CHAPTER I

INTRODUCTION

Growing water stress signifies increased usage of water resources, which has a stronger influence on resource sustainability and a higher risk of user conflict. Physical water stress is anticipated to worsen as populations and water demands expand, and the consequences of climate change become more pronounced. Climate change and increased climate variability are predicted to vary at local and basin scales, as well as throughout the year. However, dry areas would tend to grow drier, and wet areas will tend to become wetter, meaning that climate change will likely increase water stress in areas that are already under stress (UNESCO, 2019). Around one-third of the world's population, people live in physical water shortage due to the fast-expanding population and water demand per capita in various places of the world (Rana and Guleria, 2018). Over 2 billion people live in nations with severe water scarcity. Although the global average water stress is only 11 per cent, 31 nations face water stress between 25 per cent (the minimal threshold of water stress) and 70 per cent, with 22 countries experiencing water stress above 70 per cent and hence experiencing substantial water stress.

Water shortage, a major environmental concern across the world, has been aggravated by a huge rise in water extractions during the previous century. Climate and socio-economic changes are expected to increase water scarcity in many parts of the world in the next decades. (Greve et.al, 2018). The freshwater shortage has been apparent in recent decades as a result of constantly growing demand, posing a danger to human society's long-term growth. Water problems are the most significant global risk, according to the World Economic Forum's annual risk assessment 2015. The key driving causes for the expanding worldwide demand for water are the growing global population, better living standards, and changing consumption patterns (Mekonnen and Hoekstra, 2016).

Water Demand and Consumption

Population growth, urbanization, food, and energy security policies, as well as macroeconomic dynamics like trade globalization, changing cuisines, and growing consumption, all have an impact on world water demand. Global water consumption is expected to rise by 55 per cent by 2050, owing mostly to increased needs from

industrial, thermal energy production, and home usage. The industrial and domestic sectors will account for the majority of this development. Agriculture's proportion of total water usage is thus expected to decline in contrast to other sectors, but it will continue to be the greatest user in terms of both water withdrawal and consumption in the future decades.

Strong economic growth and rising middle-class living standards have resulted in dramatic increases in water use, which may be unsustainable, particularly when resources are fragile or scarce, and if water use, distribution, pricing, consumption, and management are inadequately managed or controlled. Changing consumption habits, such as growing meat consumption, building larger homes, and using more motor cars, appliances, and other energy-consuming equipment, usually result in higher water usage for both production and consumption (UNWWAP, 2017).

Water distribution on earth

The total amount of water on the planet is 1.386 billion cubic kilometers. Around 97 per cent of this is in the form of saltwater-containing seas and oceans. More than 2 per cent of the land is covered by ice caps and glaciers, and about 1 per cent is covered by rivers, lakes, groundwater, and water vapor are all examples of water vapor. Seas and oceans contain over 97 per cent of the water in the hydrosphere. All of these bodies of water are saline. They are unfit for direct consumption, such as drinking, cooking, or industrial or irrigational applications. Freshwater makes up only 3 per cent of the total amount of water on the planet. Almost 66.7 per cent of freshwater is locked up in the form of ice caps and glaciers, according to the further distribution of freshwater alone. Groundwater accounts for about 30.1 per cent of the total. Only 0.3 per cent of surface water is directly available on the ground surface, with the remaining 0.9 per cent existing as water vapor and soil water. Lakes, bogs, and rivers all share the 0.3 per cent of surface water that is accessible. Only a small per centage of this is biological water. If all of the water on the planet is gathered into a sphere, then that water ball would have a diameter of around 1385 kilometers.

Population Growth and Water Demand

In 2017, the world's population reached over 7.6 billion in mid-2017, meaning that the world's population has grown by roughly one billion in the last twelve years.

Sixty per cent of the world's population (4.5 billion) lives in Asia, 17 per cent in Africa (1.3 billion), 10 per cent in Europe (742 million), 9 per cent in Latin America and the Caribbean (646 million), and the remaining 6 per cent in Northern America (361 million) and Oceania (41 million). China (1.4 billion people) and India (1.3 billion) are the world's two most populated countries, accounting for 19 and 18 per cent of the global population, respectively.

Table 1: Population of the World and Regions

Region	Population (millions)			
	2017	**2030**	**2050**	**2100**
World	7550	8551	9772	11184
Africa	1256	1704	2528	4468
Asia	4504	4947	5257	4780
Europe	742	739	716	653
Latin America and the Caribbean	646	718	780	712
Northern America	361	385	435	499
Oceania	41	48	57	72

Source: United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects

Mother Nature's most valuable gift is water. Water is one of the planet's most important resources, and it water is required for all other forms of life. It has a significant impact on all elements of human life. Drinking water, cooking, washing, gardening, and cleaning operations, industrial processes, and agricultural activities all consume water. Water has now become an important commodity for humanity. Water has monetary worth. There can be no life without water. It is a fundamental substance that exists in solid, liquid, and gaseous forms.

