. So, naturally, when asked to further elaborate on the leakage reduction project, the aforementioned engineer replied sagely:

> “Giving information begets more questions and trouble only. The city residents know we are doing good work, and that’s all matters.” (C27)

It was later explained to me by a college professor who was married to a Metrowater engineer:

> "You have to understand that many of these men are frustrated but still take pride in their job. They have Masters and MPhil degrees and moonlight as consultants sometimes. It's not easy for them to talk about their work in an interesting way and acknowledge how much it means to them." (C28)

It was typical feminine emotional labour that she was doing in understanding and explaining this to me, especially given that most of Metrowater's project and area engineers were men. But, she had a point about their relationship to work not being straightforwardly technical. The engineers were the ones who, during the course of the leakage reduction project, did the work of supervising digs in busy intersections and convincing resident welfare associations that stopping their supply for a few days was for a good cause. Several of them, with a wink or a roll of their eyes, recounted their experience with residents walking up to them on the road and questioning them on the benefits of digging up the pipes. It was narrated in barely concealed pride, though, something like a humble-brag; for it would almost always be followed by an appreciation for how much the lay-resident took interest in water supply and how their work was appreciated by people even when they outwardly grumbled the temporary inconvenience. An Operations & Maintenance engineer at the SoPHEE event was confident that:

> "They know that we're doing essential work when we dig up the roads. The complaining, in most situations, is a pretext to knowing more about the ongoing project." (C27)

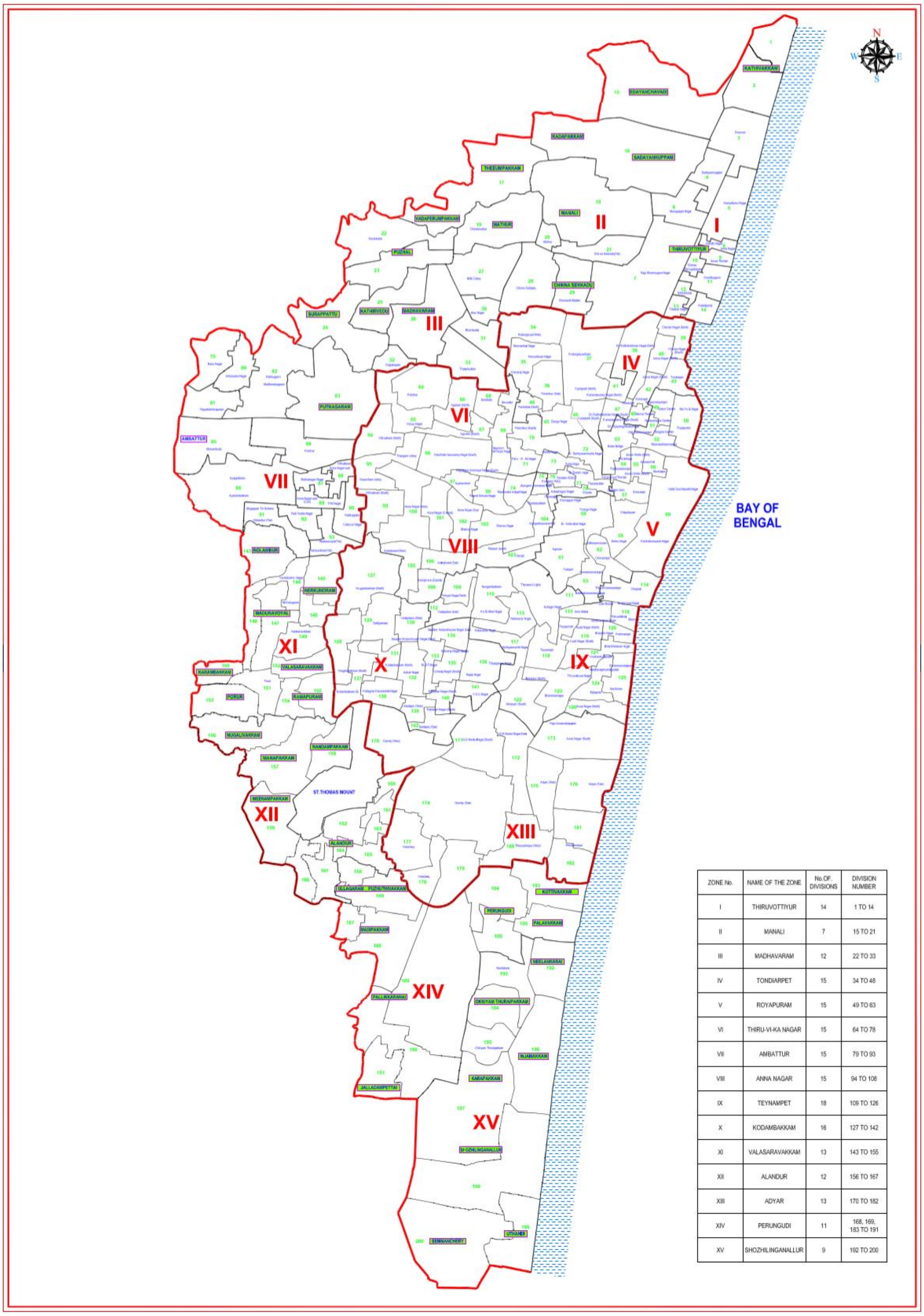
The leakage reduction figures that came out of this work was, for them, a vindication of this boring unheroic work. An engineer, who is supposed to be calculative in work and assessment, here, is only all too human in professing statistics that he knows to be unreliable because he has an affective, embodied relationship with the labour those numbers quantify. Gathered on world water day to plan for sustainable ways of managing water, which included criticism of the status quo and the institutional approach, Metrowater's engineers still owed allegiance to the everyday work they did for the institution. This wasn't quite as stark a contradiction though. What they were valourising was, in fact, affective, shared knowledges of a similar kind to that employed by Rajendra Singh to build communal water systems in Rajasthan.

### 5.2.1. Affective labour of distribution

The concept of affective labour is usually studied in the context of post-modern service-oriented work or feminist orientation towards the anti-capitalist potential of work (Dowling et al 2007). Hardt (1999) called them 'immaterial labour' to refer to their decoupling from use value and Fordist forms of production. It's not often that an engineer working for the urban water utility is said to perform affective labour. However, consider Metrowater's 15 area engineers (CE5), who are in charge of distribution from neighbourhood pumping stations to households (see Figure 16). They constitute the city's area-wise distribution scheme. Along with the city-wide operations & maintenance engineers, they act as conduit between the institution, its purifying and pumping units and the water users. They have the closest numbers on how much water actually reaches a household as they monitor a small area. "But, they under-report the household level supply figures," chuckled a Project Engineer (C14) who used to be posted on distribution. He repeated to make sure I heard right. They 'under-report' supply figures, not pad them up.

> "Their bosses sitting at the Metrowater HQ want them to reduce supply on a daily basis in order to make the reservoir storage last longer. But, that's not how things work at the ground level. You need to take into account local needs & pressures, hydraulics in the local area etc." (C14)

The area engineer here negotiates three potentially conflicting commitments. His institutional superior expects him to help him rationalise water resources by cutting down on his allotted supply. His professional obligation is to 'supply water on time, adequately and without loss' (C15) – a broad goal which nevertheless doesn't include efficient resource management.




| ZONE No. | NAME OF THE ZONE | No.OF. DIVISIONS | DIVISION NUMBER |
|---|---|---|---|
| I | THIRUVOTTIYUR | 14 | 1 TO 14 |
| II | MANALI | 7 | 15 TO 21 |
| III | MADHAVARAM | 12 | 22 TO 33 |
| IV | TONDIARPET | 15 | 34 TO 48 |
| V | ROYAPURAM | 15 | 49 TO 63 |
| VI | THIRU-VI-KA NAGAR | 15 | 64 TO 78 |
| VII | AMBATTUR | 15 | 79 TO 93 |
| VIII | ANNA NAGAR | 15 | 94 TO 108 |
| IX | TEYNAMPET | 18 | 109 TO 126 |
| X | KODAMBAKKAM | 16 | 127 TO 142 |
| XI | VALASARAVAKKAM | 13 | 143 TO 155 |
| XII | ALANDUR | 12 | 156 TO 167 |
| XIII | ADYAR | 13 | 170 TO 182 |
| XIV | PERUNGUDI | 11 | 168, 169, 183 TO 191 |
| XV | SHOZHILINGANALLUR | 9 | 192 TO 200 |

**Figure 16: Chennai Metrowater area wise engineering network.**
**Source: Metrowater website. chennaimetrowater.tn.nic.in**

Finally, he is Metrowater's interface with the households they supply to in that neighbourhood. These households could contact him when they're dissatisfied with their water supply and question him why they haven't received enough water. It is not strictly his job to answer them. But, persistent calls on his phone or pressure from the local representative could make his job harder. An area engineer seemed surprised by the suggestion that he could decline those requests as being outside his job description:

> "How can we not answer their calls? They will, of course, question us, if they get shoddy service, no?" (C82)

If affective labour is about producing value that is not necessarily materialistic, but instead a shared community or network, then the work performed by Metrowater engineers at the neighbourhood level is indeed affective. The community produced is not a complete thing, but what Simone (2014: 18) calls infrastructures of relationality where "relationships themselves constitute an infrastructure for inhabitation". Such relationships, he argues, are not merely social exchange but material carriers of circulation and "tools through which political imaginations and claims are exerted." (ibid.) The area engineers' motivation for prioritising supply over resource management or answering residents' complaints may not be external, but pertaining to the political claim he makes in the network.

Networks are often considered a classic case of depoliticised 'third way' government; a techno-fix in itself to gloss over political divisions. They blur the lines between state and market, modelling a non-ideological form of government. But, as Barry (2001) points out, they can also be a challenge to centralised bureaucratic forms of power, and along with 'community' empower anarchist politics. In other words, "it would be a mistake to view the network as the symbol of a particular political project." (p.85) In Chennai, they emerge as a socio-technical response to a situation with no centralised structure as starting point. They were pragmatic technologies of household water access that didn't fit into a neat binary of traditional and modern systems; or ally with ideologically puritan stances of environmentalism versus technological progress.

Metrowater's area engineers are 'institutional big men' (see chapter 4) to the extent that they are able to adjust pipes, pressure and gravity to benefit favourable residents or ensure universal supply, including those who may not have paid their bills or have fulfilled all requirements to be able to get a connection. The area is their 'constituency' (Mines & Gourishankar 1990) even though they are neither elected nor publicly accountable in any procedural manner. They work with counterparts from the Chennai Corporation, the city government which is divided into zones and then further into wards (CE5). Each ward has an elected councillor and engineers appointed to manage public works, like roads and stormwater drains. The stormwater drains are built only to catch rainwater and drain them off, and should not be mixed up with sewerage pipes, which are managed by Metrowater. There are also zone level engineers in the Corporation. As with the interconnected mesh of stormwater drains, sewerage and supply pipes, and roads, the engineers at different ranks in Metrowater and the city Corporation have plenty of reason to cross paths and work together.

In the Corporation's case, it is the elected ward councillor who takes complaints, requests and pressure from residents. They may even approach him for issues with water supply or sewerage – Metrowater's functions. The Corporation's ward engineers largely defer to the councillor in politically sensitive matters like water supply. Paradoxically, it is precisely because Metrowater is an unelected institution, it is embodied by its engineers posted all over the city. There are freelance plumbers and technicians who are often called in to fix local or household level water problems, including by Metrowater. But, they are dismissed as too uninterested in the network to be worthy of engagement. A south Chennai resident who was active in civic and resident welfare associations had this to say about the plumbers she often called in, mainly to work on household fittings and filtration systems:

> "They'll attend to things if you tell them. The onus is on you. They don't care. They are not really conscious that theirs is an important job. They are just plumbers like they are just electricians" (C5)

The Metrowater engineer, here, is a figure respected for his skilful handling of the essential service of supplying water. He is the face of Metrowater in that area. The public utility's area-wise engineering network is as much an infrastructure as its pipes and flows. A parallel exchange with engineering consultants in London illustrated such a relational infrastructure in blunter fashion.

### 5.2.2. London's history as legacy

Nearly a year after the World Water Day event in Chennai, I managed to get invited to a paid UK Trade & Investment workshop on global investment opportunities for British water companies, held before the World Water Tech Investment Summit. The summit was intended to be a showcase for water companies and technologies from around the world, a Great Exhibition of sorts for the water industry. The special workshop for British water companies involved managers from urban water utilities around the world pitching their city or state as opportunity for investment. There were representatives from Singapore, UAE, India, Saudi Arabia, Philippines and Brazil; most of them apologetic that their respective states insisted on retaining some kind of control over water management, unwilling to trust private consultants and international experts completely (LE1). Still, a member of the UK delegation asked (L39), did they not give water away at throwaway prices? How could they be reliable customers for British water consultants and technologies if they didn't charge for the water they supplied?

This was followed by the presentations from Russia, France, Turkey and USA on how British companies have successfully made their name in those markets. Despite the clear imbalance in how the national affiliation of the water professionals in the room affected their sense of expertise about water management, there were transactions happening throughout the room positioning them in global networks of relational infrastructure. Cleaning up of rivers and wastewater recycling was a running theme. Given that the representatives came from the ends of the world (Brazil & Philippnes, for eg.), this was a remarkably co-incidental concern (LE1). Chennai, too, was seeking Korean and German expertise on how to clean up its infamously stinking river Cooum on a Rs. 600 crore (6 Billion) project (CD1). But, in the months preceding this trade event, there had been elections in Tamil Nadu and a change in government, which meant the heads of important government institutions were all changed. The new Metrowater head did not have enough time to apply for a visa and make it to London.

There was a representative from Delhi, who just shrugged about the coming together of river clean-up and recycling issues in the room:

> "I mean, the problem with our rivers is more complicated. But, wastewater recycling is what we can get help for here, no?" (L27)

In other words, the room was filled with professionals eager to offer deals for that particular water problem, and so that became her agency. Wearing a saree in a sea of suits, she was also positioning herself in this network of mostly male water managers, through specific material devices. However, a group of British engineering consultants had a different pitch for her – instead of approaching foreign firms only for their technological solutions, wouldn't Delhi and north India be served better by employing foreign expertise towards diagnosing the problem in the first place? It turned out that one of the consultants had already worked on a North Indian project and in his opinion, the problem was groundwater depletion and the expertise he held was in diagnosing these problems. Out of the Delhi official's earshot, he exclaimed:

> "It's crazy. They have no idea what they are doing. It is the perfect opportunity. We only have to tell them what they don't want to hear." (L28)

His colleague, worried about this candour, later explained:

> "What he means is because we have been through the journey and have a history of experience here, we are able to see the problem right away and point it out." (L29)

Whether it was the saree or the history of the UK's or mostly London's messily developed water system, these intangible affiliations became a stand-in for agency in a globalised water industry attempting to tackle incredibly complex and socio-ecologically specific water problems. Expertise was not about specific technologies or projects executed by said engineer, but only having been part of a national or a global city narrative of infrastructural achievement. For example, at a workshop on planning for infrastructure in cities, a researcher from one of UK's largest engineering consultancies divided the world neatly into regions of infrastructural legacy and deficit.

> "If you take India or Africa, there is deficit; and here we have a tremendous legacy. Now, this legacy gives us the strength and experience to plan for robust infrastructures in those deficit regions. At the same time, we need to be thinking about resilience and future-proofing of our infrastructure here." (L15)

It is in these discussions that words like 'robust' and 'resilient' or 'sustainable' became useful to engineers and planners, to categorise infrastructures and determine the direction of mobility for knowledge and agency. Once London's water system has been accepted as 'robust' and a 'legacy', that can then be mobilised towards building global relational infrastructures. It was this legacy that a senior official in the Government Office for Science was drawing on when he said, on a different occasion:

> "Arguably, our greatest achievement has been the separation of the water we drink from the water we excrete. Our roads are still Roman and our sewers Victorian." (L7)

He was referring to the discovery of bacteriology and the construction of sewers to prevent water-borne diseases in London 150 years ago, to establish the importance of science in British city-building. Another consultant who used to work in Thames Water linked contemporary water issues to the construction of the sewers in the 19th century:

> "We've come from the Great Stink to the Great Think; we make technological strides by thinking about resilience, future cities." (L34)

He pointed to a picture of the Thames Barrier on a magazine near him. This rhetoric worked because of where London's engineers were situated in their global network comprising several of Britain's former colonies. It's the Eurocentrism that allowed Peter Ackroyd (2008: 3) to introduce the Thames as the 'shortest river in the world to acquire such a famous history'. Despite the Amazon, the Mississippi and the Yangtze being nearly 20 times larger, "none of them has arrested the attention of the world in the manner of the Thames," he (ibid.) says. He may have a point there, though. What the Thames lacked in size, it made up for in the colonial imagination it evoked (Picon 2018). The Chennai Corporation, in its Cooum renewal project, emphasized that it takes its inspiration from the Thames. Historical accounts of the Cooum in popular culture point out that the river used to be the Thames of Madras.[25]Some of my interviewees in Chennai promised me that I would come back one day to see the Cooum transformed like the Thames I see in London. This axis, however, has shifted, albeit only slightly with recent technologies like desalination and recycling.

## 5.3. Sharing knowledges over the water network

Metrowater's expertise has, over the years, been steadily established primarily in distribution. When the city corporation was in-charge of water supply, it focused on drawing water from major reservoirs around Chennai and conveying it to homes through pipes or lorries. The creation of Metrowater in 1978 coincided with political interest in new sources of water like the Krishna river to the city's north in the then state of Andhra Pradesh; and revival of the Veeranam project – to pipe water from the Chola-era Veeranam lake to the south of the city (see chapter 4). These were still questions of distribution rather than technological innovation. Around the early 1990s, when the city was looking to experiment with technologies like thermal desalination, Metrowater instituted a hiring freeze and began contracting out most

[25] K. Lakshmi. "What's in a name?" *The Hindu*. 18 Aug 2015. https://www.ndtv.com/india-news/will-the-cooum-river-be-chennais-thames-407041
Sam Daniel. "Will the Cooum river be Chennai's Thames?" *NDTV*. 17 Dec 2009 http://www.thehindu.com/news/cities/chennai/cooums-name-and-origin/article7552957.ece

of its projects (C5, C61), in line with the emerging logic of corporatisation in public institutions. So, the core competency or the role of Metrowater's in-house engineers continued to be in distribution. In the same period, the city grew rapidly and spouted infrastructure almost organically.

Several neighbourhoods in Chennai, as in other Indian cities, grew before they became part of the city. That is, they would develop into a settlement of neatly laid out houses and roads, but falling under the governance of a village Panchayat outside the limits of Chennai city or Corporation zones. There would be an administrative process to get them included in the city limits and then they become eligible for urban public services like water and sewerage. Before they reach that stage, its residents, often the homeowners, would facilitate their own water access or mobility using private contractors. They would rely on borewells to directly pump groundwater, and roads can be built by private companies who, then, sell them off to the Corporation. A transmission engineer who narrated his experience with this process, however, informed me:

> "The roads have to be public for us to be under obligation to supply water. If the developer doesn't want to transfer ownership, then we can refuse water supply." (C15)

In this way, residents become familiar with the topography of the region and its material connection to urban services like water supply or electricity. They also get in touch with utilities like Metrowater at this stage, partly because they are unaware of the procedure and the difference in the roles of the Corporation and Metrowater. Only the city Corporation can approve inclusion of a residential layout within city limits whereas Metrowater can only provide supply and sewerage services to those they are officially required and approved to do (CD19). But, the contacts established during this phase can lead to informal knowledge networks, where residents come to learn of the bureaucratic process and Metrowater officials come to know more about the neighbourhood. The above engineer softened from his blunt stance on obligation to provide water:

> “We walk them through the process of applying for connection. They are also middle class, no? They would have saved up from their monthly salary and bought the house or land on mortgage. On top of that, they now find out that they have to arrange for basic services too.” (C15)

Apart from identifying with their own class, it should be kept in mind that Metrowater’s engineers can exercise their skill and knowledge only on houses and areas that are officially in the network. They might be able to supply a house that does not comply with sewerage or rainwater harvesting regulations, but it will still have to fall within their urban jurisdiction. They are institutional big men (see chapter 4) only as far as their map allows them. In the case of unauthorised settlements even within city limits, Metrowater’s role is diminished to assuring water access through trucks. Although this role included socio-political negotiation, supplying water through trucks held no hidden mystery of underground pipes, gravity and connecting heads. It isn’t even that those are unknown mysteries that only a water engineer is expected to be able to deal with. In fact, several residents had a clear idea of the water network, the type of pipes and connectors used and the hydraulics of water supply in the neighbourhood. It is a body of knowledge in which the engineer is interested and invested; and this makes him a partner in urban development for suburban residents.

The resident of an affluent south Chennai apartment complex had this to say about his constant tussle with the local engineer:

> Earlier it used to be a standard pipeline of ¼ inch for all apartments and houses. Now, they have different dimensions for different building sizes. As our building has 43 apartments, we get the maximum dimension pipe. Problem is, it’s connected to the main through a head, in order to ensure that all the water doesn’t flow off to an early diversion, depriving tail-enders. That is, water bubbles up into the head before going into the connecting pipes, thus buffering flow uniformly in all directions. The bigger the dimension of this head, more pressure is required for water to raise and flow. So, apartment buildings with bigger pipes are at a disadvantage. (C59)

He was glad that the local Area engineer understood this problem even if he did not have the power to change this fundamental structure of Metrowater's network. His building was also the first one in a seaward going road, he explained. Such roads often hid sand dunes under them. Despite their flat appearance, the water pipelines underneath might be traversing upward, pushing water against gravity. So, the use of buffer heads is justified, but useless without adequate pressure. Note the step-by-step reasoning he adopted to put forth his complaint focusing on the structure of supply system, the composition and dimensions of its pipelines and the mechanics of flow through them. He had detailed and intricate knowledge of the water system in his neighbourhood, including its hydrology, pipes and how they have changed over the years. He used the right terminology for pipe components and knew their dimensions well.

The Metrowater engineer's expertise lay in distribution too, and not in new technologies like desalination which were planned and executed by external contractors, a sore point for some of the younger engineers in the public utility's service. He was not in possession of any advanced techno-scientific knowledge that was beyond the grasp of the informed citizen. As Barry (2001: 3) argues, "The citizen of a technological society expects and is expected to be informed and updated." The citizen's respect for the water engineer, then, stemmed from a shared inhabitation of this technological society. That the Metrowater engineer could be reliably expected to have knowledge of the techno-material city that this suburban resident knew is what sealed their relationship.

The resident mentioned above, for instance, wasn't impressed with the Corporation's role in infrastructure building and urban governance:

> "We should be liaising with the ward councillor – he is our representative in urban matters, after all. But, his vote bank is only in the slum settlements and so he's not interested in our problems." (C59)

The knowledge network that the middle class resident and the Metrowater engineer shared could engender a relational infrastructure in the same way that the

Corporation Councillor remained accountable and interested in the slum dweller through electoral politics. Thus, the relational infrastructures among engineers and urban residents is its own political claim. These claims were sometimes made at the global scale, as we saw in the trade event in London. At both scales, these established patterns were, however, getting reshaped by claims made from the private sector and parallel networks of knowledge and expertise.

### 5.3.1. Where expertise comes from

Several engineers in the private water sector in Chennai today trace their professional learning and expertise to having worked in West Asia where desalination and membrane technologies are used extensively. Accordingly, membrane technologies and purification come next only to borewells and pumps in the services provided by private firms in the water sector in Chennai. Signing in to visit one of the desalination plants, the visitor log listed a long line of addresses from UAE, Kuwait, Bahrain and the occasional one from Singapore or USA. Scholars, engineers and residents inevitably referred to the Middle East when advocating or criticising desalination in Chennai. It was an inter-Asian connection of sorts. A senior engineer who was now a consultant explained:

> "The way it works there is that the engineering firms produce water, and then they get to sell it to customers. So, engineers have a free rein on designing water systems, which is how we learn so much." (C26)

The act of going to West Asia to work in water engineering is also framed as a conscious effort on the part of the engineer to become an expert:

> "Metrowater engineers can just do what their bosses tell them to do and get by. I, on the other hand, have to continuously keep updating my knowledge in order to stay competitive in the market." (C13)

This, he reasoned, was why he was a chief technology officer and his colleagues in the public sector were still engineers, clearly a title signifying no growth for him. Even at junior levels, experience in West Asia or Singapore can make the difference between working as a contractor (C21) – someone who oversees projects including labour and logistics - and as a full time engineer (C33) for a private company – someone who is given a secure job and benefits for working on specific machinery.

European expertise does come into the picture in Chennai sometimes, for example like the UK company Severn Trent providing training in water quality maintenance. Yet, Metrowater engineers, contrary to their private sector counterparts returned from West Asia, have not become experts from this water quality training, but clients for Severn Trent. One of the top water managers in the private sector (C75), similarly, did not like to talk about his experience of having worked in South West Water in Exeter, for he thought he did not learn much from the experience that he could use 'back home'. He had famously bought a German water engineering company that its parent owners thought wouldn't work in India, a market unwilling to pay for water and so, offering very little returns. But, he knew better. Rather, he knew that the answer was not to get the users to pay for water, but provide the service to the government which could make room in its budget, with sufficient political obligation, for expensive water projects. He suggested that I turn my attention to the global south where such exciting innovation was happening in the water industry (C75).

