Household Access to Water and Sanitation in Chennai and Bangalore

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ABSTRACT

In India's quickly growing cities, there can be large differences in how households access water and sanitation, based on factors such as household location and status. Across the cityscape, piped water supply from the municipal water agency is not guaranteed, and households make personal investments in time and money to meet their daily water needs. Here inequalities arise, as elite households gain privileged access, the poor are often left underserved. This Supervised Research Project studies access to water and sanitation in Chennai and Bangalore, India. The project explores access to water and sanitation in four different communities and characterizes local water management for each case. These case studies illustrate a range of household water access portfolios that exist across the urban and peri-urban spectrum. Then, these studies inform broader discussions on the following themes: civic activism, urban citizenship, and gender roles in water management. I draw comparisons from across the cities and case studies, to contribute to the broader discussion on urban development and access to water and sanitation in Indian cities.

RÉSUMÉ

Dans les villes indiennes en pleine croissance, il peut y avoir de grandes différences dans la manière dont les ménages accèdent à l'eau et à l'assainissement, selon des facteurs tels que la localisation du ménage et son statut. À travers le paysage urbain, l'approvisionnement de l'eau courante municipal n'est pas garanti et les ménages investissent leur temps et leur argent pour répondre à leurs besoins d'eau quotidien. Ici, les inégalités se produisent, d'où les ménages élites bénéficient d'un accès privilégié, tel que les pauvres sont souvent desservis. Ce projet de recherche supervisé étudie l'accès à l'eau et à l'assainissement en Chennai et en Bangalore, Inde. Le projet examine l'accès à l'eau et à l'assainissement, selon quatre communautés différentes, en caractérisant la gestion locale de l'eau pour chaque cas. Ces études de cas illustrent une gamme de portefeuilles d'accès à l'eau parmi les ménages qui se trouvent dans les zones urbaines et péri urbaines. Ensuite, ces études éclairent des discussions plus larges sur les thèmes suivants: l'activisme civique, la citoyenneté urbaine et les rôles de genre dans la gestion de l'eau. Je fais des comparaisons entre les villes et des études de cas pour contribuer au débat plus large sur le développement urbain et l'accès à l'eau et à l'assainissement dans les villes indiennes.

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TABLE OF CONTENTS

LIST OF MAPS AND TABLES

ACRONYMS AND INITIALISMS

BBMP	Bruhat Bengaluru Mahanagara Palike; Greater Bangalore City Corporation
BDA	Bangalore Development Authority
BWSSB	Bangalore Water and Sewerage Supply Board
CMA	Chennai Metropolitan Area
CMDA	Chennai Metropolitan Development Authority
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board (Metrowater)
DDP	Detailed Development Plan
IT	Information Technology
KSDB	Karnataka Slum Development Board
MLD	Millions of liters per day
OHT	Overhead Tank
POA	Plot Owners Association
RBD	Rainbow Drive Layout
Rs	Indian rupees
RWA	Residents Welfare Association
SRP	Supervised Research Project
STP	Sewage Treatment Plant
TNSCB	Tamil Nadu Slum Clearance Board
TWAD	Tamil Nadu Water Supply and Drainage Board
WSS	Water and sanitation supply

CHAPTER 1: INTRODUCTION

1.1 WATER AND SANITATION IN INDIAN CIITES

India is a rapidly urbanizing country: between 2000 and 2015 the urban population grew from 28 percent to 33 percent (WHO/UNICEF Joint Monitoring Programme, 2017). This unprecedented growth puts pressure on India's municipalities, who must respond to the increasing demand for the goods and services that sustain human life, such as water resources. As urban areas expand and consume fresh water supplies, utilities are challenged to provide safe and adequate drinking water to the growing population. According to the 2011 Census, only 71 percent of households in India's urban areas have access to a water connection within their premises (Census of India, 2011). Even when households do have a water connection, this does not guarantee access to water that is adequate in either quantity or quality (Zérah, 1998). The speed of urban change is equally consequential for providing sanitation to India's urban households – only 33% of which are connected to a piped-sewer system (Wankhade, 2015).

In this context, households undertake a range of material investments to ensure reliable daily water supply and adequate sanitation facilities. This creates a complex set of water practices across India's quickly expanding urban landscapes, where access can differ based on location within the city, or other factors such as income and gender. Within the city limits, where the existing piped-network best-serves its consumers, actual water access can also depend on legal land tenure, which is not guaranteed for many urban-dwellers. On the other hand, in outer areas of cities, where much of India's current growth is occurring, the expansion of the piped water and sewerage network severely lags behind demand. In this context, wide disparities arise: while corporate consumers and elite households gain privileged access, the poor are often left underserved. To deal with the inequalities of urban water supply in this context, this Supervised Research Project (SRP) studies household access to water and sanitation in urban and peri-urban areas.

1.2 RESEARCH OPPORTUNITIES & LITERATURE REVIEW

The study of household access to water and sanitation across India's cityscapes responds to a need to base urban planning and policy on real-world experiences of citizenship, and bring forward the realities of marginalized populations who tend to go underrepresented in the water and sanitation supply (WSS) system (Hofmann, 2011). Looking across the city growth spectrum, peri-urban spaces tend to lack proper planning and management, and infrastructure delivery is uneven, which brings additional need to understand experiences of water and sanitation access in these spaces.

Today, citizenship is broadly understood as a legal status that determines the rights of individuals in relation to the state (Nuijten, 2013). This notion, however, does not fully capture

real experiences of citizenship, which can differ based on characteristics such as income, gender, or class. While it is often assumed that all citizens are equal before the law, laws seldom take into account differences in income, which can put poorer residents at a disadvantage (Hardoy & Satterthwaite, 1989). For instance, when it comes to housing, the occupation and settling on land by poorer city dwellers is often deemed to be illegal by their governments. Still, many of the poorest individuals and households occupy land illegally and build their own shelter, which often consists of sub-standard housing. In their book Squatter citizen: Life in the urban third world, Hardoy & Satterthwaite (1989) suggest that this type of settlement happens because accommodation within easy reach of jobs or places where income can be earned, is more important than the size and quality of accommodation. Essentially, the poorer the individual or household and the less stable their source of income, the less flexibility they have in terms of where they can live and how much they can pay (Hardoy & Satterthwaite, 1989).

In this setting, the urban poor are vulnerable to exploitation by land-lords and governments. For instance, governments that judge settlements to be illegal often take action to forcibly evict residents from their homes each year, most without any form of compensation (World Bank, 2016). Without proof of legal land tenure, poorer residents are unable to access civic services, such as water and sanitation, and have few options to ask for government accountability and responsibility. Effectively, their democratic participation is reduced, and they are excluded from the public realm, added to the ranks of 'second-class citizens' (Nuijten, 2013).

Here, residents take action to claim their rights to land and the basic resources of life. Holston (2009) characterizes this as 'insurgent citizenship' in which urban dwellers contest their exclusions from property rights, infrastructure and justice, by creating citizenship outside of official channels. One of these channels, as was described by Benjamin & Bhuvaneshwari (2001), is the 'politics of stealth', wherein poor groups and their alliances operate in a strategic, and 'non-visible' way, allowing them to make claims to resources. These alliances can include agreements of 'vote bank' politics, where infrastructure services are provided by locally-elected councils, in exchange for a promise of future votes. Benjamin (2008) continues to develop this concept, through the notion of 'occupancy urbanism', which is described as a political space wherein urban poor groups negotiate with local bureaucracies to obtain public investments in basic infrastructure, thereby undermining the sphere of global capital projects, i.e. high-end infrastructure and mega-projects. This citizenship modality is particularly important in the Indian context, given that the metropolises of Indian cities are increasingly developing large-scale infrastructure projects in their efforts to become 'world class cities', and evicting marginalized citizens to the urban peripheries in the process.

While Appadurai (2002) and Benjamin (2000) would qualify these types of citizen engagement as 'deep democracy' or 'inclusive governance', meaning these informal channels improve democratic systems, others describe it as clientelism or patronage (Thara, 2017). Namely, De Wit & Berner (2009) define patronage from the perspective of political parties, wherein parties

institutionalize approaches to secure voters through the large-scale dispensing of material inducements. Rather than voicing their demands through collective action, or through representatives of community-based organizations, the urban poor develop complex webs of exchange, obligation and reciprocity, with relatives or intermediaries, to safeguard livelihoods and obtain access to public goods.

These sets of actions and channels have been described by some authors as a whole new order of citizenship. Essentially, the urban poor's protests, insurgent actions and contestations are not idiosyncratic – indeed they, "propose a city with a different order of citizenship" by disrupting the established formulas of rule and privilege (Holston, 2009, p.246). These views have been reflected in the Indian experience. For instance, Appadurai's (2002) account of urban activist movements in Mumbai, shows how NGO and citizen mobilizations represent efforts to reconstitute citizenship, in their struggle to gain land tenure.

Finally, Nikhil Anand (2017) brings new light to understandings of citizenship as it relates to access to water and sanitation. In his book, Hydraulic city: Water and the infrastructures of citizenship in Mumbai, Anand describes hydraulic citizenship as, "the ability of residents to be recognized by city agencies through legitimate water services." (p.8). According to Anand (2017), hydraulic citizenship is a process, which is realized through formal laws, documents and policies, as well as social histories and political protest. Hydraulic citizenship is equally influenced by human relationships to physical infrastructure, meaning our relationships to the pipes and connections that deliver water to the city. For urban settlers, gaining legal connections to water, and securing the accompanying documents (e.g. water bills), is critical in demonstrating to other branches of city government that they are good, recognized citizens. For instance, proof of a legal water connection can allow urban dwellers to claim and access other public services such as healthcare, and education (Anand, N. 2017).

Overall, this study provides the opportunity to examine concepts of citizenship and explore the processes and players that determine who has access to urban resources, in the context of India's rapidly growing cities. The literature scan brought forward recent and important notions that surround urban citizenship, access to housing, and the right to make claims to basic services. It is important to note that while this review is informative, it is by no means comprehensive given the extensive scholarship available on these topics. Despite this limited scope, these concepts will be useful to understanding the forthcoming analysis and discussions. In the next chapter, I present the methodological approach taken in this SRP, beginning with the research objective.

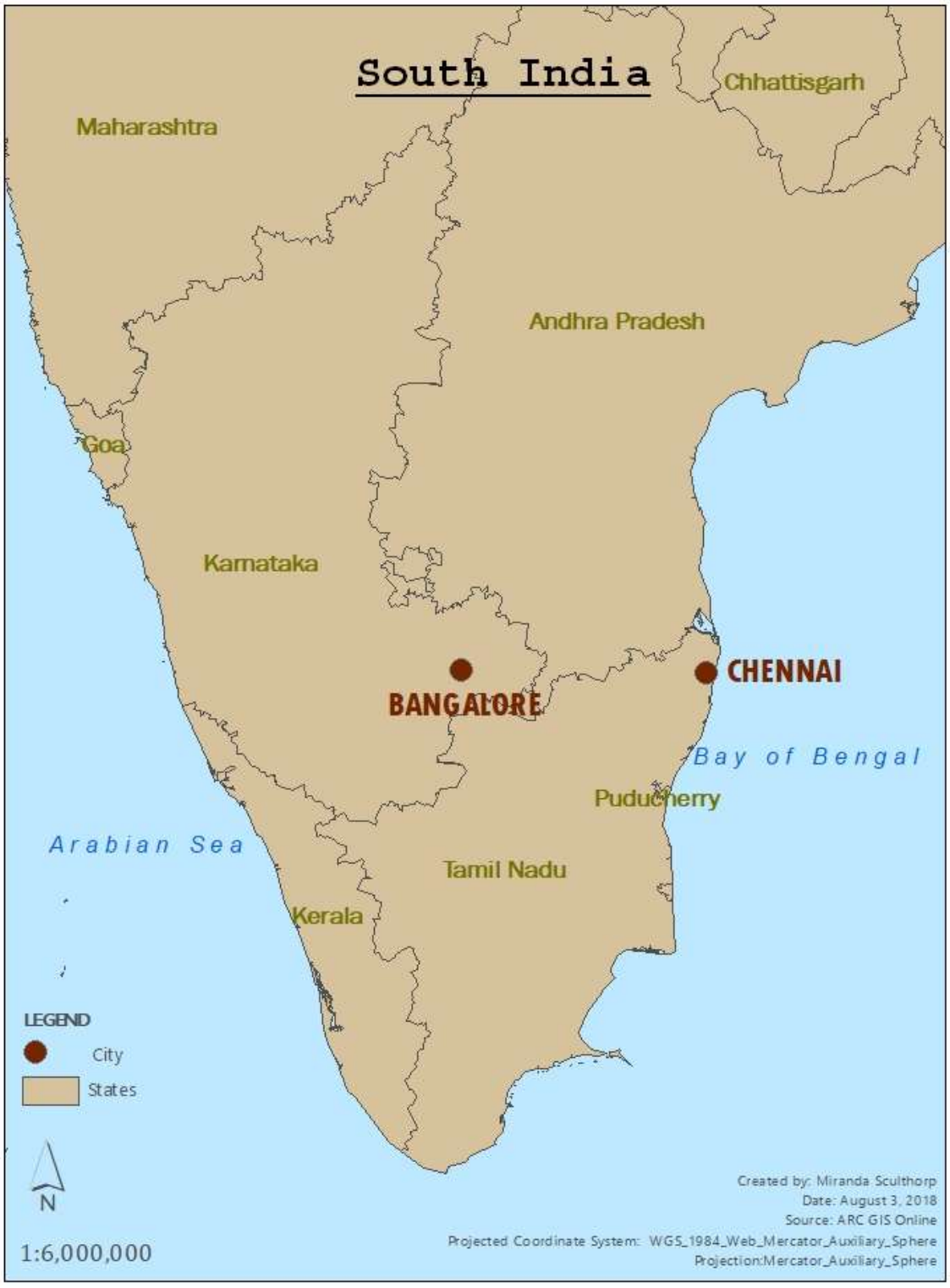
CHAPTER 2: METHODOLOGY

2.1 RESEARCH OBJECTIVE

My research objective is to understand household water and sanitation access in urban and peri-urban areas of India's metropolitan cities. Foremost, I aim to address the foregoing research gap, by bringing forth experiences of household access to water and sanitation in two major Indian metropolises. My goal is to paint a picture of these various experiences, through case studies which document the state of water and sanitation infrastructure and service in different types of residential settlements. Second, I aim to analyse some of the factors that lead to unequal waterscapes, beginning by mapping the actors involved in local governance and their respective roles in water management. This will allow me to identify the contributing factors that shape the provision and access to water in the study areas. Third, through an analysis of the case studies, I aim to provide insight on some the broader phenomena at play in each city, such as civic activism, urban citizenship and gender. Lastly, by making comparisons across the cities, I aim to contextualize the findings and contribute to the broader discussion on water and sanitation in India's growing urban areas.

