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Case Study: Water Management Issues in Chennai, India

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Abstract:

Chennai, a typically large city in south India, faces water and climate change related threats to the already growing water scarcity. The aims of this paper were: to describe water security, policy changes and to analyse the policies and adaptation strategies. The paper uses mixed- method and accidental sampling for data collection. The data show that, even with 700mm and 1100mm of annual rainfall, Chennai still has water insecurity. The survey results implied that an increase in water use efficiency is much needed. Although, Chennai has 100% pipe connections, water supply is intermittent. Eighty-seven percent (87%) of respondents reported concerns about sporadic supply, low quality and poor service. Respondents notified that purchase water for drinking and cooking adds to their household expense, and is on average 2% of their salary. The water price is 6 to 10 paisa per litre (for usage over 10KL), at an incremental rate. Thus raising major concerns regarding the fair pricing of water, as 82l/d is the per capita use.

Keywords: Water security, climate change, adaptation, urban policy change

1.0 Introduction: Water Security and Climate Change:

Unmet expectations, poor policy management, increasing demands, migration and overexploitation are the major cause of water security concerns in urban communities (European Commission, 2013). Despite technological and funding enhancements, the strategies to improve supply have not successfully helped in creating security. European countries, for example, with all their technologies and policy enhancements are still vulnerable and need new strategies to adapt to climate change (IWA and WWC, 2012). Successful water management require both supply enhancements and demand related conservation practices. A good example is Spain; the region needed further changes in use efficiency and conservation management, with household contributions to effect positive alterations. This allowed conservation during drought seasons (Mileham, 2010, Iglesias, 2010). The water supply system is intricately linked to the water cycle, which is a balance of precipitation, temperatures and evaporation (Iglesias, 2010). Iglesias, (2010) indicates that a water crisis situation arises due to major water insecurities. Water security is the availability, accessibility, affordability and allocation of sufficient good and clean water for people. Climate change causes acute imbalances in water resources both on land and at sea. The aims of this case study were: to describe supply demand initiatives, to analyse policies and adaptation strategies and to provide recommendations. The key problem analysed is the poor supply demand management that has led to water security and scarcity issues, and the possible solution to this problem within policy planning and focus on demand related conservation practices.

2.0 Overview of Adaptation:

Adaptation planning has been achieved in water systems, and yet there are many cases where water management has been inadequate for flood and drought, protection of drinking water and sanitation and to meet demand (IWA & WWC, 2012). According to the World Water Congress, water management needs quick and proactive action that can secure sources and sustain them. In order to secure sources, policy must find solutions for pollution, increased population, climate change and poorly- governed systems (IWA & WWC, 2012). A good approach to manage resources will enable water security and administer smooth adaptation and policy responses to future climatic conditions. According to the EPA, (2012) each region must have a strategic plan in order to implement mitigation and adaptation programs. A variety of adaptation strategies were used to control water stress and manage water in Europe, the US and other regions of the globe. Demand, through conservation, management, and utility, and service management are the major strategies used by several researchers as examples of successful adaptation strategies. The corresponding list of researches

include: Bakker & Allen, (2012); Balgis, (2010); Iglesias, (2010); Cook, (2012); EPA- SDWA, (2012); European Commission, (2013); GWP, (2008); Government of South Africa, (2013). These studies signify that the demand management requires efficient supply for regions without supply source. The technology has improved the level of supply, alternate source and quality of water. The major approach in recent implementations across US, EU, Asia etc., that is gaining force is the IWRM approach. While there is no specific definition for IWRM, the approach is self-explanatory, as it integrates the policy interventions for security, governance and inter-sectoral benefits to mainly improve supply and demand (IWA & WWC, 2012). Water management in Asia is political and sensitive, and requires institution specific outreach. Communication, knowledge spread and specific media are important and relevant at various spatial scales of the policy process. Current GWP research indicates that multiple sectors and multilateral approaches are integrated for attaining success in development and implementation of policies for the water environment (GWP, 2011), (IWA & WWC, 2012). The major problems affecting Asia are water shortages, inefficient use, inadequate quality and sanitation, water-logging, saline intrusions, lack of use- efficiency, inadequate maintenance, lack of zoning, lack of training and pollution through waste, chemicals etc., (Iglesias, 2010). Hence, in order to manage water during and after floods or droughts and improve water security, adaptation and mitigation are vital.