Water stress, water shortages or deficits, and water crises are examples of water scarcity. Only 4 per cent of the world's population lives in India, yet it is home to 18 per cent of the world's population. The country's yearly per capita water availability has decreased dramatically, with 163 million Indians lacking access to safe drinking water.

NITI Aayog 2018 reported that India is facing its "biggest" water crisis in history, with demand for portable water outstripping supply by 2030 unless action is

taken. Nearly 600 million Indians were under severe water stress, and about 200,000 people died each year as a result of a lack of safe drinking water (Kumar, 2019).

Water Availability in India

India's annual precipitation is estimated to be over 4000 billion cubic meters (bcm), with a potential for 1869 bcm of water resources. The utilizable water resource potential is 690 cm of surface water and 447 cm of groundwater, for a total of 1137 bcm, due to topographical and other restrictions. In 2011, India's per capita yearly water availability was at 1544 cubic meters, however, that number has since dropped owing to population growth. The following are three key challenges relating to water resource variability in India as given by Jain (2019)

(i) Water availability in India is very variable over time, resulting in calamities such as floods and droughts, among other problems.

(ii) There is a significant regional mismatch between water availability and demand, with demand for diverse applications quickly growing while availability remains almost constant.

(iii) Water withdrawal from surface and subsurface water bodies is increasing and becoming unsustainable to fulfill growing demand.

The gap between water supply and demand is widening. Water demand is mostly determined by population. With India's growing population, changing lifestyles, and expanding economic activity, the need for water is likewise fast increasing. The gap between demand and availability of water is widening in India since there is no discernible trend in yearly rainfall. Many locations already have far more demand than supply, resulting in a water shortage.

The country's three major rivers, the Indus, Ganges, and Brahmaputras, receive about a third of the total surface water. Reservoirs built in India have a total capacity of 17400 billion cubic meters of water. Only 180 billion cubic meters of water could be stored when the country gained independence. As a result, the capacity of water storage has risen tenfold (Hjorth, 1994). The annual groundwater draw is 245 BCM, which accounts for around 62 per cent of the net water available, according to the CWG Report 2011.

Current Scenarios of Water Availability in India

The live storage in 100 of India's reservoirs increased by 13.422 billion cubic meters in a week in 2019, yet the water bodies still contain only 33 per cent of their capacity. According to the Central Water Commission 2019, the cumulative storage level is currently at 54.258 BCM. This occurred at 40.836 BCM. These reservoirs held 73.162 BCM in 2018; the average of the previous ten years was 67.922 BCM, both of which were higher than the present levels. With 10 per cent or less storage, the scenario is similar in six dams in Tamil Nadu, Gujarat, Maharashtra, Karnataka, Jharkhand, and Odisha. At least 23 reservoirs are holding less than half of their capacity. The southern states position has deteriorated in the recent week. Less-than-average rainfall has increased the water deficit in Telangana and Karnataka reservoirs to 73 and 20 per cent, respectively, up from 70 and 18 per cent in 2019. Andhra Pradesh, with 84 per cent inadequacy, and Kerala, with 54 per cent, have witnessed little progress. In the five southern states of Kerala, Telangana, Andhra Pradesh, Karnataka, and Tamil Nadu, the deviation from normal rainfall was 32, 17, 16, 29, and 13 per cent, respectively.

The country is experiencing a nine per cent rainfall deficit. This has resulted in severe water scarcity, particularly in the southern and western states. While water storage in significant rivers like the Ganga, Krishna, and Mahanadi remained 'near to normal' until mid-July, these three rivers, along with the Tapi, Godavari, Cauvery, and adjoining East Flowing Rivers, have now joined the 'deficient' category. It is 'extremely inadequate' in the Sabarmati and Kutch rivers. States must begin regulating their groundwater and agricultural water. Twenty-one Indian cities, including Delhi, Bengaluru, Chennai, and Hyderabad, will run out of groundwater by 2020, affecting 100 million people; by 2030, 40 per cent of India's population will lack access to drinking water. Many Indian states, notably Andhra Pradesh, Chhattisgarh, and Tamil Nadu, are currently experiencing water scarcity, which is compounded by changing rainfall patterns, (Niti Aayog, 2018).

Rapid groundwater depletion, a reduction in average rainfall, and an increase in dry monsoon days. Between 2002 and 2016, groundwater in India was depleted at a rate of 10 to 25 millimeters per year. India ranks 120 th out of 122 countries in a global water quality index, with nearly 70 per cent of its water contaminated. India is home

to 4 per cent of the world's fresh water and 16 per cent of the world's population, (Tripathi, 2018).

Demand and Supply of Water in India

The total yearly utilizable water resources in India are 1123 billion cubic meters (690 billion cubic meters surface water + 433 billion cubic meters subsurface water). Groundwater is a valuable resource of drinking water in both urban and rural India. Over-exploitation of groundwater has resulted in water scarcity in various regions, including Delhi, Punjab, Haryana, and Uttar Pradesh. Arid climates cause water scarcity in states such as Rajasthan and Gujarat, while weak aquifer qualities cause water scarcity in Tamil Nadu, Karnataka, and Andhra Pradesh. With rising population pressures, industrial growth, and an unprecedented rate of urbanization, groundwater is being drained at a much faster rate than rainfall can replenish it. Water needs in all sectors are increasing as a result of fast economic and demographic change.