2.2 REGIONAL FOCUS: TAMIL NADU AND KARNATAKA

The South Indian cities of Chennai and Bangalore serve as primary focus areas for this study. Their respective states, Tamil Nadu and Karnataka, represent different governance climates and water challenges. As such, the findings are meant to provide a broad perspective on some of the water phenomena that are present in India's major cities. Moreover, Tamil Nadu and Karnataka are distinctly linked by water, which raises the importance of studying these regions concurrently. Tamil Nadu and Karnataka share a vital water source, the Cauvery River, which has been the subject of interstate conflict for decades (Mahapatra, 2018). By combining perspectives from both states, this research hopes to contribute to a more nuanced understanding of water challenges that exist on both sides of state lines.



Map 1: South India
Source: ArcGIS Online

2.3 HOUSING TYPOLOGIES IN URBAN AND PERI-URBAN AREAS

For this research, the zones of interest are urban and peri-urban spaces. Peri-urban areas represent a zone of fluidity between the city and the hinterland. Here, I rely on Ranganathan's (2010) description of settlement in peri-urban spaces:

> This is an area where the boundaries between illegality and legality and exclusion and inclusion are entirely negotiable. Here, a discordant jumble of villages, "unauthorized" residential subdivisions, and luxurious "planned" complexes jostle one another for space and resources. (Ranganathan 2010, p.4)

Given this variation in residential settlements, a total of four case studies were chosen in the urban and peri-urban areas of Chennai and Bangalore. These settlements were selected to provide a current look at daily life in different types of settlements in urban and peri-urban areas, and to illustrate a range of household water access portfolios that exist across this spectrum.

2.4 CHENNAI CASE STUDIES

The two study areas in Chennai were initially chosen based on the availability of a translator and a local guide to enable field visits. The first case study, Kallu Kuttai, is an informal settlement in the south of Chennai City. Second, Perumbakkam, a resettlement community, was chosen because it is located outside of the city center. As a resettlement site that is currently under construction, this study area provided an opportunity to observe water access experiences during the construction of government housing and to document experiences for those newly-arrived to the community. Together, these sites were selected, to develop and present an understanding of broader phenomena at play, namely the advent of slum eviction and resettlement that is commonplace in many Indian cities.

Map 2: Chennai Case Studies
Source: Google Maps

2.5 BANGALORE CASE STUDIES

First, Sagayarapuram is a community located in the north of Bangalore (within city limits) that receives piped water connections from the municipal water agency. The water situation in this ward merits attention, as an area which was not surveyed in the 2013 Bangalore Domestic Water Survey, the first and only representative survey of household water use across the entire city. Next, the Rainbow Drive Layout is located outside of Bangalore city limits and is a gated community in the south of the city. Recognized for its adoption of water conservation practices, this community does not receive water supplied by the municipal water agency. Together, these sites were selected to show situations of water access which differ based on the provision of water within and outside of public water service areas as well as socioeconomic status.

Map 3: Bangalore Case Studies
Source: Google Maps

2.6 RESEARCH QUESTIONS & ANALYTICAL APPROACH

Following the selection of the focus areas (urban and peri-urban) and study sites, I developed a set of research questions to answer for each case study. The development of these questions was informed by doctoral studies of housing access to water and sanitation, such as Luxion (2017) and Ranganathan (2010), as well as guidance from my academic supervisors.

RESEARCH QUESTIONS

- How do households satisfy their daily water and sanitation needs?
- What is the state of water and sanitation infrastructure and service in the community? What are the key issues?
- What (if any) initiatives by the community have influenced access to water and sanitation? How have they influenced access to water and sanitation?

- At a household level, who is responsible for water access? Who has decision-making power?
- What local actors are involved in water service provision and what are their roles? How do they manage the water supply and shape access to water?
- What are the driving factors behind the state of water supply and sanitation?

After answering these questions for each case, I formulate an analysis using an analytical approach which aims to understand how things work in practice.

ANALYTICAL APPROACH

1. Explore and describe the state of water access – what is the state of affairs?
2. Develop an understanding of the local urban management of water supply, by mapping the local actors and their actual roles – how do things work?
3. Look at the broader phenomena – why is it that things work in this particular way?
4. What conclusions come forth by looking across case studies? – what is the broader picture?

These guiding questions served to structure my analytical progression, while also allowing flexibility to pursue themes as they emerged throughout the process.

2.7 APPLIED RESEARCH METHODS

The chosen methodology for this project is case research, to intensively study the phenomena of supply and access to water and sanitation within its natural setting. Multiple methods of data collection were employed, from both primary and secondary sources, to develop inferences and conclusions that are detailed and contextualized. The case research approach was applied in an interpretive manner, as the constructs of interest were not strictly defined in advance, but emerged as the research progressed (Bhattacherjee, 2012).

Some scholars have identified the need to research water and sanitation through qualitative methods, to understand households' daily challenges in accessing water, as opposed to quantitative studies which quantify the gaps in service across the water network (Bapat & Agarwal, 2003). This argument led to the use of ethnographic research methods, which emphasize in-person observation and conversational interviews, to provide insight into daily phenomena that would otherwise go unrecorded (Bapat & Agarwal, 2003). First, the research aimed to collect qualitative data through site visits to the selected study areas. These site visits began by observing daily water rituals, such as the collection of water from water holding tanks. Photographs were taken of water infrastructures and practices to visually document the state of water access.

Next, informal interviews were conducted with residents and local leaders in each study area, with the help of a translator and local guide. These interviews were based on the research questions described in *Chapter 2.6 Research Questions & Analytical Approach.* Participants in these informal conversations were asked their household composition and occupation, how and

where they access water, how they deal with water shortages or problems with water infrastructure, and experiences with collective action or petitions with the government. Conversations took place in Tamil and Kannada, and some conversations were audio-recorded with the consent of participants. Interviews took place in public and semi-public places in the community (e.g. in the streets, outside of participant's houses). As a result, neighbours and passersby often stopped to add to the conversations, and such interruptions were welcomed, given the open and informal nature of the interviews. This research activity was approved by the McGill University Research Ethics Board Office, under ethics approval REB-I.

Sampling was done based on the local guide's knowledge of the area, and his ability to contact residents who would be willing and able to participate in the research. As a result, the nature of this sampling may have introduced bias into the results. However, this does not take away from the validity of the results, as the purpose of this study was not to be representative or statistically significant, but rather to paint a picture of various experiences of water and sanitation access in the community. The site visits and interviews with residents and local leaders provided information on the current water and sanitation situation for each case, thereby responding to the first two questions of the analytical approach: *what is the state of affairs* and *how do things work*.

Next, the conversations with local experts, academics, and representatives from non-profit organizations were held, which helped to contextualize the findings and inform the final analyses. These interviewees were identified through the already established contacts of my academic supervisors. Conversations were open, meaning they did not follow a set of pre-defined questions, and were not audio-recorded. All together, these findings were combined with other secondary sources, such as maps, official planning documents, reports and academic articles. The analysis was equally informed by knowledge that I gained by living in Chennai and Bangalore over a period of four months, which provided daily insights into the experiences of water access as an urban resident. The interviews with local experts, in combination with secondary sources, allowed me to develop a broader analysis and to respond to the third and fourth analytical questions: *why is it that things work in this particular way* and *what is the broader picture*.

2.8 STRUCTURE OF THE REPORT

This report begins with a brief introduction to Chennai, the causes for its water scarcity, the state of water and sanitation supply, and the context of slum eviction and resettlement. I present the two Chennai case studies: Kallu Kuttai and Perumbakkam. In a parallel manner, I introduce Bangalore and its water situation, and present the two case studies: Sagayarapuram and Rainbow Drive Layout.

In general, the case studies are structured to provide a background understanding of the study area and its residents, followed by a description of the state of water and sanitation supply and access. I present the main findings from the resident discussions, and describe the actors

involved in local water management. I discuss the factors that contribute to the findings. At the end of each case, I provide photos taken at each study area.

Following the case studies, I embark on the analysis. In the discussion section, I explore three main themes: civic activism, urban citizenship and gender. While this discussion is divided according to the two cities, in the next chapter I generate broader conclusions by drawing on all the case studies and looking across the cities. Finally, I provide a conclusion which summarizes the research, explains the limitations of this work, and suggests next steps.

CHAPTER 3: CHENNAI, TAMIL NADU

3.1 INTRODUCTION TO CHENNAI

Chennai (formerly Madras) is the capital of the State of Tamil Nadu, located in South India on the Bay of Bengal. The Chennai Metropolitan Area (CMA) consists of Chennai City, 8 Municipalities, 11 Town Panchayats[1] and 179 Village Panchayats (CMDA, 2018). According to the 2011 census, the population of Chennai City is 4.6 million, while the CMA population is 8.6 million (Census of India, 2011a). This makes Chennai the fourth largest urban agglomeration in India (Census of India, 2011b).

Chennai is a dynamic metropolis that blends tradition and modernity. The cityscape reflects these dual identities: Chennai is home to both ancient temples and modern high-rises. While the city developed under British rule, it retains its indigenous Tamil culture and keeps these traditions alive through arts, food and music. For this reason, Chennai is often referred to as the *Cultural Capital of India*. Chennai is equally recognized for its economic activity, as one of the leading automobile manufacturers of India. The economic base is diversified by its information technology (IT) sector, financial services, and the health care sector.

While Chennai's aspirations to become a leading Indian metropolis continue to grow, the city's infrastructure and resources are put under increasing pressure to meet the material needs of its residents. In particular, the city is witnessing the expansion of settlements in the urban periphery, in addition to the relocation of industries to these regions to gain access to land and water. This is escalating drinking-water demand, in a situation where freshwater is already scarce, due to both natural and human-made factors (Janakarajan et al., 2007).

3.2 WATER SCARCITY

Chennai faces perpetual challenges in the management of water resources. First, Chennai has the lowest per capita availability of potable water among India's large cities (Roumeau et al., 2015). The dry season sees intense drought and competition for water resources, while the rainy season brings flooding which paralyzes city life for weeks at a time. The city's water woes can be attributed to a number of factors, which can be characterized as either natural or human-made causes. I use the term 'natural causes' to refer to geographic and climatic factors that influence water availability, while the term 'human-made' causes relates to water stress that is the result of human activity.

[1] A panchayat is a local unit of administration.

3.2.1 NATURAL CAUSES

Three main geographic and climatic conditions contribute to Chennai's water scarcity. First, the city receives on average 1290 millimeters of rainfall annually, which in fact is much more than the national average. However, precipitation is highly variable, with a short rainy season that spans from October to December (Janakarajan et al., 2007; Gopakumar, 2009). Floods occur during this time of year, which have devastating consequences for the city's residents. Secondly, much of the naturally occurring water in the city is lost through evaporation and seepage losses, of around 40 percent (Centre for Science and Environment, 2001; Gopakumar, 2009). Finally, Chennai has no perennial water source – the closest riparian systems, are located hundreds of kilometres away (Gopakumar, 2009). As a result, Chennai's inhabitants are heavily dependent upon groundwater sources. These natural conditions mean that occurrence of water in Chennai is variable, which creates difficulties to ensuring a reliable water supply for the city's growing population throughout the year (Gopakumar, 2009).

3.2.2 HUMAN-MADE CAUSES

While natural factors determine the pre-existing conditions for water supply in the city, Chennai has also manufactured its water crises through its urban development. Originally, Chennai's natural landscape was defined by its plentiful waterways and waterbodies, which included marshland and lakes. The cityscape was formed around three major rivers that flow through the metropolitan area: the Kosathalaiyar, Cooum and Adyar rivers. These rivers once supplied fresh water to the city; however, over time, industrial pumping reduced water levels, and the dumping of untreated sewage and industrial effluents has deteriorated the city's water quality. As the city has expanded, the number of waterbodies has dwindled and their quality has deteriorated, which has reduced the availability of fresh water, and contributed to the intensity of flooding.

Indeed, much of the last decade's real estate boom has occurred both alongside and on top of the city's water bodies (Rajagopalan, 2013). According to a study by the Indian Institute of Technology Madras Centre for Environmental and Water Resources Engineering, 20 years ago, there were some 650 bodies of water in the Chennai metropolitan area – today, very few of these exist (Rajagopalan, 2013). Currently, Chennai's urban expansion is taking place primarily in three directions: west, southwest and south (Citizens Alliance for Sustainable Living, 2004). These development projects, such as the IT corridor in the south of Chennai, continue to encroach upon the wetlands and waterbodies located around the city. The replacement of the city's naturally-occurring water-laden lands with impermeable surfaces, means that only five percent of the city's rainfall makes it to the groundwater supply (Rajagopalan, 2013; Janakarajan et al., 2007). As groundwater sources are not fully replenished, and as water sources turn brackish due to over-extraction, the provision of good-quality water in adequate quantity to the growing urban population is a serious issue (Venkatachalam, 2014).

As a response to the city's water needs, Chennai's water agency has undertaken large-scale projects to augment the water supply, beginning as far back as the 1970s. Despite these efforts, the supply of safe and sufficient water to the population continues to be problematic, particularly during the dry summer months when water supplies are low. In the following section, I continue to describe Chennai's waterscape, by outlining the city's supply of water and sanitation.