The movement of knowledge, practices and expertise between the south-south and north-south or south-north presented different and parallel mobilities; but in all these cases, the expertise transferred was that of water management techniques that involved navigating local regulation or politics among other socio-material things rather than singular technological prowess. If in the north, this involved the most efficient technique of compliance with standards and regulations, in the south, the adroit execution of public-private partnerships or balancing the imperatives of politics and business constituted expertise to be shared.

Chennai Metrowater, for example, has been receiving visitors from states in the global North contemplating desalination, sharing with them their experience in executing two projects in the city. The Detailed Project Report (DPR) for the desalination plant, prepared by an external consultant, was a valuable document according to several of Metrowater's desalination project engineers.

> "It is a proprietary document, you know. We have obtained that after investing many millions. We are obviously not going to share it with states that intend to construct a similar project, even if we are not engaged in direct consultancy. But, that we have this report is what attests to our ability to plan and execute a project of this nature." (C37)

It did not seem to matter that the plants were planned, designed, constructed, and now, run and maintained by external private companies. It was still a desalination plant in Chennai, overseen by Metrowater. Nevertheless Chennai was also a node in this network where global water companies, from Europe or Asia, showcased their capability to execute a desalination project to their potentially bigger investors from the global North. As an executive engineer at Metrowater in charge of one of the desalination plants said:

> "When we are not receiving foreign delegations at the plant, our private company partners are. We prefer to be present at these visits so the city's image is maintained. But, those guests are mostly interested in employing the private company for a project back in their cities." (C49)

Metrowater, at the moment, does not engage in external consultancies and has no explicit monetary gain in sharing its expertise on project management. But, it is invested in developing an 'image' for the city is inhabits, whose legacy as we saw above can itself be a valuable asset in global networks of technological and expert mobilities.

### 5.3.2. The ebb & flow of research in the Thames Valley

The London desalination project would have ideally been a flagship project for Thames Water's expertise, according to former senior staff in the company (L1, L34). They entered the company in the late 1970s and early 1980s, when water supply stopped being the local council's responsibility, and was organised into river basins, each managed by a single authority (see chapter 4 for details). It was revolutionary for young scientists hired at the time to be tasked with researching how Britain's water resources could be managed in a scientific and holistic way, one of them (L34) impressed upon me.

> "It was exciting to be in charge of this resource that was of national interest, you know? It was the first time that water was thought of as something that needed to be approached in this holistic and what we might today call interdisciplinary way." (L34)

But, everyday work wasn't all breakthrough and innovation, as they found out:

> "We would do plenty of studies on reservoirs and new pipelines, but we could only commit to projects that the government had agreed to fund through its borrowing. Additionally, we were overseen by public institutions with elected members, so things were slow to get approved and processed. I think, during the time, we did a good job connecting everything together, improving things, making them more efficient. But, we didn't launch big projects." (L1)

When all water authorities were completely privatised in 1989, in theory, research continued as before. But, the means of funding had changed and that affected the research agenda, flipping the above situation, with risky or innovative singular projects, whose cost could be recovered through pricing, getting rewarded while works on the existing network that didn't add something new to the system took a backseat.

> "When Thames Water spends on technology to build something new, it can make a case to Ofwat that it has put in capital expenditure on the project and so needs an increase in its tariffs. A maintenance project, on the other hand, only incurs operational expenditure and doesn't add to its pricing calculation." (L15)

This meant that research teams could develop their own projects as long as those projects would create an asset for the company or contribute to its revenue.

> "As Research & Development manager, I had 20 staff and £ 2-3 million budget one year, and suddenly, the next year, it became a budget of £ 7 million and 70-80 staff. But, grants were always made to us on the basis that you deliver a project that saves the company money which you can invest in further research." (L34)

An example he gave is the Advanced Water Treatment programme of the 1990s that involved introducing ozone and activated carbon in treatment plants to purify water to a higher standard. This project stemming from internal research actually saved the company £ 50-100 million in complying with the drinking water directive thus saving its research budget for that year (L36).

Thames Water's research investments in the 90s coincided with its phase of global expansion. The company started bidding for contracts in East Asia and South America, executing water projects for governments around the world. In 2001, it was acquired by the German utilities conglomerate RWE, following which it either controlled or bought stake in municipal water works in Poland, Croatia, USA and China. It was when it acquired American Water in 2003 that Thames Water was at its most expansive form (LD7). This was also when the idea of a desalination plant for London was floated. According to a consultant who managed research projects for Thames Water for 30 years until 2010:

> "We were very interested in membrane technologies. We were actually focused completely on waste water recycling and potable water reuse. As you may know, similar membranes are used for desalination and recycling." (L1)

The Beckton desalination plant is, in fact, remarkably close to recycling as it uses water from the tidal Thames, which is closer to wastewater in its salinity than to seawater. In both Chennai and London, brackish water desalination is also used widely for small scale water purification. In London, this is mainly done to produce bottled water[26], while in Chennai it is a fitting in numerous homes and offices to make saline groundwater potable.

While those discrete uses of desalination continue, the new millennium saw private companies exiting the municipal water supply business, thanks to lack of profitability. Consequently, the regulatory framework in England and Wales sought to prevent renationalisation by providing relative security and protection from competition to private companies. Conversely, this also prevented British companies from consolidating and expanding into expert conglomerates the way French companies did (Hall & Lobina 2007). In 2006, RWE sold Thames Water to a consortium of investors lead by the Macquarie Group, an Australian investment bank. The consortium has since been divested with Thames Water's shares currently held by pension funds from Canada, UK, China, Kuwait and Abu Dhabi. As it should be expected from pension funds, Thames Water is now a low risk operation, running the city's 150-year old system, needing no drastic strategies or investments. Desalination plants did not feature in Thames Water's Resource Management Plan 2014 (WRMP14 – LD8) as a future option, except as small scale units recycling brackish water, that can be put to use in contingencies. A feasibility report exclusively on desalination prepared by external consultants towards finalising the WRMP19 has also recommended the same (LD9). A senior engineer in the company summed it up when he said:

> "By the time the desalination plant was built, it wasn't as if we had developed any expertise on that. It was all contracted out to fill a brief but crucial gap in our water resource management. We can maybe claim to be efficient operators of that plant." (L13)

The Innovation Department in Thames Water today is back to 'fixing' and 'bettering' things. An example given by an innovation engineer there was studies of corrosion of pipes and modelling of leakage based on place and average age of the pipe:

[26] Sophie Elmhirst. 'Liquid assets: how the business of bottled water went mad' *The Guardian* 6 Oct 2016. https://www.theguardian.com/business/2016/oct/06/liquid-assets-how--business-bottled-water-went-mad

> "We also work on prediction models for risk and demand – yeah, we use a lot of prediction models! But, London is such a complex place with too many human interventions. So, modelling is extremely difficult and when done, it may go unused." (L33)

In the thirty years since the privatisation of water in England and Wales, Thames Water has gone from scientific management of a national resource to annual cycles of cutting edge technological innovation to finally modelling based on user behaviour within the city. The global relational networks described earlier in this chapter involved almost always British consultants interacting amongst each other and with utility managers abroad, whether in trade events or industry conferences (LE1, LE2). However, the legacy of water supply in London and the urban imagination it evoked around the world play a role in these networks. The maintenance of the urban water network in terms of enabling efficient user behaviour and controlling leakage present research and development opportunities for Thames Water.

Yet, the company is perpetually at odds with regulators and urban managers on this issue and has been hauled up numerous times for failing to curb leakage in its network and for not having performed necessary maintenance. In 2017, it was fined the maximum fine of £ 8.5 million by Ofwat for failing to meet leakage reduction commitments in its supply network (LD10); and a 'record' amount of £ 20 million by EA for polluting water bodies with leaks in its sewerage networks[27]. The company's failure to tackle leakage was one of the key contentions against its desalination project. Contrary to the Chennai case of water engineers liaising with groups of urban residents, if in exclusionary ways, London's water experts engage in socio-technical othering that deems users unreliable participants in their project of urban conservation and maintenance.

[27] Damian Carrington. 'Thames Water hit with record £20m fine for huge sewage leaks' *The Guardian*. 22 Mar 2017. https://www.theguardian.com/environment/2017/mar/22/thames-water-hit-with-record-fine-for-huge-sewage-leaks

## 5.4. Leakage: banal socio-technicalities of othering

In Chennai as in the global discourse, leakage is an issue often associated with illegal, amoral and unskilled practices on the part of the urban poor, the presumed racial or caste inferior, or the gendered other. As mentioned before, unauthorised buildings or ad-hoc settlements which have gradually come to house the urban poor can only be supplied by stand pumps or water lorries. It's common to see lorries spilling water as they go around the city, and water flowing hesitantly down standpipes unattended. Often in poor neighbourhoods, there is no fixed schedule for when either of these services come bearing water. It's mainly word of mouth and the sound of the water pump or the lorry that alerts residents to the coming of water. Consequently, despite elaborate monitoring and sharing mechanisms that those neighbourhoods come up with, it's likely some water is wasted from standpipes before they're harnessed. As for lorries, their supply now extends to many affluent and planned homes in central neighbourhoods, thanks to groundwater depletion. But, because these two visibly leaking sources are associated with urban poverty, leakage is linked to a state of moral poverty.

A retired public works department official in an affluent south Chennai neighbourhood was offended by questions on the water he uses for his garden:

> "You should go down the road and look at the slums; they have public taps which leak all the time. How is gardening a waste of water?" (C18)

Several households with reverse osmosis units fitted for purification of groundwater routinely used the saline residue for their toilets or their gardens and this was an environmental subjectivity that allowed a view of leakage in public facilities with suspicions of criminality and ignorance:

> "Every time I see one of those lorries splashing water on the roads, I think that there needs to be an awareness programme!" (C20)

> "Not only does my neighbour tap water illegally, his DIY arrangement is shoddy and leaks too. If I point this out to him, he calls me a Brahmin chauvinist[28]. How can we reason with these people?" (C31)

The formal political system, these residents were convinced, was incapable of dealing with this problem, because:

> "…people like you and me who talk about it don't go and vote. The guys who get everything free, they go and vote. It doesn't matter to them if water leaks all over the city. During elections, just give them Rs. 100 and a Biryani, they'll go and vote." (C41)

For these residents, fixing leakage was a cause for the greater good than something that they saw as affecting them personally. They would 'put in a word' to their local engineer that something needs to be done about leakage, as a reformist agenda. Leakage became another issue over which their relational network of shared knowledges gets assembled.

In reality, the urban poor have more reason to be worried about leakage. Firstly, it means that the water they could be using gets wasted. Secondly, the leaked water stagnates around their less insulated houses, becoming a hygiene issue. A resident of a coastal fishers' settlement explained:

> "It is a bigger problem when drain pipes leak, of course. You know that drainage and supply are handled by the same authority, right? Children love playing in the sand. But, the inadequate drainage system in our village means there are frequent leaks and frequent illness." (C1)

When that happens, the village, as they called it, take it up directly to the Metrowater headquarters or the Corporation by writing a letter from the village association. In a inversion of Partha Chatterjee's (2004) distinction between civil and political societies, it was the urban poor who were using formal written forms of civic action

[28] Caste, much like race, may not translate into a strictly economic definition of class. It is construct of moral and intellectual superiority as in the case of class, nevertheless.

here, while the middle and upper classes turned to their relational networks and ad-hoc methods of ensuring supply and sewerage services. Given this two-pronged guerrilla pressure on its distribution systems it was logical for Metrowater to address the leakage problem. It also bestowed upon Metrowater's in-house engineers, whose experience lay in distribution more than anything else, a techno-political expertise, not attributed to specific technologies, but to the art of navigating the city's relational networks, material and social.

In London, reducing leakage by a tangible amount would count as savings for the company as it could save expenses on sourcing more water, using, for example, a desalination plant. It would count towards 'reducing demand', an objective water companies in the UK are allowed to fulfil instead of 'augmenting supply' to meet future water needs (Water Industry Act 1991). But, that's one goal for which the temporalities of finance, regulation and water flow never seem to match.

> "We could save 100-150 ML per year by spending £ 1 billion to replace about 5% of London's total network (about 100 km) over a 5 year period. If that was all we did, we would run out of water by 2020-30. The leakage reduction programme wouldn't reduce demand quickly enough." (L34)

In its Water Resources Plan 2006  (LD15)where the company lays out its arguments for why demand or leakage reductions will not be sufficient and a desalination plant is needed for the city, it argues that in a place like London, such measures involve methods to control and modify user behaviour, and so may not work. Two of its arguments are reproduced below:

> "The greatest benefit from metering is from curbing discretionary water use, such as from garden watering. With such a high proportion of flats in London it is not practical to assume that such savings will materialise.
>
> There is no guarantee that any demand savings will be achieved since it depends on changes in customer behaviour which are beyond the direct

control of the company. Indeed, there is a risk that demand could increase as customers decide to use what they pay for." (LD15, p. 101)

As with other aspects of water supply, leakage is another boundary-marker, distinguishing the engineers from the users. An engineer, who worked with membrane technologies in Thames Water, but was often tasked with conducting user perception surveys, fumed:

> "People are like children. If we start on a comprehensive leakage reduction project, they'll complain that we're digging up roads or stopping their supply, even if it's only a one-time thing for a few hours." (L33)

She should know, for she has been hearing complaints even at the mere suggestion of potable water reuse or wastewater recycling in London. She was weighing cost against benefit for brackish water desalination and wastewater recycling when I met her. She showed samples of user responses to surveys conducted on recycling, the most colourful of which read

> "Thames Water taking the P@ss as usual" *(sic)*

> "the answer to the water shortage is to repatriate 2 million immigrants that have no right to be here!" (L33)

She felt strongly that it was a sense of entitlement born from believing water is a basic right and living in what feels like a rainy, water-abundant place that made people averse to innovation in water technologies that were popular elsewhere (L33). For her, there was a clear divide between the expert – who knew the ecology of water supply in the city – and the user, who remained ignorant and reactionary to changes in water supply. As one of the top water managers in Thames Water made it clear:

> "The mark of good water supply is that people shouldn't know or need to know what we are doing for them to be able to open their tap every morning and get their water flowing." (L18)

However, in the global relational networks in which Thames Water and the UK water sector is embedded, leakage could be easily ascribed to illegal practices and the so-called populism of the global South, where the poor are supposed to be getting free and unmetered water. In the London water trade event discussed above (LE1), metering came up as an issue several times, always associated with how the poor might take advantage of the situation.

> [Q] "Don't you give water free to people?"
>
> [A] "Yes, but only on the condition that they install meters soon. In the longer run, it's more important to get people into the network than keep them out of it."
>
> [Q] "It's not clear from your presentation what opportunities your city presents for businesses here. Could you clarify that?"
>
> [A] "Well, district metering authorities are a priority, to detect leakage and ensure payment." (LE1)

As accounts of metering in various countries and cities around the world has shown (see for eg., von Schnitzler 2008), leakage is code for theft by the urban poor or for human carelessness in less automated, more flexible systems. In London too, such association of leakage with wasteful or at least unusual water use abound.

> "During Ramadan, there is a clear spike in water usage in the mornings and evenings. We used to calculate that as leakage." (L33)
>
> "Showers leak more than baths, because they are turned on and off more often. Young people these days, especially my girls, are all about showering." (L20)

By associating leakage more with user behaviour than with how the city's subterranean pipes are maintained, the issue becomes less a subject on which to develop technical expertise than one which demarcates the knowing expert from the wasteful user. It however opens up opportunities for Thames Water and social scientists alike to research user behaviour and affects related to it across the city's wide and varying water use at the household level.

## 5.5. Conclusion

Isabelle Stengers (2013), in her formulation of an ecology of practice, challenges the characterisation of practice as a compromise on truth.

> "The contrast between technology and the power of Truth is an ethical one. With technology comes a sense of responsibility that Truth permits us to escape." (Stengers 2013: 187)

She was writing in the context of physicists' response to social constructivism of science, equating physics with reason and reality. Practitioners do not have to erect this self-defensive border, she argues. Practice could be about pushing the boundaries of the truth and working with factors that have nothing to do with principle or reason (Stengers 2013). Theirs ethics and practice are instead mutually constitutive, emerging from the responsibility of acting and having to take decisions that might not be perfect or consistent with a personal logic. In this way, practitioners do not have the shield of truth to protect their actions, hence their sense of responsibility. As technological practitioners, unable to escape to Truth, water engineers were obligated to their everyday work performed as others have before them; but also, to use their practice as a conscious means of production of knowledge as well as material infrastructures. Several engineers saw themselves this way rather than as disenfranchised cogs or powerful agents in the neoliberal machine.

Yet, ethics and practices are far from individualistic. They come into being in the milieu (Stengers 2013) of the infrastructural city where certain knowledges carry greater credence than others, and reinforce unequal distribution and social relations. Yet, engineers and water managers carry on with their work even if they may not benefit from the social relations so constituted, as in Chennai, for example. Metrowater engineers were at the losing end of a battle with water managers and were critical of several of the city's water projects. But, they continued to have 'attachments' to the overall project of water engineering they had undertaken. So, rather than a binary between agency and structure, what we get is an iterative constitution of practices and social relations over urban water infrastructures. These iterative processes, this chapter has argued, could be understood as osmotic – that is, continuously negotiated. As the trajectory of research and development in Thames Water over the years when its ownership, funding and global relations changed constantly showed, the flows of water, power and expertise are messy and do not fall into a narrative of causation or circulatory metabolism. It is these messy relations that an osmotic view can instead excavate productively.

Drawing from observations of reverse osmosis filtration, which is a technology widely prevalent across cities today and is the point of departure for this thesis, this chapter contends that the idea of interactions between semi-permeable membranes determined by electrochemical gradations and carefully maintained pressures is useful in understanding the socio-technical work of engineering and building urban infrastructures. For example, it indicates the interaction between the porous yet compartmentalised identities that a Metrowater engineer traverses between his interest in community-oriented systems of water harvesting and ensuring adequate water supply to the next neighbourhood caller (section 5.2). The membranes were a useful lens to have in noting interactions between water managers, calibrated through their identities and possibilities for exchange, at the trade event in London (section 5.2.2).

These interactive practices, this chapter has argued, constitute relational infrastructures over which shared knowledges and technical expertise are built. The distribution of these knowledges over the network is its own political claim (Simone 2004) as they delineate the gradations and pressures determining which ones are validated as expertise or social relations and which ones get othered, as in the case of water use practices held responsible for leakage (section 5.4).

The complexity and unpredictability of the city and its material networks, paradoxically, heighten the banality of its infrastructure (Anand 2018).

Infrastructures have always been known to be banal in the sense of being invisible or dull elements of urban life (Star 1999). This is precisely what makes them political (Anand 2018) as their legibility is distributed over a wide set of knowledges and practices, each performed as everyday work by a range of actors. The capacity of infrastructures for unsustainable or unequal distribution of resources is wrought banal through the 'will to ignore' on the part of the engineer, the regulator, the citizen or the policymaker. The nature of engineering agency, then, is banal in the way it is exercised as everyday contributions to urban development rather than as a grand vision. Yet, it is by no means a purely technocratic contribution, deliberately or unwittingly disconnected from socio-spatialities of the city or global hierarchies of knowledge. It actively mobilises them towards technologies of infrastructure-making (Lancione & McFarlane 2016).

However, can engineering agency and knowledge really be understood as a generalisable concept? Is it only the gradation in identities, personalised compartments or geopolitical origin that introduce variation in these knowledges? The following chapter explores the variance in engineering epistemologies encountered in Chennai and how they are sought to be bridged through a standardising framework in London.

# 6. MULTIPLE EPISTEMOLOGIES OF ENGINEERING

## 6.1. Introduction

Until the late 18th century, engineering as a profession was tied to the military, developing machinery or building water and road infrastructures for purposes of warfare. There have, of course, been public works and non-military infrastructures built across the world before. But, the planners and builders of such structures did not bear the title of the engineer. They were associated with institutions of rule, kinship and state-making, perhaps more accurately reflecting the socio-technical nature of engineering work. It was when the Institute of Civil Engineers was founded in London in 1818 that there was designated a professional practice clearly distinct from military engineering and intended for civilian development (Florman 2014). Today, infrastructure projects, because of their sheer complexity and owing to the development and specialisation of the field of engineering, involve diverse disciplinary backgrounds – civil, chemical, electrical or environmental engineering. These engineering specialisations carry with them distinct epistemologies and social relations that are co-constituted with the institutional framework and technological materialities they work with. From the often conflicting multiplicity of engineering knowledges, it then follows that there is no single uniform rational engineering or technocratic logic that determines the construction of infrastructures. Following from the arguments in the previous chapter, this chapter stays with the idea of engineering knowledges, exploring how their relationality and sociality are shaped by the epistemologies of particular engineering disciplines.

Engineers have long been understood as mediators between the technological and the social (Bell et al, 2011), the technology being a modernist application of value-free science, a tool in professional hands. Historian David Channell (2017) writes:

> "The new scientific theories that emerged during the Scientific Revolution are assumed to be the basis for the transformation of technology from its pre-Industrial Revolution status as a craft based on cut-and-try empiricism and

rule of thumb techniques to a scientifically based discipline based on precise mathematical models." (Channell 2017: 27)

This was the 'standard' positivist view of technology that influences technocratic modes of governance today because it positions technology as apolitical and hence capable of clean or scientific development. But, as sociologists of technology have pointed out, peak technological development during colonial, wartime and cold war periods were experimental rather than applied science (Bijker 2001, Mitcham 1994). Rather than a one way relationship between science and technology, the idea of 'technoscience' refers to the condition of our time when science is necessarily tied to and often in nexus with technology, and so, by extension, to engineering and technocracy (Nordmann 2011). But, when Latour famously used 'technoscience' as shorthand for 'science and technology' in 1987, he made a distinction between the two phrases. Technoscience, for him, referred to the 'heterogenous components…including the social ones' (Latour 1987: 62) that come together in the production of scientific knowledge. In other words 'technoscience' is the outcome of science and technology, and much more. Technology, here, is not a mediator between science and culture, but a culture in itself. Building on this premise, this chapter posits engineering epistemologies as 'technoscience' that acculturates material infrastructures into urban social relations. What can the technoscience of water infrastructure in Chennai and London tell us about the nature of urbanisation and indeed, the values associated with technological networks in cities? How are those networks, in turn, influenced by the values their own history and materiality thrust on the city?

The socialisation of technology has never been value-free, its capability for 'development' itself being a value-laden proposition. In cities, technological networks have been associated with a hygienic modernity as in the case of 19th century London when newly built sewerage networks separated from water supply improved health and sanitation (Gandy 2006). Perhaps owing to the documentation through which it is known, history gives a clear distinction between how this techno-science of bodily hygiene influenced urban networks in London and the colonies.

While bacteriology hastened Londoner's desire for a universal system that regulated bodily hygiene, in colonial cities, notions of purity and pollution have manifested themselves through race (Kooy & Bakker 2008) or caste (Gandy 2008), acting against integrated networks. Racial and feudal differences in bodily integrity were rationalised, in fact, through the science of textual reproduction and codification of culture as an essential bodily difference. But, the establishment of inflexible and centralised infrastructural systems in European and North American cities made networked water supply an urban ideal of its own. Without this ideal, Graham & Marvin's (2001) influential theory on infrastructure argues, the urban fabric would be 'splintered' by global capital driven fragmented infrastructures dividing the city along race and class lines.

Planned and built in Chennai and London by consortia of international builders and consultants, and developed as discrete projects at moments of crisis, desalination plants fit the bill of what Graham & Marvin (ibid.) call the "growing crossover between private finance capital and infrastructural development" (p. 97); and "overlaid patchworks of unbundled networks now emerging." (p.189) However, this type of infrastructure development, they argue:

> "undermines the notion of infrastructure networks as binding and connecting territorially cohesive urban spaces. It erodes the notion that cities, regions and nations necessarily have any degree of internal coherence at all." (Graham & Marvin 2001: 16)

In Chennai as well as London, there exists a tension between a modernist infrastructural city and a fluid city of flexible technological projects. But, far from splintering, there emerge technoscientific rationalities that negotiate this tension and bring about a dynamic coherence that may not fit into an idealised vision of infrastructural cohesion, which has perhaps never existed (Coutard 2008). In London, this rationality, in fact, takes the form of resilience planning, towards ensuring that the city's legacy – its unified 24-hour networked water supply system – is left undisturbed and invisible to the city's residents as far as possible. Whereas in Chennai, the desalination plants are seen as the first step towards the creation of such a seamless water supply system. The ideal of infrastructural modernity, then, persists into infrastructures birthed by global capital and built on an ad-hoc basis.

This chapter will problematize the idea of infrastructural cohesion by placing the discourse of sustainability and resilience in London alongside plans to expand Chennai's water supply network. Despite the exceptionalism accorded to a fantastic technology like reverse osmosis and its purported role in preparing London for climate change, it is but one of the many additions that have to be made to keep the city's inflexible unified water system running. Juxtaposed against Chennai's meagre water system building up into unified infrastructure through privately built megaprojects like desalination, the malleability and relativism of the techno-modernist imagination becomes apparent. The chapter traces the dominant sources of knowledge or techno-scientific approaches that co-constitute water infrastructure in Chennai and London today. It considers how the introduction of a new technological project like desalination restructures existing techno-scientific relations; and if some infrastructural formations are less cohesive and more divisive than others.