While groundwater meets a significant portion of the water requirement, a long-term investigation of water recharge in both the pre-monsoon and post-monsoon seasons reveals a lowering of the water table due to restricted recharging. If current trends continue, India will confront a severe water shortage in the future, particularly in the agriculture sector (ADRI, 2014).

Table 2: Projection of Water Demand in India

Sector	Water Demand in BCM					
	2010		2025		2050	
	Low	High	Low	High	Low	High
Irrigation	543	557	561	611	628	807
Drinking-Water	42	43	55	62	90	111
Industry	37	37	67	67	81	81
Energy	18	19	31	33	63	70
Other	54	54	70	70	111	111
Total	694	710	784	843	973	1180

Source: Asian Development Research Institute, ADRI (2014).

Urbanization in India

India is increasingly becoming more urbanized. According to the 2011 Census, the urban population increased to 377.1 million from 286.1 million in 2001, representing a 2.76 per cent annual growth rate from 2001 to 2011. The overall level of urbanization in the country went from 25.7 per cent in 1991 to 27.82 per cent in 2001 and 31.14 per cent in 2011 – a 3.3 percentage point rise from 2001 to 2011 compared to a 2.1 percentage point increase from 1991 to 2001. A large number of new towns emerged during the decade, contributing significantly to the speeding up of urbanization. The number of statutory towns in India increased from 3,799 to 4,041 during 2001- 2011 whereas the number of census towns has increased from 1,362 to 3,892 during the decade. According to UNEUP 2018, 55.29 per cent of the world's population resided in cities, compared to 34.03 per cent in India. Between 2015 and 2020, the global average annual growth rate of the urban population is expected to be 1.90 per cent. During this time, India's urban population is expected to increase by 2.37 per cent.

Table 3: Details of Decadal Wise Urban Population in India

Census Year	No.of Towns/UAs	Cities with a population of 1 lakh and above	Urban population (in millions)	per cent Urban Population	Urban annual Exponential growth rate
1951	2843	71	62	17.3	3.47
1961	2365	95	79	18	2.34
1971	2590	139	109	19.9	3.23
1981	3378	204	159	23.3	3.79
1991	4689	273	217	25.7	3.11
2001	5161	350	285	27.8	2.74
2011	7935	468	377	31.2	2.76

Source: Census of India (2011).

India's urban population will overtake its rural population by the end of 2050. Looking at urbanization and migration trends, it appears that by the end of 2050, the urban population will outnumber the rural population. The urban population will be 87.7 million, with 78.3 million people living in rural areas. Over the last seventy years, the urban rate has continuously outpaced the overall population growth rate. For the next 30 years, this tendency is expected to continue. The rate of urbanization,

which has been increasing since 1950, is predicted to continue until 2035 (Gulankar 2019).

Table 4: Details of Census Classifications of Towns and Cities

Class of Cities/Towns	Range of Population	No.of.Towns
Class I	1,00,000 and above	393
Class II	50,000 to 99,999	401
Class III	20,000 to 49,999	1151
Class IV	10,000 to 19,999	1344
Class V	5,000 to 9,999	888
Class VI	Below 5,000	191

Source: Census India (2011),

In the above table (4) the number of Class I Urban Agglomerations/Towns with a population of at least 100,000 people have climbed from 24 in 1901 to 468 in 2011. The current census counted 264.9 million people residing in Class I UAs/Towns, accounting for 70 per cent of the total urban population. Over the census, the share and growth of class I UAs/Towns have steadily increased. The progression of several urban centers from lower population size categories to class I cities has resulted in a top-heavy urban population structure in India. Growth in the remaining kinds of towns has been negligible. Since the previous Census, the number of towns has grown by 2774. In comparison to the 2532 Census towns, only 242 statutory towns have been added in the last decade. Many of these towns are part of UAs, while the others are self-contained municipalities (Census of India, 2011).

Urbanization Trends

As per World Urbanization Prospects 2014 the growth in the number of people living in towns and cities is known as urbanization. Urbanization happens primarily as a result of people moving from rural to urban areas, resulting in an increase in the urban population and the size of urban areas. Land use, economic activity, and culture all alter as a result of population fluctuations. Rapid and unplanned urban growth hurts infrastructure, resulting in inadequate housing, water and sanitation, transportation, and health care facilities. (WUP, 2018)

The number of people living in cities is predicted to reach 66 per cent by 2014, which depicts the global change in rural and urban populations from 1950 to expected

statistics for the year 2050. A huge migration of people from rural to urban areas has occurred. The number of people living in urban and rural areas around the world. In 2017, 4.1 billion people were living in cities. This means that over half of the world's population (55 per cent) lives in cities.