3.3 WATER & SANITATION SUPPLY CONTEXT

3.3.1 WATER SUPPLY

Chennai's water utility board, the CMWSSB (Chennai Metropolitan Water Supply and Sewerage Board or Metrowater, as it is commonly known) governs the water supply system within the CMA. Metrowater supplies water to Chennai City primarily through a piped network. Over 95 percent of the households within Chennai City have some sort of access to the public supply, through private in-house connections, or through other means such as hand-pumps, public standpipes, and water tankers (Srinivasan, Gorelick, & Goulder, 2010). While Metrowater's operational area is limited to Chennai City, it is working to extend its network throughout the CMA (CMWSSB, 2018).

Metrowater sources its water from reservoirs, inter-basin water transfer projects, aquifers located around the city, and two desalination plants (Srinivasan et al., 2010). Currently four main reservoirs store the city's water supply: the Chembarambakkam Reservoir, the Poondi Reservoir, the Redhills Reservoir and the Cholavaram Eri. These reservoirs are replenished with rainwater. In addition to the reservoirs, Metrowater sources water from far outside of the city through two inter-basin transfer systems: the Krishna and the Cauvery river projects. These projects source water from the neighbouring states of Karnataka and Andhra Pradesh. When the supply of water from the rivers do not bring sufficient yield, the gap is primarily filled from groundwater sources (Haufe, 2017). Three desalination plants are in operation, which provide additional fresh water through the desalination of seawater.

Although the majority of the population has access to various public water sources, the private sector plays an important role in water supply. According to Janakarajan, Zehra, and Llorente (2006), around 25 percent of the total water demand in the city is being met by the private sector. These companies are particularly important for the supply of drinking water, as many of the households in Chennai purchase water cans for drinking. Indeed, the market for packaged water is large and growing: the state of Tamil Nadu counts 400 licensed bottled-water companies (which is 50 percent of the total in India) and 220 are operating in and around Chennai (Roumeau et al., 2015; Janakarajan et al., 2007). Water can also be consumed in bulk, supplied from private tankers who extract their water from wells located outside of the city.

Households also source their own water through private borewells[2], a well which extracts groundwater (Haufe, 2017). Typically in a private household, a well with electrical or hand pump will be located in the front of the building, with a septic tank in the back. On the property, an underground sump or water containers serve to store this self-supplied water, as well as water from Metrowater. From the sump, the water will be pumped to an overhead tank (OHT), which allows for a continuous water supply via pipes and gravity. Residential complexes normally have a similar setup in larger dimension. Many households use a reverse osmosis device to purify Metrowater or borewell water for drinking purposes (Haufe, 2017).

3.3.2 SANITATION

Chennai's piped-sewerage network does not cover the entire city. According to Chennai's Second Master Plan, 65 percent of households have facilities to dispose sewage into municipal connections and 33 percent have a septic tank or soak pit, while the remaining population uses open drain and dry latrines (CMDA, 2008). Around 71 percent of households have private bathing facilities and 70 percent have private toilet facilities (CMDA, 2008). Therefore, there remain many households which do not have access to piped-sewage and modern bathing or toilet facilities.

The city's sewage treatment capacity is inadequate. Wastewater is treated in nine sewage treatment plants (STP). Otherwise, decentralised sewage treatment schemes are in operation. However, these facilities do not treat all of Chennai's wastewater. Moreover, during flood events, storm water enters the sewerage system, making overflows commonplace. When this occurs, untreated sewage overflows into the natural water system (Haufe, 2017).

Solid waste management is also lacking; the Greater Chennai Corporation has no comprehensive plan to manage the waste generated in the city. Much of the garbage generated is dumped, rather than being disposed and recycled (Gajendran, 2016). Overall, the lack of adequate waste disposal systems has consequences for human health, and degrades the natural environment, as untreated sewage and wastes are disposed into the city's water bodies.

In summary, Chennai's water landscape is characterized by a multitude of water supply mechanisms. Many of the city's households lack sewage connections and the city's wastewater treatment capacity is insufficient. With these considerations in mind, in the next section I present definitions and characteristics of slum settlements in Tamil Nadu and Chennai, to frame the forthcoming case studies.

[2] A borewell is narrow well for water that is drilled into the ground, typically equipped with a pump to draw groundwater to the surface.

3.4 INTRODUCTION TO SLUMS & RESETTLEMENT

The Government of India Slum Areas (Improvement and Clearance) Act of 1954 defines a slum as "any predominantly residential area where the dwellings by reason of dilapidation, overcrowding, faulty arrangement, lack of ventilation, light or sanitary facilities or any combination of these factors are detrimental to safety, health or morals" (CMDA 2008, p.139). In Chennai, people have settled in slums for decades. Today, about one-third of Chennai City's population lives in slums (Census India, 2011c). Residents build these settlements without government approval and/or without formal rights to the land. As we have seen in *Chapter 1.2 Research Opportunities & Literature Review* this can be for a variety of reasons, such as lack of affordable housing choices or proximity to work opportunities. Residential areas built on unapproved layouts often lack basic infrastructure, and civic amenities such as roads, water and sewerage connections, drainage plans and street lighting.

According to the Tamil Nadu Slum Areas (Improvement and Clearance) Act 1971, settlements declared as 'slum areas' may receive slum improvement works (e.g. provision of water taps and bathing places, provision of latrines etc.) (CMDA, 2008). Conversely, settlements notified as 'slum clearance areas' are liable for eviction. This classification is problematic because communities are often unaware of whether their area is a notified 'slum area' or a 'slum clearance area'. This is true in Chennai, where there is a lack of information surrounding the status of notified slums (IRCDUC & HLRN, 2017).

In the state of Tamil Nadu, slum locations areas are classified as 'Objectionable' or 'Non-objectionable'. Slum areas on Objectionable Locations are, "slums situated on river margins, road margins, seashore and places required for public purpose" and are a high risk for eviction as, "the areas occupied by them are to be retrieved and handed over to the land-owning department to implement programmes like road widening, desilting, strengthening of bunds etc." (CMDA 2008, p.147). There are no material differences found in the living conditions in the above said slums. Indeed, both are equally liable to eviction – the main difference is that the Objectionable Location slums are referred to as illegal settlements or encroachments, and are highly prone to natural disasters, particularly floods (Vennila et al., 2014). In the year 2000, it was estimated that roughly 76,000 families are in this precarious situation in Chennai (CMDA, 2008).

Description	No. of slum families
River Margin	30,922
Feeder Canals	5,288
Road Margins	22,769
Seashore	16,519
Total	75,498

Table 1: Location of Slums in Chennai City, 2000
Source: CMDA 2008, p.148

The situation of these families has likely changed considerably since the 2000s, particularly as these populations tend to be the worst affected by the natural disasters the city has witnessed over the last decade and a half. The tsunami of 2004 and the major floods of 2015 not only severely damaged the homes of slum-dwellers, but in many cases prompted their expulsion from the city, due to evictions carried out by the Government of Tamil Nadu (IRCDUC & HLRN, 2017).

The Tamil Nadu Slum Clearance Board (TNSCB) is the statutory authority specially setup for the improvement, clearance and rehabilitation of slums across Tamil Nadu. Since the 1990s, the TNSCB has used resettlement to remove slum-dwellers from the city center. Since this time, over 100,000 people in Chennai have been relocated to settlements outside of the city (Diwakar & Peter, 2016). Despite years of resistance from families, the TNSCB continues to relocate slum-dwellers en masse (Diwakar & Peter, 2016). In an upcoming case study, I examine the conditions of one of these relocation colonies in depth, by documenting the state of access to water and sanitation in the community.

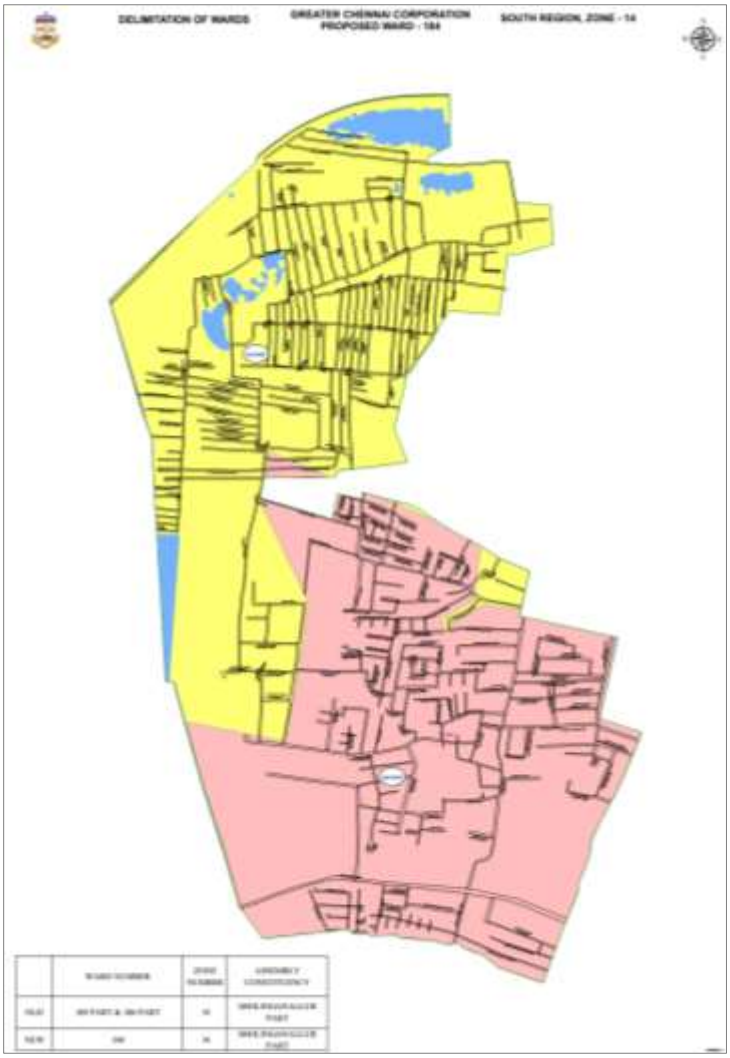
In the next two chapters, I present the Chennai case studies. These case studies document the current state of water access in an informal settlement and a resettlement community. Then, I make links to a wider set of driving forces that are contributing to the poor water and sanitation access for these households, and end with pictures of the study areas.

CHAPTER 4: CASE STUDY 1 KALLU KUTTAI, CHENNAI

4.1 BACKGROUND

Kallu Kuttai is an informal settlement located in the south of Chennai, within the CMA limits and approximately 10 km from the city center. In terms of Chennai's administrative units, Kallu Kuttai is part of Ward 184 within the Perungudi zone.

The Kallu Kuttai community is bordered by the Chennai Mass Rapid Transit System elevated rail to the north and west, Military Quarter Street to the south. Along the eastern limitation, a concrete wall separates Kallu Kuttai from the adjacent zone of Palavakkam. Kallu Kuttai is in close proximity to the Pallikaranai Marshland, as well as the IT corridor. The Kallu Kuttai Lake is located to the north of the settlement, and Perungudi Lakes lies to the southeast.



Map 4: Kallu Kuttai Ward Delimitation Map
Source: Greater Chennai Corporation Website, 2018

SOCIOECONOMIC CONDITIONS

According to the 2018 Ward Delimitation of the Greater Chennai Corporation, the population of Kallu Kuttai is 27,714 inhabitants (Greater Chennai Corporation, 2018). Residents told me that in general, men in the community work in the construction industry. Women primarily work in the domestic help sector, and/or care for the home as housewives. Most residents are Hindu, but Christianity and Islam are also commonly followed religions. Household size ranges from four to eight members.

HOUSING & LAND TENURE

The housing style is mixed: some houses are small, traditionally built huts, while other homes are multiple stories and made out of concrete. According to a discussion with the leader of a local community group, residents acquired their land by buying it from a land-owner, and some residents have proof of this transaction. However, the residents do not have legal ownership of the land and/or government approval to build on the land, which is why I call Kallu Kuttai an 'informal' settlement, despite the fact that people have been living in the area for over two decades. The lack of legal land tenure makes residents vulnerable to eviction; in fact, the community has been threatened with eviction on multiple occasions.

INFRASTRUCTURE & SERVICES

The Kallu Kuttai area lacks some forms of public infrastructure. For instance, there are no paved roads, street lighting, or garbage collection. Government institutions or services are essentially non-existent; except for ration shops and a state-sponsored daycare. To access schools and medical facilities, residents must leave Kallu Kuttai. While several privately-operated shops, such as fruit vendors, provide basic supplies, many of the residents' daily needs are located outside of the community. Fortunately, these amenities can be easily accessed by residents by going to other parts of the city, via public transit.

4.2 STATE OF WATER & SANITATION SUPPLY AND ACCESS

In this section, I describe water supply and access in Kallu Kuttai, which I observed during my visits to the community and explored through my conversations with residents.

WATER TANKERS

The main water supply in the community comes from water tankers. These tankers deliver water to the community by depositing water loads into holding tanks (of 3000L capacity) which are found at the end of every block. There are two types of water tankers and tanks: Metrowater tankers or Greater Chennai Corporation tankers (commonly referred to by residents as *Corporation water*). The Metrowater tankers source their water from the Nemmeli desalination plant, while

Corporation water is sourced from the nearby Perungudi Lake. Metrowater is used for all purposes, while Corporation water, which is not purified, is used for purposes other than drinking.

Water tankers refill tanks every other day. The water deliveries are staggered so that there is a constant circulation of water tankers throughout the day. Water is collected by residents, typically women, in the mornings or evenings, when the tanks are unlocked. Women collect the water for their household by filling up plastic pots and carrying the pots home. However, water is available for a few hours a day, usually in the mornings and evenings, which means that women's work schedules must accommodate the water timings. Women told me that the task of collecting water can take anywhere from 30 minutes to one hour, depending on how far away the home is from the holding tank, and the number of people in line. I estimate that the range of distances between the household and the holding tanks to be 100m to 500m (one way), given the frequency of water holding tanks that are found in the area. After transporting the water home, women decant the water into repurposed chemical drums, and then use the water as needed.

