PROVISIONING OF BASIC PUBLIC SERVICES: A CASE STUDY OF WATER SUPPLY IN INDIAN CITIES

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DOCTOR OF PHILOSOPHY

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DECLARATION

Date: 08-03-2021

I hereby declare that the thesis on the topic **"Provisioning of Basic Public Services: A Case Study of Water Supply in Indian Cities"** submitted by me for the award of the degree of **Doctor of Philosophy** is a bona fide work. It has not been submitted so far in part or in full for any degree or diploma of this or any other university.

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We recommend that the thesis be placed before examiners for evaluation.

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“No single measure would do more to reduce disease and save lives in the developing world than bringing safe water and adequate sanitation to all”.

- Kofi Annan, Former Secretary-General (1997-2006), the United Nations.

“The right to water as the right of everyone to sufficient, safe, acceptable and physically accessible and affordable water for personal and domestic uses.”

- Resolution A/RES/64/292. United Nations General Assembly, July 2010

“By 2030, achieve universal and equitable access to safe and affordable drinking water for all.”

- Target for Sustainable Development Goal 6.1. United Nations.

I dedicate

this work

to my mentor

Dr. Daisaku Ikeda

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CHAPTER 1: INTRODUCTION

India had 17.74% of the world's population, 2.45% of the world's land resources and 4.5% of fresh water resource in 2008 as per Ministry of Water Resources. Since then the availability of water has gone further down. Indian urban areas are particularly in high stress.

The present work is an analysis of access to drinking water supply in urban India - various inequalities in such access, public expenditure pattern on urban water supply and its impact and the role of non-public sector in provisioning of drinking water in urban areas. Majority of work in this thesis is based on data from the last two decades – especially the time period when National Water Policy 2002 and 2012 were adopted. Most of the data for analysis in the thesis have been sourced from the NSSO 58th round in 2002, the 69th round in 2012 and the 76th round in 2018.

Till the First Water Policy of 1987 there was hardly any pan-India policy to guide provisioning of Drinking Water. The 7C of the Millennium Development Goals (MDG), adopted in 2000, targeted halving the proportion of people without sustainable access to clean and safe drinking water by 2015. Yet, there was no nation-wide program relating to development of a robust water infrastructure for urban India, despite the announcement of the revised Water Policy in 2002.

Starting in 2005, the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) was the first major step to address the inadequacy of urban water and sanitation infrastructure along with other urban services and issues in 63 large cities. UN General Assembly recognised in 2010 the Human Right to Safe and Clean Drinking Water and Sanitation.

MDG targets as well as program and allocation under JNNURM hastened work on the ground. By 2015 India partially achieved MDG 7C target by halving percentage of people without access to safe and clean drinking water compared to the percentage in 2000, but failed to achieve adequate and equitable sanitation and hygiene for all. According to the Joint Monitoring Programme (WHO and UNICEF), in 2017 India had 94% of Households covered by 'improved' (source that is protected from major contamination) water source (improved source = piped water, safe bore well,

protected well stream or collected rain water), 96% of households in urban India and 93% Households in rural India had access to basic drinking water (from improved source but collection time up to 30 minutes). One has to bear in mind that improved water does not necessarily mean safe water source.

In 2012 India adopted its latest and updated Water Policy. The Water Policy 2012 envisaged, inter alia - (i) Safe Water for Drinking and Sanitation is pre-emptive need; (ii) Pricing of Water to encourage Fairness, reward Conservation and ensure Efficiency and Equitable Access to Water; (iii) establishment of Independent Statutory Water Regulatory Authority by each State; (iv) Principle of Differential Pricing of Water for Drinking and Sanitation.

The Sustainable Development Goal Number 6.1, adopted in 2015, states that Universal and Equitable access to Safe and Affordable Drinking Water must be ensured for all by 2030. Along with other developing and under developed countries, India is working to achieve the Sustainable Development Goals.

Atal Mission for Rejuvenation & Urban Transformation (AMRUT) programme started in 2015 targeted that every Household will be connected with tapped water and sewerage line by 2022. The project includes 500 cities and urban centres of various categories across India. Har Ghar pe Jal (tap Water in every (rural) Household) initiative by Government of India started in 2019.