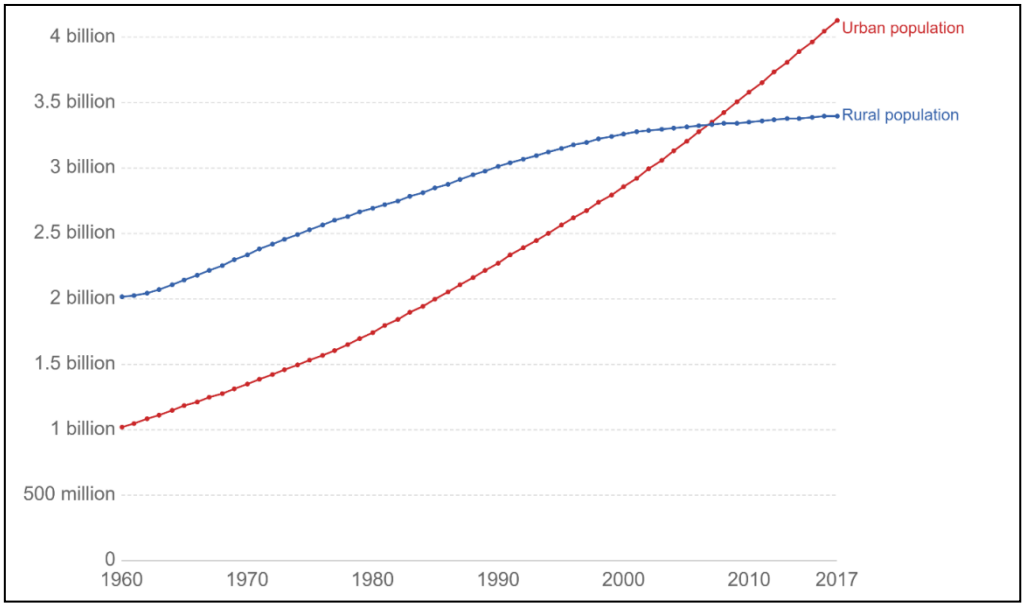

Figure 1: Impact of Population Growth on Water Resources

Population expansion is a major driver of rising water demand, both directly (for drinking water, sanitation, and hygiene) and indirectly (e.g. through growing demands for water-intensive goods and services, including food and energy). Over the last few decades, water demand has outpaced population increase by a factor of two. The global population is increasing at a rate of 80 million people per. As of June 2017, the world's population had risen to 7.6 billion people. By 2030, it is predicted to be around 8.6 billion people, with further growth to 9.8 billion by 2050. Nearly all current population increase is accounted for by Africa and Asia.

Water availability per person is determined by a country's population, and in India, per capita, water availability is decreasing as the population grows. The average annual per capita water availability was estimated to be 1816 cubic meters and 1545 cubic meters in 2001 and 2011, respectively, and is expected to decrease to 1486 cubic meters and 1367 cubic meters in 2021 and 2031. According to the Ministry of Housing and Urban Affairs, the guideline for urban water supply is 135 liters per capita per day (LPCD) (Ministry of Water Resources, 2020).

According to the Falkenmark Index, over 820 million Indians residing in twelve river basins across the country have per capita water availability near to or below 1000m^3 the recognized threshold for water scarcity. In India, about 82 per cent of rural families do not have their own piped water supply, and between 81 and 163 million people live without access to clean water within walking distance of their houses. India's surface water is contaminated to the tune of 70 per cent. India's average per capita water availability, which is currently low enough to be classified as water-stressed, is anticipated to drop even further to 1341m^3 by 2025 and 1140m^3 by 2050, putting it near to the official water scarcity threshold. According to estimates, investments of INR 20,00,000 crores will be required to close the predicted water supply gap by 2030 (Niti Aayog, 2019).

Table 5: Demand and Supply of Water Resources in India

Census Years	Population (Million)	Decadal Growth (per cent)	Urban Population (Million)	Per capita Water Availability($m^{3)}$
1951	361.1	13.3	62	6372
1961	439.2	21.6	79	5239
1971	548.2	24.8	109	4197
1981	683.3	24.7	159	3368
1991	846.4	23.9	217	2719
2001	1028.7	21.5	285	2236
2011	1210.0	17.6	377	1902

Source: CGWB, (2016)

India's precious and vulnerable water resources are stressed and deteriorating, despite the country's fast population growth. Because India's population had risen fourfold in the previous 70 years, population growth was the key to the entire equation of water supply and use. India's population, which was roughly 238.4 million at the turn of the twentieth century, climbed to 1210 million by the turn of the twenty-first century. According to Table 5, population increase was diminishing per capita water supplies. Water per capita in India was about 6372m^3 per year in 1951; it is presently around 1902m^3 per capita. With each rise in population, there was a proportional decrease in per capita water availability. In 2050, India's population is expected to reach between 1.5 and 1.8 billion people. Water availability per capita will then be roughly 1200m^3 per year, making good water management in India more

urgent than in most other countries. As a result, good water management is more important in India than in the majority of other countries.