Water is purchased through a community-organized token system, which is arranged on a block basis. According to the women responsible for this system, households purchase a token, and each token provides access to an allocated number of water pots for the household. Token payments are collected by a resident who submits the payment to Metrowater. According to Metrowater's website, the costs of a mobile water delivery to a slum is 40Rs per 1000L (CMWSSB, 2018a). If needed, households can purchase additional water directly from the tanker drivers. Some households have private water holding tanks on their property, which they can also fill by paying water tanker drivers.

WATER CANS

Many households buy water cans for drinking water, at the cost of 40Rs per 20L. Flatbed trucks deliver water cans.

PUBLIC WELLS

Public wells are found throughout the community. Residents explained that while these wells used to be an important source of water for many households, they are used less because water quantity and quality have diminished. During the summer, some wells dry up completely.

PRIVATE BOREWELLS

Some households have private borewells on their properties, which extract groundwater.

PRIVATE SUMPS

Certain homes in the neighbourhood have their private sumps on the property, which they can pay Metrowater to refill. Sumps pump water to OHTs, which supplies water to the household through pipes.

PUBLIC WATER LINE

One public water provides water from Perungudi Lake. This line provides a small stream of water that exits through a spout and can be accessed by the community when the water is running. Residents told me that they gained this public water by negotiating with a local leader, but it is not a reliable water source.

TOILETS & WASHING

Households typically build private toilet and washing facilities for their homes, which are located outside of home. One stall contains a toilet, and the other stall is for washing. The toilets are connected to a septic tank, which are emptied by the Chennai Corporation for a fee. Households that do not have toilets use open areas, such as streets and empty lots. Household washing (e.g. clothes, dishes) is done by women, and takes place outside of the home.

DRAINAGE & WASTE

There is no planned water drainage system in the community. The lack of paved roads creates problems particularly during the rainy season, as streets become very muddy and difficult to navigate.

There is no provision of public waste bins in the community. Waste collects along the side of the roads and in open areas. Wastewater stagnation and garbage disposal in open drains are common phenomena, which increases the risk of flooding in the area. Surrounding the community are a number of small ponds and wetlands, which are polluted with solid waste.

WATER-RELATED HEALTH HAZARDS

Kallu Kuttai lays on low-lying land and is surrounded by water bodies. During the rainy season, this location, along with inadequate drainage, contributes to regular flooding throughout the community. According to residents, the floods of 2015 devastated the community. During this period, some residents with two-storey homes stayed in the upper levels of their house. Some families took shelter at the Perungudi train station for up to a week, while others sought refuge with extended family.

The waterbodies that surround Kallu Kuttai, as well as small pools of stagnant water found throughout the area, are breeding grounds for mosquitoes, which spread illnesses such as malaria.

SUMMARY

Water access comes from a patchwork of different sources, the primary source being water supplied via tankers, from either Metrowater or Chennai Corporation. While the state of water access appears to be consistent across the community, residents informed me that water access changes with the seasons. During the dry season, water scarcity is a concern for residents. Water tankers come less frequently and wells run dry, meaning that residents are obliged to ration water. Overall, accessing water can be burdensome due to its variability, and the daily costs of time and energy that residents spend in securing their daily water needs. Like many informal settlements in Chennai, Kallu Kuttai is vulnerable to the city's water-related crises: drought and flooding. A table which summarizes all access mechanisms is provided below.

Supply Mode	Supply Source	Location	Access Mode	Price & Quantity	Use
Water tankers	Metrowater (from Nemmeli Desalination Plant)	1-2 water holding tanks are allocated per block	Water tankers deposit water in holding tanks, residents collect water from tanks using pots to carry the water home	Price that residents pay per pot is determined by a community organized token system. Metrowater's mobile water supply cost for slums is 40Rs per 1000L.	All uses
	Chennai Corporation (from Perungudi Lake)				Primarily for washing and cooking, but some households use it for drinking water
Water cans delivered via flatbed trucks	Sourced and packaged by private vendors	Mobile delivery	Purchased by individual households	40Rs per 20L can	Drinking water
Public wells	Borewell	Public wells are scattered throughout the area	Residents collect water from wells using pots	Free	Washing, cooking etc.
Public water line	Chennai Corporation (Perungudi Lake)	One public water line is found in the community	Residents collect water from public line using pots to carry the water home	Free	Washing, cooking etc.
Private sumps	Metrowater (from Nemmeli Desalination Plant)	A small number of homes have private sumps	Water tankers deposit water in sumps, sumps pump water to overhead tanks	Residents pay Metrowater per sump refill	All uses
Private borewells	Borewell	A small number of homes have private borewells	Private borewell supplies water through tap located outside of the home	Free, however household must pay installation costs and electricity usage	Washing, cooking etc.

Table 2: Kallu Kuttai Water Access Summary Table

4.3 MAIN FINDINGS FROM RESIDENT DISCUSSIONS

During field visits to Kallu Kuttai in January 2018, informal discussions with around twenty residents and a few leaders in the community revealed local perspectives on water and sanitation. The main findings are generalized as follows:

- Residents said that the water and sanitation situation has generally improved over the last two decades, as prior to the arrival of water tankers and tanks, women collected water from the local water bodies or hand pumps.
- At the same time, the quality of groundwater has decreased and is no longer usable. This means that the traditional water sources, namely wells, are no longer a water source for residents.
- When asked how they would like to see the water and sanitation situation improved in the community, residents asked for the following improvements:
    - Daily water delivery to the water holding tanks
    - Paved roads, for general circulation and to enable the easier transport of water (by foot and for water tankers)
    - Private water connections for each household

Overall, while the water access has improved in material ways with the installment of water holding tanks; the traditional ways of water access in the community, namely groundwater wells, are no longer available. The quantity of water available is insufficient: according to residents, this is one of the main problems in the community. While those responsible for water collection, the women of the household, wished to see the introduction of daily water delivery and paved roads, the local leaders (mostly male) wanted to see individual water connections installed for each household. This divide may indicate a disconnection between men's ideas of what constitutes an improved water supply, and the realities of household water collection.

Here, I think that women's preference to improve the current water system diverges from the pervasive development discourse which separates women into two categories: either the 'traditional' woman who is illiterate and fetches water by hand, and the 'modern' women who becomes empowered through taking active roles in projects that bring improved (i.e. piped water) to their community (O'Reilly, 2006). Women have preferences for water improvement based on their daily habits, needs, values, and ideas which can change between individuals and over time – their desire to improve the current system does not mean that these women are 'backwards', or poorly informed. On the other hand, men's preference for individual water connections falls in line with concerns about status and modernity, where the introduction of individual water connections can transform a woman from traditional to modern (O'Reilly, 2006).

4.4 LOCAL GOVERNANCE MAPPING

Kallu Kuttai has an active self-organized governance system, wherein a local resident's association works towards gaining better access to water and other basic amenities by organizing petitions. In terms of the management of the public water supply, water delivery in Kallu Kuttai is managed by the Metrowater Depot Office, while the presence of other government departments or elected officials in the community appears to be limited.

SELF-ORGANIZED GOVERNANCE

Kallu Kuttai's primary community-based organization is a Residents Welfare Association (RWA), which works to improve access to public services, upgrade community infrastructure, and initiate projects surrounding education and resident welfare. Households can gain membership to the RWA by contributing a fee. The active membership of the RWA is predominantly male – it is the male head of the household who joins the RWA. However, women are still engaged with the RWA. For example, if there is a problem with water delivery, the women may talk to their husband or father, who will submit the complaint to the RWA. From there, the RWA will organize and submit complaints and requests to the Metrowater depot office.

While the RWA is the main locally-organized body in Kallu Kuttai, other forms of community networks are present. There is a strong sense of community in Kallu Kuttai, wherein established bonds between households reproduce acts of giving, sharing and reciprocity. If a family is running low on water, neighbours step in to provide an extra pot. In this community setting, I found that women take important leadership roles. For example, some women explained to me that when water deliveries fall short, they call the water tanker driver directly to resolve the issue. They organize the token system to ensure water payments and submit their grievances to the RWA.

METROWATER

The Metrowater Depot Office carries out the work of ensuring the daily water supply to Kallu Kuttai. For example, if there is a problem with the water supply in their neighbourhood, residents may submit a complaint with the Depot Office. According to information gathered from a Metrowater public meeting I attended, the water engineers of the Depot Office will address the complaint, which are prioritized based on the urgency of the issue. The Metrowater Area Office oversees the water supply across the wards in a given area. While the Depot Office is responsible for ensuring the regular daily water supply, the Area Office plans and executes new water schemes and improvements (Metrowater Area 14 Public Hearing February 10, 2018).

MUNICIPAL GOVERNMENT

The presence of the Greater Chennai Corporation government appears to be lacking. The Chennai Corporation is responsible for providing civic services to Chennai, such as roads, storm

water drainage and solid waste management, among others. Due to Kallu Kuttai's status as an unapproved housing settlement, the Chennai Corporation is not obligated to provide the same public services that it does to households with legal land tenure. However, from the government documents that I found relating to informal settlements, the government's specific responsibilities here are not clear. For instance, in *Chapter 3.4 Introduction to Slums & Resettlement* we saw that settlements declared as 'slum areas' *may* receive slum improvement works – but when, how, by whom and what are unspecified. Moreover, during the time of my visit to the area, the position of ward councillor for Kallu Kuttai was vacant due to interrupted election cycles, which made it difficult to verify such information.

4.5 CONTRIBUTING FACTORS

At the core of Kallu Kuttai's current water situation is land tenure. As an unapproved layout, Kallu Kuttai receives its public water supply through water tankers, instead of through Metrowater's piped distribution network. According to officials that I spoke to during a public hearing, Metrowater is not obligated to provide piped water to Kallu Kuttai because residents do not have legal land tenure (Metrowater Area 14 Public Hearing February 10, 2018). Moreover, as a parastatal agency, which operates at an arm's length from the Greater Chennai Corporation Government, Metrowater has no stated obligations of serving the urban poor in an equitable manner (Coelho, Cullet, Gowlland-Gualtieri, Madhav, & Ramanathan, 2010). On the whole, the difficulty in accessing public information and elected officials, which I encountered first-hand, makes it complicated for residents to understand governments obligations, let alone call for government accountability.

At the same time, the state of sanitation and the water-related health risks in Kallu Kuttai is influenced by its location in the city. Kallu Kuttai is close to the Perungudi dumping site, which spans over 200 acres. Authors have documented that the dumping of waste without proper disposal has resulted in the spread of disease near the dumping yards. According to Parvathi (2014), garbage has been dumped in Perungudi for more than 10 years, which has turned it into a breeding place for mosquitoes. Kallu Kuttai is located on low-lying land, and is surrounded by water bodies. This makes Kallu Kuttai prone to flooding, and contributes to occurrence of water-related illnesses. Therefore, Kallu Kuttai's location, close to the dump site and surrounding water bodies, seems to be a contributing factor here. However, as we have seen, urban poor households often do not have the privilege of choice when it comes to where they live – residents told me they live in this area because it is close to their work, and their children's school – other options are not affordable.

Lastly, Chennai's urban development plays a determining role in Kallu Kuttai's water and sanitation situation. The area surrounding Kallu Kuttai is developing quickly, due to its proximity to the IT corridor. This urban development has been related to the phenomena of groundwater depletion and induced saline intrusion to Chennai's groundwater table. The residents of Kallu Kuttai are witnesses to these events, as they confirmed to me that over the last decade the quantity

of groundwater has reduced, as well as its quality. The development of the IT corridor also puts the population at high risk for flooding, as the paved surfaces in the corridor have replaced naturally-occurring systems and divert water to the adjacent low-lying areas. The surrounding urban development also makes Kallu Kuttai highly vulnerable to eviction, as the land occupied by the settlement becomes an increasingly attractive site for future IT related development.

To summarize, the state of water and sanitation in Kallu Kuttai is the outcome of many factors: from the complexities of land tenure and government responsibility, to the location of the settlement, and the advent of urban development. In the next chapter, I present the second case study in Chennai, a resettlement area located outside of the city center.

4.6 PHOTOS OF KALLU KUTTAI

Man with empty water cans

Private toilet and washing facilities

Water tanker truck

Water storage containers

Public well

Women collecting water

CHAPTER 5: CASE STUDY 2 PERUMBAKKAM, CHENNAI

5.1 BACKGROUND

Perumbakkam is a slum resettlement community located outside of Chennai City, in the Kanchipuram District. The resettlement site is found within the boundaries of the St.Thomas Mount District Panchayat, and the Perumbakkam Village Panchayat. Perumbakkam is a housing scheme developed by the TNSCB. The development is divided into three phases, which all together are intended to provide over 20,000 new housing units to former Chennai city-dwellers.

Name of Scheme	Number of units	Project Cost (Rs in tens of millions)
Ezhil Nagar (Perumbakkam)	3,936	175.36
Perumbakkam Phase I	10,452	686.03
Perumbakkam Phase II	5,988	5988
Total	20,376	6849.39

Table 3: Details of Perumbakkam Housing Scheme
Source: TNSCB Website, 2018

A large proportion of the Perumbakkam scheme is still under construction. Currently, two of the proposed schemes have been completed. Ezhil Nagar, the area to the south of Perumbakkam Main Road, is made up of 32 completed apartment blocks, of which 3,811 units are occupied. Perumbakkam Phase I is located on the north side of the road, made up of 156 blocks, of which 802 units are occupied.

Name of Scheme	Number of units available	Total number of units occupied
Ezhil Nagar (Perumbakkam)	3,936	3,811
Perumbakkam Phase I	10,452	802
Total	14,388	4,613

Table 4: Occupied units in Perumbakkam as of 2016
Source: IRCDUC & HLRN 2017, p.9

The area that surrounds Perumbakkam is characterized by the presence of multiple water bodies, marshland and new development. Over the past decades, these wetlands and waterbodies have been encroached upon by both private and public-initiated development. The development in the area, including Perumbakkam, has been built directly on top of marshland which puts residents of Perumbakkam at risk for flooding. While private residential development avoids flooding by raising the ground floor of the building, the apartment blocks of Perumbakkam are flooded

regularly. The Perumbakkam resettlement site is a government-built housing scheme which was planned to house residents in a known flood-risk area, without adequate flood protection.