The chapter is broadly divided into two sections, one on each city – Chennai and London. The section on Chennai elaborates on the variety of engineering epistemologies that prevail in the city today across government institutions and the private sector. It begins with the role of chemical engineers in matters of environmental impact and water quality, especially when it comes to reverse osmosis desalination (section 6.2.1). It then explains why the values associated with this form of engineering are distinct from those espoused by civil engineers working on distribution systems. It also delineates civil from environmental engineering and the institutional arrangements in which they find their place in Chennai (6.2.2). In discussing all three disciplines, what emerges is a picture of intense complexity that requires a rethink of what modernist infrastructure might mean in the global south and how cohesion can happen outside the bounds of technological and global capital flows. So, the subsequent sections (6.2.3 & 6.2.4) demonstrate, through the everyday socio-technical work done by water engineering contractors in housing development, how dynamic forms of cohesion and exclusion emerge in discrete technological systems of water access in Chennai. The London section (6.3) focuses on the overarching epistemology that attempts to bring together this complexity under objective calculation – of risk and the associated discourse of resilience. It traces the history of risk as a discipline to understand technoscientific rationalities as, in fact, likely irrationalities or unequal agencies made legible through calculative governance structures (section 6.3.1). It then traces the temporal transition of risk to resilience in water infrastructure planning to argue that the attempt at resolution of multiple technological knowledges works to keep the city's infrastructure in a unified singular form.

## 6.2. Chennai: Intersecting fragments of technical knowledge

### 6.2.1. Operational chemistry of water engineering

"Have you seen the 1955 Alfred Hitchcock movie 'To catch a thief'?" was a senior water engineer's (C12) cryptic question, when asked about the environmental sustainability of water projects.

> "To catch a thief, you send a thief. Same way, to detect chemicals in the environment, you send more chemicals. They test for foreign particles, pollutants in the environment – soil, residue water etc. – by introducing some other chemical which will detect the undesirable one." (C12)

Predictably, he translated environmental sustainability implicitly as chemical testing of the environment. Yet, it was unexpected that he would liken colorimetric testing – used to assess safety of treated effluents - to a Hitchcockian chase, involving heroic action rather than banal execution. It was what came afterward that was illuminating:

> "The chemical engineers doing the testing know it's all a formality. So, they'll make sure the values they enter are within limits, unless there is something dramatically wrong in the readings." (C12)

He was remarkably blasé about his certainty that environmental impact monitoring was an exercise in merely reading a measurement, which was not always recorded precisely. To be sure, it was not the testing engineers' doing that the environmental impact of a water project is reduced to a number indicating chemical concentration. But, rather than the routine oversight in banal infrastructural work that Nikhil Anand (2018) critiques recently, they held the agency to exercise discretion. When their job involved recording a number, they recorded an unambiguous number – that is, a number which would allow the project to continue. It was only when the reading exceeded limits dramatically that the desire for lack of ambiguity might work against said project. They worked as part of the team to make a contribution, which negative readings didn't seem to count as.  "Well, that's what engineering education teaches us, isn't it?" another water engineer wondered aloud:

> "In our laboratories, we knew what the outcome of our experiments or tests were supposed to be. So, we made sure that we entered the appropriate values in our record books even if that's not exactly the result we got. I mean, it was important to learn to work the machines, but at the end, the record needed to short the correct values. So, we learnt to work the machines to give us the values we desired." (C7)

In a sense, this is what engineering is about – manufacturing a world that fits into one's expectations and values. It is the imagination of the material world as modelling clay that drives fantastic innovation or a project like desalination. Irrespective of whether it was heroic discretion or banal teamwork, the outcome is of making the socio-material fit within pre-calculated rationalities. One of the questions that introducing desalination in Chennai or London might provoke is whether some technologies or infrastructural forms could be more divisive, bureaucratic or legible than others; and whether those are related to specific epistemologies of engineering.

Desalination and other membrane technologies have certainly attracted attention from chemical engineers more than other elements of water supply had in Chennai. College of Engineering Guindy, Chennai's top engineering college and the seat of the prestigious Anna University collaborates regularly with Metrowater and various water companies to conduct research on water engineering. Their Water Resources Institute is housed under the department of Civil Engineering. But, queries about desalination are directed towards the department of Chemical engineering, whose laboratories host interests in solute concentrations and semi-permeable membranes. This difference between the engineering epistemologies of mechanical and membrane technologies extended to the industry too, as was evident in a massive trade fair conducted in Chennai every year called the Water Expo & Watman Conference. At the $8^{th}$ edition of the fair held at the Chennai Trade Centre – a sprawling complex of exhibition and conference halls along the southern industrial corridor built jointly by State and Central Government trade development agencies – the extent of water's longstanding relationship with technology and the growing influence of membrane technologies was quite literally showcased (CE15).

In the exhibition hall crammed with stalls displaying pumps, motors, chemical purifiers, efficient dispensers and various aids to irrigation, rain water harvesting, heating and cooling, the frontline of stalls, also the largest with the most dazzling displays, were of membranes – for desalination, effluent treatment and recycling. Since this was a business-to-business exhibition, the displays focused more on how the technology worked and what their features were rather than on what they did. The manager (C10) of a stall with a giant flowchart explaining the process of effluent treatment introduced himself as a researcher from the University of Côte d'Ivoire. That wasn't unusual, he clarified. Engineers interested in water technologies could be found studying in unexpected places, wherever they could manage to learn the technology and trade affordably.

> "Water technologies evolve according to local necessity and innovation could happen in any place. For desalination, the major breakthrough was not in reverse osmosis itself, but in preventing fouling – the clogging of pores by scaling and bacterial deposits. Developing resistant membranes involved a lot of chemical engineering, testing materials, using chemical anti-scalants etc.

This, for instance, might have developed in a place that has had to deal with scaling issues in general with water.” (C10)

Unlike the civil engineers who narrated an experience of training in discipline with a long illustrious tradition of public service, membrane engineers stressed their adaptability, their reflexivity in reacting to a fast changing industry and environment and the novelty in their work. But, they would also argue that there is very little room for negotiation with the technology, which runs on strict parameters. This is partly in response to the illegibility of reverse osmosis feeding fears of its potential danger in the future, but partly because the membranes themselves were manufactured units installed in warehouse style desalination or recycling plants. So, the extent of involvement a private sector engineer has with membrane technologies depended on his position in the project’s hierarchy.

There were only about 10 engineers working in the whole of the 150 MLD desalination plant in Minjur to the north of Chennai, all in the control room (CE17). One of them was a control engineer (C33) who had a diploma in chemical engineering, which meant he went to a polytechnic college rather than an engineering degree college. He called the control room the SCADA room, SCADA being the application used to programme the computers that run the desalination plant. The PLC or the programmable logic control used in these desalination plants is taught to students of electronics engineering through plant visits and industrial training programmes (C28). But, according to the control engineer:

> “There is very little that the SCADA can do to modify the desalination process; and even lesser that I can do with the SCADA as a process engineer. Every modification or variation in the systems outside correspond to a value or a parameter in the SCADA, like 3 units or 0.3 units or 33 seconds etc. That’s where efficiency or sustainability would have to be fine-tuned. But, that can only be done by the PLC programmers or SCADA designers working behind that glass door.” (C33)

He had worked in the desalination plant of a power company in southern Tamil Nadu before. He, then, went abroad to East and then, West Asia to work on more industrial water systems, sometimes involving desalination. The SCADA engineers were programmers, who may have studied any branch of engineering, but dabbled in the writing of universal logics that could be applied to various machine systems i.e. programmes. Even they could only make small changes to the parameters which came as part of the plant design essentially.

What were these all important parameters on which the desalination plant seemed to pivot? "The three vital stats for water are pH, turbidity and conductivity," the control engineer (C33) explained. But, this was a desalination plant. Salinity had to be an important parameter to monitor. There was even a technical term which was commonly used in the city: TDS, total dissolved solids, referring to the concentration of minerals which gave water the saline taste.

> "Oh, that is conductivity. Salinity = Conductivity * 0.55. Water engineers just prefer to use salinity because it makes it seem like a lower numerical value. So, desalination brings down conductivity of water; and finally, lime is added to equalise its pH." (C33)

Is that what gave the water some taste finally, I queried. "It equalises pH," he (C33) repeated refusing to budge from technical terms.

The chemical engineer's epistemology remained firmly techno-mathematical. It was concerned with measuring chemical parameters of running the plant and not with the water supply system per se. If engineering was about the conquest of nature and building an environment according to human desire, engineers closely working with the desalination plants or reverse osmosis technologies hardly ever were those heroic engineers. Instead, they exercised their will to modify the environment only in reporting or recording data, their technological approach often in tension with a traditional idea of engineering as negotiated environmental work. Historian of Technology Colin Divall (1996), writing about the development of chemical engineering in the UK in the early 20$^{th}$ century, argues that 'chemical engineering' was something of a misnomer because it referred to the materials those professionals worked with in a manufacturing or a ‘physical’ environment. Professionals who worked with chemical processes were chemists, who did not become chemical engineers by merging their profession with that of engineering.

> “The principal tasks of the chemical engineer were to ensure the containment of chemicals during the manufacturing process, to secure their movement from one stage of the manufacturing process to another, and to provide the physical conditions that would permit chemical reactions to work on the large scale.” (Divall 1996: 678)

Chemical engineering has, later, been identified as a practice well-suited for sustainability transitions (Clift 1998) owing to the discipline’s core concepts:

> “…material and energy balances (for the most part exclusive to chemical engineering curricula), the systems approach to which these constructs relate, the second law of thermodynamics and the associated concept of entropy.” (Byrne & Fitzpatrick 2009: 24)

As one of the desalination plant engineers (C40) observed, “This is a rare moment when our colleagues in environmental engineering are joining us – those from a chemistry background.” According to him, more students of chemistry, not necessarily engineers, were also finding work in the field of membrane technologies for water treatment. He also explained the conductivity and salinity conundrum:

> “We use electrical control instruments to run the plant, right? So, we need to convert chemical measurements of the water – things like salinity – into a measure that the machines understand – an electrical measure. Hence, salinity becomes conductivity. Chlorine content becomes oxidation reduction potential (ORP). Looks like the other desalination plant employs some poorly trained chemical engineers to just operate the machine, and not necessarily know it well.” (C40)

He worked in the Nemmeli desalination plant (CE16), which was better known and more politically important to Metrowater as well as the ruling government. It was located in the south of the city on a popular roadway, very visible and known to the affluent residents of the region. The other plant, located in an industrial zone to the north of the city, was nearly hidden and not owned by Metrowater. Both plants were built and run by private companies. But, the first one in the north continues to be owned by the private company, with Metrowater simply purchasing water from it. The second one, built after the success of the first one, is Metrowater's own plant, contracted out for building, operation and maintenance functions (see chapter 4 for details). This is a closely monitored plant where visiting consultants and policymakers are usually taken to showcase Chennai's expertise and innovation. Beyond epistemology and disciplinary background, there was an institutional politics to the nature of knowledge held by engineering professionals.

#### 6.2.2. Institutional divergence of civil and environmental engineering

Chennai's institutions of water governance have neatly divided up the engineering functions of handling the city's waterscape. Metrowater concerns itself with the supply of water and the disposal of sewerage; the public works department takes care of its water bodies; the city corporation looks at how those water bodies can be made ecological services that the city can use. In this triad of engineered water management, Metrowater's engineers believe they represent an older school of public health engineering amidst emerging enthusiasm for environmental management. When asked about how environmentally responsible Metrowater's projects were, an engineer had this to say:

> "We are civil engineers! We work with the environment to see how it can be put to civil [sic] use. This does mean that we have to be aware of how the environment works and make sure that it gets utilised in a judicious way. But, all this emphasis on environmental sustainability changes our fundamental obligation - which is towards people, and their needs for water." (C14)

His boss, a senior engineer who managed allocation of engineers in projects confided:

> "We are encouraged to hire more environmental engineering students – because colleges have those courses now, no? But, environmental assessments can be done by consultants. That's what we did for the desalination plant. It doesn't seem like a job for our full time engineers, you know?" (C36)

Two epistemologies of engineering are indicated here. In the eyes of the first engineer, civil engineering is inherently a public practice, that is obligated towards people. Even though the word civil itself was formulated in opposition to military engineering, for him, the word was tied to civic obligations towards the city's residents. This is, in fact, a shared view held by water engineers across public and private sectors as this chapter will show. The second engineer is not sure that environmental knowledges are necessarily an engineering function at all. At any rate, it didn't have to be a component of Metrowater's engineering, for him. The civil engineer's or at least the Metrowater engineer's take on environmental knowledges became significant since the institution's renewed search for water sources like the desalination project is often criticised as modernist techno-solutionism disconnected from the region's traditional ecological systems. Environmental researchers from other institutions found Metrowater's functional focus on the city's water systems exasperating. To this end, they attempted to transfer their knowledge to Metrowater.

A senior water researcher bequeathed his painstakingly surveyed map of disappeared and deteriorating water bodies in the city's hinterland to Metrowater, in aid of reviving the historical waterscape of the region. "It is for you to make use of it to build more sustainable water systems for the city," he (C52) told a gathering of Metrowater engineers. A geologist at the Institute for Water Studies (IWS), a newly created institution of the public works department, said:

> “We collect data from different departments and use it to inform the data that we, in turn, supply to them. It’s all about the data [chuckles]. For example, we get information from the agriculture department on crop patterns that season and use it to extrapolate what the water usage could be like. We also suggest plans like where to get water for a particular supply – from foothills? From the village or town itself? Where to sink borewells for irrigation. But, the departments are free to listen or not to us. When they make plans, sometimes they ask us for reports – like with Veeranam scheme, we had to show what was the best way to get water from there and transport it to Chennai. They anyway have to engage independent consultants. We are in more of an advisory role.” (C23)

Institutions of environmental research or governance are tasked with literally producing comprehensive knowledge on the environment, as data points. This data however seldom feeds into plans already made for water engineering., according to staff in the IWS. It was a similar narrative in the Tamil Nadu Environment Directorate, whose functions included the generation and publication of periodic environmental data, which might nevertheless have limited relation to how engineering and state institutions mediated socio-environmental relations.

> “Look, it is a national project to publish environmental data. But, there is no guidance or monitoring on exactly what kind of data needs to be published. So, we look up publicly available information and post it on our online publication system. We don’t have the resources to do primary research even if we were interested in it! You can see for yourself – there are three of us in this office. Which one of us is supposed to collect all this data?” (C50)

He was referring to the national project of environmental data collection called ENVIS (Environmental Information Systems) which aims for “integration of national efforts in environmental information collection, collation, storage, retrieval and dissemination to all concerned.”[29]

[29] See: http://tnenvis.nic.in/Content/TNDatabase_1160.aspx

It was only in the Chennai city Corporation that a different approach towards the question of the environment was emerging. They were increasingly getting more interested in environmental engineers, and regularly brought in experts on ecology from universities or worked with environmental activists and NGOs (C42). They recruited students of environmental engineering, but not necessarily for jobs involving their specialisation. A top official in the Corporation said:

> "They are like all our other recruits. They'll be on training and then on a rotation of jobs. But, it is all part of an initiative to build up expertise on the subject in some years' time. All recruits are trained on the city's biodiversity – what kind of flora and fauna live here, apart from human beings and what are the conditions in which they live." (C53)

For an organisation that had been at the forefront of engineering the city in the past – building roads, canals, water supply and sewerage – recent developments in urban ecological governance converged with the possibility for environmental engineering. The Corporation's role in the urban waterscape has been changing over time. It was originally in charge of water supply in the city – hence the shorthand of 'corporation water' used by an older generation of residents in the city. Metrowater has been around long enough now and active in the city's public sphere for the colloquialism to have become eponymous. That is, residents are more likely to refer to networked supply simply as 'metrowater' these days. A project engineer in the Corporation commented:

> "That meant our interaction with water was only to drain it. We saw Chennai as four basins – Kosasthalaiyar, Cooum, Adayar and Kovalam. The first three are river based drainage systems and the last one is a marshland ecosystem." (C63)

But, there are efforts to change this mental map of the city now. Rather, there have been efforts to rethink those water systems as 'ecological services' rather than as drainage basins. According to another project engineer:

> "Frankly speaking, we haven't had the incentive to maintain water bodies because we are not using them for water supply. But, now, this concept of ecological services means there is a purpose to maintaining them." (C64)

That's how the Corporation has been involved in widely publicised and criticised projects like the Adyar Poonga (Coelho & Raman 2010) – a park at the estuary of the Adyar river, the Cooum river restoration project and the restoration of the Chetpet lake. Criticism has largely fallen in the categories of bourgeois environmentalism or neoliberal urban regeneration accompanied by economic and aesthetic cleansing. They have also been 'special initiatives' rather than institutionalised changes in planning for water in the city, meaning that work on the projects is done by teams constituted specially for this purpose and not by the Corporation's in-house engineers as part of their routine jobs. An environmental consultant who is part of one such team said:

> "So, who trains environmental engineers recruited by the Corporation? External consultants or designers, who can push their own agenda. We're an environmentally conscious NGO working with them, but I could easily just be advocating slum eviction as the primary means of cleaning up water bodies. I suppose we all work within the constraints of the system and make the best of it." (C42)

Yet, the Corporation was recruiting more environmental engineers with a view to expanding its expertise on the subject over years. The senior official in the Corporation explained this newfound interest:

> "I don't know that economic activity in Chennai is getting hindered by its imperfect water management or lack of environmental harmony. People are buying houses, foreign firms are investing. When senior corporate executives settle here, they may look for good international schools or elite hospitals. Presence of great parks or water bodies doesn't seem to have been a factor for them. For the institution, though, this is a chance to consider water bodies from an entirely new angle – the beauty and biological richness they bear

> rather than as a source of water or drainage. It is exciting to do that! Plus, because of the limited funding that such projects get, it makes sense to do them as special initiatives with partner organisations than completely in-house." (C53)

Neither romanticisation of traditional environmental wisdom nor modernist techno-utopia, this presented a pragmatic yet desirous approach towards an environmental epistemology of water governance in Chennai. What is framed here as a deep ecological approach to Chennai's water bodies is, in fact, a more utilitarian approach to the environment than the imagination of 'four drainage basins', which would have theoretically taken into account the complex interplay of soil, water and the life forms they house in determining Chennai's urban development. So, what the corporation was espousing was an infrastructural epistemology of water. It was still an engineering epistemology, as the senior official put it:

> "We had civil and mechanical engineers first. Then came the electrical engineers and now, we have environmental engineers." (C53)

The natural environment was on its way to becoming a significant infrastructure of city building – like electricity and roads and needed to be engineered to fit urban lifestyles. But, this was neatly compartmentalised in parallel to the civic function that water served for Metrowater.

The institutional ecology in which engineers in the corporation and Metrowater worked co-produced distinct epistemologies of water resource management along with the material and political environments that they interacted with. The publics that each of these institutions of water governance co-opt are different and defy a clear definition of what urban cohesion or individualising modernism might mean. The Corporation, in planning for ecological infrastructure, was enthusiastic about inviting participation from NGOs and academics, reposing its faith in traditional civil society models. An environmental consultant who has been working in NGOs since the 1980s, and goes along with the pragmatic approach to water resources that the Corporation puts forth said:

> "We do work within the realm of the possible and keep away from rigid posturing. The advantage in doing this is that now, government departments including the PWD and the pollution control board (PCB) have come to rely on our data and reports for their meaningful functioning. We have become reliable and credible and get access to their planning processes. The Corporation has been approaching us more often than before too." (C22)

This NGO is prominent in the field of environmental activism in Chennai, and is often accused of legitimising the state's destructive policies (CE8). But, there is hardly any other organisation that fits the bill of a civil society organisation working with the government in environmental matters. This, according to the above consultant is a matter of lack of knowledge about the natural environment. She continued:

> "When it comes to water supply, though, even we don't have the required research background. I mean, the state of our water supply is so fragile that I'm really not sure anyone can put up a meaningful opposition to the projects that Metrowater comes up with to augment water supply, even if they are sometimes problematic and never holistic." (C22)

Metrowater, simultaneously, was quite clear it didn't need to consult with environmental NGOs. Said an engineering director in the organisation:

> "The desalination plant goes through environmental clearance from the Ministry of Environment & Forests of the Union Government. There were two consultants involved – one to prepare Tender documents, another to evaluate Tenders. They had to take environmental impact into consideration. The district Collector (a revenue officer) has to get a no-objection from the local residents. I don't think there's any room for environmental consultants to get involved here." (C36)

Metrowater's institutional interface, then, remained within a technocratic circle, but its engineers shared their knowledges and drew from the experiences of local residents widely (see Chapter 5). Their engagements spanned an organic civil society, fostered by the socio-material linkages their work created. They recognised this civil work as 'public' work, intended to better public health, sanitation and the city. It wasn't just Metrowater's civil engineers who associated their work with public health and welfare, though. Civil engineers in the private sector working with water supply and sewerage expressed a similar sentiment; their work arguably could be said to contribute towards urban cohesion as much as towards fragmentation.

### 6.2.3. A civil infrastructure – connecting people across time

The designation of a civil engineer was historically applied to builders and designers who put their skills to civilian rather than military use. This usually involved constructing public things like roads, bridges and sewerages. This 'public'-ness remains inherent to the identity and practice of engineers in Metrowater; and is mutually constituted with the structure and function of the things they built. As one of them explained:

> "A networked supply or sewerage system runs on the logic of collective numbers. That is, the water network needs to have sufficient subscribers in order to be carrying a volume of water capable of exerting the necessary pressure to reach the length and breadth of the city." (C16)

But, like other cities around the world, Chennai's rapid development has also meant that piecemeal water supply options like water trucks and small scale reverse osmosis units abound in areas that have been built up far before urban infrastructural networks have caught up. But, even in those neighbourhoods and the so-called gated communities in the outskirts of the city, water engineering emerges necessarily as a public enterprise connecting disparate people spatio-temporally. Rather, the materiality of water infrastructure renders a network inevitable.

For instance, until recently, multi-storeyed apartments seeking to build their own sewage treatment plant (STP) or potable water reuse units needed to get a No-Objection-Certificate (NOC) from Metrowater (C36). The reason was that Metrowater requires a certain volume of sewage running through its system in order for it to function properly. This was when Metrowater had started expanding its system to reach the newly incorporated areas within the expanded city limits:

> "Around three years back, small scale STPs started becoming affordable to building associations and definitely, to real estate companies. It was a nightmare. Suspended solids were getting stuck to pipelines, we couldn't circulate the sewage well enough because subscription was so low. Every day was spent dealing with one issue or the other." (C15)

It wasn't unusual for households in several cities of Tamil Nadu to have a localised sewage tank which disposed their waste until recently. So, the idea of STPs in apartment complexes was not far-fetched to home owners or renters. But, for Metrowater engineers, sewage treatment needed to be public in order to work. It, then, made sense for engineers to think about water supply or sewerage systems as 'bundles'. There is a fundamental paradox to modernist infrastructure that this exposes. If modernist infrastructure indeed enabled individualised water access from the privacy of the home (Gandy 1999), rather than in shared resources in public spaces, it also connected all the individual water users through a network over which they had very little control. They were inevitably part of a network, whose operators are then tasked with the initiative to public welfare and urban cohesion.

The NOC-requirement for private apartments to set up their own STPs was recently made discretionary since environmental responsibility obligates newly built multi-storeyed apartments to incorporate wastewater treatment units within their premises (CD6). Builders set these up as wastewater recycling units instead to take care of watering shared gardens. An engineer who worked for a leading developer of several large residential apartments and IT parks described his obligation thus:

> "If a development has more than 20 dwelling units, we would need to build a sewerage treatment plant within the premises. Most new development happens in the outskirts where a connection to the main sewer is unlikely to be available. So, we'll need to show that we are taking care of sewage to get building approval." (C21)

A specific kind of infrastructural cohesion or exclusion was encouraged by this framework – a private developer building homes for the upper middle class could build their STP, independent of the networked supply and bringing together those households under a shared infrastructure. Real estate companies had, at their service, an array of consultants and contractors to take care of such building approvals and infrastructural requirements. As the engineer put it:

> "There are external consultants for everything – architectural, structural, MEP (Mechanical, Electrical & Plumbing). Only the civil engineers are internal." (C21)

He meant engineers like himself. But, unlike Metrowater engineers who had Masters and research degrees to their name from the top technology institutions, he had competed chemical engineering at one of the hundreds of private colleges that cropped up across south India around the turn of the millennium, catering primarily to the global software industry, and subsequently to the local construction industry as well. He now managed MEP for the real estate company. MEP had become a crucial function for the construction industry because of the multi-layered, negotiated knowledge and tasks it entailed. If a building development were to be planned, it is likely to be outside the city limits now, and required the approvals and STP construction detailed above. "The first step would be to test the soil and find out if it can withstand pumping groundwater for the whole building, actually," the engineer (C21) explained.

As we spoke at his makeshift office in a project site at the southern margins of the city, a steady stream of assistants and contractors popped in to consult with him or get some purchase signed off. One such assistant was assigned to show me the water treatment facilities in the campus; needless to say he was not pleased, when he needed to be negotiating over labour and payments for jobs done by the external contractors (CE18). Even for individual houses, the first step of the construction process has, of recent, been sinking a bore well to extract groundwater, available anywhere between 5 and 250 metres below ground, according to the Central Public Works Department that researches groundwater in the city (C99). This is the water that would be used even for construction - to mix concrete, to cement bricks in place, to plaster over them.