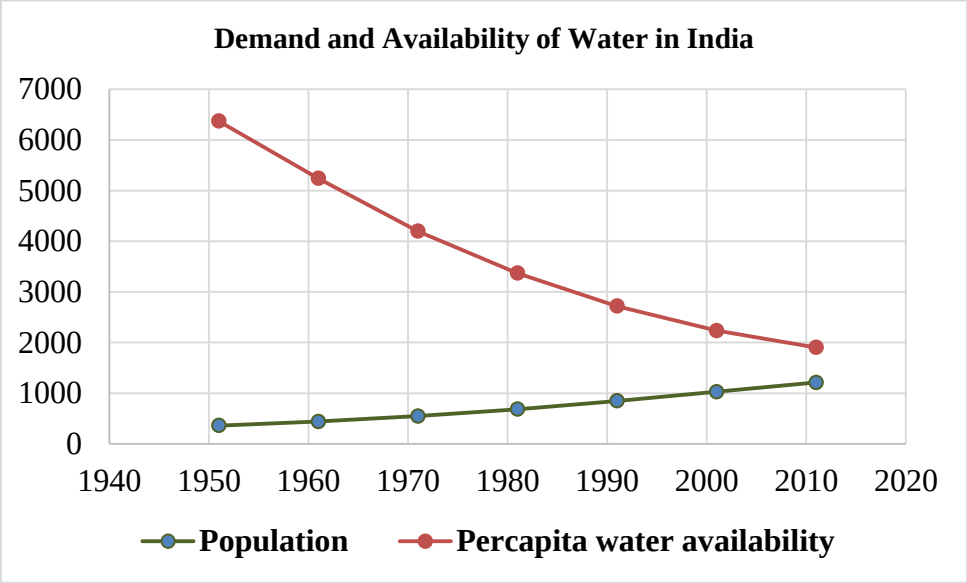

Figure 2: Demand and Availability of Water in India

Water delivery to inhabitants is one of the mandatory tasks of local governments. Although municipal level boards have taken over this function in many metropolitan areas, delivering safe water to the entire population remains the responsibility of the responsible public body. However, providing water to the entire population necessitates ongoing investment in expanding and enhancing the water supply system. Water supply coverage of the population has improved over time, although reaching 100 per cent coverage of the urban population will take some time.

Urban Water Demand in India

The steady increase in the pace of growth of India's population has also led to an increase in demand for water, notably in urban regions where the rate of growth is faster than in rural areas. In 2001, the urban population was 285 million, and assuming a water supply of 135 liters per capita per day, domestic water demand was predicted to be roughly 38,475 million liters per day (MLD), however, in 2011, the urban population was 377 million, with a domestic water demand of 50,895 MLD. It demonstrates that increased urban population development results in additional water demand of 12,420 MLD in urban areas. For home water consumption in urban local bodies, a water supply of 135 liters per capita per day (LPCD) should be provided as a service level benchmark. According to the Central Public Health and Environmental

Engineering Organization (CPHEEO, 2018), the average water supply in urban localities in 2018 is 69.25 LPCD. There is a significant imbalance between the demand for and supply of water in India's metropolitan areas. Access to safe drinking water and sanitary facilities in India's metropolitan regions is also a serious challenge. It is anticipated that by 2050, half of India's population would be living in cities, creating severe water shortages (Ali and Dkhar, 2018).

Drinking-Water Adequacy in Urban India

Urban water issues have become increasingly complex in recent years, partly due to the ongoing pressures of urbanization and urban population increase, and partly due to the restricted amount of water available for urban use. The country's urban population has been growing at twice the rate of rural population growth; on the other hand, urban water amounts to 5-6 per cent of total water consumption in the country, which is grossly inadequate in comparison to water demand. The supply of safe drinking water and sanitary facilities in urban areas is deficient. There is also a significant disparity in the distribution of basic services in general, and drinking water and sanitation in particular, not only at the intercity but also at the intracity level. The CPHEEO Manual's norms are listed in the table below (Suprabha, 2016).

Table 6: Norms Fixed by the CPHEEO Manual

Classification of towns /cities	Recommended Maximum Water Supply Levels (lpcd)
Towns provided with piped water supply but without sewerage system existing/planned	70+ 15 per cent for leakage
Cities provided with piped water supply where sewerage system exists/planned	135+ 15 per cent for leakage
Metropolitan and Megacities provided with piped water supply where sewerage systems existing	150+ 15 per cents for leakage

Source: As quoted by Suprabha (2016)

The majority of urban Indian households rely on municipal water supply for their everyday needs. More than 70 per cent of these people rely on tap water, with a small number relying on tankers. The second significant source is access to groundwater. Wells, tube wells, and hand pumps account for more than 27 per cent of

a household's primary water source. Other sources, such as tanks, ponds, springs, rivers, and canals, are insignificant in urban areas.