5.2 SOCIOECONOMIC CONDITIONS

According to a recent study from the Housing and Land Rights Network (HLRN) and the Information and Resource Centre for the Deprived Urban Communities (IRCDUC), the population of Perumbakkam is 2,359 residents. Of the resettled families, 60 percent of families are Dalits and 40 percent belong to Other Backward Classes. Twenty-three percent of adults are illiterate, 46 percent have completed primary school, 18 percent have completed high school, 4 percent have completed higher secondary school, and 9 percent have a college education (IRCDUC & HLRN, 2017).

The household income of 53 percent of the households is less than 3,000 Rs per month while 36 percent of the families earn an income ranging from 3,001 Rs to 6,000 Rs (IRCDUC & HLRN, 2017). During my visit to the area, residents told me that men in Perumbakkam mostly work in unorganized daily wage labour, such as construction work or as autorickshaw drivers. Women care for the children and the household, some also work as tailors.

Families resettled to Perumbakkam originate from the following areas of Chennai and Kanchipuram:

- Anushiya Mandapam (Saidapet)
- JJ Nagar (Nandambakkam)
- Jothi Ammal Nagar (Saidapet)
- Ambedkar Nagar (Kotturpuram)
- LDG Road (Saidapet)
- Soorya Nagar (Kotturpuram)
- Pudhu Kuppam–Tambaram (Kanchipuram District)

Perumbakkam is located approximately 25 to 30 km from these places of origin. (IRCDUC & HLRN 2017, p.13)

HOUSING & LAND TENURE

There are two types of apartment blocks found in the Perumbakkam housing scheme. The Type A design has 32 blocks: each block has 8 stories, with a population of about 750 individuals. The Type B design (156 blocks), also has 8 stories but fewer units per story, housing about 380 individuals (IRCDUC & HLRN, 2017).

There is poor information surrounding land tenure in Perumbakkam. Residents make monthly payments to the TNSCB for their allotted housing, yet the TNSCB does not have any

mechanism in place to ensure that sale deeds will be issued to residents on completion of payments (IRCDUC & HLRN, 2017).

INFRASTRUCTURE & SERVICES

According to the TNSCB website, tenements are provided, "Basic infrastructure facilities such as water supply, sewerage, road, street lights, ration shops, community hall, vocational training center, pre-school, milk booth, police station etc." (TNSCB, 2018). However, basic infrastructure is lacking in the Perumbakkam resettlement site. During my visit, I observed that there is no public street lighting. Many of the blocks do not have elevators installed. Residents told me that there is a lack of adequate daycare and educational facilities. Many children have dropped out of school since resettlement, because of the distance of the resettlement site from the former schools in the city. Moreover, following relocation, many families report accessing private health facilities because public healthcare is not available (IRCDUC & HLRN, 2017).

5.3 STATE OF WATER AND SANITATION SUPPLY & ACCESS

In this section, I describe water supply and access in Perumbakkam, which I observed during my visits to the community and explored through my conversations with residents.

INDIVIDUAL WATER CONNECTIONS

The Perumbakkam apartment units are fitted with a household water connection. Water flows from OHTs which are located on the roof of each building. Sumps are located outside the ground floor of each apartment block, which pump water to the OHTs. Each water tank serves two apartment units. Water is available for a few hours each day. During field visits to Perumbakkam in January 2018, I spoke with 24 residents of the community and inquired into the daily use of these water connections:

- Water quality is poor. Residents said that the poor quality of water that they get from their taps gives them skin rashes. When residents asked what improvements they would like to see in the water situation, most residents asked for purified water or better tank cleaning.
- The water supply can be variable. For instance, if there is an electrical outage, the water pumps stop working and water must be taken directly from the sump on the ground floor. Tank cleaning disrupts the flow of water for up to two days at a time.
- The quantity of water available to each household can depend on the household's location within the building. Two units share one tank. These units are located on two different floors: the unit located on the upper floor has the primary access to water, while the unit located on the lower floor often runs out of water. In these situations, households share pots of water to resolve the issue. In some cases, residents travel to the adjacent community to collect water.

WATER CANS

To fulfill their drinking water needs, residents buy canned water at the price of 40Rs per 20L can. Canned water is delivered by flatbed trucks to the main floor.

TOILETS & WASHING

Each apartment unit is fitted with one wash stall and one toilet stall. Most residents do their clothes-washing by hand, while some families have purchased washing machines. Residents with a larger number of household members in their unit told me that that these facilities are not sufficient for their family's needs.

WATER-RELATED HEALTH HAZARDS

While residents were originally relocated to Perumbakkam due to flood-risk, the resettlement site, located directly on marshland, is equally flood-prone. During the rainy season, regular flooding affects primarily the ground floor of each block. The units of the ground floor are typically used for childcare facilities and/or for office space, which means that these educational and productive activities are often interrupted during the rainy season. Moreover, the surrounding water-laden lands are a breeding ground for mosquitoes, which spread illness to residents.

DRAINAGE & WASTE

The water pipes that carry water and wastewater to/from each apartment block requires maintenance. The wastewater pipes are attached to the exterior of the buildings, and these pipes are leaking. I saw that on many buildings, the leaking wastewater accumulates and pools outside of the ground floors, which is a health and safety concern for residents. The water sumps at the ground floor of each building are also dysfunctional, as they overflow and create large pools of stagnant water.

There is no comprehensive storm water drainage plan for the area, which worsens flooding during the rainy season. Solid waste is collected in community waste bins, which are located at the base of each building. Despite scheduled waste collection, solid waste collects along the sides of roads and in open drains.

DESIGN-RELATED WATER ACCESS ISSUES

The design of the apartment blocks creates difficulties in accessing water and using sanitation facilities. For instance, residents explained to me that when there is not enough water, a household member must go down to the main floor sump to collect water. When elevators are broken (or have yet to be installed), this means residents carry pots of water up narrow staircases. Moreover, the configuration of the apartment units is inappropriate, as there are many different

household activities that are located very closely together. For instance, the toilet stall has a vent which leads into the kitchen area, which is an unsuitable design.

SUMMARY

Overall, households are supplied public water and access this water through taps that are installed in each apartment unit. However, the water supply is problematic due to the poor quality of water and its variable supply. The lack of a dedicated storm water drainage plan, as well as the poor design of apartment blocks and units, creates environmental, health and occupational hazards for residents.

5.4 MAIN FINDINGS FROM RESIDENT DISCUSSIONS: RESETTLEMENT

During my field visits to Perumbakkam, my conversations with residents on water and sanitation, also expanded to include residents' experiences with resettlement. I include these findings below:

- Residents were not given a choice about their relocation to Perumbakkam, they were forcibly moved to the area following flooding in their former communities.
- Many residents prefer their former communities in Chennai over Perumbakkam, due to the lack of employment and educational opportunities, and the distance from the city.
- Residents find that they devote a large proportion of their income to commuting costs, particularly for those that maintain their jobs in the city following relocation.

5.5 LOCAL GOVERNANCE MAPPING

The recent construction of the Perumbakkam resettlement site means that forms of self-organized government, such as a RWA, are not established. On the other hand, there is an overlap in agencies and government units which are supposedly responsible for supplying and maintaining public infrastructure. Overall, the TNSCB is the main government authority in Perumbakkam; however, this agency provides limited options for citizen consultation.

SELF-ORGANIZED GOVERNANCE

There are few forms of community-based organization that I encountered during my visits; this is not surprising given that Perumbakkam is still under construction and a large number of units are unoccupied. However, I came across examples which showed that residents organized in small groups to make improvements to their apartment blocks. For instance, residents of one block told me that they collected money from each unit to buy new lighting for their building.

TAMIL NADU SLUM CLEARANCE BOARD

The TNSCB is the main governing authority in Perumbakkam. Each block has a designated TNSCB representative, and residents can bring complaints to these representatives; however, I found no accountability measures that would ensure the resident's needs are addressed in a fair and timely manner. Residents told me that they were not informed of any ways which they can get involved in TNSCB decision-making for their apartment blocks.

METROWATER

The Perumbakkam resettlement site is officially outside of Metrowater's jurisdiction as it lies outside of the CMA. Accordingly, Perumbakkam is formally within the jurisdiction of the Tamil Nadu Water Supply and Drainage Board (TWAD). However, water in Perumbakkam is supplied by the Metrowater desalination plant in Nemmeli, which brings Perumbakkam into Metrowater's area of responsibility. And, while the TWAD is the agency responsible for the planning and construction of water infrastructure, the assets it builds are supposed to be maintained by the local administrative body (i.e. the panchayat) (Citizens Alliance for Sustainable Living, 2004). So far, however, the water infrastructure is being maintained by the TNSCB.

Perumbakkam is also within the CMDA's realm of responsibility. For instance, the CMDA is developing a Detailed Development Plan (DDP) for Perumbakkam. DDPs are the plans prepared for small areas with the objective of providing good road network, plot wise land use and improvement of infrastructure (CMDA, 2018a). Clearly, the provision of water and infrastructure in Perumbakkam is characterized by the overlap of agencies, which makes it difficult for residents to know whom to approach to have their concerns addressed, let alone get involved in citizen consultation or participation processes.

MUNICIPAL GOVERNMENT

Perumbakkam is within the St.Thomas Mount District Panchayat, and the Perumbakkam Village Panchayat. These government units are responsible for providing communities with roads, lighting, drains, cleaning of streets, among other functions. The Tamil Nadu Panchayats Act, 1994, says that these government bodies are equally responsible for, "the construction and maintenance of water-works [for the supply of water for drinking, washing] and bathing purpose" (p.38). Therefore, important questions remain surrounding the official division of responsibilities between the TNSCB and the local governments.

5.6 CONTRIBUTING FACTORS

The water and sanitation situation in Perumbakkam is related to the phenomena of slum resettlement in Chennai, which I first introduced in *Chapter 3.4 Introduction to Slums & Resettlement*. In order to bolster its reputation as a 'world-class city' Chennai welcomes large-

scale infrastructure developments and river restoration projects (Rajagopalan, 2013). These projects uproot the urban poor and resettle them outside of the city center. The mass relocation colonies, which are government-planned, are almost always sited on low-lying marshlands or flood plains on the city's peripheries (Coelho & Raman, 2010). This means that resettled families continue to be susceptible to floods and at risk for mosquito-borne illness. Not only this, resettled residents also face the added vulnerabilities of livelihood loss, as they become distanced from the social and economic opportunities they once enjoyed as urban residents (Coelho & Raman, 2010).

I also attribute the poor state of water service and the dysfunctional water infrastructure in Perumbakkam to government failure. According to the National Rehabilitation and Resettlement Policy of 2007, "in all cases of involuntary displacement of 400 families or more en masse in plain areas, comprehensive infrastructural facilities and amenities notified by the appropriate government shall be provided in the resettlement area(s)" (Diwakar & Peter, 2016 p.105). Here, the responsible agency, the TNSCB, has failed to provide adequate basic civic infrastructure and services to the resettled population.

Overall, I find that the state of WSS in Perumbakkam begins with the government-planned displacement of the urban poor to flood-prone land. It continues with the TNSCB's failure to provide adequate public services, where citizens lack clear channels to hold their government and its agencies accountable.

5.7 PHOTOS OF PERUMBAKKAM

Water can delivery

Overhead water tanks

Marshland surrounding Perumbakkam

Leaking sump

View from top of apartment blocks

Hallway in apartment block

CHAPTER 6: BANGALORE, KARNATAKA

6.1 INTRODUCTION TO BANGALORE

Bangalore (officially called Bengaluru) is the capital of the state of Karnataka, located in South India. As of 2011, Bangalore City is home to 8.4 million inhabitants, while the Bangalore Metropolitan Region counts 8.5 million (Census of India, 2011d). The city's municipal area is called the Bruhat Bengaluru Mahanagara Palike (BBMP), which currently spans around 800 km^2, and includes seven City municipal councils, one Town municipal council and 111 villages (BBMP, 2018).

Bangalore is a modern South Indian city, and the second-fastest growing major metropolis in India. Over the last four decades, the population has grown from 1.65 million people in 1971 to 8.5 million people in 2011 (Mehta, Goswami et al., 2013). Bangalore's economy is diverse, serving as an industrial hub for public sector heavy industries, particularly aerospace, telecommunications, and defence organizations. However, the city's economy is most known for its position as one of the largest IT exporters in the country, from which Bangalore gets its name the *Silicon Valley* of India. Bangalore is home to 30 percent of the total IT workforce in the country, which sustains a personal disposable income which is greater than the Indian city average (Sudhira, Ramachandra, & Subrahmanya, 2007). Bangalore is also known as the *Garden City of India* for its vast tree cover, broad streets, and public parks. The city's landscape is largely modern, with the presence of high-rises, large shopping centers and IT parks. While this rapid growth and new infrastructure is key to the city's economic development, it also brings problems which characterize India's quickly urbanizing cities: rising inequality, the eviction and dispossession of the urban poor, and spatial disparities in the availability of civic services such as water and sanitation.

6.2 WATER SCARCITY

6.2.1 NATURAL CAUSES

Bangalore faces water scarcity, having recently been deemed by the media as the 'next Cape Town' due to the likelihood that the city will soon run out of drinking water (BBC News, 2018). Indeed, Bangalore's public water agency predicts that by 2031, there will be a 1450 MLD (millions of liters per day) shortfall in supply of water. The city's water stress can be partially attributed to the fact that unlike other big cities, Bangalore is not close to any large perennial waterbodies. The Bangalore plateau is in the rain shadow of the Deccan hills, and has always been dependent on natural and artificial lakes for drinking water and irrigation (D'Souza & Nagendra, 2011).