The questions the present work seeks to answer began with the kind and extent of Inequalities across urban households in access to improved drinking water and the factors behind such inequalities. The Thesis sought to identify Characteristics of Water Poverty in India through an analysis of distance to water source, availability of piped water and ownership of water facilities. An attempt was made to understand the complex socio-economic relations between Access to improved water and the uneven Burden on women to arrange water for the household. In a separate chapter, the Thesis analysed impact of States' expenditure on accessibility of improved water source in respective States and identified other macro factors which influence accessibility. In the last chapter, the thesis explored the nature and scope of non- Public and private participation in provision of Drinking Water in India.

1.1 Background

Water is the essence of support to the mankind both for social and economic prosperity (Agnew & Woodhouse, 2011). Not having access to safe and adequate water seriously diminishes the scope and quality of life, undermines human dignity – indeed, puts life to profound threats (UNDP[1], 2006)[2]. Among the multiple uses of water, drinking is considered the most important and the first priority. Global situation is greatly alarming. 76.8 crore people among the World Bank benefited countries are still deprived of improved water sources (World Bank, 2014). One out of three persons in the world does not have access to 'safe' drinking water[3] (Joint Monitoring Programme[4] (JMP), 2017a). Joint Monitoring Programme also revealed that globally 210 crore people in the world did not have access to safely managed[5] water for drinking and 450 crore people did not have safely managed[6] sanitation facilities in 2015 by the completion of Millennium Development Goals. In terms of coverage by improved water sources, progress is significant, but improved sanitation is still a worldwide challenge to reach the Millennium Development Goal (MDG) target (World Bank, 2014).

The public service of water supply is considered 'critical' infrastructure of an economy (Slay & Miller, 2007; Janke et al., 2014; Faily et al., 2015). Water supply infrastructure must ensure service at the best of reliability, safety and purity to the users. The present study examines urban India's condition vis a vis accessibility of drinking water to all with piped water. This study follows the Census of India's definition of "Urban Area" in 1971. That definition considered places under Corporation, Municipalities or Cantonment, places of Town area and other areas with at least five thousand population, minimum 75% male population of the area involved in non-firming or non-agriculture activities and the density of population of that area at least 1,000 per square kilometre (MoSPI, 2001).

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1 United Nations Development Programme

2 UNDP declares that "not having access to water and sanitation is a polite euphemism for a form of deprivation that threatens life, destroys opportunity and undermines human dignity" (UNDP, 2006).

3 https://in.one.un.org/un-press-release/1-in-3-people-globally-do-not-have-access-to-safe-drinking-water-unicef-who/

4 UNICEF and WHO

5 Access to improved water source on demand, on premises and free from microbiological and priority chemical contamination.

6 Proper separation of faecal wastes from human body on-site and their proper off-site treatment and availability of hand washing facility on site with soap and water

1.2 Sustainable Development Goals and Water

Out of 17 Sustainable Development Goals (SDGs), goal number 6 deals exclusively with water and sanitation services and their accessibility. SDG 6.1 calls for universal and equitable access to safe and affordable drinking water for all 2030. As a party to SDGs, India strives to achieve this goal of accessibility to all with equity, quality and affordability.

SDG 6.2 seeks sanitation service to all with adequacy, equity and hygiene, gender equality and special attention to vulnerable section of society. The effectiveness of sanitation infrastructure depends on water supply.

Subsequently, SDG 6.3 mentions of water quality. This quality dimension is linked to the control of pollution, elimination of dumping into rivers and other water bodies, stopping release of hazardous chemicals and materials. The Goal targets the halving of untreated wastewater of its current size, incentivizing recycling and safe reuse of water.

SDG 6.4 sought increase of water-use efficiency across domestic, industrial, irrigation & agriculture sectors. Goal 6.4 addressed water scarcity by emphasizing sustainable withdrawals and freshwater supply. India annually withdraws 33.9% of total renewable water resources, whereas the South Asia region holds at 25% in 2017 (UNDP, 2019).

The SDG 6.5 is regarding the implementation of water resources management at all levels. The SDG 6.6 discusses on conservation and reinstatement of ecosystems relating water like rivers, aquifers, mountains, forests, wetlands, and lakes by 2020.