Table 7: Urban Water Sources: National Sample Survey Office

Major source of Drinking water	49th Round: 1993 (per cent)	58th Round: 1998 (per cent)	65th Round: 2009 (per cent)	69th Round: 2012 (per cent)
Bottled water	NA	NA	2.7	5.2
Tap	70.4	73.6	74.3	69.1
Tube well/hand Pump	18.5	19.6	17.5	19.9

Source: NSSO Data 2012

Urban water issues have become increasingly complex in recent years, partly due to the ongoing pressures of urbanization and urban growth, and partly due to the limited amount of water available for urban consumption. The country's urban population has been growing at twice the pace of rural population growth; yet, urban water amounts to 5-6 per cent of total water consumption in the country, which is grossly inadequate about water demand. Because of the country's constantly expanding demand for water and inflexible supply, water is accessible to around 85 per cent of the entire urban population, although usage is 30-60 per cent lower than nationally mandated water consumption limits. Water distribution systems are almost always unreliable. Most families have limited service hours and poor pressure, and 20-60 per cent of water is lost in the distribution system and through unlawful use by urban residents. Public spending on urban water supply and sanitation accounts for 1.2 per cent of total plan investments, falling far short of expectations. The direct result of insufficient provision is a rapid decline in service standards. The economic and social consequences of inadequate water supply are estimated to be quite substantial (Om Prakash Mathur, 2001). Although the urban population's access to safe drinking water has improved over time, there are still issues with unfairness in water distribution, water quality, and quantity.

Urbanization Trends in Tamil Nadu

Tamil Nadu is at the forefront of the observed urbanization trend; nonetheless, several difficulties related to urban housing must be addressed. In Tamil Nadu, 48.45 per cent of the population lives in urban regions, compared to the national

average of 31 per cent. In 2011, the average population density in the state was 554 people per square kilometer, while in urban areas, it was 3521 people per square kilometer. The state's urban population growth (27 per cent between 2001 and 2011) exceeded rural population growth (6 per cent during the same time), and the state's urban population may soon outnumber the rural population.

Table 8: Details for a Relative Comparison of Urban Population among States in India

State	Population (In Lakh)	Urban Share (in per cent)
Delhi	163	97
Rajasthan	171	25
Madhya Pradesh	201	28
Karnataka	236	39
Gujarat	257	43
Andhra Pradesh	284	33
West Bengal	291	32
Tamil Nadu	349	48
Uttar Pradesh	445	22
Maharashtra	508	45

Source: Tamil Nadu Urban development planning group, (2018).

Tamil Nadu is first among big states in terms of urban population percentage, and third in terms of the absolute urban population. Tamil Nadu, with a provisional urban population of 34.9 million, has 48.45 per cent of its population residing in urban areas, according to 2011 census preliminary estimates. Table (8) provides details for a relative comparison of urbanization (among states and in India) and demonstrates that Tamil Nadu is the most urbanized state (State Planning Commission Tamil Nadu, 2018).

Tamil Nadu Urban Population

In Tamil Nadu, urban areas account for 48.40 per cent of the total population. The overall population of urban areas is 34,917,440, of which 17,458,910 are males and the remainder 17,458,530 are females. In the last ten years, the urban population has grown by 48.40 per cent. In Tamil Nadu's urban areas, the sex ratio was 1000 females for every 1000 males.

Table 9: Details of Urbanization Trends in Tamil Nadu

Census year	Total Population (in lakh)	Urban Population (in Lakhs)	Share of urban population (per cent)	Urban Growth Rate (per cent)
1951	301	73.3	24.35	8.39
1961	336	89.9	26.69	22.59
1971	411	124.6	30.26	38.64
1981	484	159.5	32.95	27.98
1991	558	190.7	34.65	19.59
2001	621	274.8	44.04	44.06
2011	721	349.5	33.73	27.16

Source: Census of India 1951-2011

According to the 2011 census, the population of Tamil Nadu is approximately 72 million, which is not as large as some of the other major states in the country. This is also reflected in the fact that the state's population density is approximately 555, which is approximately 150 points higher than the national average. The state has a growth rate of roughly 15 per cent, which will continue to rise due to the state's overall infrastructure and development index. As a result of the state's progress, the state's population is rapidly increasing.

Water sector overview and challenges

No Indian city has piped water available 24 hours a day, seven days a week. Regardless of the quantity available, piped water is never provided for more than a few hours every day. Most households, forced to deal with a low-quality water supply and sanitation services, spend time and money on costly and risky substitutes that cost far more than their monthly water bills. Inefficiencies in services and costs are passed on to customers, with the poor bearing the brunt of the burden (World Bank, 2011).

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Tamil Nadu is at the forefront of the observed urbanization trend; nonetheless, several difficulties related to urban housing must be addressed. In Tamil Nadu, 48.45 per cent of the population lives in urban regions, compared to the national average of 31 per cent. In 2011, the average population density in the state was 554 people per square kilometer, while in urban areas, it was 3521 people per square kilometer. The

state's urban population growth (27 per cent between 2001 and 2011) exceeded rural population growth (6 per cent during the same time), and the state's urban population may soon outnumber the rural population.