**Figure 17: Residential development in Chennai with the STP (sewage treatment plant) shed in the foreground.**
**Source: Fieldwork photo.**

According to the assistant MEP at the project site mentioned above:

> “The groundwater in these parts is too hard even for construction. So, along with borewell, we also need to install a treatment plant with a reverse osmosis filter. Residents would need to treat the groundwater to make it potable when they move in and so, we might as well start doing that even at the building stage. Also, the labourers, as you know, will be staying in the site itself. They will have to end up drinking the hard water if we don’t treat it on site.” (C66)

Construction labourers are almost always migrant workers who are hired on contract from further north of Chennai. They would move from project to project, setting up house with their families in the very sites they work in. With little stability, protection or entitlement in their contracts, they depended on such rationalities of their employers to access basic services like water, child or healthcare (CE18). But, interestingly for engineers, who are often charged with being technocratic, the socio-materialities of water infrastructure enabled a networking across class lines if only through a temporal separation. That is, far from sharing a network, the home-owner's use of the water treatment plant would come only after the workers' use. The engineer's or the developer's consideration of workers' needs is influenced by their demands on site on a daily basis. But, it was only because a civil engineer on a construction job is typically in charge of labour as well as technical components that they needed to develop a socio-technical engagement with the construction site. There were people involved in this work as much as a filtering unit or pump was.

There was a parallel material logic to it as the MEP engineers identified treatment of hardwater and recycling of waste water as similar functions executed with nearly identical equipment (C21). So, once the basic apparatus for treatment had been set up, they repurposed it for wastewater recycling once the apartments had been occupied. Wastewater recycling involved constructing a series of pre-treatment units that prepared the greywater to be filtered through reverse osmosis to satisfactory quality. So, while groundwater would be passed through a dual media filter of sand or pebbles and activated carbon before being passed through the RO filter, wastewater would go through a 2-step pre-treatment before it goes into the filter. Groundwater is usually sent into the dual media filter directly from storage. Wastewater is first kept in an aeration tank, where it is extensively blown to remove any putrid odours. Then, it goes through a pressure sand filter followed by an activated carbon filter and then finally through the RO filter (CE18).

The MEP engineers also had a complex understanding of the preferences of their clients – the potential residents of their buildings.

> "One of the reasons why the groundwater treatment plant needs to be repurposed after occupation is because residents prefer not to receive a centralised groundwater supply. It makes them feel like they have no control of their water. But, recycling can only be done at the building level and is not possible at the household level. So, the treatment units are repurposed as recycling units." (C66)

> "In households, they are unhappy to use greywater for flushing. They might even use it for washing, if it can be proven that it doesn't damage their clothes. But, they want their toilets to be clean. But, in office buildings, flush toilets are the biggest use for recycled water, along with cooling systems for air conditioners." (C67)

This engineer was from the company that had taken up the contract for water treatment in an IT park. None of these engineers mentioned the environment or sustainability of water systems as rationale for waste water recycling. It was only implied in discussions with senior managers, if at all, as cost-effective and efficient solutions to 'Chennai's water problem'. Recycling technologies, nevertheless, were seeping into the city's waterscape incidental to this managerial discourse.

Writing about modernist water infrastructure development in 19th century Paris or 'Haussmannization', Gandy (1999) traces a shift from communal attitudes towards the body and personal hygiene embodied by pubic baths and night soil collection, to a retreat of water consumption into private dwellings, contained within the new institution of the household bathroom. This "sharpening sense of self-identity under modernity," he argues was leading to a "breakdown in premodern conceptions of the organic cycle linking the body and the city." (Gandy 1999: 25) Yet, the evolution of water infrastructure in Chennai today defies a simple narrative of modernisation, where each infrastructural assemblage comes about through inevitable linking of bodies, through land, water and membrane technologies. Even individual households relying on private property rights to draw groundwater from their backyard were acutely aware of the continuities in the underground water table (CE19). That didn't necessarily translate into communal action or a commons approach to groundwater.

But, they were embedded in a socio-material waterscape that they negotiated on a daily basis. Initiatives towards rainwater harvesting started in 2003-04 accentuated an urban identity of shared water usage even if it lead to no radical political action (see chapter 4). Water engineering, as such, is a public project in Chennai. At this point, it helps to understand the significance of engineering to Chennai's urbanisation at the turn of the millennium.

### 6.2.4. Fragmented but not splintered

Chennai is arguably criss-crossed by institutions of technical education as much as by water bodies and connecting canals. When information technology industries took off in India around the turn of the century, south Indian cities were at the forefront of training and employing young people in technology, encouraging both activities as profitable business. Chennai, consequently, housed numerous engineering colleges, apart from hosting Nehruvian era central government institutions of advanced research like the Indian Institute of Technology and the National Institute of Ocean Technology. Interestingly, several of them were built over existing water bodies or areas of sensitive biodiversity, miring students in urban hydro-politics even before they joined a particular trade[30]. The above institutions still only reflect the top rung of technical education. The second tier is comprised of government-funded ITIs (Industrial Training Institutes) and Polytechnic colleges enabling students to acquire a trade accreditation or diploma in a technological discipline (CD7). With its history of affirmative action and investment in primary education, Tamil Nadu saw widespread interest in young people from eclectic backgrounds taking up these avenues of technical qualification. The many tiers of technical education and its alumni, thus, form a spatial and hierarchical infrastructure supporting everyday urban life and the physical built environment. This also means that there exists a wide range of engineering knowledges, out of which emerges a pragmatic quasi-

[30] Chennai's "IT corridor and a Knowledge Corridor consisting of engineering colleges constructed on waterbodies, and automobile and telecom SEZs and gated residential areas built on important drainage courses and catchments." Jayaraman, N. 18 Nov 2015. Available at: https://scroll.in/article/769928/chennai-floods-are-not-a-natural-disaster-theyve-been-created-by-unrestrained-construction

technocratic approach to everyday water issues that looks nothing like modernist conquest of nature or local knowledge steeped in traditional environmental wisdom.

Most households rely on a combination of groundwater and centralised water supply for their needs. They have a household motor and purifier, usually installed by a plumber, who is likely to have developed his expertise on the job rather than through formal training (CE6). Residents, then, negotiate their anecdotal and experiential knowledge on the materiality of water infrastructure with a similar experiential knowledge held by the plumber. A resident who built his house in the 90s chuckled that he chose the water closets for his bathrooms by talking to a truck driver who transported plumbing equipment around the city. “It helped me get an idea of what type of closet was being ordered the most across the city,” he (C46) explained much to the chagrin of his building contractor who fumed that his sophisticated knowledge on water systems was wasted on clients like this one (C44). A retired engineer (C26) had scoured the market for a sensor to be placed in the overhead water tank to warn when it overflows. A couple of years later, when the city suffered from an extended drought, the sensor became a widely available and used product.

> “There are such simple technological solutions if you knew how to look for them. Obviously, the water sensor must have been made outside Tamil Nadu, that’s why it gives warnings in English and Hindi, rather than in Tamil.” (C26)

And then, there was the Treatment & Transmission engineer from Metrowater who hadn’t gotten over his wonder at the size of the consultant reports on membrane bioreactors (MBR) that adorned his shelves. He had just been posted on the job, but was retiring in 5 months.

> “I joined the Regional Engineering College [institutions on a tier just below IITs] in 1974, then transferred to a Tamil Nadu State college because I was worried about bullying. And now, I’m learning about biofilters and ultra-filtration. What a journey! It’s amazing being an engineer. You never know from whom and how you will learn technology. But, I really don’t know much about reverse osmosis or filtration technologies. You should talk to my

> predecessor about that – he had a Masters degree, you see, and was more clued into latest developments in technology." (C16)

This cacophony of contradictory voices, actions and practices could make a classic case for unbundled infrastructures and a splintering urbanism. But, far from fragmenting societies, each of these technological interventions were what Simone (2004) describes as:

> "incessantly flexible, mobile, and provisional intersections of residents that operate without clearly delineated notions of how the city is to be inhabited and used." (Simone 2004: 407)

This, he (ibid.) calls 'people as infrastructure' because the intersections "depended on the ability of residents to engage complex combinations of objects, spaces, persons, and practices" and were "a platform providing for and reproducing life in the city" (p.408). Urban fragmentation might only come about where infrastructure has necessarily lead to a singular urbanisation and technology has meant efficient ordering of urban space. Instead of a divided urban functionality of engineering experts and responsible water users, there is an 'all hands on deck' approach to technologies, knowledges and practices of water access and use in Chennai. This also meant that there was a sense of a shared material city, where there were nevertheless agencies and hierarchies of power acting to claim a larger share of resources than others.

Older and richer residents of the city, for instance, were infuriated by what they think the growth in multi-storeyed apartments and rapid industrial and residential development in the city does to their supply of water. Their concerns are about groundwater which they have been able to pump freely from their backyards using borewells so far.

> "But, it's not like a storage tank behind my house, you know? Groundwater is like a continuous river under the ground. So, if a builder pumps water for a

> large apartment complex in the next street, it will affect my water table too." (C47)

The rainwater harvesting campaign of 2003-04 emphasized the need for individual houses to build these systems in order to improve the groundwater table of the city as a whole, cultivating a biopolitical subjectivity, linking bodies to the urban and its material ecologies. Gandy observes of modernising Paris:

> "The reconstruction reflected the needs of an urban mercantile class that faced the consequences of modernity not by an escape into romantic anti-urbanism but through a celebration of the possibilities for the technological mastery of urban space and progressively greater degrees of social and spatial order." (Gandy 1999: 29)

Deployment of water technologies in Chennai was hardly leading to any 'mastery of urban space' or 'greater degrees of social and spatial order'. But, the city's middle classes would certainly identify with the sentiment of celebrating possibilities to negotiate urban life through the aid of these technologies. In this way, they have much in common with what Simone argues about African cities:

> "…these flexible configurations are pursued not in some essential contrast to non-African urban priorities or values but as specific routes to a kind of stability and regularity that non-African cities have historically attempted to realize." (Simone 2004: 410)

Simply put, global technologies that circulate in Chennai are among the various strategies and socio-technical manoeuvres that its residents adopt to fulfil deeply personal needs. They are indeed in pursuit of modernity, just not the same one that European cities might have pursued before; their methods are indeed full of flaws and injustices, and cannot be essentialised as a fundamentally distinct philosophy to that of European modernism or informed by ecological wisdom. Furlong & Kooy (2017: 888) analyse these spatialised power relations as "distinct forms of fragmentation" brought about by a water supply system "where neither water nor nature are wholly contained by infrastructure." But, as seen above, infrastructure does not have to be defined as necessarily a physical network that works seamlessly in the background. In many ways, 'people as infrastructure' captures the interconnected, even invisible nature of urban relations that characterise the epistemologies of water engineering in Chennai. They could indeed be described as fragmented infrastructures, but they are far from being splintered (Graham & Marvin 2001) by the introduction of global capital or private partnerships. If anything, it is the building up of a unified network that could ultimately splinter the networks of people as infrastructure, by making locally negotiated relational infrastructures redundant or unnecessary. In London, on the contrary, water engineering does not focus on networks, but seeks to keep the water supply system as unified and monolithic as possible. To this end, as we'll see in the following section, it works to isolate any risk of that system getting disturbed and seeks to ensure that the urban fabric is as little disturbed as possible.

## 6.3. London: Cyclical epistemologies – risk and resilience

Engineers in British water companies, it was recently revealed, are sometimes in the practice of using divining or dowsing rods to check for leakage in pipes underground. When a science blogger[31] spotted this happening and tweeted to the water company concerned, almost all UK water companies including Thames Water responded confirming that they indeed did use this 'technology'[32]. The reasoning they gave was that detecting leakage was notoriously difficult and an inexact science. So, they tried every trick in the book to get it done. The concern here is that 'divining' is in no book. It wasn't a method accepted by modern science or engineering practice; nor was it known to work, however inexplicably, except in obscure anecdotes. These anecdotes are usually accounted for by statistical randomness (the chances of detecting water at a place would have been the same if it had been dug up at random) or unconscious

[31] "In 2017, UK water companies still rely on 'magic'". Salle Le Page. Medium. https://medium.com/@sallylepage/in-2017-uk-water-companies-still-rely-on-magic-6eb62e036b02
[32] "UK water firms admit using divining rods to find leaks and pipes". The Guardian. 21 Nov 2017. https://www.theguardian.com/business/2017/nov/21/uk-water-firms-admit-using-divining-rods-to-find-leaks-and-pipes

motor movements by the engineers who have a sense for where the water leak could be through prior experience or environmental data[33]. This is an extreme example of UK water companies' outcome-oriented rather than practice-determined or scientifically reasoned approach to water management. Nevertheless, it is an example of how water engineering in the UK takes the path of least risk. It also indicates the 'irrationality' of certain modern practices, which would usually be attributed to superstition or insufficient modernity elsewhere in the world, but in the UK with its claim to the longest and strongest legacy of scientific water engineering, forces analytical thinking about the socio-material assemblages that nurture its existence.

'Divining' for leaks, for UK water companies, was an inexpensive and one of the least risky means of getting measurable output, even if that measurement could be discouraging. The output or the number of leaks detected might be the same as the number of leaks guessed through random probability. But, it is also a zero cost technology, meaning it was very low risk, but still an action against leakage. For an engineer working on membrane technologies, on the contrary:

> "Our projects, anyway, require rigorous modelling before it can be executed, to ensure safety and elimination of possible risk. Water quality is, after all, defined in terms of risk. But, for the recycling project, it was necessary to do even higher risk assessment, by conducting public perception studies." (L33)

> "In Thames Water Authority, the public body, there was political reluctance towards borrowing for or spending on risky projects. Now, between regulation and investors, something like wastewater recycling is risky because of public perception. If something goes wrong, it is a higher risk of failure." (L34)

[33] "Water divining is bunk. So why do myths continue to trump science?" Philip Ball. *The Guardian*. 22 Nov 2017. https://www.theguardian.com/commentisfree/2017/nov/22/water-divining-bunk-popular-myths-science-sally-le-page

It was an interesting articulation of risk as something heightened by or measured through public perception, since risk as a professional concept involved quantifying perceived uncertainties into calculable numerical values (MacGillivray et al. 2006). Among the myriad of engineers, consultants and managers working on water in London, several scientific knowledges converged on this epistemology of risk. It was the theme most repeated in my interview codes, with concepts like cost, politics, climate change and resilience all translating into risk in unscripted conversation. As a senior official in the Government Office for Science, talking about a collaborative project with scientists on the future of cities, said:

> "Resilience is a key component of the 'Future of Cities' project. Imagining what British Cities would look like in the next 50 years involves imagining and preparing for a lot of risk and ways to mitigate or reduce that." (L7)

Water was framed as particularly risky business by those in the industry like the 'Global Water Business Leader' of a leading consultancy in London:

> "Water presents big risks in the future because that's how the effects of climate change will be felt – through shock events like floods and storms and through incremental changes like sea level rise." (L8)

Risk, as historians of technology have argued, has been a field that did intentionally bring together a wide range of knowledges and disciplinary backgrounds (Hansson 2005, Jasanoff 1993). It was an interdisciplinary epistemology to begin with, meant to tackle the increased or distinct nature of risk that modern society was perceived to be facing (Beck 1992). It is precisely because risk is imprecise as a pure scientific concept – that is, it is a social attribute assigned to events in the material world – that it attracted interdisciplinarity and a governance approach to techno-scientific initiatives. Yet, the statistics and numerical values attached to risk perception are often construed as an objective rather than a subjective measurement of a socio-material world, in some technocratic circles (Aven et al 2011). For engineers and consultants in London, the imminence and quantifiability of risk made it a legitimate scientific epistemology. Various engineering and resource management epistemologies were sought to be bridged through a governance framework structured around risk and resilience.

Some of these quantified risks are easily traceable to subjective perceptions or even strategies, like the 2014 annual water report prepared by the London-headquartered global thinktank CDP (formerly the Carbon Disclosure Project) titled *From Water Risk to Value Creation*. A report ostensibly about risk in the water sector or of water problems is, in fact, attempting to answer the question "what shareholder value is put at risk by poor management of water exposures?" (LD14, p.8) A director of cities in the thinktank explained its approach to assessing risk:

> "It is a survey methodology. We send questionnaires to companies and cities about their environmental futures. Most businesses do respond with concern – nearly 68% said that water poses a substantial risk to their business; 22% said it constrains their growth. Cities have a lesser response rate – only about 30% responded totally." (L9)

The risk reported by the thinktank is clearly a calculation of the perception of how much a company stands to lose through potential problems with water, which could range from specific local climactic variations to institutional or political issues in the geography they operate in. But, the above figure of 68% of companies reporting risk becomes objective data on global water risk.

### 6.3.1. Quantifying and materialising uncertainties of an invisible environment

In the UK water sector, risk is a factor built into the regulatory framework governing water companies. Regulation attempts to bridge the disciplinary differences in water management through a shared formula of risk mitigation. For Thames Water, the Security of Supply Index (SOSI) – a measure monitored by Ofwat – was important in explaining the desalination project. Ofwat explains the index as:

> "The index allows us to assess each company's compliance with its duty to ensure the security of its water supplies. It does this by assessing the extent

> to which a company is able to guarantee its planned level of service at the end of the report year." (LD11)

Scored on a maximum of 100, the SOSI allows for companies to place restrictions on their service, like hosepipe bans under exceptionally dry conditions, by measuring supply against the company's own 'planned level of service'. To declare this planned level of service, companies have to work out the estimated demand and plan for a 'headroom' over their existing supply (LD15, p. 8-9). The calculation of SOSI, is then, based on a range of techno-material variables including a private company's planned level of service for a given year and a government's expectations of a certain level of service and its stipulation of what counts for a drought. In conversations with water managers, the SOSI is often explained in the language of risk, with the regulatory formula standing in for an objective calculation of that risk.

> "What the regulatory system does is to run on a risk basis and they want the water companies to take that risk. There are environmental or demand conditions beyond the control of the regulators or the companies, which is what leads to risk of shortage in water supply or imposing use restrictions. Companies are obliged to plan for these changes in demand by investing in new infrastructure or demand control measures. They have to then plan for it in such a way that there is no corporate risk in making those investments. As far as the regulators are concerned, the risk is transferred from the environment and users to the companies." (L17)

From a governance perspective, the concern raised is that water companies might then declare a lower headroom, thus risking water supply as well as the environment by being unplanned for water shortages. A House of Lords committee on science & technology examined the effectiveness of this regulatory framework in preparing for drought in 2006 when the south east of England faced low rainfall and potential water shortages. It observed:

> Companies that underestimate target headroom values are likely to need to apply customer restrictions far more frequently than claimed and may be

placing the environment at risk as they seek drought permits—which allow them to take water from new sources or to alter restrictions on existing abstractions—in periods that are not exceptionally dry. (LD1, p.18)

But, as seen in the case of the desalination plant, environmental risks are financialised into assets through material infrastructure, working in the company's interest to estimate a headroom than not. As Loftus & March (2016) point out, it was rather 'convenient' for Thames Water that their estimated headroom was exactly 150 MLD, matching the capacity that the desalination plant was planned for. The Beckton desalination plant, by most accounts, was conceived and built over this period of low rainfall in the Thames Valley, which ostensibly faced a potential shortfall of about 150 MLD in available supply or estimated headroom.

"Under drought conditions only, the desalination plant needs to be active. At other times, which is most of the time, it's just sitting there, not using up much of the company's resources. But, it fulfilled the regulatory obligation and goes into the company's assets, which will enable an increase in charges that can be collected for water. From a corporate perspective, not a bad plan." (L17)

Since water supply is essentially a private monopoly in England & Wales, Ofwat regulates the price that users pay for water in each river basin. This is determined by a measure called the Regulatory Capital Value (RCV) which assesses the capital base of the company each year. The RCV is supposed to incentivise investment in the water infrastructure by allowing companies to charge the user for the benefit of those investments. So, the desalination plant, for example was an investment that Thames Water made for which it will be allowed to charge users, who, in theory, benefit from improved security of water supply. The initial value of RCV was calculated in 1990, the year after privatisation, as the sum of each company's average capital value in financial markets and the value of its debt. With this as the base, each year, RCV is calculated as follows:

> "Capital expenditure to enhance and maintain the network, which is assumed in setting price limits, is added to the RCV. Any capital grants or contributions towards the cost of the new assets are deducted. Current cost depreciation, which is assumed in setting price limits, is deducted from the RCV each year. Expenditure in any one year to maintain and replace infrastructure assets (infrastructure renewals expenditure or IRE) is not directly added to the RCV" (LD12)

Simplifying it, investments in new infrastructure are rewarded by price increase while maintenance is expected to be financed through the company's own means. As an assessment of RCV as a model for utility markets submitted to Ofgem's (the gas & electricity regulator) review of energy network regulation in 2009 argues:

> "…when utility prices are set to cover current cost depreciation, and to earn a market interest rate of return on the current cost capital value of the industry, (as happens under current cost RCV pricing), then the very act of investing in capital assets yields a large cash surplus to the utility. Investment itself thus becomes a highly profitable activity - largely irrespective of whether or not the investment yields an adequate physical return" (LD13)

Essentially, the risk conception of a regulator turned out to be very different from that of a private company, which converted it quite literally into an opportunity. But, as a former civil servant (C37) who consults extensively with regulatory agencies observed, what works for a single company's shareholder value may not work for the industry as a whole.

> "The water industry has financed its huge capital expenditure (£108 billion from privatisation in 1989 to 2013) by borrowing rather than through raising share capital. This trend has been encouraged by very low interest rates…the financing structure is too risky as losses would quickly wipe out many companies rather limited equity bases, leaving them insolvent." (L37)

In other words, the risk, once financialised, might not have been converted into an opportunity but spatialised through material infrastructures. Unlike engineering knowledges, different epistemologies of risk obscure the transformation of environmental uncertainties into public infrastructures of material and financial flows (Bear 2015), through a seemingly objective calculative framework. The calculations, in attempting to make legible subjective perceptions and expectations, reinforce the boundary-marking quality of water infrastructure. They are meant to be known and deciphered only by experts in water management, yet they involve the city and its residents in the risk through the materiality of the boundary object (Star 2010) – the essential role that water supply plays in urban society.

### 6.3.2. The temporal transition of risk to resilience

Risk wasn't only spatialised but also went through a temporal translation. It was always a prediction of what was to come, of course. The desalination plant built presently was not as a response to existing need, as in the case of Chennai, but meant to address a potential need or problem that might arise in the future. What's of interest here is how far into the future infrastructural planning is allowed to look.

> "The whole regulatory model inspires small increases; it encourages you to take small bites. You're still under short term risks, but you're not allowed to take a big bite. That's partly why, when Thames Water worked out their plans during the low rainfall years, a desalination plant that could be built in under 4 years took precedence over their long term plan for a reservoir at Abingdon. The shortfall was only about 150 MLD; sure, a reservoir would have taken care of long term shortfalls, but it would have required huge capital investment which would not be allowed to be passed on to the user through pricing. Long term risks were out of the question." (L17)

A big risk is reduced by planning for it over a long term, because the capital cost is recovered over a very long time period. But, an asset like a reservoir depreciates in the 30-40 years over which its cost is to be recovered, eventually making little difference to the company's RCV and potential increase in water pricing. The water companies could make those investments without passing on the price to the users, which, naturally, is not in the interests of a private for-profit business. So, the gradual yet perceptible processes of climate change and urbanisation, occurring over decades or centuries is sought to be handled in instalments of annual planning cycles. The risk is, then, renewed each year, and kept alive, driving the process of calculation, infrastructure building and further risk assessment.

> "In London, we work with what we call the risk of two dry winters. Summer showers are too minimal and lost to evaporation. It's the winter precipitation that replenishes our reservoirs and aquifers. If it's one dry winter, we have enough storage capacity to keep going. But, two dry winters and we'll have to declare drought. There are an average of about two such droughts over twenty years. So, there is always a risk of two dry winters." (L38)

When there is a drought, Thames Water, as a first step can issue a hose pipe ban – preventing use of hosepipes to water gardens or clean cars etc. This, as the above respondent (L38) explained, took 12-16 weeks to be approved after public consultations.

> "The Environment Agency would also put pressure on you to implement this ban to protect ecological reserves. But, from a supply point of view, by the time the ban is approved, you've already crossed halfway through the drought period and it's already too late to implement meaningful demand control." (L38)

Not only is the long term risks posed by climate change distilled down to a matter of annual drought, but its control measures are determined by a time period of 12-16 weeks. Risk also inevitably increased over time or in a given time period:

> "In 2005-06, we could predict that in the next 5 years, the risk of moving to standpipes and stopping piped water would increase. We couldn't say which year that might happen, but the water system was under stress and that would only keep increasing. We were calculating risk based on predicted

> demand and population increase; but we couldn't predict that the rainfall would be better next year or the year after." (L34)

Standpipes here were only an imagination of the stress that the water system was under. The risk of standpipes, water managers freely admitted, was only a bogeyman. The very purpose of the institutions of water management was to ensure that the standpipes never materialised and remained an image of risk in planning processes (LD11). This was called the 'resilience' of water systems.