Year	Population (Million)	Water Demand (MLD)	Current Supply (MLD)	Shortfall in Supply (MLD)
2011	8.499	1400	950	450
2021	10.581	2100	1450	650
2031	14.296	2900	2070	1450
2041	17.085	3400	2070	1950
2051	20.561	4100	2070	2650

Table 5: Bangalore Population and Water Supply Requirements
Source: BWSSB Website, 2018

6.2.2 HUMAN-MADE CAUSES

In recent years, Bangalore's population growth has put acute pressure on the city's water resources. Over the last two decades, Bangalore has transformed from a sleepy green city to a global technology center, a growth pattern which has relied on the use of natural resources including water and green spaces (Connors, 2005). Beginning in the 1970s, when the city began to import water from a distant water source, lakes were no longer perceived as being critical for the supply of fresh water, and many of these lakes were converted to other land uses. Bangalore, once known as the *City of Lakes* was previously home to 200 lakes. The number of lakes has fallen as they have been filled and converted to other uses including bus stands, golf courses, malls and residential areas (D'Souza & Nagendra, 2011). As of 2011, there are approximately 100 lakes left, most of which are contaminated with sewage (Ramachandra & Aithal, 2016). The situation of dumping of untreated sewage and industrial effluents into Bangalore's lakes is alarming. The dumping has caused Bangalore's largest lake to catch on fire, forcing the eviction of nearby residents (The Guardian, 2017).

The city's rapid growth and IT boom are also restricting the replenishment of groundwater sources: a report from the Energy and Wetlands Research Group indicates that between 1973 and 2016, urbanisation caused a 1005 percent increase in paved surfaces and a decline of 88 percent in the city's vegetation, which significantly reduces the amount of water available to recharge aquifers (Ramachandra & Aithal, 2016). The reduction of wetlands and green areas is also contributing to frequent flooding, which occurs even during normal rainfall (Ramachandra & Aithal, 2016). Overall, as urban development has contributed to the degradation and depletion of Bangalore's natural water resources, the city is increasingly dependent on the groundwater table, which is also sinking (Connors, 2005). The Energy and Wetlands Research Group report predicts that in the coming years, if Bangalore continues to welcome the conversion of green surfaces to paved surfaces, the city will not only be characterized by water scarcity but will also become "non-resilient and unlivable" (Ramachandra & Aithal, 2016, para.3).

6.3 WATER SUPPLY & SANITATION CONTEXT

6.3.1 WATER SUPPLY

Since 1964, Bangalore's piped water supply has been managed by the Bangalore Water Supply and Sewerage Board (BWSSB), an autonomous agency which operates under the Karnataka state government. The BWSSB is responsible for providing adequate water supply and sewage disposal for the BBMP; however, the current BWSSB boundaries do not cover the entire BBMP area (Luxion, 2017).

The BWSSB supplies water to households through a piped water system, by pumping, treating and distributing water from the Cauvery and Arkavathi Rivers (Mehta, Goswami, et al., 2013). The BWSSB supplies this treated water through the piped-network, where distribution losses account for about 40 percent (Ranganathan, 2010). The BWSSB distribution network is strongly correlated with the degree that the city's areas are 'planned'. BWSSB connections are most prevalent in the Bangalore core area and in layouts planned and approved by the Bangalore Development Authority (BDA) (Ranganathan, 2010). As the demand for water has increased over the years, the BWSSB's focus has been to increase the water supply through its piped system: beginning in the 1970s, the BWSSB has undertaken several projects to expand the Cauvery River water supply, with major projects in the 1980s, 1990s, and 2000s. The latest expansion has brought Bangalore's consumption of river water to the maximum allowed by interstate law (Luxion, 2017; Ranganathan, Kamath, & Baindur, 2009). The Cauvery River is in high demand not only from Bangaloreans, but is also an important water source for other populations in South India, as the river provides water to the rest of Karnataka and Tamil Nadu. For decades, this arrangement has given rise to several water disputes between the states, even prompting the intervention of the Supreme Court (The Times of India, 2018).

Apart from its river sources, the BWSSB also supplies about 70 MLD of groundwater from over 7,000 borewells (Mehta, Goswami, et al., 2013). As these groundwater sources dwindle, the BWSSB has instituted measures aimed at groundwater recharge. Rainwater harvesting is now compulsory on large properties and for commercial establishments (Anand, C., 2017). Since the implementation of this law in 2009, adherence to the program has been growing slowly (Anand, C., 2017). As of 2018, only 60 percent of the buildings governed by this rule now follow it (Gururaj, 2018).

BWSSB water makes up only a portion of total domestic water consumption in Bangalore. Residents also access water through other sources such as private borewells, private water tankers, bottled water, and untreated surface water bodies like lakes (Mehta, Sekhar, & Malghan, 2013). Outside of the core area of the city, these sources become more important, as water supply from the BWSSB is not guaranteed. Most of the new population growth in Bangalore between the last two decennial census enumerations has happened in the peripheral wards of the city (Mehta, Goswami, et al., 2013). In these newer, outer wards, on average, BWSSB supply for domestic consumption is very low (Mehta, Goswami, et al., 2013). A study by the Institute for Social and

Economic Change in 2005 found that the amount of water sourced from private borewells and water tankers was up to 30 percent as much as that officially provided by the BWSSB (Narain, 2012). The demand for water from water tankers has allowed for the tanker market to flourish – in fact, many accounts claim that this market is now controlled by a water mafia that sets unfair prices (Subramanian, 2017). In the summer, as water becomes scarce, these tankers play a vital role in determining access to water in Bangalore's urban and peri-urban areas.

6.3.2 SANITATION

Since its inception in 1964, the BWSSB has undertaken major works to expand the sewerage system and improve the wastewater treatment process. However, the sewage treatment and disposal network remain insufficient. Bangalore, like many other Indian cities, currently does not fully utilize its installed capacity for wastewater treatment (Mehta, Goswami, et al., 2014). This means that untreated waste is dumped into the city's waterways, in the order of 400-600 MLD (The Guardian, 2017). Furthermore, household's illegal conversion of storm water drains into sewage drains, causes wastewater to drain into natural water bodies. These factors have contributed to the conversion of possible water sources into waste sinks and carriers, and the pollution of groundwater, which amplifies Bangalore's situation of water scarcity (Mehta, Goswami, et al., 2013).

Outside of the BWSSB's core service area, households make use of septic tanks and individual latrines, and many are left without adequate wastewater treatment facilities. In the case of medium size residences, in 2016 the BWSSB mandated that apartments must build their own STP; however, this rule was recently revised following resistance from citizen advocacy groups (Chatterjee, 2017). As Bangalore's peri-urban areas expand, the city faces real challenges in terms of delivering basic infrastructure and services to all its stakeholders.

In summary, water supply in Bangalore is characterized by a multitude of water sources, as households located in the outer areas of the city respond to the lack of public supply by purchasing water. The city's sanitation network is problematic, as untreated waste makes its way to the city's water bodies, and peripheral areas expand without connections to the underground sewage network. In the next chapters I present two case studies in Bangalore, beginning with a mixed-income community located in the city center. The final case study examines sustainable water management practices in a gated-residential layout, located outside of the BWSSB service area.

CHAPTER 7: CASE STUDY 3 SAGAYARAPURAM, BANGALORE

7.1 BACKGROUND

Sagayarapuram is a mixed-income community found within Bangalore city limits, situated north of the city center. According to Bangalore's administrative boundaries, Sagayarapuram consists of Ward 60, within the Pulakeshi Nagar division. The ward population is 34,874, and the ward area is 0.77 km^2 (Bangaluru Governance Observatory, 2018) The Sagayarapuram Ward is divided into 11 blocks. For this case study, blocks numbered 1 to 5 serve as the primary study area (see map below). The ward is bordered by the railway to the north, Hennur Main Road to the east, Pottery Road to the south, and Tannery Road to the west.

Map 5: Sagayarapuram Ward Delimitation
Source: BBMP Website, 2018a (in this figure numbering is my own addition)

7.2 SOCIOECONOMIC CONDITIONS

From my site visits to Sagayarapuram in April 2018, I found that the population of the ward is characterized by a range of incomes, from low-income to wealthy households. The main

religions are Islam, Hinduism and Christianity. In terms of employment, there are several small enterprises that are found within the ward or in adjacent communities. In these outlets, residents work as tailors, carpenters, mechanics, or in other semi-skilled trades. Other residents commute to the city for their employment, to work in the construction industry, or as clerks and security guards. Wealthier residents tend to work in office jobs or they operate businesses. Therefore, earning potential across the ward differs considerably between households.

HOUSING & LAND TENURE

Blocks 1 to 5 contain mostly lower- and middle-income houses and apartments, while blocks 6 to 11 have large apartment complexes, where wealthier residents reside. Low-income housing consists of one to two room concrete buildings. These houses have been allotted to residents by the Karnataka Slum Development Board (KSDB). Middle and upper-income households live in apartment buildings that are typically 2 to 4 stories. These buildings are shared by multiple households.

Based on my discussion with the ward councillor for Sagayarapuram, over the last two decades the area has changed from a slum area to a mixed-income neighbourhood. Approximately two thousand houses were built or improved over this time. Residents told me that land value in the ward has increased significantly over the last two decades and is continuing to rise.

INFRASTRUCTURE & SERVICES

The area is well-serviced in terms of amenities and shops that are located within the ward. Throughout the community, small shops such as snack bars, tailors, and mechanics provide residents access to their daily needs. Residents speak of good quality schools and several private medical facilities that are found close by. The ward is serviced by bus routes along Tannery Road and Hennur Main Road.

7.3 STATE OF WATER & SANITATION SUPPLY AND ACCESS

In this section, I describe water and sanitation supply and access in Sagayarapuram for blocks 1 to 5.

PIPED WATER FROM THE BWSSB

Water is supplied by the BWSSB to Sagayarapuram every other day, for a few hours each day. However, household access to this water can vary depending on household income. For instance, the KSDB-allotted households, which are the lower-income households in the community, typically have one water line which is located outside of the home. When water is available, these households use the water line to fill their various water storage containers, to make sure they have enough water to last until the next supply period. On the other hand, middle- and upper-income households typically have sumps that connect to OHTs, which allows for a

continuous 24/7 water supply. The pumps that automatically transfer water to the OHTs, means that these households can access water within their home and without effort. And, because the sumps automatically pump and store water, these households do not have to concern themselves with the water schedule or worry about running out of water on a daily basis. Overall, these mechanisms provide higher-income households with better water security.

Lower-income households also make considerable investments into their water supply. For instance, I saw many KSDB homes that had purchased small electric hand pumps, which are used to draw water up from the BWSSB pipes. Residents told me that this was necessary, because water pressure in the pipes is low. Water availability for KSDB-allotted houses can also depend on household location within the neighbourhood. For instance, some residents told me that they do not receive BWSSB water because their home is located on a sloped-area, where water pressure is low. These residents rely on other water sources. Residents pay for water based on the following BWSSB rates:

Tariff for Domestic Connections				
Slab	Water Tariff, Rs	Sanitary	Sanitary for Borewell, Rs	Meter Cost (15mm), Rs
0-8000	7	Rs.14/-	Rs. 100	30
8001-25000	11	25%		50
25001-50000	26			75
Above 50000	45			150

Table 6: BWSSB Domestic Water Rates
Source: BWSSB Website, 2018a

OPEN-ACCESS WATER SOURCES

There are several open-access water sources that can be found in the community. For example, water tanks are scattered throughout the ward, which provide non-potable water for free during specific time periods. Women are responsible for collecting water from these tanks and for transporting them to their household's storage containers. As this water is free of charge, it is an important water source for residents that cannot pay for BWSSB water. Other open-access water sources include hand-pumps and public water lines.

PRIVATE SOURCES: BOREWELLS & CANS

Private water sources include private borewells and water cans. Most households drink BWSSB water using a filtration process: low-income households boil water, and higher-income households use a filtration system. I also talked to several households that purchase water cans for drinking purposes.

TOILETS & WASHING

KSDB-allotted homes have a toilet/bathing room in the house, which is connected to the underground sewage system. Small apartment blocks have toilet facilities on each floor, which are also connected to the underground network. In addition, three public restroom facilities can be found in the community. For lower-income households, washing (e.g. clothes, dishes) is done by women, and takes place outside of the home. Some households have washing machines, which are located outside, close to the entrance of the home.

DRAINAGE & WASTE

The ward has paved roads, an underground sewage network, and a water drainage network. Garbage is regularly collected by the Greater Bangalore City Corporation (also called the BBMP).

SUMMARY

In summary, the BWSSB provides water to Sagayarapuram. Actual access to water, differs between households due to factors such as household income and location. Lower-income households have the poorest access to water in terms of water quantity and reliability, as they are required to fill and store water as it arrives from the BWSSB. Middle and upper-income households have the best access to water, due to their ability to purchase pumps, water storage and water purifying devices. Water access can also depend on household location, as water pressure varies across the neighbourhood's piped water network. Other sources include open-access water, such as water tanks and public lines. These sources are most important for low-income households. Additional details are provided in the summary table below.

Supply Mode	Supply Source	Location of water supply/ Household type	Access Mode	Price & Quantity	Use
Piped water	BWSSB (from Cauvery River)	Middle- and upper-income homes	Accessed directly from taps located in the home (via sumps and OHTs)	According to BWSSB rates	All uses, drinking water is filtered through UV system
	BWSSB (from Cauvery River)	KSDB-allotted homes	Accessed through water tap located outside of the home (via hand collection and/or electric hand pumps)	According to BWSSB rates	All uses, water is boiled for drinking
Above-ground pipe	BWSSB (from Cauvery River)	KSDB-allotted homes	In one part of the neighbourhood, one large above-ground pipe runs along a row of houses, each house can connect to the pipe outside of their home	According to BWSSB rates	All uses, water is boiled for drinking
Public water tanks	BWSSB (from borewell)	Handful scattered around the community	Residents collect water from holding tanks using pots to carry the water home	Free	Washing, cooking etc.
Public hand-pumps	BWSSB (from borewell)	Hand-pumps are commonly found throughout the community	As of 3 years ago, no water is available through the hand-pumps	N/A	N/A
Public water line	BWSSB (from borewell)	32 public water connections (across all of Ward 60)	Residents collect water from public line using pots to carry the water home	Free	Washing, cooking etc.
Private borewell	Borewell	Apartment buildings use borewell water in combination with BWSSB water	Accessed directly from taps located in the home (via sumps and OHTs)	Free, however household must pay installation costs	All uses, drinking water is filtered through UV system or other
Water cans	Private vendor	Various households buy water cans	Purchased	40Rs per 20L can	Drinking water

Table 7: Sagayarapuram Water Access Summary Table

7.4 MAIN FINDINGS FROM RESIDENT DISCUSSIONS

During field visits to Sagayarapuram in April 2018, informal discussions with around 15 residents revealed local perspectives on water and sanitation in the community. The main findings are generalized as follows:

- Residents are generally happy with their living situation and the community.
- Overall, while the availability of BWSSB supplied water has improved over the last two decades (in the past water was pumped twice a week and now it is provided every other day), the quantity and quality of groundwater has diminished.
- The main problem in the ward related to WSS is the low water pressure and water billing. Poor water pressure means that some houses do not get access to BWSSB water, even though they are connected to the BWSSB network. A number of households receive BWSSB water and have water meters installed, but water bills do not arrive consistently.
- Certain perceptions exist regarding water access by lower-income households. For instance, some middle-class residents told me that poor households are "not decent" and that by using electric hand pumps, these households are taking water away from others.