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Source: Census of India 1951-2011.

According to the 2011 census, the population of Tamil Nadu is approximately 72 million, which is not as large as some of the other major states in the country. This is also reflected in the fact that the state's population density is approximately 555, which is approximately 150 points higher than the national average. The state has a growth rate of roughly 15 per cent, which will continue to rise due to the state's overall infrastructure and development index. As a result of the state's progress, the state's population is rapidly increasing.

Population Growth and Per Capita Water Demand in Tamil Nadu

Tamil Nadu constitutes 4 per cent of India’s land area and is inhabited by six per cent of India’s population, but has only 2.5 per cent of India’s water resources. More than 95 per cent of the surface water and 80 per cent of the groundwater have already been put into use.

The demand for water in Tamil Nadu is increasing at a fast rate both due to the increasing population and also due to larger per capita needs triggered by economic growth. The per capita availability of water resources, however, is just 900 cubic meters when compared to the national average of 2,200 cubic meters. Agriculture is the largest consumer of water in the State using 75 per cent of the State’s water resources.

Table 12: Details of Urbanization Trends in Tamil Nadu

Year	population Millions	Per capita water availability
1951	30.1	1492
1961	33.7	1333
1971	41.2	1090
1981	48.4	928
1991	55.9	804
2001	62.1	723
2011	71.3	590

Source: Tamil Nadu Water and Drainage Board, (2019)

The collected information showed that in the year 1951 India`s population was about 30.1 per cent where the per capita water availability was 1492 in the year 1961 there was an increase in the population from 30.1 to 33.7 but the per capita availability of water decreased from 1492 to 1333, in the year 1971 India`s population again has seen an increase from 33.7 to 41.2 and again the per capita water availability decreased from 1333 to 1090, in the year 1981 the population has grown to 48.4 million whereas the per capita water availability decreased to 928, in the year 1991 the population was 55.9 million with per capita water availability reduced to 804 whereas the same scenario can be witnessed in the year 2001 and 2011 where the population of India was 62.1 million in 2001 and 71.3 million in 2011 but the per capita water availability reduced to 723 in the year 2001 and 590 in the year 2011. This clearly shows that there is an inverse relationship between population and per capita, water availability as with the increase in population the per capita water availability is seen to be decreasing. In India, one of the highly populated countries the lack of availability of water for the citizens is one of the social distress faced every year. Data from 1951 to 2011 was collected through the Tamil Nadu Water and Drainage Board.

Development of Urban Water Supply in India: Five-Year Plans

Good policies, good local governance systems, and sound arrangements to finance public services are critical elements in sustainable urban development and shape the nature and quality of public services provided. Demands for better infrastructure and better public services in India’s urbanized areas are large and growing. Local governments need access to adequate revenue resources to finance the

public services they are mandated to provide (Suprabha, 2016). Plan wise investment in water supply and sanitation is given in the Table 13.

Table 13: Plan Wise Investment in Water Supply and Sanitation

Plan Period	Total Public sector plan outlay	Total plan outlay for water supply & sanitation sector (per cent of public sector outlay)	Plan outlay for urban water supply & sanitation sector (per cent of public sector outlay)	Plan outlay for Rural water Supply &sanitation (per cent of public sector outlay)
I Plan (1951-56)	3360.00	1.46	1.28	0.18
II Plan (1956-61)	6750.00	1.07	0.65	0.14
III Plan (1961-66)	8573.00	1.23	1.04	0.19
3 Annual Plans (1966-69)	6664.97	1.6	N.A	N.A
IV Plan (1969-74)	150902.00	2.75	1.77	0.97
V Plan (1974-79)	39303.50	2.62	1.4	1.22
Annual Plan(1979-80)	12549.63	3.43	1.58	1.85
VI Plan (1980-85)	97500.00	4.15	1.81	2.34
VII Plan (1985-90)	180000.00	3.62	1.65	1.98
2Annual Plans (1990-1992)	137033.15	3.23	1.26	1.97
VIII Plan (1992-97)	434100.00	3.85	1.38	2.47
IX Plan (1997-2002)	859200.00	4.46	2.16	2.43
X Plan (2002-2007)	1525639.00	2.89	1.3	1.6
XI Plan (2007-2012)	3644719.00	3.31	1.32	1.99
XII Plan (2012-2017)	8050123.00	3.17	1.64	1.52

Source: As quoted in Suprabha, (2016). And Twelfth Five Year Plan – 2012-2017, Govt. of India

The first five-year plan which was commenced from 1951 to 1956 added water supply and sanitation for their national agenda. The Ministry of Water Resources made a new amendment for National Water policy in the year 1987 by which there were guide provided for the planning and development of water resources across the country, this has also made many recommendations namely

- water resource management and according to domestic water supply the highest priority
- design standards for groundwater structures to protect groundwater sources
- water quality monitoring and mapping, and
- data management and valuation.