Policy Adaptation: Given these problems, water policy changes are essential for management and enforcement, they act like a buffer system, maintaining a balance and managing resources while aiming to cause positive changes towards security. A policy implemented will have varied responses according to the level of enforcement or the level of commitment to find solutions. The solutions must include societal participation and adaptation of policy. According to GWP, (2011), adaptation is a slow process. The strength of the policy depends on enforcement and local acceptability, and level of adaptation. The government can enforce policy but in a democratic country, with corruption it becomes harder to understand if policy acceptance will be successful. In a country like India, the water use policy has drawn more attention but the policies are weakened due to low positive response (Lakshmi & Ramalingam, 2012; Srinivasan, 2008). The society's response is crucial for a policy decision towards a goal for it to achieve success. Hence, social acceptance, awareness and education are elements that are vital for the study of community response. For example, in California when there is drought, watering lawns is prohibited unless they have sprinkler systems in place, and the timings for use are also specified, there are fines levied on violators of this policy (EPA, 2012). The "polluter pays" policy makes for an effective reinforcement, in this case is necessary for India. Not everyone adopted the policy instantly but it is re-enforced several times with fines, so that most communities have sprinkler systems installed in California. Hence, re-enforcement of policy will enable policy success (EPA, 2012). Every policy change effects positive changes within the community and the environment depending on how well it is accepted and re-enforced by the administrative bodies.

3.0 Water Management:

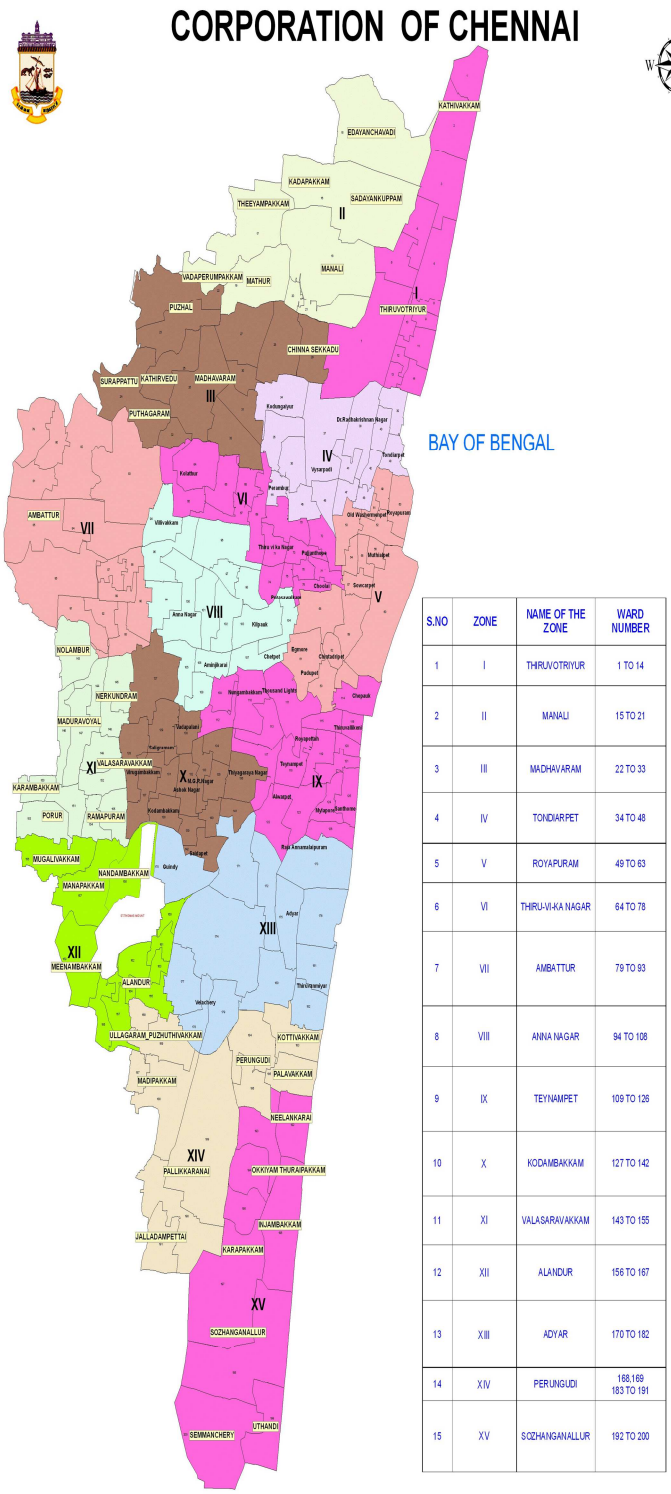
There are three sides to water management, water administration and utility management, and supply and demand side management. Certain administrative programs for adaptation include upgrading customer advisories (for the user), improving utility measures, reducing water loss, surveying and provisioning effectual informatics, practical approach and goal setting for future management, enhancing education and creating awareness, improving local participation and managing grievances and feedback (GWP, 2011). Ground water extraction, pricing, fines within the regulatory system, staff regulations, and code of conduct for the public and administrative boards make up the major policies within the administrative system for utility management. The supply side policies, programs, and projects incorporate enhancement and renovation of supply infrastructures, maintenance of quality and amendment of policies to include strategies i.e., allocation, zoning, source maintenance, quality control etc. Major distribution related adaptation strategies are: inspect and renovate pipelines, maintain valves and sumps, improve service for setup of RWH and AR equipment, renovate supply infrastructures (including dams and canals), install and maintain transfer conduits and increase supply through desalination plants. While the demand side includes all the policies, programs, and projects to improve the demand related technologies and policies, i.e., conservation, pricing, pipelines and metering etc (SOPAC, 2013).