> "Perhaps some residents may not mind interruption of supply or reduced water supply. But, on behalf of populations at risk – the elderly, hospitals etc. – water systems have to be resilient. They have to at the very minimum supply water 24 hours per day on all 7 days of the week. This is a reasonable expectation." (L34)

> "For any British water company, there are literally hundreds of options at disposal to augment supply or control demand. But, there is the matter of resilience to take into account. That's why brackish water desalination emerged as the ideal solution to London's supply gap." (L38)

For desalination is termed a drought-proofing technology or climate-change mitigation measure in that it was not dependent on rainfall or other annual climactic vagaries to function. But, it still formed only a finite back up of 150 MLD, which was bound to fall short very soon. Beyond simply balancing supply and demand, a senior executive at Thames Water even gave risk of a potential terrorist attack on London as reason to build a desalination plant.

> "Resilience planning is not simply about checking if we have enough water in the pot to last this year. We have to take all kinds of factors into account – what if there was an attack on London? The city has been constantly under threat – we need technological projects, then, that can handle any kind of crisis." (L18)

It was unclear why technologies like desalination were more resistant to unknown threats than other options like pipes with reduced leakage. When asked, the executive declined to explain further as it was a matter of national security that Thames Water had to handle with caution. Risk and resilience then formed a virtuous cycle. Prediction of risk would need planning for resilience, which being non-negotiable, will always prevent any predicted risk. In the absence of predicted risk, there were always unknown risks like the ones the executive above mentioned.

As scholars from a wide spectrum of disciplinary backgrounds and political approaches have pointed out, it is necessary to understand that resilience is a multifaceted thing (Anderson 2015) and that it is a way of working with the fundamental uncertainties of socio-environmental relationships rather than avoiding them definitively (Dessai et al. 2013). There has been attempt to separate the ecological and social aspects of resilience (Cote & Nightingale 2012) or rethink how the descriptive concept of resilience can be converted into a normative agenda (Weichselgartner & Kelman 2015). But, these studies still maintain that there does exist a scientific or normative idea of resilience that needs to be reconciled with social needs. Critical analyses of resilience, as Anderson points out (2015), can swing to the other end, terming resilience more often than not a neoliberal construct. He posits instead that we take the 'diversity of resilience' seriously and understand how they actually assume a certain form and practice.

It is precisely this question that Patricia Gober raises about the water industry when she contends:

> "…the water resources community has been slow to embrace new paradigms for long-term water planning and policy. Too much attention has been focused on reducing, clarifying, and representing climatic uncertainty and too little attention has been directed to building capacity to accommodate uncertainty and change." (Gober 2013: 955)

Her arguments are based on findings in North American water industries, and so, indicate that it is not strictly the regulatory framework in England and Wales that drives Thames Water towards this mode of resilience planning. They direct towards a broader rethink of how we understand socio-natural interactions and what we believe the social agency in managing them is. The attempt to quantify risk and plan for it as an objective measure to be overcome also has:

> "a tendency to reinforce a long-standing blame culture that drives interest in the development of behaviour change initiatives while the relatively unchallenged hydraulic mission to provide safe drinking water and sanitation progresses." (Pearce et al. 2013)

The 'hydraulic mission' of building a desalination plant in London, however, was challenged, by the then Mayor of London, who questioned the practice of resilience by disrupting the annual planning cycles that the water sector followed, demanding that the longer term issue of fixing the city's leaky pipes be undertaken instead. This was however possible only because of the individual discretionary power vested in the Mayor, and was not successful in the end. The next chapter will explore the contestation between the Mayor and Thames Water in detail.

## 6.4. Conclusion

The framing of technical networks as socio-technical in the social sciences has been echoed in the engineering disciplines, where there have been calls for a paradigm shift in the approaches needed to tackle issues of the Anthropocene like sustainability or climate resilience (Halbe et al 2015, Marlow et al 2013). Engineers have been urged to take further interest in the institutional, political and social structures that their work is embedded in, in order to achieve sustainable changes in technical networks (Clift 1998). To this end models and methodologies such as integrated water resource management (IWRM) or Life Cycle Analysis have been developed (Lundin & Morrison 2002). However, these approaches start from the premise that engineering work is scientific and technical, and unaware of its social embeddedness. The above chapter considered what those technological epistemologies might be and how they interact with the socio-political environment. It has traced how the multiplicity of engineering knowledges constitute the compartmentalised identities of water professionals discussed in the previous chapters.

In Chennai, distinct engineering disciplines were visible in the work performed for urban water supply, especially in new technologies and efforts directed towards more consistent and integrated flows. Each of those disciplinary knowledges were co-constituted with the institutional structure they were part of and the larger political geography of the city in which the work was embedded. In other words, engineering work was already social and political. Engineers were far from being unaware of this, and frequently used their knowledge of the surrounding social ecology in their work, sustainability being incidental to it, even if working on green technologies like recycling. In London, the diverse technological functions that make up a water management system were sought to be reconciled through standardised calculations and regulatory formulas. This chapter paid specific attention to the calculation of risk and how it came to be a dominant epistemology of water management. Through the 'scientisation' of risk i.e. adhering to mathematical models using supposedly objective data, "the epistemological ambiguity – implicit multivalency – of 'realist' environmental and risk discourse" (Wynne 2002: 460) was made into technocratic truth.

In the light of this renewed attempt at infrastructural networking in cities, across disparate contexts and very different consequences, their 'multivalent reality' is ignored by Graham & Marvin's (2001) theory of splintering urbanism, which reposes far too much certainty in the cohesive power of centralised networks:

> "In the broad shift from the single, coherent infrastructure networks laid out during the modern ideal to the competing, overlaid patchworks of unbundled networks now emerging, we would argue that the geographies of topological connection and exclusion, as manifest within contemporary cities, are becoming much more complex and uneven. Single geographies where networks bind spaces and cities are giving way to multiple, overlaid and customised grids that unevenly connect parts of cities together and to intensifying interactions elsewhere." (Graham & Marvin 2001: 189)

What they have described here is fundamentally the nature of urbanisation, even in the era of peak modernisation. The mushrooming of several discrete technologies of water access and the associated knowledges they sprout, this chapter has argued, need attention at the micropolitical level and cannot be taken to be agents of splintering necessarily. They also exist to bring the network together or keep a centralised network as unchanged as possible. This, however, does not mean that there aren't spatial hierarchies or divisions produced through the planning and construction of infrastructure.

In cities of the global South discrete bundled networks engender dynamic forms of coherence as seen through the shifting uses of reverse osmosis filters in the building sites of Chennai's suburbs. This was enabled through the work of engineers who utilised the membrane technologies in multiple and efficient ways to cater to what they conceived as their social constituents. However, the coherence they achieved through temporal separation of their uses also maintained the class-based divisions across those temporalities (section 6.2.3). Attention to the everyday practices of infrastructure-making, especially the people who constituted the networks though their physical mobilities, here allowed excavation of the lived experience of resource access and exclusion within a bundled network. Additions to London's water infrastructure, on the other hand, are driven towards keeping it as unchanged and unitary as possible through planning for risk and resilience. Tracing these concepts in practice in Thames Water's planning for the desalination plant, it is evident that this is oriented towards a goal of hydraulic continuity rather than achieving the simultaneous goals of preparedness for environmental change and universal supply that 'resilience' is expected to address.

Tensions between environmental and hydraulic or engineering rationales are however not limited to conservation of water and the maintenance of networks for consistent urban water use. As the following chapter will show, contestations against the desalination plants rooted in the realm of the environmental emerged in Chennai as well London, albeit from very different places.

# 7. POLITICS OF CONTESTATION

## 7.1. Introduction

This chapter presents an account of political contestations around the desalination project in Chennai and London, both of which, however, did not manage to alter the project or the larger infrastructure planning for the city in any immediate sense. Yet, they gave rise to a mode of doing politics and to specific political groupings. The recent surge of interest among social scientists in the study of infrastructure, in fact, reflects precisely such inevitable political possibilities that complex socio-technical projects present. That's why infrastructures have been called *res publica*, even if they were privatised and run for profit – their materiality and utility make them a public matter (Colas & Kharkhordin 2009), no matter their governance structure. Andrew Barry (2002), however, goes a step further to argue that technological projects have unique political potential precisely because the rationalities that make them legible and the metrological work done to depoliticise them produce contestable outcomes or objects.

These objects usually take the form of information, published or circulated, which are contestable not necessarily for their content but because of the attention they draw in the public sphere.

> "Metrology puts new objects into circulation. It multiplies realities by creating objects that can be regarded neither as reflections of reality nor as the expressions of the social subjects who created them." (Barry 2002: 277)

This approach to infrastructural politics, then, limits the extent to which the state, a particular institution or private company could be held accountable for public affairs, especially if they pertain to a distributive resource like water. Instead, it distributes responsibility through social and material networks to reveal the complex and intricate connections that sustain infrastructures the way they are. This means it also demands attention to the marginalised concerns and connections that those infrastructures give rise to (Coutard & Guy 2007). In some cases, these contestations, much like traditional politics, manage to effect long lasting change in institutional structures, policies or the spatial and material construction of the city.

However, in social studies of water, desalination plants continue to be viewed through the lens of technological solutionism and depoliticising technocracy. They have been called a hydro-scalar fix:

> "Whereas terrestrial waters are marred by complex property rights, inserted in dense regulatory and institutional arrangements, infused with all manner of social, cultural, and ecological conflict, and integral parts of often intractable geopolitical tensions, seawater appears to be free of these highly charged meanings, claims, and practices. As such, the incorporation of the sea into the politics of produced water can be usefully identified as a scalar fix" (Swyngedouw 2013: 262)

As the case of Chennai and London will show below, the coast or any littoral space is far from being free of meanings, contentious or otherwise. Making use of them for urban development, as seen through the history of the coast in Chennai and of the Thames in London (Kelly 2018), involves a continuous negotiation of claims and practices. Despite the analytical similarities, though, the political opposition in the two cities were very different in terms of who it came from and how. In Chennai, it is the physical materiality of desalination that gave rise to it; and in London, the abstract discourse that justified desalination. So, the chapter will deal with them on a case study basis, delving into coastal Chennai first followed by the corridors of the London government in the second part. Section 7.2 explains the coastal ecology of Chennai, followed by an ethnographic encounter with the socio-ecological condition of its northern coast where the first desalination plant was built (section 7.2.1). Section 7.2.2 discusses how coastal development in the city has been challenged through ontological manoeuvres on the part of two prominent groups of activists. Section 7.2.3 then traces the emergence of an organic but contradictory and contingent practice of political contestation from the city's southern periphery where the second desalination plant was built. Section 7.3 sets out the background for the contestation of the desalination project in London by delineating the background of sustainable development objectives that formed the basis of the constitution of the London government in 1999. Section 7.3.1 introduces the political background of the first elected Mayor of London and what this meant for the agenda of the London government. Section 7.3.2 discusses the Mayor's contestation of the desalination plant on detail, arguing that the discretionary powers vested in the individualised authority of the Mayor enabled an antagonistic politics that had not been common in planning for water infrastructure in the city.

## 7.2. Chennai - Between sea and land

Along Chennai's long, nearly unbroken coastline, neither the sea nor the coast are uninhabited spaces outside urban politics. It social ecology is unique owing to the persistence of fishing communities, settled at regular intervals along the coast. Between river estuaries, ports and popular beaches, there are settlements comprised of a mix of huts, self-built homes and low income housing complexes where these communities of urban poor reside (see Figure 18 & 19). When there is an industrial or beautification project proposed along the coast, voices of dissent almost always emerge from those communities who, rightly, fear eviction or a forced end to their life in that part of the city. The arguments put forth in protest are usually two-fold – of lives and livelihoods.


**Figure 18: Nochikuppam, a coastal settlement in the heart of Chennai, near the Adyar estuary.**
**Source: Fieldwork photos.**

Since they were fishing communities, displacing them would affect their access to the sea thus placing them at severe disadvantage towards their means of survival. The term ‘livelihood’ carries with it the connotation of a job performed by the poor for bare survival; and often firmly coupled with the identity of the people in question. Thus, if fishers were denied their livelihood, they would then be unable to do any other work just as well because fishing was not just their job – it was their very way of life, tied to their bodily ability and social identity. That fishers might have to end up doing some other job also constituted a collective failure to protect a purer, more organic way of living and a loss of ecological heritage.


**Figure 19: Map of key coastal sites, Chennai.**
**Source: Map data from Google.**

The case of Nochikuppam located near the city's iconic Marina beach was one such high-profile instance of feared eviction.[34] Environmental and rights activists adopt the same strategy in putting forth a case against undemocratic anti-poor projects, forced evictions and environmentally destructive planning as well.[35]

The desalination plants, located on the coast, have, in the course of being announced, planned and built, attracted similar criticism and protest[36]. But, located far away from the city centre, the coastal communities they could potentially affect were not really related or even allied with the more politically experienced and visible coastal communities within the city. So, while there were occasional reports of protest against desalination by local residents and environmentalists raised concerns about how the discharge of residue from the plants could affect marine life, there wasn't the kind of consistent mobilisation as in Nochikuppam. This section will attempt to understand how and why this happened, through interactions with the coastal communities concerned combined with observation and follow-up on the ecological politics that have developed around those areas. It argues that the category of fishers is a political subjectivity, one that has evolved recently in response to the littoral development of the urban. The subjectivity is also often something thrust on an imagined community, whose politics can be understood better using the concept of desire than of collective environmental sustainability. Coastal development in Chennai including projects like desalination provokes amongst these communities:

[34] "Fisherfolk flag concerns over Marina Loop Road extension". The Times of India. 25 Jun2 2017. See: https://timesofindia.indiatimes.com/city/chennai/fisherfolk-flag-concerns-over-marina-loop-road-extension/articleshow/59305599.cms

[35] For further information on opposition to the beach beautification or coastal development projects, see:
http://theothermedia.in/fishers-oppose-beach-beautification-project/ and https://coastalresourcecentre.wordpress.com/2015/03/13/eviction-notice-given-to-fishing-communities-on-marina-loop-road/

[36] See: http://www.downtoearth.org.in/news/a-salty-resort-53979 and https://www.thenewsminute.com/article/nemmeli-desalination-plant-ruins-ecology-and-livelihoods-tn-govt-plans-two-more-units-54145

> “complicated emotional investments that induce a range of sometimes counterintuitive responses and distinct, if ephemeral sensibilities.” (Larkin 2013: 234)

The divergent and often contradictory ways in which coastal communities responded to the two desalination plants and yet, fed a uniform narrative of fishers’ livelihoods demonstrates the tension between Chennai’s dynamic hydro-ecology and its rapid infrastructural development.

### 7.2.1. Placing fishers in coastal resistance

The two desalination plants in Chennai are in vastly different locations – one in the northern outskirts and the other longitudinally opposite in the southern end of the city’s coastline. Both plants are carefully situated just outside the city limits, thus falling within the administration of the local Panchayat rather than the Chennai city corporation. It isn’t just their positioning in the city’s extremities that make them differently situated, but also the distinctive spatial politics of those locations.

The first desalination plant was opened in 2010 in a village called Kattupalli, about 30 km to the north of the city centre. The village was located on a long island that, in maps, appears to have inadvertently detached itself from the city in allowing the Kosasthalaiyar river to join the sea. Its efforts might be in vain though, as the river estuary, known as Ennore creek locally, is the site of massive industrial development and so, is in danger of silting up and blocking the river’s flow into the sea. But, the island’s detachment from the city stays unchanged, the industries on its fragile land hardly accessible or visible to the city-dweller.

> “They pick the island for industrial development because there, it’s only nature they have to deal with, not as many people who may object or demand accountability. They can use technology on nature, but people can’t be silenced with the same tools, can they?” (C32)

This was from a supervisor (C32) at one of the industries in the island; he was also an activist and a co-ordinator for journalistic visits or political mobilisation in the area.

He seemed to have spoken too soon, though, as the road that lead us from Chennai's northernmost commuter terminal of Ennore to the Kattupalli plant was gradually reverting to its presumably original marshy state. Nature, it appeared, couldn't be taken over by technology, either. He didn't have to take that road on his daily commute because he lived even further north of the island in the town of Pulicat, a historic trading port with links to the Arabian peninsula and would-be European colonisers[37].

The town was on the banks of the Pulicat lake, one of the largest brackish water lakes in India, formed at the estuary of the river Arani. The whole region defied the binary between land and water or salt and fresh, with rivers and sea intertwining among villages. It nurtures an ecosystem rich in aquatic life; attracts migratory birds annually; and is home to diverse communities with trading histories. Yet, all that one sees north of Ennore are huge warehouse style buildings, chimneys spewing smoke and lorries carrying things, leaving clouds of dust behind them and pockmarking roads beyond usability for other commuters. Ennore is home to thermal power stations, oil refineries, fertiliser and cement factories and a port. To the north of Pulicat lake, there is even one of India's two main space stations – in an island called Sriharikota in the neighbouring state of Andhra. It is in this setting that Kattupalli island's recent industrialisation fits in. A private company has been building a shipyard cum port in the island since 2009; so at the time of fieldwork most of the island sported fences and large signs warning that work was underway, but without much by way of built structures. The public sector Ennore port was also located in the island, with conveyor belts taking goods across the river's breadth, connecting materials seamlessly across land and water.

The island had an air of something of a large scale industrial development about it, giving away no clues about its history or human settlements. It serves as the supplier of essential materials for sustaining Chennai – power, oil, cement and now, water. But, like the rest of Chennai, coastal settlements co-exist, if uncomfortably, with

[37] "The Pulicat Story", The Hindu, 04 Jul 2013, see: http://www.thehindu.com/todays-paper/tp-in-school/the-pulicat-story/article4878802.ece

heavy polluting industries. To the south in Ennore and to the west, on the other side of the river in Minjur (the name translates as 'fish town'), this has been the case for decades now. But, it would be difficult to encompass the experience of those villages and its residents within a uniform paradigm of fishers' livelihoods. In one of Kattupalli's villages, Koraikuppam, a resident said:

> "We have never fished in the river before, but now, all the industries discharge their effluents in the sea. So, we're having to make do with river fish – we don't have the knowledge to catch those efficiently." (C34)

Some of the villages around there had disappeared or 'moved' to make way for industries. But, the next village, Sathankuppam, and the one after that, Kattupallikuppam, had a different story:

> "People here don't go out to fish in the sea because the river has so much to offer. They are river fishers. So, we don't know much about how the industries might affect life in the sea. But, if the river silts up, yes, we can't go fishing." (C79)

> "Fishing was not really our traditional occupation. Our ancestors kept moving from the north, in Andhra, until somehow they ended up in this swampy area. So, fish was just one of the many things we ate and in order to eat it, we had to catch it first." (C80)

This fishing activity is not necessarily performed exactly where a coastal community lives. For one, fishing involves going out to the sea, which is usually not on a straight line from a point on the coast. Small scale fishers also have a common dock to unload and sell their catch south of Ennore at Kasimedu Harbour, which comes under the control of the Chennai port. The fish that is sold in markets along coastal settlements, as in Nochikuppam, is a mix of catch brought in by the local fishermen and fish bought by the traders, almost all women, in the Kasimedu market. In some households, it was only the women who was engaged in fisheries by being a trader in the market while the men went for work in the city, neatly inverting the expectation that fishers are men, helped by the women in their family.

In coastal North Chennai, both men and women went to work in the industries around there.

> "You came down the road, so you know what that's like. We rely on company-provided transport to get to work and back. Without that, we wouldn't be able to get anywhere. Some of the women in the area have pooled together to get a 'share auto' to serve the area. That still means they have to leave very early in the morning and return when the auto driver is willing to spare time for this area." (C34)

The new private port in Kattupalli and the desalination plant may be recent; but residents in the area have lived next door to power plants, oil refineries, cement and fertiliser factories, if only in an unhealthy relationship.

> "We have been crying ourselves hoarse about fly ash from factories dispersing in the wind. Some political parties take interest sometimes, but not much changes. Well, the fly ash is now discharged into the water rather than let out in the air. That's change, I guess. The desalination plant is simply adding to this marine pollution by discharging their brine residue in the sea. I'm not saying that their pollution is excusable or lesser in any way. But, you have to understand that they are the least of our problems here." (C80)

> "There are so many industries here that it is difficult to find out from where which effluent comes. But, we know the different discharge pipes, where they are let out into the sea and at what times to expect effluent flow. We can show you exactly – just last week, we took some environmental activists from south Chennai who wanted to know the extent of damage to the waters here." (C81)

This claim could be independently verified with the said environmental activists (C77), although there was no way to know if the effluents and their sources were identified correctly. It was hardly possible to knock on factory doors and ask to see their backyards. The residents of coastal north Chennai were up against the same cordoned off walls and invisible authorities of too many polluting industries that any researcher or journalist investigating the area would be. Additionally, many of them worked there and did not feel as strongly about environmental pollution as about how the polluting substances might get into their food or their lungs through the air they breathed.

The problem, as several of them saw it, was to do with the mode of effluent discharge rather than preservation of their ecological systems, as Chennai's environmental organisations argued. Those organisations have also, over the years, developed a close working relationship with coastal communities in south Chennai, through a particular settlement called Ururkuppam along the estuary of the Adyar river. This is why some of Kattupalli's residents felt obliged to explain why they hadn't protested against the desalination plant, or other industries, especially on the island. Coastal community leaders from the city centre or south Chennai, along with environmental groups, often urged them to mobilise. But, Kattupalli was more involved in industrial work than fishing at this point. When fishers in north Chennai do mobilise, it is for concrete demands like preferential allocation of waters for them in fisheries policy; the protests, then, are carried out through official fishers' unions and not through their residential affiliations as it happens with middle class mobilisations elsewhere. Even though the protests happened just off Ennore around the Kasimedu harbour, it did not mean that the protestors – the fishers – lived right there. They were fishers from various parts of Chennai and the surrounding districts.

Conversely, when there were protests held by local residents against pollution by industries, the protestors were not all fishers and it was often their lives that were more affected than their livelihood. Some villages along the northern coast, for instance, experience a 'carbon rain' in the evenings.

> "When the factories close, that's when they disperse the fly ash in the air, showering us with minute particles of carbon. Our kids come back from school

at that time, they buy snacks and eat it along the way. It is sickening to think they are inhaling and ingesting those carbon particles." (C80)

The concern about kids' health and industrial pollution is a universal one rather than one specific to fishers. Yet, a coastal identity is expected of residents in Ennore, Kattupalli or Pulicat, the title of fishers ready to vest in them the authority of environmental knowledge and the political inclination to defend that. The head of the Tiruvallur District Traditional Fishers' United Association resided in Pulicat. According to him:

> "Associations like ours exist for the political purpose. So, we haven't tried simply persuading the whole village to protest. We would rather write petitions or meet with the local politician. There are many traditional fishers in this town. This is an ancient community, after all. But, even here, many people prefer the development of industries than sticking to fishing. I mean, where is the ambition in doing that when the whole world is moving ahead?" (C73)

A resident in the nearby village of Arankuppam who worked as a security guard in one of the factories echoed his views:

> "Why do you expect us to protect coastal ecology? There are mechanisms to do that. Like the Pollution Control Board, which visits every six months and routinely certifies that emissions and effluents are under the limit. There are public consultations where only favourable responses are recorded. Those are hardly coastal or fishers' problems, are they?" (C78)

There were a few respondents who pointed out the irony of a water supply plant in Kattupalli, where the local Panchayat taps groundwater from further west or north to supply households because the local groundwater table was heavily contaminated.

> "Why would we oppose desalination? It's an excellent idea – to supply water to us!" (C78)

> “They should have brought desalination plants to us a long time ago; instead, now, they only give us its brine discharge.” (C80)

Rather than form a consistent pattern of fishers’ consciousness or provoked coastal political mobilisation, the responses from around Kattupalli suggest an urban politics of desire, where people expressed individual ambitions and views rather than work towards the collective restoration of a lost ecology. This may hardly be environmentally progressive, but it reflected urban life as lived by most of Chennaiites, whose identities and politics may be shaped by what they wanted rather than hark back to a primordial identity of ecological belonging. Rather than born of lack – of livelihood, of resources, of water – it is born of an active want. It is not because they have lost a way of life or livelihood that there is contestation of coastal developments, but because of how they want their homes, the region and themselves to be treated in the course of the development.

### 7.2.2. Ontological challenges to coastal development

There is a coastal village called Ururkuppam on the Adyar estuary nestled within an affluent part of south Chennai. The traditional fishers in this village have been quoted more in the media about problems with coastal projects in the city than any other fishing association. This has to do with an active elite environmental group in the Adyar neighbourhood that has cultivated a relationship with Ururkuppam’s fisher community and reposes faith in the revival of a dwindling pool of traditional environmental knowledge in the city. To this end, it has created an institution called the Coastal Resource Centre (CRC) in Ururkuppam that helps communities planning political action and provides information to the media on what it deduces are serious coastal and hydrological issues in and around Chennai. The environmentalist who spearheaded the initiative was convinced that the contradictory and lacklustre responses to coastal development was bravado towards a changing city and its demanding development trajectory:

> “The fishers are not interested in saving the coast or maintaining its ecological aesthetic. But, their livelihood and way of life is under threat. So, they have

> aspirations or compulsions for upward mobility, unlike in southern Tamil Nadu where there is some pride in the traditional occupation." (C77)

According to the CRC, there were multiple desalination plants along the northern coast, built and run by the industries that needed to source their own water. This produced a cumulative brine discharge that couldn't be accounted for only by the Kattupalli plant that sold to Metrowater.