7.5 LOCAL GOVERNANCE MAPPING

SELF-ORGANIZED GOVERNANCE

The Richards Town Citizens Association is an active RWA in Sagayarapuram. The RWA serves primarily residents of Richard's Town, the wealthiest area in the ward. Residents told me that in the past, the Francis Xavier Joseph residents' association was a social network that served all members of the community, but since the death of the group's founder, the association is no longer active.

In general, when it comes to issues relating to WSS, residents call the ward councillor. The councillor redirects these complaints to the BWSSB. How the complaints are prioritized and addressed; however, remained unclear based on my conversations with the ward councillor and BWSSB engineers.

According to India's 74th Constitutional Amendment, local citizen participation should be channelled through a ward committee which is responsible for civic themes such as water, sanitation, waste collection etc. (Chamaraj, 2017). This committee is supposed to be representative of the local population, by mandating that the committee contains two members from Scheduled Castes, three women and two representatives from registered associations (Adavi, 2017). However, the fair representation of community members through this committee is not guaranteed. This is because the councillor is able to personally choose the members of the committee, which often results in a committee made up of the ward councillor's family and friends (Adavi, 2017).

Therefore, while Sagayarapuram's ward committee meets once a month, I am not convinced that this committee represents all members in the community equally and fairly.

KARNATAKA SLUM DEVELOPMENT BOARD

The KSDB is the government agency responsible for slum improvement and upgrading in the state of Karnataka. As such, the KSDB has been involved in the area's improvement over the years and provides allotted housing in the ward.

7.6 CONTRIBUTING FACTORS

At the outset, Sagayarapuram's water situation is determined by its location: as the area is within Bangalore's city limits and receives piped BWSSB water. The current situation of water supply and access is the outcome of incremental developments in the community, as it has transitioned from a slum-area to a mixed-income ward, water supply from the BWSSB has improved. However, this has also prompted a transition from open-access water sources to paid-for private water connections. In the last five years, water meters and billing were introduced to the community, yet the roll-out of the system appears to be problematic, as several households told me that they do not receive regular water bills.

Furthermore, water access can depend on household income and location. Some households cannot access BWSSB water due to low water pressure, which means they must use open-access water sources. These are generally KSDB-allotted homes. Higher-income households use water pumps to overcome any potential issues with water pressure. Generally, middle and upper-income residents have better water access because they have the means to invest in water pumps and storage, which reduces the energy and time required to meet their water needs.

In conclusion, Sagayarapuram receives piped water from the BWSSB, but this is not the only source of water for households. Other sources include private borewells, open-access sources and water cans. While the overall public water supply has improved in the community in the last few years, daily access still depends on a range of factors such as household income and location. In the next chapter, I look at an example of water access outside of the BWSSB's service area, where the community has worked to reinforce its water supply through sustainable water management practices.

7.7 PHOTOS OF SAGAYARAPURAM

Water line located outside of KSDB home

Washing machine

KSDB-allotted housing area

Water collection from holding tanks

Four-story apartment building

Public water line

CHAPTER 8: CASE STUDY 4 RAINBOW DRIVE LAYOUT, BANGALORE

8.1 BACKGROUND

Rainbow Drive Layout (RBD) is a gated residential community located in the southeast of Bangalore, outside of BBMP limits. Across India, RBD is recognized as a leading community in rainwater harvesting techniques and water supply management. As such, this case study follows a different structure than the previous case studies, by highlighting lessons learned from the RBD case, particularly for peri-urban areas that are unconnected to piped water networks.

RBD is within the Halanayakanahalli Panchayat, though it is practically a part of Bangalore. RBD and its surrounding area does not receive any water or sanitation service from the BWSSB. All development in this area, including RBD, is completely dependent on groundwater sources, typically supplied through borewells or delivered via water tanker. Since the 2000s, the area has changed rapidly as new IT parks and large apartment complexes have sprung up, a part of Bangalore's urban expansion. Indeed, between 2001 and 2011, the BBMP ward adjacent to RBD was one of the fastest growing wards in the city, with 289 percent population growth (Bangalore Urban Metabolism Project, 2018).

Map 6: Rainbow Drive Layout
Source: Krishnamurthy 2017, p.3

8.2 SOCIOECONOMIC CONDITIONS

A community manager for RBD told me that residents work primarily in the nearby IT industries or run businesses, while about a quarter of the residents are retirees. Residents own their homes, with a few renters. The neighbourhood is close to amenities such as shopping centers and banks.

8.3 SELF-ORGANIZED GOVERNANCE

According to a recent study of the area by Biome Environmental, the RBD layout was built in 2000 and was initially provided 6 common borewells. However, within a few years, residents were already facing water scarcity, as borewell yields decreased. This led some residents to dig their own private borewells, which reduced the quantity of water available from the common borewells. The area also began to experience urban flooding, as heavy rainfalls prompted flash floods. The treatment of wastewater was also problematic: the STP was inadequate to deal with the quantity wastewater, and stagnant wastewater began to pool in the neighbourhood. Within a few years, residents faced three major water related problems: water scarcity, flooding and insufficient wastewater treatment capacity (Krishnamurthy, 2017).

A resident's association of 12 members, officially titled the Plot Owners Association (POA) was formed in 2004, and began to tackle these issues. The POA began by looking at water wastage practices and saw that much water was used indiscriminately by residents and construction crews. At the same time, the POA began to research water supply management practices and started documenting the true cost of water which was not borne by residents. They found that the production cost of water was much higher than what was being charged for consumption. Through a process of data collection and calculation, they began to price water that built in all costs, including costs for wastewater treatment and pipe maintenance. By educating and raising awareness about the cost of water and the need to reduce demand, the POA effectively implemented a new tariff regime, that incentivized water conservation. This prompted residents to evaluate their water usage and reduce consumption by changing habits and installing water-reduction technologies such as aerators and low-flush toilets (Krishnamurthy, 2017).

The POA also took the initiative to ensure a more reliable water supply and dealt with the issue of flooding. Each household was encouraged to do rainwater harvesting and/or groundwater recharge, for which they get a 100Rs discount on their water bills. The program was largely successful – there are around 300 recharge wells in RBD, which is the highest density of recharge wells anywhere in India. These recharge wells are connected to a storm water drainage network, which directs storm water outside of the layout (Krishnamurthy, 2017).

Finally, residents looked at the issue of wastewater treatment. Beginning in 2014, a phytorid technology sewage treatment plant was built, which treats wastewater using anaerobic digestion, followed by a root-zone treatment. This STP treats wastewater and returns water to each

house, which can be used for gardening. This solution solved the wastewater treatment problem and added greywater reuse to the community's water practices (Krishnamurthy, 2017).

8.4 STATE OF WATER & SANITATION SUPPLY AND ACCESS

Overall, the community went from one of water scarcity and flooding, to a leader in water recharge and conservation. These reforms were enabled by a long-term commitment from residents, where education and communication were key to implementing water conservation strategies. The change also happened through a series of investments in rainwater harvesting, groundwater recharge and water supply management techniques. These infrastructures are summarized in the following table.

Infrastructure	Purpose	Description	Location
Rainwater harvesting	Groundwater recharge & non-potable water supply	Rainwater harvesting	Private housing plots and common areas
Recharge wells (individual and common wells)	Groundwater recharge, reduces flooding	36 common recharge wells, most residents have recharge wells on their properties	Private housing plots and common areas
Borewells	Water supply (potable and non-potable)	11 borewells have been dug in the community, 2 of which are currently in use. Borewells direct water to two overhead tanks, which supply water to households.	Common areas
Phytorid technology STP	Wastewater treatment, greywater reuse	STP treats wastewater. Treated water is sent back to homes for gardening.	Common area
Storm water drainage network	Drainage	The system directs rainwater to leave the layout, which may contribute to flooding in adjacent communities.	In parallel with the road network

Table 8: RBD Water Infrastructure Summary Table

8.5 CONTRIBUTING FACTORS

The RBD transformation was enabled by several factors. First, RBD is a wealthy gated-community, situated in Bangalore's urban periphery. Due to its location, RBD is outside of the BWSSB service area, and does not receive Bangalore city municipal services. RBD is under the administration of the local panchayat – these small municipal governments are often unable to deliver civic services to quickly growing peri-urban populations. In the case of RBD, the developer of the layout built civic amenities, such as street lights and water supply, without involvement of the panchayat or the water agency. Then, following major water problems (falling borewell yields, flooding etc.) RBD continued to by-pass government involvement and designed their own solutions for water supply management.

This example demonstrates the fragmentation that arises in public service provision in India's peri-urban areas. While the urban core remains highly-serviced by public infrastructure, utilities and amenities, public service provision in the urban periphery is inconsistent. This is true in Bangalore, where the BWSSB piped network does not include many of the city's peri-urban areas. Here, large differences arise between the state of access to water and sanitation across different socioeconomic groups. Wealthier and more powerful groups can ensure water and sanitation access, for instance by buying private solutions (e.g. water tankers) or by devoting resources to adopting sustainable water management practices, which I described in the RBD case. On the other hand, the peri-urban poor have fewer options and resources to help them cope with water insecurity or flooding.

Finally, the RBD case highlights the complexities of urban governance in the city fringe. While BBMP limits continue to expand and RBD gets absorbed into these new boundaries, will the community maintain its ability to operate in isolation from the government? Further, as the area enters the BWSSB service area, will RBD's water conservation initiatives be pushed to conform to BWSSB frameworks? Urban peripheries are quickly changing landscapes, and while RBD has been pushing back against recent involvement from the BBMP and BWSSB, its ability to remain isolated from its local government is uncertain.

Overall, the RBD case describes several water management strategies that created better water security for residents. At the same time, this example shows the differences that arise in service provision in urban peripheries, where government provision of infrastructure and services is not guaranteed. While RBD residents had the money, time and resources to put towards organizing and implementing solutions to secure a stable water supply, these solutions are not available to all. The next chapter opens a broader discussion that draws upon the findings from the case studies. This discussion treats each city individually. I begin with Bangalore's civic activism environment. Next, I draw conclusions for Chennai relating to urban citizenship and gender.

8.6 PHOTOS OF RBD

Rainwater harvesting containers

Phytorid technology STP

Typical house

Storm water drainage network

CHAPTER 9: DISCUSSION

9.1 BANGALORE: CIVIC ACTIVISM AND MIDDLE-CLASS AGENDAS

Bangalore's middle-class progresses self-interest agendas, and their voices render the needs of the urban poor less visible.

Bangalore has an active civic society environment, where residents' associations and non-profit organizations work to create change for civic issues. While these associations exist across all types of settlements and classes, authors such as Harriss (2006) have found that Indian civil society is deeply stratified and that organizing plays out differently across class lines, which appears to be the case in Bangalore.

Bangalore's middle-class is best represented by educated professionals connected with the city's booming software economy (Upadhya, 2017). Their relatively high salaries enable them to live in the large enclave apartment complexes that have sprung up across the city (Upadhya, 2017). This class is at the forefront of diverse movements that are trying to tackle environmental issues of waste, water supply, air quality and the loss of green space. However, their interventions tend to focus on keeping their own gated communities clean and serviced, often pushing for 'privatized solutions' that assume that the state cannot fulfill its public responsibilities. This was the case in RBD, where the POA secured the community's sustainable water supply, outside the government's involvement.

To take another example, in 2016 the Karnataka state government made it mandatory for all apartment complexes having more than 50 units to have their own STP (Chatterjee, 2017). Following this new requirement, the Bangalore Apartment Federation, an association that represents almost 200 apartment buildings in Bangalore, protested the government and successfully had the law repealed (The Times of India, 2017). Here, the middle-class succeeded in pushing forward their agendas through political protest. In contrast, the relationship of poor people to the state is largely constructed as 'populations' to be managed (Hariss, 2006). Hariss (2006) argues that the state does not view poorer residents as people with agency, or as individuals with the rights and responsibilities of citizenship (p.462).

Furthermore, as part of Bangalore's growing emphasis on 'e-governance', middle-class citizens have a range of technology solutions that enable them to participate in civic change, and demand better access to water and sanitation. For example, mobile applications such as iChangemyCity allow residents to make public posts about civic issues in their community. The BWSSB allows citizens to lodge complaints or apply for connections directly from their computer or smartphone (BWSSB, 2018b). While these applications aim for stronger government transparency and accountability, their ability to voice the concerns of all residents equally is not

guaranteed, because these technologies are largely available to a literate, informed, middle and upper-class population.

Finally, the BWSSB is currently institutionalizing the 'datafication' of Bangalore's water distribution network through a partnership with IBM. A recent study by Taylor and Richter (2017), shows that the project embodies the idea that, "the right of citizens to water is somehow contingent on location or socioeconomic status" (p.732). Essentially, the datafication assumes that poorer residents do not have the same right to public water supply, due to their informal living arrangements and water connections.

Overall, the middle-class groups successfully progress their agendas and have easy access to public participation mechanisms. Their needs are most visible in Bangalore's 'datafied' waterscape. In this environment, we saw the Sagayarapuram case study, where poorer households were not guaranteed an equal voice in local decision-making, and the RBD case, where a wealthy residential group sought water solutions in isolation from the government. All together, these findings suggest that the strength of the middle-class, whose voices are most dominant in urban development processes, can render the urban poor, and their basic needs, invisible (Chaplin, 2011).