The water resource management is like any other management system; it is often flawed and failing. A few of the above mentioned studies indicate that water management systems in the respective countries require change and re-enforcement.

Likewise India, China and South Africa are in the midst of introducing new technologies, administrative measures and conservation techniques in order to improve their adaptability. Administrators use strategies to create and implement policies to manage water to create security and adapt to stress factors. Although, there is need to meet the requirements of demand on the water table, it is equally essential to consider the overall aspect, people, environment, economic conditions and climate. Consideration given to the impacts of climate on water security and on the environmental sustainability is vital while planning for adaptation (GWP, 2011), (UN-Water, 2006). Thus, the overall supply-demand management establish foundation for adaptation societal response. It depends on the strength of supply demand policies and how they are enforced. Hence, supply-demand management does have a great impact on adaptation policy success.

4.0 Background Information on Area of Study: Chennai:

Chennai, with a growing population faces water security and climate change related threats to the already growing water scarcity. The Metropolitan Area of this city is the fourth most populous metropolitan area in India, after Mumbai, Kolkata and Delhi. 45% of the population is urban. Among Chennai's sectors examined, majorly water starved include some regions of North Chennai, and some regions of Southwest Chennai (based on pilot household interviews and surveys conducted in Chennai in January 2010 and August 2011). In addition to Chennai metropolitan city, the jurisdiction of the Chennai Metropolitan Water Supply and Sewage Board (CMWSSB) extends to urban outlying regions of about 164.6 sq. km, and rural regions covering about 142 sq. km. Chennai is surrounded inland by Kanchipuram and Thiruvalluvar districts. Chennai comprises of the city and its urban outlying regions of about 164.6 Sq. m and the rural regions covering about 142 Sq. m. The urban outlying areas are called Adjacent Urban Areas (AUA), and the rural regions are called Distant Urban Areas (DUA) (CMWSSB n.d.). The water demand in Chennai is 900 ml/d for the urban domestic sector (households), while there is only 700 to 730 ml/d supplied. Hence there is a supply and demand gap. Supply initiatives are the main focus and hence, the desalination plants, Krishna and Veeranam supply schemes and most failed to improve the water scarcity. Although, Chennai has 100% pipe connections, water supply is intermittent.



S.NO	ZONE	NAME OF THE ZONE	WARD NUMBER
1	I	THIRUVOTRIYUR	1 TO 14
2	II	MANALI	15 TO 21
3	III	MADHAVARAM	22 TO 33
4	IV	TONDIARPET	34 TO 48
5	V	ROYAPURAM	49 TO 63
6	VI	THIRU-VI-KA NAGAR	64 TO 78
7	VII	AMBATTUR	79 TO 93
8	VIII	ANNA NAGAR	94 TO 108
9	IX	TEYNAMPET	109 TO 126
10	X	KODAMBAKKAM	127 TO 142
11	XI	VALASARAVAKKAM	143 TO 155
12	XII	ALANDUR	156 TO 167
13	XIII	ADYAR	170 TO 182
14	XIV	PERUNGUDI	168,169 183 TO 191
15	XV	SOZHANGANALLUR	192 TO 200