> "Why do the fishers care whether it is a plant that supplies drinking water to the city or manufactures water for the industries. They only see the effluents in the sea and tell you about that." (C77)

The environmentalist agreed, however, that it was difficult to condense the diverse coastal communities of Chennai and surrounding districts into a single category of fishers. Each coastal village could be made up of a different community, with some holding fishing as an occupation and others not. There was no easy way for them to work together for a common cause given that there was so much in terms of work, culture, practices and beliefs that differed between them and there might not even be an agreement on what the common cause would be. A writer from one of Tamil Nadu's many fishing communities and a chronicler of Tamil Nadu's coast pointed out:

> "Fishing is not the only way in which coastal residents interact with the sea. It is by no means the only traditional coastal occupation either. They may be mangrove-dependent; or use water simply for transport and ferrying. Yes, there is an ecological basis to all of this. But, like everyone else in modern Chennai, there is no community yearning to doing their traditional job just as their forefathers did." (C70)

Even if a coastal identity and cause could unite these disparate communities, there was the issue of space. They may reside contiguously on the coast but are certainly separated by large physical distances. An activist from another NGO, Human Rights Advocacy and Research Foundation (HRF) was more blunt about the differences:

> “They all belong to different castes. Fishing wasn’t one of the caste occupations traditionally in most places. So, it would be different communities, migrant or otherwise, who would have settled at a particular place in the coast and started fishing, sometimes along with another traditional caste occupation like trading. There are also rich and poor fishers.” (C76)

While these two activists agreed that fishers included a diverse group whose mobilisation was however essential for environmental activism in Chennai and Tamil Nadu, they differed in their strategy to do so, representing two broadly different philosophies towards environmental sustainability. The human rights approach was to secure the status of a protected tribe for fishers, thus protecting their traditional occupation, cultural practise and the coastal ecology required to carry them out. This is currently how certain forests and their tribal dwellers were supposed to be protected, in theory.

> “Don’t get me wrong – we know the value of coastal ecology independent of its utility for fishers. We fought for eight years to save Kattupalli island, in fact. But, focusing on protecting the land rather than the people is risky. It will come down to who protects the land and how. The government can easily take over land from fishers even if they were given title deeds for the informal settlements they live in.” (C76)

It is, however, the land-oriented approach, spearheaded by the CRC, that has become popular now in Chennai with even movie stars and political parties taking notice. Coastal land, that is the beach, where desalination plants or other projects are built, this approach contends, is treated as ‘*poramboke’* – a land use classification popularly understood as ‘wasteland’ that’s managed by the government (CD20). The many rain-fed lakes around Chennai, for instance, dry up during the summers when they are *poramboke* rather than used for cultivation. Because *poramboke* is waste, it then follows that it can be taken over for urban development. *Poramboke* is traditionally an agrarian distinction between cultivable and uncultivated land. Activists in Chennai today argue that such uncultivated land were traditionally the commons, meant to provide some form of communal benefit that may not be immediately apparent to a profit or property oriented system of understanding land values. These commons are essential for contemporary Chennai to serve as the city's ecological buffer – protecting it from floods and absorbing rainwater to replenish the groundwater table. Therefore, it cannot and should not be taken over by the government or for any other private interest (Kumar et al. 2014).

Unlike in the case of Ururkuppam where individual residents, presumably fishers, settled there over a long period and were given title deeds for their houses, reimagining coastal land as commons prevents any form of ownership and so, cannot be taken over for development. Assisted by a local policy institute and researchers, coastal residents in central Chennai mapped their usage of the beach – to park boats, dry nets, sort and cure fish etc. - to establish how coastal land serves as commons (C68). A prominent musician composed a song[38] about environmental destruction in north Chennai titled '*Poramboke'* to draw attention to the useful ways in which the word and the land it denotes can be understood. The song and several other proponents of the '*poramboke'* approach stress the ecological function served by marshes, mangroves and other 'wasteland' - urban flood protection, if nothing else.

If infrastructures are 'ontological experiments' i.e. "*emergent systems that produce variable practical ontologies*—novel configurations of the world and its elements" (Jensen & Morita 2015: 84), then, it only seems natural that resistance to them is framed as an ontological reinterpretation of one of its many socio-material elements as well. Yet, in practice, the argument for protection of coastal sands often boils down to its use by fishers. Both approaches discussed above – based on tribal rights and common lands – hinge on fishers continuing to practice their traditional occupation and remaining in the coastal settlements. It also presumed that coastal settlements would be occupied largely by fishers in the foreseeable future, whereas several coastal settlements in Chennai were home to a large number of migrant workers in the construction, manufacturing and other industries. Ururkuppam, for instance, was a relatively secure settlement because of the title deeds that many

[38] The music video is available at: https://www.youtube.com/watch?v=82jFyeV5AHM

houses had been given and the political action it was involved in (CE12). So, many of its residents were able to rent out a room or build-to-rent particularly to young women from outside Chennai working in the city's factories or its service industries. They are typically not accounted for in activities that happen in the village or when issues affecting the coast are discussed.

> "I don't think we have even interacted with the Urur Fishers' Society. You have to be part of the fishing community and then, they issue you a card to be part of the Society and its schemes. They know about our existence, of course. They allot separate quotas for us – the tenants - for water and such public services. I think it's fine. I mean, they have fought a lot to get the kind of services they do now. It is only fair that they take the responsibility of distributing it to us." (C83)

> "I come from the North East (Darjeeling) and work in a beauty parlour around here. I can speak the language and everything now. Like tenants everywhere in the city I just pay for my water, electricity and boarding and get on with my work." (C84)

In fact, a whole section of Ururkuppam, with poorly constructed houses, was comprised of migrant workers. Given Chennai's rapid development, rising cost of living and the insecurity of living in informal housing anywhere in the city, coastal settlements were some of the most reliable places for migrant workers and the urban poor to occupy.

Despite the demographic flux, there was emergent coastal resistance and fishers' identity, albeit contingent on variable and unpredictable desires. As seen in the case of Chennai's desalination plants, they emerged in response to coastal projects in an inconsistent but inevitable manner.

### 7.2.3. Dissent emerges in the southern periphery

There is a road that begins in the affluent neighbourhood of Thiruvanmiyur in south Chennai and runs along the coast all the way to the southern tip of the country and the state of Tamil Nadu. Called the East Coast Road (ECR), it is considered a scenic drive and is popular for weekend getaways from Chennai. It was formed in 1998 by connecting several villages and cutting through coastal features for a aesthetic parallel with the seashore[39]. A resident of Soolerikadu, the village adjacent to Metrowater's desalination plant in Nemmeli explained:

> "That's how we ended up on the beach and the agriculturalists on the other side of the road. Not that we formed a united community even before. They are Vanniyar[40]. But, this road divided us clean, leaving us firmly attached to the sea and disconnected from the rest of the village." (C39)

This is a theory about how the ECR came to be dotted with coastal communities at regular intervals – that it was the construction of the ECR that cleared mangroves and created pristine sandy beaches as well as allowed settlements on the coastal sands, whereas traditionally villages had to have been beyond the mangrove forests and not right on the sand (C35). Villagers along the coast were vague about their history tracing their lives along the seashore to about 50 years, but not specifically this part of the coast. In any case, residents of Soolerikadu pointed out, they weren't wedded to the sea or the coastal land. They would be happy to be relocated if the government would house them in an accessible location. In fact, the desalination plant there was built on land acquired by the government from a temple trust (CD3), to which it was bequeathed by a 19th century philanthropist.

Unlike Kattupalli, the Nemmeli desalination plant was a lone industrial unit right off the ECR, visible for motorists on their way to one of the many beach resorts in the area or simply traveling south from Chennai. It was owned by Metrowater but built and operated on contract by a private company. So, when the plant was proposed to be built there, villagers around weren't sure of what to expect out of it; but it also presented a change in status-quo.

[39] "East Coast Road Project", Tamil Nadu Road Development Company Ltd. – project details, see: http://tnrdc.com/ecr/

[40] A common name for an intermediary caste in northern Tamil Nadu.

> “NGOs did approach us asking if we wanted to protest; fishing community leaders from Ururkuppam warned us it was bad news. But, we were swayed by the prospect of development.” (C56)

The NGO referred to here is the Human Rights Advocacy & Research Foundation, which viewed fishing as a right to life and livelihood for coastal residents.

> “It’s not that we don’t want to do fishing. But, it is honestly tough work with meagre returns. It is not a modern occupation our children would want to do. But, some of them are already taking up fishing now, because their education isn’t fetching them jobs. One can, however, dream…” (C39)

> “It may seem foolish in retrospect, but for some reason, we thought we’ll find jobs in this water factory. It wasn’t just that, though. It was like…something different from daily existence, trying to eke out a living between fish and various jobs in Chennai. Something that was almost stable compared to the uncertainty of living here. The factory was coming next door to our village, amidst all this coastal land.” (C56)

There is no recorded promise of development or jobs associated with the Nemmeli desalination plant. It might have been mentioned word-of-mouth. It is not recorded in the public consultation proceedings, because there is no such document. A clerk at the Nemmeli panchayat said:

> “If the government was putting up a plant, why would they ask for permission from the village? You have strange notions. Metrowater would have sent a letter to the panchayat leader who would have approved it.” (C58)

In theory, consent is needed from local residents; in practice, it is always obtained. The panchayat leader explained this further:

> “It wasn’t me who gave consent to the plant. It was the previous leader. He is technically supposed to consult with the villagers – but, he didn’t. But, request for consent usually comes as an order from the district collector’s

> office. He could hardly say no to that - he would have been threatened that he would be removed from his post. So, he can't really be blamed." (C57)

But, as the villagers had said before, a public consultation may not necessarily have attracted dissent. In any case, the plant was set up in Nemmeli without much opposition. That was when trouble began.

> "You see that building? That was demolished by sea intrusion. This has started happening only after they built the plant. The seashore erosion that happens in north Chennai hasn't affected us so far; we were safely away from the port and other industrial development. But, after the plant came, we face regular sea intrusion and soil erosion. The sea is now chipping away at our homes." (C56)

Two men who took tourists from nearby resorts out to sea on their boats explained:

> "On the shore we experience the sea as waves coming to the load from the sea - so we think all the water is moving towards that wave motion. But, there is flow of water under the surface in different directions – as currents. When they built the plant, they dredged underwater and disturbed these currents. That's why the sea is now entering our village more often." (C71)

It was for this issue that the residents of Soolerikadu started holding protests and petitioning for relocation or government built housing. By then, any jobs that the villagers had got during construction of the plant had dwindled as running the plant did not require much labour, except from trained chemical engineers. The villagers were paid a one-off compensation for their trouble. But, that wouldn't have taken care of housing or relocation.

**Figure 20: Building reportedly damaged by sea intrusion, Nemmeli, Chennai. Source: Fieldwork photo.**

> "We continued protesting. In 2013, during a demonstration, the police came and told us we needed to go over to the police station to get permission for our protest. When some (21) of us went to get this done, we were detained for over a month. The whole village then had to focus on getting us out on bail rather than protest against the desalination plant. Typical tactics to suppress dissent." (C39)

Interestingly, this also prompted residents of Soolerikadu to reach out to more politically active fishers in the nearby village of Kovalam and in Chennai. Kovalam was a village off the ECR located at the point where the Buckingham canal joins the sea at the backwater of Muttukadu, forming a marshy system once contiguous with the Pallikarnai marshes further west. On the beach are some of the most popular resorts on the ECR. Residents of Kovalam had a history of guerrilla resistance to encroachment on their beach use space by resorts – parking boats on their driveway or dumping rotten fish in their backyards. Kovalam, like other villages on the coast, could not be described as entirely a fishing village either. But, material artefacts of fishing became a symbolic as well as the most direct mode of protest for them. As the human rights activist pointed out:

> "Fishers can make for powerful protestors. When we organise them, they are ready with their boats for blockade; carrying oars in their hands, they look like they mean business. Plus, their clustered living on the coast enables quick mobilisation and a powerful image with the sea in the background and the materialities of coastal living apparent." (C76)

The question that arises then is whether this is a case of an organic community mobilising or of an organic politics emerging through technologies of identity building. Interaction with coastal communities around the two major desalination plants in Chennai suggest it is the latter. Consider the argument made by the writer on the politics of fishers in the rest of Tamil Nadu:

> "Inland residents imagine that the destruction of the coast only affects fishers, thus keeping their eyes wide shut." (C70)

Since fishers have been neglected by inland residents, they allow coastal development to their own detriment, according to him. However, in Chennai today, it is this very imagination that has created the political category of fishers who are expected to be resisting ecological destruction in support of activists in the city. They are also expected to possess unique knowledge to carry out this resistance. Irrespective of whether coastal residents are traditional fishers or experienced in the ways of the littoral to have developed significant knowledge on them, they are able to make use of their spatial position to invoke this political image. They access boats, oars and other such materials in ways that make political objects out of them[41].

[41] During the floods of late 2015, the fisher community rowed into the flooded streets of Chennai on their boats to aid the rescue efforts. See: "Flood of kindness as the skies open up", The Hindu, 02 Dec 2015, Available at: http://www.thehindu.com/features/metroplus/society/chennai-residents-lend-a-helping-hand-in-the-rain/article7940986.ece

Even though they are labelled fishers, it is their residence on the coast that enables them to formulate this identity and use their space for resistance. It is also only because they interact with the water either as fishers or simply as coastal residents that they have the need to raise these objections. The coast typically lies outside the planning area and even the permitted space for urban development in Chennai. The coastal regulation zone (CRZ) typically bans housing and any other construction within so many metres of the High Tide Line[42]. But, the traditional residence of coastal communities have paved way for continued settlement of the urban poor in those coastal areas, thus allowing for a coastal identity to emerge. The politics of dissent against desalination, then, was distinctly urban and informal.

Ajantha Subramanian, in her account of the political contestation by fishers in southern Tamil Nadu, describes a coherent community of fishers of the same caste, living under a common leadership of religious authority, who "constitute themselves as subjects of rights in relation to existing histories and hegemonies." (Subramanian 2009: 4) The case of Chennai's coastal residents is, in many ways, the opposite. Neither a contiguous spatial community nor united in their common occupation or caste, their claim to political citizenship was embedded in an urban spatiality with all the material and desirous assemblages it entails. The constitution of their identity as fishers followed from the mechanics of their contestation, which mobilised practices and material artefacts of littoral living. Where their position does parallel Subramanian's analysis is in their urban living being a "subalternity…that is relationally constituted and politically mobilized for particular ends." (ibid.: 27)

## 7.3. London - Strategically Sustainable

London's desalination plant is located within Thames Water's existing sewage treatment works campus in Beckton in the eastern borough of Newham. One of the poorest boroughs of the city, Newham has of recent seen several regeneration projects including the 2012 Olympics (LD22). But, it is still not a borough that takes

[42]"Building norms for coastal zones", The Hindu, 17 Jun 2016, see: http://www.thehindu.com/features/homes-and-gardens/Building-norms-for-coastal-zones/article14428006.ece

exception to further saline discharge in the river or access to a clean river; in any case, Londoners' interaction with the river is unlike that of coastal residents in north or south Chennai. It is also unlike that of their counterparts in Oxfordshire, who have successfully prevented Thames Water from building a large reservoir in Abingdon for the past 10 years. The reservoir was proposed in 2006[43], but deemed ill-conceived after public enquiries in 2007 and 2010. The campaign against the reservoir, called 'Group Against Reservoir Development (GARD)', is driven by residents of the Thames Valley outside London and their ties to nature through private property and leisure.

Employing consultants and water industry experts to advise them, they suggest bulk transfer of water from the River Severn to the Thames Valley and more desalination plants on the Thames Estuary as 'environmentally sustainable sources'[44]. Thames Water has once again included the reservoir in its Water Resource Management Plan for 2019-2045 and GARD has responded promptly by mobilising against the plan and voicing its objections to it with the media. In Newham, there was no such local group that rose in dissent against the desalination plant. Sustained opposition to the plant, however, came from unexpected quarters – the Mayor of London – and played a role in determining the nature of political power that his office could wield. This section will offer a brief account of this contestation and what that means for water infrastructure and urban governance in London.

In water sector conferences or interactions with engineers, consultants and water managers, the word sustainability almost never came up. As explained in the previous chapter, resilience was the concept driving projects like desalination. It wasn't that sustainability had gone into disuse – on the contrary, it appeared sustainability had become part of the public sphere and incorporated into city governance. It was no more a specialist practice, instead becoming a popular political term. In a major water industry conference, for example, it was only the

[43] "Britain's "leakiest" water supplier Thames Water has announced plans to build a £1bn reservoir to meet increased water demand." BBC News. 14 September 2006. See: http://news.bbc.co.uk/1/hi/england/5343646.stm

[44] The Group Against Reservoir Development meticulously documents its opposition to Thames Water's plans. See http://www.abingdonreservoir.org.uk/index.html and http://www.abingdonreservoir.org.uk/gardsalternatives.html

representative from the Greater London Authority (GLA) who spoke on sustainability issues. He (L11) was the Policy & Programmes Manager (Resilience & Quality of Life) at the GLA; but, his message stayed on the sustainability initiatives taken by the GLA, which revolved around quality of water bodies, long term water security and sustainable handling of drainage in London. Sustainability, here, was largely about ensuring availability of clean and accessible water for use by future generations.

The GLA also had a London Sustainable Development Commission[45], set up in 2002, to advise the Mayor in fulfilling one of its core strategic objectives of sustainable development. In fact, when the GLA was established through an act of Parliament in 1999 (LD23), the powers and responsibilities of the institution were heavily oriented towards environmental objectives. One of its three 'principal purposes' as laid out by the Act was 'promoting the improvement of the environment in Greater London', the other two being social and economic development. However, in balancing between its three principal purposes, the GLA is advised to take into consideration how its actions might affect or contribute towards 'sustainable development in the United Kingdom'. Accordingly, the authority is assigned a set of environmental functions, which the London Plan as formulated by the Mayor attempts to address as per the GLA Act's strategic objective (LD24).

As per the law and the institutional mechanism in place for London, its urban governance is based on sustainable development as a strategic objective. The GLA was meant to replace and co-ordinate functions of London's development planning so far shared between various borough councils, the central government and special institutions like London Transport and the London Ecology Unit. That is, the GLA wasn't setting out these objectives and responsibilities for the very first time in London. But, it was the first time that these objectives were given the body of an institution to be housed in. The unique nature of this institution and the political agenda of its office holders will necessarily shape how its policies affect the city then. It is also of interest that the GLA was expected to function with the environment as

[45] For further details on London Sustainable Development Commission see: http://www.londonsdc.org.uk/lsdc/default.aspx

a strategic objective, indicating that London's multi-scalar political relations were sought to be institutionalised.

For the UK water industry, the EA was the institution in charge of sustainability. Much like how Ofwat was expected to protect the interests of customers keeping water companies from over-charging them or providing inadequate service, the EA was expected to ensure that water companies acted in the interest of environmental sustainability. The regulatory framework that governs water companies includes restrictions on the level of abstraction that companies are allowed to make on surface and groundwater; and requirements for maintaining the quality of those water bodies.

> "The EA is the guardian of the environment – its job is to ensure health of the environment. It takes a multifaceted view of abstraction licenses for different sources - groundwater, surface water. It also licenses discharge contents. These are arrived at on the basis of complex catchment level calculation, balancing flow, dilution, demand and environmental demand which are in turn determined by soil type, level of urbanisation and hydrological patterns. Using all of this, they create a model to say this is the sustainable amount of water to be abstracted – not just in total but peak daily, monthly and annual rates." (L17)

> "In the case of desalination, the EA didn't have to do much modelling. Water was to be abstracted from the Tidal Thames which came under the Port of London Authority; the EA would have only been concerned about water quality, which is not so much of an issue in the tidal part of the river." (L34)

Modelling is techno-mathematical work that can only be performed by skilled professionals with access to data on all the components that the above consultant claims inform EA's sustainability model. Sustainability is then, outsourced to the EA, and externalised from concerns of the water industry. It works as a boundary object marking the government from the governed, at least until the Mayor of London decided to take matters into his hands.

The regulatory model in which the EA plays guardian of the environment has been credited with achieving record quality in England's rivers and other water bodies (LD31, LD32). But, this model does not take into account the sustainability criteria for how that quality is achieved. That is, whether the water companies used high energy consumption technology to produce clean water is not subject to institutional scrutiny, except as carbon emissions commitment that private companies might have.

> "Since the Blair era, there has been significant political push towards reducing carbon emissions. That's why desalination is disliked by the public – it is perceived to be unsustainable and expensive. It is, despite advances in efficiency. But, the widespread alarm over it is because of how sustainability became a political issue in this country." (L17)

This consultant may have been overestimating the disapproval of desalination in the public sphere to emphasize the pressures of sustainability that private companies were under. The London desalination plant is not even widely known outside the water sector; if it was once a contentious issue, it has simply disappeared from people's memory. Its harshest and most vocal critic at the time – Ken Livingstone, then Mayor of London – is widely believed to have engaged with it due to the political contingency of the Green Party's support in the London assembly (L21). The Green Party held a significant position in the first and second elected London assembly in 2000 and 2004 because the two major parties – Labour and Conservative – held nearly equal number of seats. Considering the importance of environmental policies to the formation of the London government, the Green party was also heard more in the London than in national politics. So, when the desalination plant was planned in 2003-04, its energy consumption became an issue for the London Mayor.

### 7.3.1. Livingstone vs Thames Water

London has had a municipal government from 1889, first as the London County Council with an arguably smaller mandate and then as the Greater London Council (GLC), established in 1965 with the aim of rationalising planning in post-war London, through wide and large scale rebuilding of housing and roadways. This was where Labour politician Ken Livingstone rose to prominence, elected as one of its members in 1973 and then its Leader in 1981 (Carvel, 1984). His tenure, until the GLC was abolished in 1986, came to be known as controversial for its policies on transport and policing in London, but more so for the radical political stance it took on central various issues not directly related to urban planning – economic, defence and minority affairs. Those views, especially on minority rights, may not look as radical today (Campbell & Jacques 1986). The GLC, housed in County Hall (now converted into an aquarium and tourist kitsch) opposite the Parliament to the south of the river, under Livingstone was also visually demonstrative in its opposition, famously posting London unemployment figures on its rooftop for Parliamentarians to see on their way to work (Hebbert 1998). In 1986, the conservative government under Margaret Thatcher abolished the GLC as part of a manifesto promise to cut out this wasteful tier of government.

Eleven years later, when an elected government was set up for London under a different era of New Labour's consensus politics, Ken Livingstone was elected as Mayor, clearly bringing with him some of those policy and political ideas from his GLC days. For instance, there were sweeping changes brought to London's transport system under his Mayorality including the introduction of the Oyster card and the congestion charge. Till date, one of the key policy announcements expected from the elected Mayor is on transport – fares mainly, but also the congestion charge or technological change in the system. In other words, the introduction of the Mayoral system in 2000 allowed for the first holder of the office to explore and define the kind of politics and powers it could espouse. The first Mayor happened to be Ken Livingstone, who brought with him an interesting political history for us to consider London's contemporary urbanisation with.

If Livingstone's views on sexual minorities or transport were considered radical in the 1980s, the environmental focus of the GLA at the turn of the millennium brought forth from him ideas practised elsewhere in the world but considered unusual for the city's water infrastructure:

> "There were two things I wanted to do about the water system. One was to fix the massive leaks we were suffering because of years of underinvestment in repair and maintenance of our very good Victorian mains. Then I wanted to explore the possibility of a dual system – greywater for flushing and treated water for all other uses. But, Thames Water was not interested in any of these things." (L30)

The high energy consumption of reverse osmosis desalination, then, became a hook to get Thames Water to take interest in alternative projects. The Mayor's office was public about its opposition to the plant, denouncing it as 'energy guzzling' and linked it to a national narrative calling it a 'retrograde step in UK environment policy' (LD16). Livingstone uses the same idiom of a shared London legacy that engineers and consultants use to refer to the city's water system; but rather than establish an expertise through it, he attempts to initiate a popular politics of water. But, he does draw the line between a professional politician and the general public.

> "People aren't invested in the water system because they haven't been invited to be. Besides, one they've elected representatives, they don't expect you to keep asking them what you should do. It is then your job to lead public opinion. They are worried about air quality as shown by polls. So, why not water leaks and carbon emissions?" (L30)

The idea of 'leading opinion' echoed his political stance and working in the GLC from the 1980s. It was also well-suited for the newly created office of the Mayor, which was not vested with much in terms of institutional authority, but gave the directly elected Mayor a hefty personal mandate, thanks to the size of the London electorate. The three London Mayors so far have built a personal brand for and through their Mayoral actions, linking personal identity and practices with their political position. Boris Johnson (2008-16) modelled himself a cyclist with a penchant for green spaces and ease of doing business with; Sadiq Khan (2016-) has called himself a feminist and campaigned for a London open to migrants, religious minorities and of course, international business. Even if their goals were similar, each Mayor has worked towards it through a uniquely crafted personal identity. Livingstone had a well-known political identity long before he became Mayor of London. He used it to define what the Mayor of London could and couldn't do.