Apart from SDG 6, some other Goals include different targets are sensitive to water and sanitation. SDG 3.3 called for eliminating outbreak of AIDS, tuberculosis, malaria, tropical diseases, combat hepatitis, water-borne diseases and other infectious diseases (WHO, 2016). The study has briefly introduced the role of incidence of diarrhoea in allocation of public expenditure to water and sanitation sector. Among

other pollution-related factors, SDG 3.9 has drawn attention to reduction in the number of casualties and afflictions due to water pollution[7] by 2030.

SDG 11.5 has gone further on measuring the economic losses through un-reaped GDP due to the number of deaths caused by water-related and other disasters. SDG 12.4 accounts for sound management of the environment, including water. SDG 15.1 and 15.2 are on conservation of wetlands, freshwater ecosystems and related other resource, which directly impacts quality and availability of water. Most of these aspects are not part of this study.

Fulfilment of SDG 6 has potential to impact on reducing burden of population including children due to water arrangement and releasing time involved in such arduous work which could otherwise be utilized in studying or working in productive manner. Thus SDG 6 facilitates to the aim of SDG 5 which is regarding to opening up of new employment opportunities for such people, SDG 1 which is abolition of extreme poverty and SDG 4 which is enabling children to attend school.

Water and sanitation are considered essential infrastructure without which inclusive growth and poverty reduction associated with targets of SDG 1 and SDG 8 will be constrained (Geest & Nunez-Ferrer, 2011) because of 'additional' impact. Thus, SDG 6 is essentially a theme target to achieve other goals relating to sustainable human development. The concept of sustainable development is well designed, comprising all three dimensions - environmental, social and economical (Pathak, 2014). Water has a central place in SDGs.

1.3 Present Situation of Water Supply in India

India is recognized as a region of fast deteriorating water stress. India's per capita water availability was around 1,170 m3 per person per year in 2010 (National Institute of Hydrology, 2010), which is just above the criteria of 1,000 m3 per person (World Research Institute, 2007). Projected water demand per annum per capita will rise from 813 billion m3 per person in 2010 to 1093 in 2025 and 1447 in 2050[8] (Ministry of Water Resource, 2000). These figures signal mismatch between demand and

[7] Deaths and illnesses from hazardous chemicals, and air, water, and soil pollution
[8] For details, Table 2.1

supply and a threatened future. The estimated dis-satisfaction level would be 50% by 2030 if ongoing style of use of water continues (Jia et al., 2016).

Other than sustainability, the SDG requirements of 'safe' 'adequate' 'affordable' and 'equitable' distribution are far from satisfactory. According to World Health Organization (WHO) 'improved' water sources (for details, refer to Appendix 1) comprises tap water in the dwelling or yard/ plot besides public taps or standpoint, protected tube wells or boreholes, protected dug wells, protected springs to rainwater collection, bottled water and delivered water, including tanker, trucks or small carts (JMP, 2017b). None of the 'improved' sources of water considered in the WHO definition suffice to ensure contamination-free water supply (Godfrey et al., 2011; Bain et al., 2014; Shaheed et al., 2014; Heitzinger et al., 2015). For instance, though about 98% of households in rural Maharashtra receive drinking water from an improved water source only 50% out of improved sources are free to acceptable levels of faecal bacteria (Seifert-Dähnn et al., 2017). The acceptability level decreases across various seasons, mainly monsoon.

United Nations Children's Fund (UNICEF) and World Health Organization (WHO) Joint Monitoring Program (JMP) noted that 89% of the global population is covered by a basic water service in 2015. The basic water service implied exposure to an 'improved' source for which a maximum time of 30 minutes is deployed to complete the collection of water per trip[9]. The basic improved water accessibility at all India was 79% in 2000 and 93% in 2017 (JMP, 2019). For urban India, the figures stand at 91% in 2000 and 96% in 2017. With such improved water supply coverage, India acquired a significantly high score in provisioning improved supply across selected Asian countries (Estache & Goicoechea, 2005), though the score on improved sanitation was remarkably low. There are two major areas major concerns - the safety of water from all such sources and adequacy of water (Annan, 2000; Godfrey et al., 2011; Clasen, 2012; Onda et al., 2012). Even water collected at the water point as safe in the quality could be unsafe while storage, container, or covering distance (Wright et al., 2004; Godfrey et al., 2011).