Figure 1: Chennai Metropolitan and City Map, **(http://chennaicorporation.gov.in/zone/index.htm)**

The population growth of Chennai and adjacent regions is rapid. The population was about 7.5 million (in the Metropolitan Area; about 5.5 million in the city area) as of 2010. Chennai district is the 27th most populated of the 640 districts of India. The population density of the district is about 27,000 inhabitants per sq. km, and the

growth was measured at about 7.8% over a decade (measured between 2001 and 2012) (TWAD 2010 – 2012). Other districts in Tamil Nadu state, like Madurai and Coimbatore, have populations only one fifth the size of Chennai's. A section of Chennai's population within 5 communities were selected to analyse this issue. Mixed method and accidental sampling method were used for data collection. Interviews (open and closed ended) were conducted within the water boards (7 administrators) and the local communities (500 local residents).

5.0 Findings: Water Security and Supply Policy:

The survey results implied that an increase in water use efficiency is much-needed. Eighty-seven percent (87%) of respondents reported concerns about sporadic supply, low quality and poor service. Respondents notified that purchase water for drinking and cooking adds to their household expense, and is on average 2% of their salary. The water price is 6 to 10 paisa per litre (for usage over 10KL), at an incremental rate. This raises major concerns regarding the fair pricing of water, as 82 l/d is the per capita use according to surveys.

The following are some of the major changes to the supply system in Chennai:

1. Currently, the CMWSSB and TWAD supply 831 MLD's (as of 2013), with the 100 MLD from the new Nemelli desalination Project added to supply.
2. The CMWSSB is now in the process of acquiring water from Poondi, Tamaraipakkam (155 MLD), and Neyveli aquifer (75 MLD).
3. The Chennai Metro Water Supply Board is digging 100 more wells to expand the existing wellfields and develop water facilities for semi urban regions.
4. Increased Amma water production and supply to all regions. This policy is yet to show results as it is relatively new.
5. In response to drought, the TWAD contracted 9000 or more lorries for meeting domestic supply (currently on standby).
6. To repair and restore existing tanks and Ooranis, TWAD's works (within and outside) are in progress. The RWH department indicated that about 9000 tanks are under scrutiny. Right now about 5000 of them are in use and the rest of them are not in use. (Sivakumar, 2013) indicates that these tanks are reconstructed and 1400 new ones will be constructed all over the city.

The policies and issues are not very transparent in Chennai. This is clear via the surveys that the source of information for respondents is only through bulletins and the news. Those involved in working for the Public Works Departments – Water have an idea of the policies and programs but common-man needs to approach the board for information or use the website. About 30 % of the respondents, in this study, required detailed information to comprehend the situation in Chennai to answer the survey sheet (Survey, 2012). Hence, training, workshops, awareness, and feedback and response enhancements are required for water supply management in Chennai. Training and workshops improve awareness and enable people to understand policies and adapt it to their daily life. This indicates the need for workshops in order for the residents of Chennai to understand water system, supply, uses, conservation techniques and also quality to make an informed decision and useful feedback.

6.0 Policies and Survey Analysis:

The access to water for Chennai is mainly through direct in-house, outside tap, storage tanks, metro water tank, common/ independent wells, community wells, and private tankers. Chennai's water board claims to have 100% city pipelines, yet many streets have no piping and some that do, have no supply. This issues is due to inability of the supply lines to cover areas and, this stresses the need for the boards to improve coverage. According to the Tamil Nadu Water Supply and Drainage Board (TWAD) there are 130 or more streets without supply. The government provides residents the choice of tank water, 300 trucks that make 1300 trips twice per week bearing water. This option is available to all residents who have trouble gaining access to water. Thus there is some amount of inaccessibility in Chennai, clearly requiring attention. Municipality abstracts about 20% of the total water for domestic purposes. Of the 20% certain zones get higher quantities compare to others. About 2 -5% percent of this is lost either during transport or misuse. In the zones surveyed, many residents fight for daily water needs. This is because water is not allocated evenly, some regions get 6 hours and others get it once every two days via tankers. When availability and access are poor it is a clear sign that the allocation is uneven. The public supply is less in direct-house when compare to the tankers and outside taps. Hence, the foray into Chennai's supply system indicates that the supply is poorly allocated with careful planning can be enhanced. Contamination and Diseases: The most common water-borne diseases mentioned were Diarrhoea,