> "I am an activist. I wanted to bring about change in the city by putting every agency I had to use. In the process, I developed the capabilities and powers that the Mayor could have. I regretted some of it because I lost the election to Boris, who was then able to get away with the agenda he wanted." (L30)

Livingstone was always known for his deep involvement in the politics of London and his interest in urban government. In his role as a Blair-era Mayor, he initiated a network across 18 'megacities' around the world with the sole focus of tackling climate change. The network, called C40[46], has today grown to 90 cities and is a data-driven institution working to deliver 'measurable' action on climate change. This time around, Livingstone was clearly set to make environmental sustainability a legacy. Interestingly, the mode of politics he adopted to push for it in London's water supply clashed with the same kind of technocratic policy-making that his legacy institution proudly claimed to do. In any case, the assemblage of urban networks, institutions, regulatory texts and professional expertise that the London desalination project was embedded in would serve to mellow the Mayor's claims to political leadership and legacy.

The London desalination plant, to be built within Thames Water's existing treatment works in Beckton, required planning permission from the borough of Newham, which approved the plan as per recommendations from its own committee. Acknowledging the strong objection it received from the Mayor on the project's sustainability credentials, it wrote, in its report:

> "It is concluded that there is a need for additional water supply in the London and Thames Gateway area over the short and medium term, and that out of all the various alternatives that Thames Water considered, the WTP[47] was the most sustainable… it is considered that the impacts associated with the WTP

[46] For the history of C40 and Ken Livingstone's role in its inception, see: http://www.c40.org/history
[47] WTP – Water Treatment Plant

> will be minimised wherever possible and will not be of such a degree as to justify refusal on the basis of the relevant planning policies." (LD17)

The Mayor had submitted a letter to the Newham council stating his objections as per the provisions of The Town & Country Planning (Mayor of London) Order 2000, since the desalination plant was deemed to be of 'potential strategic importance'. The letter covered substantial ground, drawing attention to not only reverse osmosis' high energy consumption but also the lack of sufficient reasoning for not working on leakage reduction, the economic rationale for favouring desalination over leakage reduction, the lack of evidence towards the commitment to generate renewable energy from the premises, and the potential impact the pipelines could have on local biodiversity. The letter argued:

> "The strategic need for the plant must be demonstrated against the overall sustainability argument in terms of energy use, biodiversity, design and impacts on Metropolitan Open Land." (LD17)

If the desalination plant were to go ahead, it needed to use more renewables than the London plan typically expected businesses to do, which was 10% of overall energy use. The letter added for good measure:

> "The overall design of the reverse osmosis building is bland and unimaginative. The industrial process within the building should be and the focal point for views, should be redesigned using strong, simple lines and by making the industrial processes within the building more visible to passers-by." (LD17)

Seeking aesthetic construction of a reverse osmosis unit to be located near an existing sewage treatment plant, while objecting to its high energy consumption, Livingstone's objection was a text that brought together the antagonist politics of the Mayor and the evidence-based institutional role of his office in an intriguing, if peculiar, fashion. Livingstone was direct about what his opposition really was to:

> "I have nothing against the technology, in general. My opposition was to the ideology of cutting expenditure and not investing in infrastructure – leaking pipes, in this case. Water offers a natural monopoly in a given geography. This simply cannot work in private hands."(L30)

Sustainability here was a political technology that enabled the Mayor to contest what he saw as a problem of economic governance. He did espouse a traditional political contestation based on macro-economic theory; but, the institutional, technological and urban framework he was working in shaped how it played out in the public sphere and eventually affected the material ecologies of the city.

### 7.3.2. Clash of political technologies

The objection letter was sent in October 2004, following which the Newham Council approved the plant, subject to referral to the Mayor and the GLA. The Mayor's objection had not been simply a formal one for he then used his power to direct refusal of permission. Newham had received planning application from Thames Water in June 2004. Exactly a year later, it sent the water company a notice of refusal for planning permission, on the Mayor's directions (LD18). The refusal, of course, allows for a right of appeal, based on which a public enquiry was held by the Planning Inspectorate between March and June 2006.

The Mayor's evidence in the enquiry argued that it was wasteful to use energy to desalinate water from the Thames when the city was potentially losing 915 MLD of purified water to leaky pipes. He pointed out that water shortages in London and the city's increasing vulnerability to tidal flooding were both potential consequences of climate change.

> "[the desalination plant] will use more energy and therefore make a greater contribution to global warming than the alternative of Thames Water managing its supply network more efficiently. It would mean that London was responding to climate change with a solution that adds to climate change."(LD19)

The repeated appeal to common sense that the Mayor's arguments made did not fit into the complex and strict regulatory framework that governed water companies in the UK. For instance, the enquiry report submitted by the Planning Inspectorate, in assessing the Mayor's evidence, says:

> "The GLA seems to suggest that the energy hierarchy requires that the TGWTP proposal should be assessed against other proposals to determine whether the proposal itself is essential. I find no such test in the policy, or the supporting text; the energy assessment is only required of the proposal being promoted."(LD20)

Since the provisions of the GLA Act and the London plan policy use broad concepts like 'conservation' or health of the environment, the enquiry report also concluded:

> "According to the GLA, policy 4A.11 requires the consideration, as a matter of preference, of whether there are alternative means of securing larger water contributions through better leakage control and demand management measures. However, the policy indicates that 'the Mayor will work...to protect and conserve water supplies'… I can find no sequential testing of resources in the wording of that policy or in the supporting text." (LD20)

Livingstone's message, on the contrary, was deceptively simple:

> "I want to send out a clear message that as Mayor of London, I will not back new developments that contribute further to the problem of climate change." (L19)

The enquiry was heard by the Secretary of State for Communities & Local Government and the Secretary of State for Environment, Food and Rural Affairs, who gave Thames Water planning permission to go ahead with the desalination project, without needing referral to the Planning Inspector. The Mayor was up against the Central Government once again, and he took the decision for judicial review by the High Court.

The enquiry report (LD20) starts by pointing out that the lawful regulators of Thames Water were the Environment Agency and Ofwat, both of whom were accountable to the Parliament and satisfied with the plan for the desalination plant; thus setting the state for a tussle between the authority of the central and city governments. The report also makes it clear that the technologies under consideration were only desalination and indirect effluent re-use (wastewater recycling). On leakage, it states:

> "It is also necessary to appreciate the concept of Economic Level of Leakage, which is the level where it would cost more to make further reductions to leakage than to produce water from another source" (LD20).

The Mayor's challenge to the economic rationale for choosing to produce water over fixing leakage was then inconsequential. In many ways, the Mayor's challenge to the desalination plant was a challenge to the framework of governance and planning itself. In the enquiry, while the evidence given by the Mayor questioned logical flaws in planning for a desalination plant, including the absence of an alternative plan to deal with the stated dire risk of drought that the city was in, Thames Water's response reiterated the calculations based on which the necessity for treated water was determined and desalination chosen to deliver that volume of supply. The kind of political contestation that the desalination plant provoked then was not simply about its energy consumption or environmental credentials or even about infrastructural policy. It was about the very mode and scale of doing politics.

London's water supply had long been a managerial system, mired in issues of governance rather than popular politics. Thames Water, for instance, had long failed its leakage targets and was fined by Ofwat for that only over the course of the public enquiry for desalination (LD10). Fifteen years since privatisation of water in the UK, Ken Livingstone's campaign against desalination introduced an antagonistic politics into this mode of government, not only challenging the economic and risk basis of the regulatory framework but also contesting the very governance approach that has dominated water infrastructure as *res publica* in London. A senior official in Thames Water was none too pleased about this confrontation:

> "He was running a one man show of opposition to us – even his advisers agreed with our view point. In consultations with the Mayor's office, we tried explaining the risk and resilience calculations that we have to use to ensure our level of service for London. But, he simply said he was willing to take that risk and that he wasn't really buying into our resilience framework." (L18)

It was an unusual intervention marked by Livingstone's pledge that the 'colossal' leakage that London's pipes suffered at a time of increasing scarcity was "the most important issue of my second term as Mayor of London."[48] But, it clearly wasn't an issue that people rallied behind for he lost his third election for London Mayor in 2008 to Boris Johnson.

Johnson withdrew the legal challenge to the planning permission given to Thames Water soon after he was elected, based on a deal with Thames Water to not block roads while doing mains replacement work. By then, Thames Water had also finalised a biofuel plant within the premises of its Beckton treatment plant, thus making desalination 100% fuelled by renewable energy. Under Johnson's tenure, the Climate Change Adaptation Manager became Thames Water's point of liaison and close working contact to decide on water management strategy. Yet, following the controversy and more importantly, planning delays, triggered by Livingstone's opposition to the Beckton desalination plant, Thames Water has been cautious in proposing the technology as a possible resource option again. In its most recent Water Resource Management Plant (2015-40), it rules out any recycling options for London's future water infrastructure development on the basis of "public acceptability and potential water quality and environmental considerations" (LD21). It then weighs the benefits of desalination:

> "On a cost basis, desalination would be chosen over other large resource options such as transfers and reservoir development. However, selection of desalination results in a significant increase in the environmental, social and

[48] Telegraph 18-Jul- 2007, Desalination plant approved for London. Available at: http://www.telegraph.co.uk/news/earth/earthnews/3300864/Desalination-plant-approved-for-London.html

> carbon cost of the programme and the locations of both plants on the Thames Estuary has identified wider environmental concerns.” (LD21)

It then decides to assess only Thames catchment reservoirs and Severn-Thames transfers as potential options, setting desalination aside for the moment. The company’s sustainability head appeared for a hearing on climate change pressures on London at the GLA’s Environment Committee in October 2015:

> “…there is a good deal of discussion with all our stakeholders both in London and outside about what those options should be and a lot of very detailed modelling work on the costs and benefits of different options. That does not include desalination.” (L39)

Later, discussing the option of wastewater reuse, he said:

> “The problem there is that to do that safely - and we have had an international panel of experts looking at this - they believe we would need to use a reverse-osmosis membrane. Not everybody agrees with the panel but that is the best advice we can get. Of course, reverse osmosis is the same technology that you use in desalination and it is very energy intensive.” (L39)

During the hearing, he (L39) also stressed that there was time to develop water resource options this time and the plans they were discussing then were pertaining only to the next water resource management plan, to be published five years later. But, the desalination project had taken four years since its first planning application was submitted until it was finally given the go-ahead. The techno-politics of water infrastructure in London emerged as much out of temporal friction as it did from a clash of ideologies and modes of politics. In fact, a significant point of dispute in the public hearing on desalination was on the time period it would take to execute the alternative of wastewater recycling – 7 years or 10 years. This minor distinction was said to be critical for London’s existing drought and scarcity, of which the Mayor was, of course, sceptic. The length of the Mayoral tenure was, eventually, the temporality that paved way for the building of the desalination plant in London.

Thus, in London, the objects created by the development of the desalination plant – the planning approval sent to the borough of Newham for example - set in motion in a series of events that developed into a tussle for political authority in the city. The newly created position of the elected Mayor of the city enabled this politics as much as drawing authority from it and constituting its discretionary powers.

## 7.4. Conclusion

This chapter started on the premise that technological projects, even if calculative and anti-political, spur an organic form of politics that may not be easily reducible to an already existing small range of contestations – public vs private; state vs society; or class divisions (Barry 2002). Instead the kind of political action they spur may be contradictory, contingent and emergent, taking shape along with the infrastructural formations that they are embedded in. So, this chapter presented an empirical engagement with the political contestations that arose around the desalination plants in Chennai and London. This approach allowed for a discursive narrative of the politics of dissent that emerged in the two cities, albeit from very different urban actors.

Chennai’s defining topological feature – its long coastline, which enabled it to harness the sea for its water supply, also houses settlements of the urban poor in its stretch from the north to south. They were traditionally fishing villages that have undergone similar demographic change as the rest of the city to now be comprised of a mix of migrant workers and low-income groups engaged in a wide range of occupations. However, the urban imagination of fishers’ livelihoods as well the coastal residents’ variegated approach to development along and in the sea has meant that the fisher has emerged as a political identity and environmental subjectivity in the city. This identity, in turn, has been put to use by activists for an ontological reinterpretation of the coast and its urbanisation. In following these developments, the chapter noted how the spatial contingencies around each desalination plant shaped the politics of its neighbouring coastal communities in different ways. It has thus traced a narrative of environmental knowledges and politics as highly situated and constantly shifting in response to infrastructural development in the city.

In London, the construction of the desalination plant was challenged by the then elected Mayor of the city, in an unusual employment of his discretionary planning powers. In picking apart the framework of water resource planning that justified the desalination plant using an idiom of popular politics and common environmental knowledges, the Mayor's efforts may be read as an attempt to constitute the powers of his newly instituted office. His challenge, however, was enabled by the elaborate process of technocratic infrastructure-making, which generated contestable 'objects' (Barry 2002). Despite this form of contestation being far more concrete, direct and clear than the discursive and contradictory coastal politics of Chennai, its longer-term effects are less observable. Both cases delineated above, despite their vast differences in the who, how and why of political contestation, however, demonstrated that environmental subjectivities as well as action on them are highly contingent on a range of socio-material factors in cities.

# 8. Conclusion

The construction of large infrastructures is frequently considered a phenomenon of modernism and 20th century national development agendas. However, recent scholarship in the social sciences has excavated processes of infrastructure-building, alive and well today across the world, even if they may take forms different from in the era of centralised planning (Furlong 2014, Graham & McFarlane 2014). They are often built by private companies in collaboration with quasi-state institutions and global finance; they sometimes involve little building and more organisation or installation. Their purpose, while continuing to encompass goals of development and universal access to resources, is also to address rising concerns about environmental sustainability and resilience to climate uncertainties, particularly in the case of water infrastructure. Cities, whose growing importance in global circulations and changing place in national polity have spawned new institutions and mechanisms of urban governance, have been at the forefront of this infrastructure building. Changes in the way infrastructures are conceived, funded and built have thus raised valid concerns about who they benefit, and what kind of knowledges and politics they engender. In short, the 'public' value of infrastructures has been a central theme of their social investigation (Collier et al 2016).

This thesis locates its endeavours in this line of scholarship, exploring recent developments in water supply infrastructure in two cities across the global South and North – Chennai, India and London, UK. It places them in a comparative analysis, where ideas and empirical material from one city inspires critical thought in the other, finally resulting in a set of common themes that becomes a starting point for theory building. The point of departure in both cities is the opening of large scale desalination plants (initially one in each city, followed by one more in Chennai), standalone projects driven by globally circulating technology that nonetheless lead to a dense web of social, political and ecological entanglements constituting infrastructure. It isn't just the socio-technical effort of supplying water in pipes, seamlessly or otherwise, that is identified as infrastructure here, but the continuous practice of engaging a wide range of knowledge and political claims in shaping urban waterscapes and consequently transforming the status of water as well as the institutions and practitioners involved in shifting, always incomplete ways.

As the review of literature in chapter 2 showed, dominant approaches to the study of urban water systems have tended to analyse these developments through the lens of metabolism or metabolic circulations. In bridging the nature-culture divide prevalent in the social sciences, they visualised cities as sites where natural resources were 'metabolised' by circulations of capital and technology, resulting in hybrid techno-natures (Swyngedouw 2006). While this was an outcome driven by early 20th century bacteriology and then modernism in cities of the global north, urban infrastructures in the colonised global south came to be 'fragmented' because of their incomplete networks and partial circulations (Gandy 2008). Recent modes of infrastructure building described above deviate from this northern experience and have thus been termed 'splintering' in their potential for changing what we understand as cohesive urban form (Graham & Marvin 2001). Useful in mounting overarching critiques of urbanisation under late capitalism, these analyses, however, have little to say about how the myriad of urban residents and practitioners, including engineers, city managers, and government institutions, work towards actually materialising any form of infrastructure or urban development. What if we take seriously precisely these techno-environmental quotidian relations involved in the making of infrastructures without reducing them to a circulatory logic? What if the dense assemblage of competing political claims and contradictory practices that characterises infrastructure-making, in fact, determines the nature of urbanisation?

This question is usually framed as the distinction between privileging agency and structure or between a descriptive and critical approach (Brenner et al. 2011). But, as the chapters in this thesis delineated carefully, individual and material agencies as well as technological practice constitute an accumulation of relationships between the city and its waters, or an 'infrastructure of relationality' (Simone 2014), which forms the shifting, constantly negotiated and processual structure of urbanisation. Description, in this approach, is thus an identification of such an infrastructure at a particular place and moment of working, tracing a 'genealogy' of how the city came to be (Simone 2011). Water, the material of concern here, becomes a 'boundary object', whose varying ontology is mutually constituted with its modes of access, use and government, and is the plane on which a range of practices and relationships are negotiated, leading to political and knowledge claims, often shaping environmental epistemologies. Its agency is thus neither a straight-forward resistance to be overcome by technology nor 'equal' to human intent and action, but rather something holding ontological and epistemological uncertainties to be negotiated through socialisation. Eventually, water becomes infrastructure not only through the planning and construction of a socio-technical project but also through its multivalent use, socialisation and governance in the city.

As Brian Larkin (2013: 336) points out, in his seminal article on the politics and poetics of infrastructure, challenging the widespread presumption or idealisation of their invisibility:

> "Infrastructures are metapragmatic objects, signs of themselves deployed in particular circulatory regimes to establish sets of effects….Invisibility is certainly one aspect of infrastructure, but it is only one and at the extreme edge of a range of visibilities that move from unseen to grand spectacles and everything in between." (Larkin 2013: 336)

That is, within the presumed invisibility of infrastructure lies a spectrum of constant work mobilising urban imaginations, environmental subjectivities, political affiliations and embodied relations to the 'ambient' (ibid.) environment to deliver a sense of infrastructures as abstractions like 'modern' or 'colonial' or indeed invisible. This is not to argue that the making of infrastructure is a perfectly orchestrated process capable of controlling how it is used and experienced. On the contrary, it is a recognition of the more-than-material work that goes into the construction of infrastructures requiring sustained practices of negotiation and socialisation from professionals largely considered technocratic, say engineers. It is also to posit that 'public'-ness persists as an ideal of infrastructures because they are realised through necessarily interactive and relational experiences of urban materialities as well as shared imaginaries. In other words, it isn't just a coming together of material and human agencies that constitute infrastructure, but the layered iterations by which knowledge and uncertainties about the urban environment come to exist and are put to use in further shaping cities through interactive technological practice.

This iterative process of building socio-natural relations in cities, this thesis has termed as 'osmotic', drawing from popular and engineering understandings of the process of 'reverse osmosis (RO) filtration' that runs desalination plants in Chennai and London, and in most parts of the world today. Osmosis or reverse osmosis is a process that mediates electrochemical gradient between organic material, in this case between saline and freshwater, by constant calibration and recalibration of pressurised flow, through a semi-permeable membrane that acts as a filter (chapter 5). For engineers working on desalination, this presented a continuum with other forms of water engineering that required continuous negotiation and delicate calibration of competing pressures and political or technological claims. Their preoccupations were with the layers of membranes and the repeated iterations of reverse osmosis operations that could eventually lead to a steady flow of synthesized, desalinated water. Since technological mediation and engineering work is inevitable to urban water access, the thesis draws on this technoscientific process to further its understanding of infrastructure-making in cities.

It conceptualises socio-natural relations or relations of infrastructure-making as osmotic rather than metabolic, characterised by semi-permeable membranes that allow interaction or restrict flows between the categories of technology, the engineer, the urban resident, material structures etc., sometimes inhabited by the same profession or institution in their hybrid thinking and practice. Any discourse or knowledge emerging from this is not necessarily a convergence of various interests but a practice that seeps through the membranes of conflict and communication. By the same token, interactions are constantly negotiated, always in a state of development or incompletion and contingent on continuing interaction. This also reflects the shifting and transforming being of water within infrastructural formations, where its multiplicity is channelled towards a singularised ontology or is further diverged into a hybrid of permeable categories.

The thesis has traced such osmotic relations across the historical trajectory of water supply and development in the two cities, revealing the boundary-making role played by water in the process (chapter 4). Contemporary engineering practices of infrastructure-making in so-called fragmented urban developments, similarly, reveal dynamic forms of cohesion, but carefully calibrated by temporal membranes of separation (chapter 6). Significantly, engineering epistemologies and practices, far from being technocratic or mere outcomes of structural changes, emerge as contingent on the networks of relationality and political pragmatics in which infrastructures are embedded. These may include global mobilities of engineering expertise or the spatial positioning of the desalination plant within the city (chapter 5 and 6). Osmotic relations can also be observed in contestations of and resistance to the urban infrastructural project, which do not necessarily follow a consistent logic or stick to fully formed political identities. Instead, they are processes over which multiple identities, political leanings and desires come together or diverge, flitting between semi-permeable membranes of action (chapter 7).

In all these cases since osmosis is a useful metaphor to explain the contradictions and complexity of the urban condition, the notion of osmotic relations, therefore, can be seen seeping through the thesis rather than present itself as the overarching analytical framework. Mediation by a semi-permeable membrane has allowed an understanding of human or material action as capable of occupying multiple political identities and ontological uncertainties. Yet, however negotiated and constantly changing this practice is, it still forms an infrastructure – an underlying 'structure of contact' (Amin & Thrift 2017: 33) that evolves and changes over time, but through 'recurring moments' in cities accumulates 'multiple layerings' (ibid.). Infrastructures, then, present the indefinite potential as well as the inertia of cities.

The thesis has presented its findings using three main themes – articulation of a mode of governance or idiom of the state through infrastructures; the role of engineering knowledges in building connections and cohesions in and across cities; formation of urban political configurations through contestations of the infrastructural project. Among these themes, the key preoccupation of the study has been with the range of techno-environmental knowledges constituted and the political claims they inscribed into the urban fabric. Chapter 4, for example, delineated how the state is articulated through urban infrastructures albeit in very different ways across Chennai and London. However, far from being defined by their positioning in the global South and North, they presented a parallel picture of technologically mediated authority built around the ability of water to be governed (Meehan et al. 2013). In Chennai, the chapter traced a continuity in water's illustrious history as a vibrant political object imbibed with the state's technology-aided welfare populism – or 'techno-populism' (Arabindoo 2011) – to its present assimilation into infrastructures of urbanisation and the idiom of rule that it entails. Any environmental or technological claims made about water in Chennai were automatically political claims as well. In London, the tight and inflexible regulatory framework was shown to have, in fact, gone through a trajectory of 'tacking back and forth' (Star 2010) between different environmental conceptualisations of water, thus materialising a technoscientific state. Since the state was the most dominant presence in the empirical data I had gathered, this was one of the early chapters I had written which gave me the opportunity to think about two important issues as I continued with my analysis.

One was the absence of any overt discussion on environmental sustainability in the state's rhetoric or practices and documentation of water governance and engineering. It was almost as if academic and media concerns hadn't kept up with the changing language of techno-environmental engagement in practices of infrastructure-making. This language, to be sure, encompassed epistemologies of framing human-nature relationships that had implications for how cities shaped the natural environment around them, as in the case of London's Security of Supply Index (chapter 6) or Chennai's land use classification of poramboke (chapter 7). But, this process was seemingly far too contingent to occupy the energies of practitioners who instead positioned their role in relation to the immediately and intimately experienced materiality of water and its indispensability to everyday life. Based on this, the analytical approach to data was recalibrated to pay attention to conceptualisations of the natural environment and how the human role in shaping it may be recast in terms of an ideal of public health or resilience or an imagination of urban cohesiveness. These are, hence, some of the themes that chapters 5 and 6 address and engage with.

The second issue that arose from chapter 4 was the matter of urban comparison. This chapter, while tracing the common theme of the state's articulation across the cities, clearly told very different stories about the making of urban infrastructures in them. This was partly a function of the differences in the nature of the empirical material gathered through ethnographic fieldwork, which was discussed in chapter 3. So, how best to put the urban comparison to use in generating a 'cross-pollination' of concepts and identify starting points for theory? The empirical arguments this thesis made were structured into chapters based on four conceptual themes. These themes were identified through a comparative coding the research data, elaborated in chapter 3. It used ideas and patterns emerging from one of the cities, often Chennai, to locate processes of interest in the other city.

So, the regulatory framework overseeing water supply in London, which is usually examined within the paradigm of governance, became a starting point for an exploration of the state. Similarly, the analysis of risk and resilience in chapter 6 as an epistemological convergence was inspired by the multiplicity of engineering disciplines and their respective epistemologies in Chennai. Chapter 5, in exploring the relationality of infrastructure, builds on the hierarchies of expertise and knowledge flows among engineers which has been widely studied in urban geography. But, it places the interactions and techniques of 'agencing' (Hillier & Abrahams 2013) employed by water professionals in London to assert a global expertise in the same plane as the highly localised practices of Chennai's area engineers whose expertise was built over shared engineering knowledges with lay residents. In doing this, it constructs a narrative of engineering knowledges as simultaneously situated and interconnected with a variety of material and imaginative geographies.

On the whole, what the thesis has achieved through its experimental comparison (Lancione & McFarlane 2016) is to draw out the 'minor geographies' of cities. That is, it has engaged with and brought into the fold of infrastructural study, processes, actions, practices and material formations that typically are incidental to the subject.