9.2 CHENNAI: URBAN CITIZENSHIP

The resettlement process deprives former urban-residents of the material and social goods that constitute urban citizenship.

In both case studies in Chennai, the lack of safe, adequate and sufficient water and sanitation has implications for urban citizenship. In Kallu Kuttai, residents lack legal land tenure, and do not receive piped water connections. This also means that they do not receive water bills – a document which can help to establish inhabitants as rights-bearing citizens. For instance, without proof of legal land tenure and municipal service bills, one cannot legally demand water or other services from city agencies. Here, I depend on Anand's (2017) description of hydraulic citizenship, which I first introduced in *Chapter 1.2 Research Opportunities & Literature Review*.

In informal settlements like Kallu Kuttai, residents are largely excluded from hydraulic citizenship in the eyes of the state. Kallu Kuttai residents employ a variety of personal coping mechanisms and undertake material investments to improve their water supply and sanitation facilities, without Metrowater's involvement. Residents purchase their own water tanks, and construct latrine facilities for the household. They also initiate individual or collective action outside of formal channels to obtain basic resources from government agencies. To take an example, residents in Kallu Kuttai told me that they negotiated with a local councillor to get access to a public water line from a nearby lake. Holston (2009) would characterize these actions as 'insurgent citizenship' in which urban dwellers contest their exclusions from property rights, infrastructure and justice, by seeking solutions outside of official channels.

On the other hand, residents of Perumbakkam are formally recognized as rights-bearing citizens via the TNSCB's provision of housing and piped water connections. However, the makings of substantive citizenship, which constitutes the lived experiences of belonging, are limited in resettlement colonies. As I explored in Perumbakkam, the displacement process failed to provide consultation with residents, and the TNSCB continues to exclude residents from local decision-making (IRCDUC & HLRN, 2017). The resettlement site also fails to provide access to the public institutions (e.g. schools and hospitals), and amenities residents once had in the city. Access to these goods and services establish a basic sense of civic belonging and responsibility. Therefore, this case study demonstrates how urban residents are not only pushed to the periphery of the city, but also stripped of the urban citizenship they once enjoyed.

In conclusion, I find that while Kallu Kuttai residents are excluded from hydraulic citizenship, residents of Perumbakkam are denied the social and material goods that previously established their sense of belonging, and right to the city.

9.3 CHENNAI: GENDER-ROLES IN WATER MANAGEMENT

Water collection is the responsibility of the women; however, they lack decision-making power in local water management.

In both Kallu Kuttai and Perumbakkam, women are typically responsible for the daily task of securing water for their families. Women spend considerable time and physical energy in collecting water, which reduces the time available for income-generating or education activities. They also bear an emotional burden related to water collection, as they are responsible for thinking and worrying about how they will provide daily water to the family.

Women are not only water gatherers and managers at the household level, but they are also water activists. For instance, in Kallu Kuttai, women worked through official channels (by bringing water supply complaints to the RWA) and outside of official channels (by directly calling tanker drivers if a water delivery was missing) to secure water. Through a token system, the women self-organized to pay for water. Women are the primary managers of water resources for the household, yet they lack decision-making power. In Kallu Kuttai, water-related decision-making is the responsibility of the male-dominated community group and Metrowater employees.

In Perumbakkam, the advent of piped water connections, provided through government housing allotments, presumably frees women of the gender roles which are inscribed in water collection processes. However, despite the individual water connections, Perumbakkam women are still tied to household chores, as they need to be home to collect water during the few hours a day it is available. In addition, the absence of healthcare and educational facilities in Perumbakkam disproportionately affects women, as they are frequent users of healthcare services throughout motherhood. The lack of adequate educational institutions further confines women to the home, as

they are obliged to take on additional roles as educators, for children that dropped out of school following relocation. These circumstances show how the resettlement process bears a disproportionate burden on women. Unfortunately, the Perumbakkam resettlement planning processes excluded women's participation (Diwakar & Peter, 2016). Overall, slum resettlement served to reproduce existing gender-inequalities and failed to include women in the planning process.

To summarize, while women are the primary household water managers, they may lack local decision-making power when it comes to water and sanitation. Slum resettlement serves to reinforce gender-roles, by further constraining women to their prescribed positions in the households.

CHAPTER 10: COMPARISONS

While the foregoing discussion treats the cities and their respective case studies separately, in this last chapter I take the opportunity to draw comparisons and conclusions from across the research findings.

10.1 HOUSEHOLD INCOME AS A DETERMINANT OF WATER AND SANITATION ACCESS

First, I found that Chennai and Bangalore's household access to water and sanitation is similar, in that it can be dependent on household income or status. Household income is an important determinant of water access, because those with financial means, have a wider set of strategies available to them to help deal with water access issues. In both cities, we saw that low-income households are required to secure water from a variety of sources to fulfill their needs. Poorer households invest considerable time, energy and money to ensure a safe and reliable water supply by collecting water by hand, by purchasing electric pumps, and by buying drinking water.

In some cases, low-income households also face higher water prices – for instance, for all case studies we saw that many low-income households purchase drinking water by the can (for about 40Rs per can). In both Chennai and Bangalore, middle and upper-income households can pay public water rates and purify their drinking water, for a lower per-unit cost. In some cases, such as RBD, wealthy residents can opt out of the public system completely and seek their own solutions to water access – most poorer households simply do not have this option. Overall, middle and upper income households have easier access to water and sanitation. They have more options to deal with water insecurity, and in some cases they can even pay lower water rates than poorer households. This can serve to reinforce existing income inequalities, as low-income households invest proportionately more resources to securing their basic needs.

10.2 CITIZEN-DRIVEN MANAGEMENT OF WATER AND SANITATION SUPPLY

Throughout my research, I also found some differences between the two cities. A recurring theme during my conversations with water experts in Bangalore, surrounded how the BWSSB places a certain burden on Bangalore residents to manage their water supply, and even solve the city's water issues. Both Chennai and Bangalore have rainwater harvesting laws, which require residents to install rainwater harvesting structures on residential properties. What I found to be unique in Bangalore is that the water agency has few resources available to support citizen-uptake of these strategies, and residents that do not follow these laws face harsh penalties by paying commercial water rates (Anand, C. 2017; Shekhar, 2018).

In *Chapter 9.1 Bangalore: Civic Activism and Middle-Class Agendas*, I used the example of Bangalore's STP law which was revoked following protest from resident's group, to show how middle-class groups progress self-interest agendas. However, I think this example is interesting

for another reason. During the protest, the Bangalore Apartment Federation published a pamphlet which argued that, "Instead of working towards making a sewerage system available to all consumers, BWSSB, through its notification, seeks to absolve itself of providing the service and shifts the onus of managing the same to a set of consumers (apartments)" (Bangalore Apartment Federation, 2017). Although this is not conclusive evidence, I think these examples may indicate the BWSSB's mindset, which places a certain burden on citizens to take responsibility for the water and sanitation system. Further research in this area could explore the BWSSB's role in managing the city's water supply, to confirm or deny this observation.

10.3 URBAN DEVELOPMENT AND 'WORLD CLASS CITIES'

Finally, I found that in one way or another, all the case studies touch upon a broader pattern of urban development, where many of India's major cities aspire to become 'world class'. Chennai's planning documents make it clear that the poorer residents are not welcome in its modern future. Indeed, Chennai's Second Master Plan says that slums should be removed from the city, "The Government of Tamil Nadu holds the view that slums are not acts of God, but of human folly and that they can be banished by wise planning" (CMDA 2008, p.140). With the slum areas removed from the city, land is free to be redeveloped for various beautification and infrastructure programs, which promotes Chennai's status as a modern city. These infrastructure programs often exclude the participation of the urban poor, which was the case with the Perumbakkam resettlement.

Similarly, Bangalore's growth has been driven largely by an influx of foreign capital, concentrated in IT-related industries. Today, the urban landscape showcases its internationally competitive infrastructure: from high-end enclave apartment complexes, to super-malls and cutting-edge technology centers. Benjamin's (2000) work on poverty and planning in Bangalore finds that richer groups, with their higher level bureaucratic and political connections, can easily influence development policy. On the other hand, most documents relating to the poor focus on the number of "slums" and estimates of their population (Benjamin, 2000). This was reflected in the Bangalore discussion, where the activism of the middle-class served to render the needs of the urban poor less visible.

Overall, Chennai and Bangalore's urban growth trajectories in the race to become internationally-attractive cities puts poorer groups at a disadvantage by expelling them from the city center and limiting their participation in planning processes.

CHAPTER 11: CONCLUSION

11.1 SUMMARY

In her work *The Ethnography of Infrastructure* Susan Leigh Star (1999) says, "Study a city and neglect its sewers and power supplies (as many have), and you miss essential aspects of distributional justice and planning power" (p.379). The aim of this study was to document differences in household access to water and sanitation in Indian cities and their peripheries and explore the factors that shape water access. I did this through four different case studies, where I documented water access and inquired into water collection experiences through site visits and conversations with residents. This allowed me to understand daily water habits and local decision-making for each community, which informed my broader discussions surrounding themes such as civic activism and urban development.

The case studies showcased a variety of water access infrastructures and practices that can be found in settlements that range from informal occupations to gated residential layouts. First, I summarize the Chennai case studies. Water and sanitation access in Kallu Kuttai, where water tankers provide the primary water supply, is shaped by land tenure and urban development. In Perumbakkam, the government's failure to provide adequate public services contributes to the state of water access, where citizens lack clear channels to hold their government accountable. In Bangalore, Sagayarapuram receives piped water supply from the BWSSB, but daily access still depends on a range of factors such as household income and location. Lastly, the RBD case describes sustainable water management practices, which were adopted by an upper-class community in the urban periphery. This case suggests that differences in water and sanitation access arise in urban peripheries, depending on a community's ability to cope with a lack of government-provided infrastructure and services.

In the discussion section, I explored topics relating to *planning power*: middle-class activism, urban citizenship and gender-roles in water management. Here, I looked at how Bangalore's middle-class activism progresses self-interest agendas, and their voices dominate the water landscape. For Chennai, I discussed how the resettlement process deprives former urban-residents of the material and social goods that constitute urban citizenship. I also made links between water practices and gender-roles, for both Kallu Kuttai and Perumbakkam.

The last chapter made comparisons from across all case studies and cities. In spite of the differences in livelihoods, income, location, and water access for each settlement, I found that in all cases, higher-income households have more options to deal with water insecurity, while low-income households invest proportionately more resources to securing their basic needs. This can serve to reinforce existing income inequalities. Next, I found that the case studies touch upon the broader pattern of urban development, where many of India's major cities aspire to become world

class. Finally, I noticed that Bangalore's water agency puts an onus on citizens to manage their water supply, an observation that could be explored in future research.

11.2 LIMITATIONS OF THE STUDY

This research shows how India's water and sanitation landscape is complex and diverse, a seemingly never-ending research topic. While this SRP aimed to understand the workings of local water supply and experiences of water access, it is not intended to provide a comprehensive overview of all water characteristics of each city. Indeed, due to the limited scope of this research, many related topics, such as the ecological and cultural value of water resources, could not be covered in depth. The quality of public information and the difficulty in finding and contacting public officials also limited the quantity of information available for analysis. Moreover, the language and cultural barriers that I faced in the field, particularly as a foreign researcher that does not speak the local dialect, may have influenced the results and introduced bias. Nonetheless, the report intends to provide a starting point to understanding some of the on-the-ground water dynamics that can be found in India's growing cities.

11.3 REFLECTIONS & NEXT STEPS

Throughout my work, I found that the provision of adequate water and sanitation to communities in cities and peri-urban areas is a distinctive challenge that deserves the attention of researchers and planners. In policy circles and scholarship, there has been a tendency to focus on macro projects that engineer large-scale water solutions, while there continues to be a need to understand the specific contributing factors to the spatially-uneven distribution of infrastructure and services, at a localized level (Luxion, 2017). While my work contributed to this area, there were several questions that I was unable to answer during my fieldwork, relating to water access differences based on class, race, and religion. Further research could continue with these questions, to continue to expand our understanding of inequalities in household water access.

Next, my work allowed me to understand the interlinked nature of land and water problems. Work in the water and sanitation sector can rarely be carried out in isolation of considerations of land tenure (Ranganathan, 2010). For instance, while my initial research questions asked how households accessed water and sanitation, my work in Chennai showed that land tenure was a key driver of the water situation. According to Ranganathan (2010), "Struggles over the right to water are as much about the right to the city and claims over land tenure, for instance, as they are about water access and affordability" (p.196). Future urban research, as well as research in other disciplines, such as public policy and engineering, should continue to embody this intertwined nature of land and water problems.

This research also brings up questions relating to our perceptions and classifications of housing settlements. I initially set out to study different types of residential areas because I wanted

to gain a first-hand understanding of daily life in a variety of Indian neighbourhoods. In this report, I referred to Kallu Kuttai as an 'informal' settlement, but in fact people have been living there for decades. This made me think, what makes a neighbourhood a slum or an informal settlement? I realized I had started this research with some pre-conceived notions about slum-dwellers and their living conditions, which I was able to personally re-evaluate during my time in India. I think this raises the need to continue to develop more nuanced understandings of slum settlements, their development and the perceptions that surround them, and to generate informed conversations in academic and policy circles on these topics. This is important, because these perceptions and classifications can determine a lot, from who is considered an urban citizen, to who has the right to land, housing and services.

This brings us back to the persistent question that underpinned this study, and continues to drive my passion for research on urban phenomena: who has the right to the city and its resources? In the era of 'world-class' cities in India, and across the Global South, it often seems that urban development forces, the elite and their power circles are the winners, while the poor are dispossessed and denied quality public services. At the same time, there are also many contrasting examples of planning processes that are inclusive, and that bear positive outcomes for all stakeholders and ecological systems. For instance, the Orangi Pilot Project in Karachi Pakistan, provided water and sanitation infrastructure for urban poor communities, and is considered a success story for improving urban infrastructure with community engagement and participation (Hasan, 2010). I think it is important to study and learn from these examples, and to be optimistic about a future that includes the meaningful participation of marginalized voices in urban decision-making, as we continually work towards equitable access to urban infrastructure in the developing country context.

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