Typhoid, Paratyphoid, Cholera, Dysentery, Protozoal, viral infections and Helminthic (worm) ailment. These diseases are pathogenic and contaminate water through sewerage or unsanitary toilets. All respondents have had water-borne diseases at some point in their life and, 70% (384 out of 548 respondents) of them indicated that they spend money on water-borne diseases in the last ten years, also indicated that they had sanitation issues and store water for over 3 days.

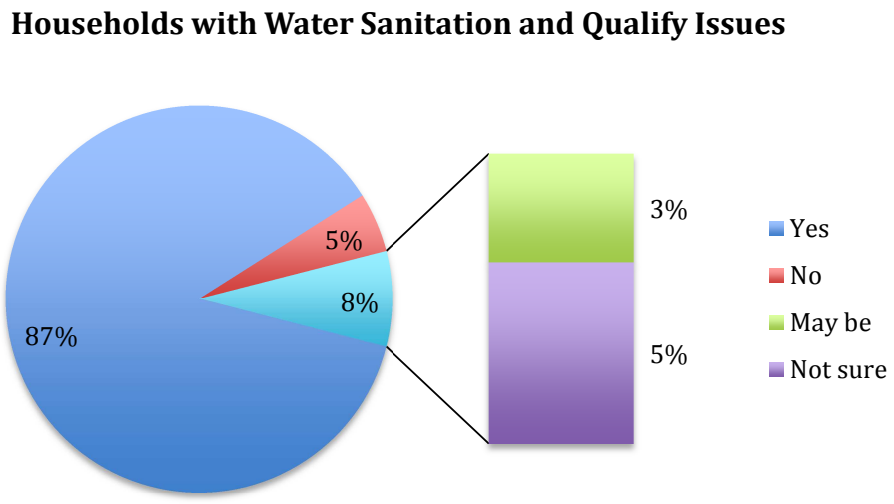


Figure 2: HH Facing Water Sanitation and Quality Issues, **Source: Data Collection, 2012/2013**

Survey indicates that about 87% of the respondents have faced water quality related problems at least once during the last 10 years and 91% feel the need for improvement, respectively. This proves that Chennai has serious water quality issues in certain areas, the surveyed regions. One in four drains examined outside HH's were open and the sewer water flows out in the open. This indicates that the sewer mains are not managed well and quality of the existent water resources is poor. Out of the 500 responses collected, about 140 said they were slightly affected and 200 indicated that they were affected badly due to open sewer systems. A variety of responses convey that the sewer not only affects their water or the environment, it creates issues such as skin ailments and stench. The government officials indicated that they have started dealing with the issues and the sewer mains were being maintained. While this was true, in some regions the opposite was observed. Observation identified that sewer drain lids were left open or half open in all the regions surveyed and hence, it is clear that enhanced maintenance is much required. This issue requires attention in order to manage quality of water sources in Chennai.

Ground Water Abstraction: Interviews with the TWAD officials indicate that Chennai's groundwater sources have improved and the policy implementations are all successful. A closer look into the situation through interviews and discussions with local residents in T Nagar, Minjur, Purashawakkam Anna Nagar, Mylapore and Besant Nagar indicates that groundwater extraction is high. The Poonamalle freshwater source in Chennai is largely exploited. Janardhanan (2011) study indicates that there is illegal pumping and sales of freshwater sources. The Joint Director of the Centre for Groundwater Sources, Sudhakar indicates that: "In this area, large numbers of illegal groundwater pumping stations have sprung up where, everyday, about 30-35 tanker loads are filled and sold in the city for Rs 750-Rs 1000 per tanker. Besant Nagar too has many water pumping stations besides hundreds of bore wells in apartment complexes," (Janardhanan, 2011). The major well fields are highly exploited and these well fields are also used for sectors other than domestic. Besides keeping track of the number of wells, it is also very hard to maintain record of how much well water is extracted, consumed or wasted in these cases. "Currently, 40 million litres of water is drawn from Metro-water's wells in Neyveli, Poondi, Thamaraipakkam and Minjur to augment the supply from reservoirs" (Mariappan, 2013). Observation reveals that the wells were dug up between the years 2003 to 2005 to support extra sources, when Chennai faced drought and started

relying on well and tankers for supply. Thus, this issue needs more survey and dynamic action from all stakeholders and policy makers in Chennai.