9 https://apps.who.int/iris/bitstream/handle/10665/258617/9789241512893-eng.pdf;jsessionid=80DB6450892C92B950650FAF921DD0AF?sequence=1

The Ministry of Urban Development (MoUD) launched in 2015 the AMRUT program aiming at, among other targets, provision of clean drinking water, sanitation, sewerage and solid waste management of over 500 Mission cities with a population of 1 lakh and above and specific other categories[10] of cities.

1.4 Rationale of Research

The Indian urban population's decadal growth rate was 31.3% in 2001-2011 and projected at 31.8% during the present decade. The share of urban pupation to the total population in 2001 was 27.8%, which increased to 31.16% in 2011 (Census of India, 2011). 55.29% of the world population live in urban areas in 2018, whereas the figure is 34.03% for India (UNDESA, 2018). India's urban population was estimated to grow at 2.39% during 2010-15, which is higher than other BRICS[11] countries except for China (2.94%) (MoHUA, 2018). India seems to follow a projected pace of urbanization at 2.37% annually during 2015-2020, higher than the global projected urbanization rate at 1.90% (UNDESA, 2018).

Urbanization is both challenge and opportunities. One of the challenges is the need for commensurate growth in infrastructure, which demands resource, planning and urban management. Benefit of urbanization can be reaped only through social inclusivity and environmental sustainability (Sadashivam & Tabassu, 2016). India's urbanization is unplanned. Rural migration to urban area in pursuit of economic opportunities mostly leads to unauthorised settlements without provision of public services (Acoca et al., 2014).

Besides the provision of water and other amenities, the urban authorities in India face challenges of management and preservations of urban 'blue space' – scant water bodies in urban India (Rietveld et al., 2016). However, economic growth depends not on the extent of urbanization itself, but the quality of opportunities urbanization offers (Annez & Buckley, 2009). In this overall context, water supply is a critical aspect

10 All cities and towns with a population of over one lakh with notified Municipalities, including Cantonment Boards. The cities are all Capital cities/Towns of States/UTs not covered in the previous category, all cities/towns classified as Heritage Cities by Ministry of Urban Development under the HRIDAY scheme; Thirteen cities and towns on the stem of the main rivers with a population more than 75,000 but less than 100,000; ten cities from hill states, islands and tourist destinations (not more than one from each State).

11 Brazil, Russia, India, China and South Africa

which requires study and reflections. Yet the proportion of drinking water to total water demand is much smaller than irrigation, industrial or energy use, it is increasing gradually with time. Dimension of demand-supply mismatches across regions is alarming (Kumar et al., 2012). The study reflected on these aspects.

Lack of access to safe water contributes significantly to disease and death resulting from diarrhoea and other enteric illnesses and their indirect health effects. As defined by the World Health Organization (WHO), the list of waterborne diseases includes diarrhoea, cholera, typhoid, hepatitis A and E, enteric fever, dysentery, and hepatitis[12] (WHO, 2000). Diarrhoea alone estimated to cause about 4% of worldwide deaths and 5% of health loss or disability[13], 58% of this death is on low income and middle income countries (UN, 2014).

Diarrhoea is responsible to loss of life for nearly 13% of deaths in this age-group, in India annually[14]. Diarrhoea - the predominant form of the waterborne disease both in urban and rural India – is estimated to impact on child mortality more than the combined child mortality by the 'Big 3'-HIV/AIDS, tuberculosis, and malaria- (Lopez & Mathers, 2006; Alemu et al., 2013; Venturini et al., 2014;). By this, diarrhoea third most significant cause of death in 'under-five' children - responsible for 13% of this age group's deaths - killing an estimated 300,000 children in India each year[15] (Lakhminarayana & Jayalakhmi, 2015).