There was a revision made to the 1987 policy and National Water Policy 2002 was introduced by which primacy to drinking water was established. All the states in India were intimated to take up the water policies for the next two years few states namely Karnataka, Madhya Pradesh, Orissa, Rajasthan, and Tamil Nadu have already commenced many new policies which were as per the new national policy. The Eight Five Year plan (1992-97) has stated that "Safe drinking water and basic sanitation are vital human needs for health and efficiency given that death and disease, particularly of children, and the drudgery of women are directly attributable to the lack of these essentials." Larger preference was allotted to serving of villages which have not taken up Economics of Urban Water Supply system. This VIII five-year plan has also figured out several aspects like management of water as a commodity, principles of effective demand for delivery of water services, user's willingness to maintain a level of standard services of water. Both the IX five-year plan and X five-year plan had followed the pathway of the VIII five-year plan, where the main responsibility of the plan was to allocate drinking water and sanitation facility in the country. In the various five-year plans of the country, the planners ensured that there are sufficient funds given for the entire state budget for proper supply of water and maintained of sanitation.

(a) Protection of the environment and safeguarding of health through the integrated management of water resources and liquid and solid waste;

(b) Organization of reforms, promoting an integrated approach including changes in procedures, attitudes, and behavior, and the full participation of women at all levels;

(c) Community management of services, backed by measures to strengthen local institutions in implementing and sustaining water and sanitation programs; and

(d) Sound financial practices, achieved by better management of existing assets and extensive use of appropriate technologies.

The X five-year plan wanted to provide cent per cent coverage of the rural and urban population with good drinking water facilities for which certain norms and standards which are 40 LPCD of water within 1.6 kms or between 100 meters in a hilly area and at least one hand pump or spot for every 250 people living in the country.

The plan also extended its policies to nationwide monitoring and surveillance system, cost-effective and social operation, and maintenance of rural water supply and management. By the X five year plan, the policymakers advocated that water is an economic asset and it is not a free product so it is necessary for the people and authority it use the water resources carefully this plan also established comprehensive development of water resources in the village focal unit and the coverage has remained as one of the important agenda for those accorded as “not covered”, “partially covered”, “habitations with less than 10 liters of water supply” and those areas affected with drought. In the previous plans, the objective was to provide universal coverage and adequacy in terms of per capita water consumption but in the X five-year plan urban water supply and sanitation opposed the strong change in the agenda formulated.

To facilitate pure water for drinking for all by the end of the year 2009 without any slip back was the main agenda of an eleventh five-year plan for which the first there were reforms taken for Bharathnirman Programme in which there were 55,067 habitations not covered, 2.8 lakh. The second half period of the program was in the duration of the first two years of the XI five-year plan by this duration the states have taken up their effort in covering the slip back of the habitations which were 1.63 lakh habitations and not covered habitations which was about 23,000 habitations. Even though the achievement has been made but yet they did not reach the target that was laid by the policymakers. With 2.17 lakh habitations on 1.04.2005, almost 70,000 habitations were addressed. In the year 1994, the Accelerated Urban Water supply Programme was introduced and the towns which were often neglected by the policymakers were facing the severity of drought problem during the period the Water Supply Schemes for 1244 towns were granted which was around the cost of Rs. 1822,38 crores. As in 2005-06, there were no schemes that sanctioned any fund under the program so later the program merged itself with the Urban Infrastructure Development Scheme for Small and Medium by which Rs. 826.60 crores was funded for the states which suffered from droughts and the program has incurred the expense of Rs.805.83 crores and the total expense was Rs.1, 412.88 crores. The result of the program was found in 62 towns in 24 states had resulted in the supply of water and improved health condition. With the five-year plans, the center`s took up the responsibility of establishing organizations to lend for states. And it has taken growth

in providing recommendations for water supply and sanitation to promote needs for training and research and most recently in providing water quality and also to monitor human resources development programs. Many new government institutions at the center took up the role to maintain drinking water supply and also to provide water resource coordination, pollution control, and also to provide finance for the infrastructure development with so many series of five-year plans India is reflecting the ideas of central planning of the planning commission.

Research Gap

There are various research works carried out on urbanization and its impact on water resources and numerous works are available on domestic water consumption. Many research works are available on climate change and its impact on water resources and attempts are made to examine willingness to pay for better water sources but very limited studies are available on willingness to pay for improved urban water service and also very limited studies are available on the application of the theory of planned behavior especially in Coimbatore district there are no studies based on this theory. In this study, the researcher has tried to bridge this gap and have investigated willingness to pay for improved urban water supply based on income group classification and have implied theory of planned behaviour to study the water-saving behavior.

Objectives

- To study the Socio-economic background of the selected households.
- To understand the economic aspects of the domestic water consumption of the selected households.
- To assess the environmental aspect related to domestic water consumption and health impact.
- To analyze income groups' willingness to pay for improved urban water supply.
- To examine the domestic water conservation knowledge and practices of selected households.
- To analyze the reasons and problems faced by the households in the urban water supply.
- To analyze the water-saving behaviour among the selected households; and
- To suggest and recommend the policy implications for the selected sample area