While plans, managerial decisions and financial investments are automatically taken to be influential in the development of urban infrastructures, seldom are localised trade events; diverse engineering ethics; unsuccessful, forgotten and unclear contestations; or obscure government institutions key to unpacking infrastructural geographies of cities. This thesis, has, however depended entirely on these sources to inform and complicate its arguments, "which cannot be readily understood in the terms of a major language of social and political thought" (Barry 2017). Thus, it has drawn from the very engineering disciplines it studies to formulate a language of osmotic relations that it has employed to make sense of its empirical material in the 'minor register' (ibid). The comparative framework, in fact, created the analytical limitation that enabled the narrative here to go beyond paradigmatic accounts of urban infrastructure or water supply and engage with cities as they are worked out. In doing this, it has not only decentred theory-building from the Euro-American axis but also enabled the understanding of infrastructures as they are worked out in the everyday messiness of cities, rather than from the top-down rationalities of their planning. However, the value of the comparative gesture is limited within a single project and demands a longer term epistemological commitment to engaging with cities as existing within a world of connections, relations and relationalities that can be better explored through conjunctive thinking. This may indeed amplify their divergences than lead to any coherent urban theory; which in itself would be a contribution towards not only diversifying urban theory but also interrogating the process of theory-building without the aid of minor urban geographies.

Chapter 7, which traces a narrative of political contestations of the infrastructure project in Chennai and London, is one such account in the minor register, offering only an account of the unruliness of contestation precisely because they are an organic politics spurred by a technological intervention. The distributed agencies and everyday negotiations involved in the access and use of water and waterscapes in Chennai means political contestation is inevitable and often, antagonistic. The political formations this chapter traces have emerged out of the entanglements in one significant feature of the city's materiality – its coastline, which however presents a case of diverse and contingent political subjectivities. In London, it was the figure of the Mayor and the discretionary power vested in an individualised authority that generated a political formation usually associated with popular politics unexpected in the technocracy of London government. It was still confined to the mechanics of planning approvals, which meant that there was never an opportunity to explore how infrastructures were shaped through use in London. This presents a possibility for future research on the topic.

This thesis has developed an understanding of infrastructures as visible in a variegated manner and constitutive of negotiated, shifting and technologically mediated socio-natural relations, even when they aim for seamless networking as in cities of the global North like London. So, the study of the governance structures and practices of water managers in London presents only a partial picture of the story. In Chennai, this wasn't as much of an issue as state and engineering practices were shaped through constant interactions with users, who have a significant presence in the infrastructures of water supply. Additionally, the distributed labour of accessing water was conveyed in the ethnographic material because of its visibility in everyday urban life. In London, even though there were references to user perceptions and subjectivities, and some of the regulatory framings are based on this, there was no possibility for ethnographic engagement with this because they are made private by the infrastructures of modernity (Gandy 1999).

In fact, there exists a significant research gap in the limited qualitative engagement with everyday infrastructures of water use in London as with several other cities of the global North where water supply is assumed to have been made invisible. But, as emerging ideas of infrastructural resilience based on the flexibility of its use or the figure of the average user incorporated in calculative frameworks demonstrate (Allon & Sofoulis 2006, Page & Bakker 2005, Sofoulis 2011), this is a key component of urban infrastructures in Northern cities that has not been explored much in academic literature. Thus, the understanding of regulatory politics of water in London sketched in this thesis could be expanded and complicated through a study of water users and their mediation of private access through a range of household technologies. Identifying such research gaps that could lead to development of fully rounded theories of urban infrastructures has also been an outcome of the 'experimental comparison' (Lancione & McFarlane 2016) that this thesis undertook.

Similarly, in Chennai, this thesis focused on the use of reverse osmosis filtration in the networked supply, although the technology has been prevalent in household filtration of groundwater sources for a long time now, which in turn, was fed by the rapid adoption of borewells during a phase of the city's development. This trajectory is echoed by other cities in the global South, particularly outside of metonymic metropolises like Mumbai (Harris 2012), where technologies of water access are overlaid with each other and socialised by the work of professionals and residents. A desalination plant, here, isn't a novel introduction so much as something germinated in an already existing techno-political set-up. As Furlong & Kooy (2017) point out, this draws attention to the need to 'world' the study of urban water, by engaging with the myriad of sophisticated methods by which cities of the global South access water, and the complex social and ecological interconnections emergent in the process. By recognising historical continuities in the infrastructural systems and techno-environmental knowledges that contemporary developments like desalination plants engender, this thesis has opened up an avenue for further research excavating the layers that make up cities.

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# 10. APPENDIX

## Appendix I - Chennai Fieldwork Details

### A. List of Ethnographic Encounters in Chennai

| Code | Chennai Ethnographic Encounters |
|---|---|
| CE1 | Metrowater Head Office, Pumping Station Road |
| CE2 | Chennai Corporation, Ripon Buildings |
| CE3 | Tamil Nadu Secretariat - Municipal Administration and Water Supply Department (MAWS) |
| CE4 | Tamil Nadu Environment Directorate - housing State Level Environment Impact Assessment Authority (SEIAA) and State Coastal Zone Management Authority (SCZMA) |
| CE5 | Metrowater Area Offices |
| CE6 | Tamil Nadu Public Works Department (PWD)- Institute for Water Studies (IWS), State Ground and Surface Water Resources Data Centre (SGSWRDC) |
| CE7 | Office of Former Mayor of Chennai, DMK Party Office, South Chennai |
| CE8 | Non-Governmental Organisation - Care Earth Trust |
| CE9 | Non-Governmental Organisation - Coastal Resource Centre |
| CE10 | Non-Governmental Organisation - Human Rights Advocacy and Research Foundation |
| CE11 | Coastal communities at Pulicat and Kattupalli |
| CE12 | Coastal communities at Adyar Estuary |
| CE13 | Coastal communities at Nemmeli |
| CE14 | Society of Public Health and Environmental Engineers (SoPHEE) World Water Day Event |
| CE15 | Water Expo and Watman conference, Chennai Trade Centre |
| CE16 | Nemmeli Desalination Plant |
| CE17 | Minjur Desalination Plant |
| CE18 | Sewage Treatment Plants (at private residential and commercial complexes) |
| CE19 | Household observations |

### B. List of Documentary Materials from Chennai

| Code | Chennai Document Source Details |
|---|---|
| CD1 | Chennai Corporation, 2015. Cooum River Eco-restoration Project – a summary note shared with the researcher by the Chennai Corporation on 18.03.2015. |
| CD2 | Tamil Nadu Water Investment Company, 2015. Report on Addressing the Drinking Water Security in Ramanathapuram and Thoothukudi Districts through Desalination. Author: K Ashok Natarajan, CEO. |
| CD3 | Environment Directorate, 2008. Detailed Project Report for Nemmeli Desalination Plant prepared by Mecon Ltd in association with Adeco – obtained from the TN Environment Directorate by researcher. |

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|---|---|
| CD4 | Chennai Metropolitan Development Authority (CMDA), 2018. Tamil Nadu Housing and Urban Development Department, Government Order (GO) - No. 13 - dated 22.01.2018. Available at: http://www.cmdachennai.gov.in/GO.html |
| CD5 | Government of Tamil Nadu, 2018. Public Works Department Policy Note 2017-18 - Maps of TN River Basins & Regions. Available at: http://www.tn.gov.in/documents/dept/42 |
| CD6 | Chennai Metropolitan Development Authority, 2016. Establishment – CMDA – Development Regulations – Concurrence for design of proposed STPs and NOC for Swimming Pools issued by CMWSSB. (Office order No. 17/2016) Available at: http://www.cmdachennai.gov.in/pdfs/officeorders/17-2016.pdf |
| CD7 | Department of Technical Education, 2016. Citizens Charter 2015-16. – Tamil Nadu Ministry of Higher Education. Available at: http://www.tndte.gov.in/wp-content/uploads/2016/07/DOTE-CITIZEN-CHARTER-ENGLISH.pdf |
| CD8 | Tamil Nadu State Planning Commission, n.d. TN 12th 5 Year Plan - 2007-12. Section 9. Water Supply, Sewerage and Sanitation. |
| CD9 | Tamil Nadu State Planning Commission, n.d. TN 12th 5 Year Plan - 2012-17. Section 6. Water Supply and Sanitation. |
| CD10 | Municipal Administration And Water Supply Department, 2014. Policy Note 2014-15. Available at: http://www.twadboard.gov.in/twad/downloads/Policy%20Note%202014-2015.pdf |
| CD11 | Chennai Metropolitan Water Supply and Sewerage Act 1978 (as amended in 1997). Tamil Nadu Act 28 of 1978. |
| CD12 | Ministry of Environment and Forests, 2006. State Level Environment Impact Assessment Authority Notification (S.O 1533 - Published in the Gazette of India, Extraordinary, Part-II, and Section 3, Sub-section (ii) ). Available at: http://envfor.nic.in/legis/eia/so1533.pdf |
| CD13 | Ministry of Environment and Forests, 2012. Tamil Nadu State Coastal Zone Management Authority Notification (GO No. 288, From the Director of Environment Letter No. P1/1006/2012, Dated 26.4.2012. Gazette Notification No. S.O.(E) 91 dated 18.01.12 ). Available at: http://cms.tn.gov.in/sites/default/files/gos/eandf_e_288_2012_D.pdf |
| CD14 | World Bank, 2004. Implementation completion report on a loan in the amount of US$86.5 million to India for the second Madras Water Supply Project (CPL-39070 SCL-39076 - Dated 21 Oct 2004). Available at: http://documents.worldbank.org/curated/en/865341468750544187/pdf/29333.pdf |
| CD15 | Chennai Metrowater Supply and Sewage Board, 2001. Policy Note 2001-02. Available at: http://cms.tn.gov.in/sites/default/files/documents/chennai%20metropolitan%20water%20supply%20and%20sewerage%20board_0.pdf |
| CD16 | Water Resources Organisation, n.d. Tamil Nadu Public Works Department - Web site and documents. Available at: http://www.wrd.tn.gov.in/ |
| CD17 | Tamil Nadu Water Supply & Drainage Board n.d. - Web site and documents. Available at: http://www.twadboard.gov.in |
| CD18 | Chennai Metropolitan Development Authority, 2008. Master Plan (Volume 3) – Chapter 07 – Infrastructure. Available at: http://www.cmdachennai.gov.in/Volume3_English_PDF/Vol3_Chapter07_Infrasructure.pdf |
| CD19 | Chennai Metropolitan Water Supply and Sewerage Board, n.d. Application For Water / Sewer Connection. Available at: http://www.chennaimetrowater.tn.nic.in/pdf/GENERAL.pdf |
| CD20 | Department of Land Resources, n.d. Standard Classification for Land Use. Available at: http://dolr.nic.in/dolr/mpr/mastercodes/landusecodes.pdf |

## C. List of Interviews in Chennai

| Code | Interviewee Role | Institution/Sector/Location |
|---|---|---|
| C1 | Activist | Fishers Association, Adyar Estuary |
| C2 | Activist | Environmental Non-Governmental Organisation |
| C3 | Filmmaker | Environmental Issues |
| C4 | Activist | Fishers Association, Adyar Estuary |
| C5 | Resident | South Chennai |
| C6 | Manager | Indo Korean Cultural Centre |
| C7 | Professor | Anna University |
| C8 | Consultant | Academic |
| C9 | Journalist | |
| C10 | Businessperson | Water Tech |
| C11 | Businessperson | Water Tech |
| C12 | Engineer | (Retd.) Metrowater |
| C13 | Engineer | Private company |
| C14 | Engineer | Metrowater |
| C15 | Engineer | Metrowater |
| C16 | Engineer | Metrowater |
| C17 | PRO | Metrowater |
| C18 | Resident | South Chennai |
| C19 | Consultant | Business & Tech |
| C20 | Resident | South Chennai |
| C21 | Engineer | Private company |
| C22 | Activist/Consultant | Environmental Non-Governmental Organisation |
| C23 | Joint Director | Institute of Water Studies (Public Works Department) |
| C24 | Chief Engineer | Institute of Water Studies (Public Works Department) |
| C25 | Journalist | |
| C26 | Consultant | Independent |
| C27 | Engineer | Metrowater |
| C28 | Engineer | Private company |
| C29 | Engineer | (Retd.) Metrowater |
| C30 | Engineer | Metrowater |
| C31 | Resident | South Chennai |
| C32 | Activist | North Chennai Resident |
| C33 | Engineer | Private Company |
| C34 | Resident | Kattupalli (Minjur) |

| | | |
|---|---|---|
| C35 | Activist | Environmental Non-Governmental Organisation |
| C36 | Engineer | Metrowater |
| C37 | Engineer | Metrowater |
| C38 | Finance Officer | Metrowater |
| C39 | Resident | Soolerikadu (Nemmeli) |
| C40 | Engineer | Private Company |
| C41 | Resident | South Chennai |
| C42 | Activist | Environmental Non-Governmental Organisation |
| C43 | Activist | Environmental Non-Governmental Organisation |
| C44 | Building contractor | South Chennai |
| C45 | Joint Director | Dept of Environment |
| C46 | Resident | West Chennai |
| C47 | Resident | South Chennai |
| C48 | Engineer | Metrowater |
| C49 | Engineer | Metrowater |
| C50 | Superintendent Engineer | Dept of Environment |
| C51 | MD | Metrowater |
| C52 | Professor | Madras Institute of Development Studies |
| C53 | Commissioner | Chennai Corporation |
| C54 | CEO | Tamil Nadu Water Investment Company (TWIC) |
| C55 | Engineer | Central Govt. Institution |
| C56 | Resident | Soolerikadu (Nemmeli) |
| C57 | Panchayat Head | Nemmeli |
| C58 | Panchayat Clerk | Nemmeli |
| C59 | Resident | South Chennai |
| C60 | Former Mayor | Dravida Munnetra Kazhagam (DMK) politician, Chennai |
| C61 | Administrator (Civil Servant) | Former Metrowater Managing Director (MD); Former Municipal Administration and Water Supply Department (MAWS) Secretary |
| C62 | Engineer | Metrowater |
| C63 | Project Engineer | Corporation |
| C64 | Project Engineer | Corporation |
| C65 | Administrator (Civil Servant) | Municipal Administration and Water Supply Department (MAWS) Secretary |
| C66 | Engineer | Private Company |
| C67 | Engineer | Private Company |
| C68 | Activist | Urban Governance Non-Governmental Organisation |

| | | |
|---|---|---|
| C69 | Activist | Environmental Non-Governmental Organisation |
| C70 | Writer | Coastal & Fishers issues |
| C71 | Resident | Soolerikadu (Nemmeli) |
| C72 | Engineer | Metrowater |
| C73 | Resident | Fishers Association, North Chennai |
| C74 | PRO | Water Tech Business |
| C75 | MD | Water Tech Business |
| C76 | Activist | Environmental Non-Governmental Organisation |
| C77 | Activist | Environmental Non-Governmental Organisation |
| C78 | Resident | Kattupalli (Minjur) |
| C79 | Resident | Kattupalli (Minjur) |
| C80 | Resident | Kattupalli (Minjur) |
| C81 | Resident | Kattupalli (Minjur) |
| C82 | Area engineer | Metrowater |
| C83 | Resident | Ururkuppam (South Chennai) |
| C84 | Resident | Nochikuppam (South Chennai) |

# Appendix II – London Fieldwork Details

## A. List of Ethnographic Encounters in London

| Code | London Ethnographic Encounters |
|---|---|
| LE1 | UK Trade and Investment Seminar - Export Opportunities in International Water Markets |
| LE2 | Research Councils UK Water Showcase - Water in Future Cities |
| LE3 | Greater London Authority - Environment Committee Meeting |
| LE4 | London Sustainable Development Commission |
| LE5 | Thames Gateway Water Treatment Works (Beckton Desalination Plant) |

## B. List of Documentary Materials from London

| Code | London Document Source Details |
|---|---|
| LD1 | House of Lords, 2006. Science & Technology Committee - 8th Report of Session 2005-06. Available at: https://www.parliament.uk/business/committees/committees-archive/lords-s-t-select/lords-s-t-select-reports-and-publications/ |
| LD2 | Environment Agency, 2007. Areas of water stress: Final classification. Available at: https://www.iwight.com/azservices/documents/2782-FE1-Areas-of-Water-Stress.pdf |
| LD3 | Environment Agency, 2013. Water stressed areas: Final classification. Available at: http://webarchive.nationalarchives.gov.uk/20140328104527/http://cdn.environment-agency.gov.uk/LIT_8538_535424.pdf |
| LD4 | Ofwat. 2015. The Development of the Water Industry in England and Wales |
| LD5 | Department of the Environment, 1971. The future management of water in England and Wales: a report by the Central Advisory Water Committee. Available at: http://discovery.nationalarchives.gov.uk/details/r/C11753497 |
| LD6 | New Policy Institute, 2013. The water industry: a case to answer. Authors: Adam Tinson and Peter Kenway. A report commissioned by UNISON. Available at: https://www.npi.org.uk/files/8213/7545/1688/Water_industry_a_case_to_answer_unison_version.pdf |
| LD7 | RWE Thames Water, 2004. RWE Group Reorganization: A Step Ahead for Multi Utility. The RWE Innogy/RWE Thames Water Perspective. Author: Tim Weller, Member of the Board Thames Water. RWE Investor Lunch. Available at: http://www.rwe.com/web/cms/mediablob/en/253182/data/213106/1/rwe/investor-relations/events/archive-2004/blob.pdf |
| LD8 | Thames Water, 2014. Final Water Resources Management Plan 2015 – 2040 - Executive Summary. Available at: https://corporate.thameswater.co.uk/-/media/Site-Content/Thames-Water/Corporate/AboutUs/Our-strategies-and-plans/Water-resources/Our-current-plan-WRMP14/WRMP14_Section_0.pdf |
| LD9 | Thames Water, 2018. Thames Water WRMP19 Resource Options: Desalination Feasibility Report - Prepared by Mott Macdonald. Available at: https://corporate.thameswater.co.uk/-/media/Site-Content/Thames-Water/Corporate/AboutUs/Our-strategies-and-plans/Water-resources/Document-library/Thames-Water-reports/Redacted-Desalination-Feasibility-Report-February-2018.pdf |

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|---|---|
| LD10 | Thames Water, 2017. Annual Performance Report 2016-17 Available at: https://corporate.thameswater.co.uk/About-us/Our-investors/Annual-Report-2016-2017 |
| LD11 | Ofwat, 2007. Security of supply 2006-07 – supporting information. Available at: https://www.ofwat.gov.uk/wp-content/uploads/2015/11/rpt_sos_2006-07secofsupplyinfo.pdf |
| LD12 | Ofwat, n.d., Publications. RD 04/10 Regulatory capital values 2010-15. Available at: https://www.ofwat.gov.uk/publications/rd-0410-regulatory-capital-values-2010-15/ |
| LD13 | Ofgem, 2009. Fundamental Flaws in the Current Cost Regulatory Capital Value Method of Utility Pricing. Contribution to RPI-X@20 review of energy network regulation. Available at: https://www.ofgem.gov.uk/publications-and-updates/fundamental-flaws-current-cost-regulatory-capital-value-method-utility-pricing-contribution-rpi-x20-jim-margaret-cuthbert |
| LD14 | CDP, 2014. From water risk to value creation - CDP Global Water Report 2014. |
| LD15 | Thames Water, 2006. Water Resources Plan - December 2006. (Shared with researcher on request). |
| LD16 | London Assembly, 2007. Seventy-Third Mayor's Report to the Assembly – 18 July2007. Available at: https://www.london.gov.uk/LLDC/Data/London%20Assembly%20(Mayor's%20Question%20Time)/20070718/Agenda/4%20Mayor's%20Report%20RTF.rtf |
| LD17 | Newham Council, 2004. Regeneration and Development Committee Report (Application Ref. P/04/1002) – Published 19 Feb 2009. Available at: https://pa.newham.gov.uk/online-applications/applicationDetails.do?activeTab=documents&keyVal=ZZZYFCJYXC801 |
| LD18 | Newham Council, 2005. London Borough of Newham - Notice of Refusal of Application for Planning Permission (Application Ref. P/04/1002) – Published 19 Dec 2013. Available at: https://pa.newham.gov.uk/online-applications/applicationDetails.do?activeTab=documents&keyVal=ZZZYFCJYXC801 |
| LD19 | London Assembly, 2006. Sixty-Second Mayor's Report to the Assembly<br>Author: The Mayor – 21 Jun 2006. Available at: https://www.london.gov.uk/moderngov/Data/London%20Assembly%20(Mayor's%20Question%20Time)/20060621/Agenda/3%20Mayor&8217s%20Report%20RTF.rtf |
| LD20 | Planning Inspectorate, 2010. Report to the Secretaries of State for Communities and Local Government and Food - Water Resources Management Plan Regulations 2007 Inquiry Into The Thames Water Revised Draft Water Resources Management Plan 2010-2035 September 2009. Available at: http://www.whitehorsedc.gov.uk/node/6548 |
| LD21 | Thames Water, 2014. Final Water Resources Management Plan 2015 – 2040 - Section 8: Programme Appraisal. Available at: https://corporate.thameswater.co.uk/-/media/Site-Content/Thames-Water/Corporate/AboutUs/Our-strategies-and-plans/Water-resources/Our-current-plan-WRMP14/WRMP14_Section_8.pdf |
| LD22 | Newham Council, 2014. Newham's Legacy Story. Available at: https://www.newham.gov.uk/Documents/Misc/NewhamsLegacyStory.pdf |
| LD23 | Greater London Authority Act, 1999. Available at: https://www.legislation.gov.uk/ukpga/1999/29/contents |
| LD24 | Greater London Authority, 2004. The London Plan 2004. Available at: https://www.london.gov.uk/sites/default/files/the_london_plan_2004.pdf |
| LD25 | Environment Agency, 2016. Managing water abstraction. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/562749/LIT_4892.pdf |

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|---|---|
| LD26 | Ofwat, 2007. Memorandum by the Water Services Regulation Authority (Ofwat) – Presented to Parliament. Available at: https://www.parliament.uk/documents/upload/ofwat.pdf |
| LD27 | Environment Agency, 2017. Drought response: our framework for England. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/625006/LIT_10104.pdf |
| LD28 | UK Water Industry Research Limited, 2013. Managing through Drought: Code of Practice and Guidance for Water Companies on Water Use Restrictions – 2013. Available at: https://www.water.org.uk/managing-through-drought-code-practice-and-guidance-water-companies-water-use-restrictions-%E2%80%93-2013 |
| LD29 | Drinking Water Inspectorate, 2003. Drinking water 2002: A report by the Chief Inspector. |
| LD30 | Consumer Council for Water, 2007. CCWater response: Environment Agency Identifying Areas of Water Stress. https://www.ccwater.org.uk/wp-content/uploads/2013/12/CCWater-response-Environment-Agency-Identifying-Areas-of-Water-Stress.pdf |
| LD31 | Department for Environment, Food and Rural Affairs, 2001. UK maintains record-breaking performance for river quality (press release). |
| LD32 | Environment Agency, 2001. Decade of clean-up brings best-ever river and estuary quality results (press release). |
| LD33 | Atkins, 2012. Future Proofing The UK Water Sector: Positioning the UK water industry for long term success. Consultant Report. http://www.atkinsglobal.co.uk/~/media/Files/A/Atkins-Corporate/group/sectors-documents/urban-development/future-proofing-the-uk-sector-leaflet.pdf |

## C. List of Interviews in London

| Code | Interviewee Role | Institution/Sector/Location |
|---|---|---|
| L1 | Consultant | Former Thames Water R&D engineer |
| L2 | Writer | London Water History |
| L3 | Businessperson | Confederation of British Industry |
| L4 | Policy manager | Industry-Expert interface |
| L5 | Policy manager (resilience) | Industry-Expert interface |
| L6 | Policy manager (environment) | Industry-Expert interface |
| L7 | Policy manager | Industry-Expert interface |
| L8 | Consultant | Private |
| L9 | Consultant | Private |
| L10 | Consultant | Private |
| L11 | Sustainability & Resilience manager | Greater London Authority |
| L12 | Consultant | Private |
| L13 | Senior engineer | Thames Water |

| | | |
|---|---|---|
| L14 | Research consultant | Academic |
| L15 | Consultant | Private |
| L16 | Consultant | Private |
| L17 | Consultant | Private |
| L18 | Senior planner | Thames Water |
| L19 | Consultant | Private |
| L20 | Sustainability Consultant | Independent |
| L21 | Policy Researcher | Greater London Authority |
| L22 | Journalist | The Guardian |
| L23 | Water manager | Asian City |
| L24 | Water manager | Asian city |
| L25 | Water manager | Asian city |
| L26 | Water manager | UK Trade and Investment |
| L27 | Water manager | Asian city |
| L28 | Consultant | Independent |
| L29 | Consultant | Independent |
| L30 | Former Mayor | London |
| L31 | Engineer | Beckton Desalination plant |
| L32 | Senior engineer | Thames Water |
| L33 | Innovation/Membrane engineer | Thames Water |
| L34 | Consultant | Former Thames Water R&D engineer |
| L35 | Engineer | Beckton Desalination plant |
| L36 | Director of Sustainability | Thames Water |
| L37 | Regulatory consultant | Former civil servant |
| L38 | Water manager | Former Thames Water executive |
| L39 | Asia Editor | Global Water Intelligence trade magazine |