One out of nine under-five death in the world is caused by diarrhoea (Centres for Disease Control and Prevention, 2015). One out of every five under-five year child deaths occurs in India (UN Desk, India). As per UN, 'unclean' water is the world's 'second-biggest' killer of children. The unsafe water supply, sanitation, and hygiene service in India attributed 186 deaths in every 1 million population in 2016 (UNDP, 2019). Obviously, urban water supply is a critical issue impacting health and mortality.

Economic burden due to water-borne diseases cannot be ignored in urban India. The estimated annual financial burden of water contamination is about $600 million a year

12 https://www.who.int/water_sanitation_health/diseases-risks/diseases/diarrhoea/en/
13 https://www.un.org/waterforlifedecade/pdf/04_2014_water_and_health_info_brief_eng.pdf
14 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4367049/
15 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4367049/

for India (Reddy et al., 2011). On the other hand, the benefit-cost ratio of investment on water supply and sanitation over South Asia, East Asia and sub-Saharan Africa was 5.5 for sanitation, 2.0 for water supply, and 4.3 for combined sanitation and water supply where benefit included health and savings of time (Hutton, 2013).

The waterborne disease annually has an estimated economic cost of a loss of about 73 million working days globally. However, the totality of socio-economic implications of lack of adequate safe water at household, particularly in terms of opportunity cost of wage foregone, lost gainful activities and impact on girls' education is far more than one can estimate. In the study uneven impact of the burden of water-fetching on adolescent girls and women have been analysed in detail.

The present situation in India calls for a fundamental reassessment for a better water management model (World Bank, 2019). The solution for health and life loss lie in significant policy and program implementations on all three WASH dimensions - water, sanitation and hygiene together (Dutta et al., 2016; Patel et al., 2020). At present, 2.41% of urban households in India, as per NSSO, 76th Round, depend on unprotected wells and springs for their principal sources of drinking water. The figure moves to 1.09% for urban households who have no water provision facilities except surface water. As per finding from the National Sample Survey Organization (NSSO) India Unimproved sanitation is also noticed across 0.25% of urban households in 2018 (For details, Appendix 2).

The public expenditure across the States itself is unequal. Inequity in public spending in towns and cities and the resultant differences in poor and wealthy areas are significant. In terms of consumption, substantial disparity exists within intra- society and across country. The disparity in consumption pattern attributes partly to the uneven availability of the resource.

Globally, water usage across industrialized countries is 30-50 times more than developing countries (UNWWDR, 2003). High-income countries have about 37% more use of domestic water (which is an 11% share of total) than low-income and middle-income countries (which is an 8% share of total) (ibid.).

In this study, inequality to access to water in India is explored through economic and caste groups, location differences and many other factors. The impact of inequalities

to access to amenities is carried forward through generations and has an essential bearing on human development because of their association with opportunity for 'survival, education, and income poverty' (UNDP, 2006). At the end of it water supply and closely linked issues are about human dignity, opportunity and survival. The present studies threw light on some of these issues keeping people at the centre of focus.

1.5 Research Aim and Objectives

Creation, expansion, and maintenance of physical infrastructure in supplying water depend on public policy and resources. Whether inequality can be controlled or will aggravate depends on implementations of policies, management and regulation of water institutions dominated by the public sector because water is predominantly a State subject and a public good.

Given the unfolding water stress with growing water demand and the apparent failure of the public structure with the entry of the non-public and private sector to provide utility services, main objectives of the study were as following.

1. To examine the nature and depth of inequality in the accessibility of modern water arrangement by the public sector;
2. To examine the nature and pattern of public investment on water supply and sanitation as a mode of responsibility for public water provision;
3. To examine the nature and scope of non-governmental effort in delivering services in water supply;
4. To suggest a set of strategies for institutional development linked with development of water supply provision in urban area.

1.6 Research questions

The present Thesis sought to find answers to the following questions.