Climatic Factors: Officials indicate that the ground sources are fast depleting and Chennai's rain retention is very low, about 80 percent of it drains into the sea. This indicates that the water retention is low ground water table has reduced in Chennai. This is due to the fact that not all residences have RWH installed due to unfavourable housing conditions, for example, hutments do not have the facility for installation. Besides, the scheme to implement roadside RWH and AR was only partly successful, as the installations were not uniformly adopted throughout Chennai. Observation suggests that the roadside pits for AR are not installed properly nor were proper drains to collect rain in an efficient manner present. As of now the climate related water shortage occurs every 4 years due to lapse in monsoons, this is strengthening by the year due to increased frequency of sudden extremes climate change. There was a four-year period of frequent floods in Chennai and the coastal sides of Tamil Nadu. The floods in East coast also affected millions of people due to contamination of water. This is due to changing extremes of Climate. The increase in floods creates penetration of saline water into the fresh sources and ground water sources. This creates issues for people due to the zero utility value within households. The salinity can be managed if the floods are channelled in a proper fashion. Road water reuse after treatment is also an option for policy makers to consider. Managing floods require proper quality control, which is not looked at in detail in this paper due to the vastness of the topic.

Recently, Chennai temperatures indicate an increase in the maximum temperatures to about 42 degrees centigrade in summer and this is one sign that should be enough for Chennai to take steps to prevent severe droughts. Chennai's actions went to the extent of transporting existing and available sources in closed conduits to distribution units or for storage in Redhills. This temperature increase also poses quality problems and breeds diseases. There are several bacterial infections that make water un-usable and this creates more water waste and reduces water security. The TWAD information through the interview, documents indicate that Chennai is prepared to tackle the upcoming water security issues that may rise. The supply and demand management investigation indicates otherwise. The supply and demand management through this research indicates issues and concerns that could intensify with worsening climate change. While climate change may not look like a pressing issue, it is impossible to ignore the signs as droughts occur approximately every 4 years and floods approximately every other year (mild intensities). In addition, drought in Chennai is mostly source supply and demand related, at present, rather than purely climate related, but it is not possible to ignore the signs of water scarcity and insecurity.

Other Issues: While, due to the prevailing water shortage and poor management conditions in regions like Purashawakkam, T. Nagar, Anna Nagar, Ennore, Tambaram and Ambattur, are forces to seek water from tankers, Chennai's management indicates that the water security management is quite adequate. Through observation and interview it is clear that Chennai's water management has certain restrictions in acting towards a problem. Transparency of data, most data requested on finances and cost and quality of water were not available (as seen during survey). Ability to act dynamically on projects is not enforced (seen through failed projects in Chennai) as well as lack of centralised project planning. Enforcing policies, Rupees 500 is levied on people who do not install rainwater harvesting or fail to follow supply rules. It is unclear through survey and interviews how fines and penalties are helping Chennai's policy enforcement, as the problems in supply are persistant.

7.0 Conclusions:

Based on investigation, the following conclusions indicate the condition of water management in Chennai (as of 2012/ 2013): Poor water security. Results suggest that water supply is irregular, unreliable and inadequate. This is due to accessibility issues in certain areas. Contamination is mid to high due to domestic and other wastes and, hence the water-borne disease spread during summer. Open sewers impact increase contamination in three regions out of five (regions of study). Demand management is lacking as the major project focus of policies is on supply improvement. While Rainwater harvesting does exist, the current demand management programs are insufficient to support Chennai's population growth, management through conservation and efficiency needs further enhancement and dynamic action. Chennai needs enhanced control of project management, planning, as there are several supply implementations, out of which two major failures, recorded (during data collection). A

few interview responses and survey results were contradictory to the fact that there is a water security issue that hampers water supply management in Chennai. However it is clear that water scarcity issues and security concerns exist in Chennai due to many unheard voices from the communities. Evidence indicates that the Chennai water boards are trying their best to reduce the issues and improve water supply and demand management, there are certain obstacles that affect this, including policy strengths, schemes, distribution issues, quality issues, customer advisory, awareness etc., as mentioned within the supply section.

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