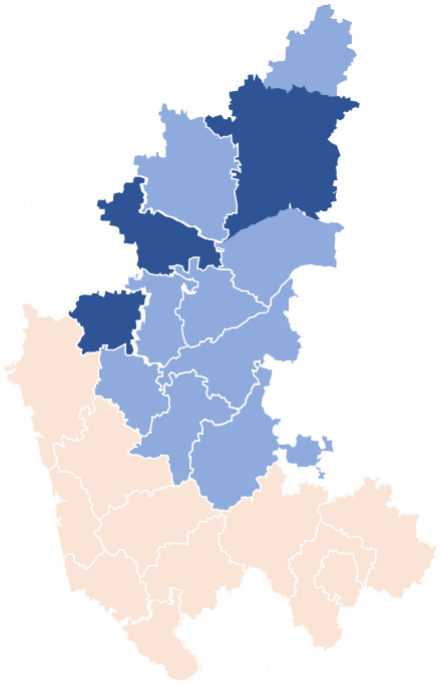
- What is the extent of Inequalities across urban Households in their access to improved drinking water, which is an SDG goal? What explain the Differences and Inequalities across households in access to safe drinking water in urban India?

- What are the Characteristics of Water Poverty in India in terms of Distance to water sources from the Household, Accessibility to piped water and Ownership of water supply facility?
- What are the linkages between Accessibility to Water and Gender Inequality in urban Indian context? What Socio-economic factors influence the uneven burden on Women for arranging water for the urban Household?
- How Indian States' public expenditure worked so far in terms of Accessibility to Improved source of water? What are the other Macro Factors that influence Accessibility to water source across States?
- What is the Nature and Scope of non-Public participation in provision of Drinking Water in India? What are the recent developments?

1.7 Study Area

The study mainly focuses on the urban area of the Indian States. In the study NSSO data from erstwhile State of Jammu and Kashmir have been used. Post 76th round of NSSO, the State was reorganized into two separate Union Territories. No such city-wise analysis has been done in detail. For the case study in Chapter 6, the case study is based on the urban area in Hubli-Dharwad, Gulburga, and Belgaum districts of the inland northern Karnataka region to study public-private participation (PPP) in water supply provision.

Figure 1.1 KUWSSP- PPP in Water Sector: Karnataka



Colour	Description
	PPP in Northern Karnataka Region
	No-PPP in Northern Karnataka Region
	Other Region excluding Northern Karnataka Region

1.8 Data Source & Methodology

The study used the sample study findings of the National Sample Survey Organization under the Ministry of Statistics and Programme Implementation. The study used the unit level data based on seven rounds, namely 44th Round, 49th Round, 54th Round, 58th Round, 65th Round, 69th Round, and 76th Round of NSSO with report numbers 376, 429, 449,489, 535, 556, 584 respectively. The study extensively used the last four above mentioned rounds. The 69th and 76th rounds focus mainly on 'drinking water, sanitation, hygiene and housing conditions in India'. The surveys of various rounds used in this study are comparable to each other (the NSSO rounds 58th, 69th and 76th are comparable to each other). The study used the standard set of questions as in NSSO.

However, the categorization of the response patterns changed across the rounds. For this reason, the study considered categories to be comparable across rounds. The public expenditure analysis of Chapter 5 used data from Finance Accounts by the Ministry of Finance of Government of India and the State Finances by the Reserve

Bank of India. Chapter 6 focused on data provided by the PPP cell of the Ministry of Finance recorded by its Department of Economic Affairs. The case study on the PPP model in Karnataka has been based on the analysis of the 76th Round of NSSO. Following research questions, this study is more quantitative than qualitative in both types of data and research design. The quantitative analysis attempted construction of index and multivariate and bi-variate logistic models. The "Difference in the Differences Model" technique is applied in Chapter 6. This technique helped us identify the PPP-applied region's changes compared to the surrounding non-PPP-experienced region over time points before and after the PPP project were implemented.

1.9 Structure of the study

Access to safe, adequate and affordable water is a human right. Studying, understanding and analysing water supply provided by the public sector is necessary in light of existing law, rights, acts and policies. Chapter 2 of the thesis outlined glimpses of water policies and laws over years in India through different periods – primarily, the first Water Policy adopted in 1987 and subsequent two versions of Water Policy in 2002 and in 2012. Changes in policies have been examined from the angle of inequality to access and institutional complexity. The importance of a Water Regulatory framework has been assessed.

Chapter 3 discussed the nature of existing inequality and inequity in urban water supply due to various factors such as income, social group based on caste, female education and employment, household size, household location and tenant or ownership status, access to sanitation infrastructure etc. The study went into details of piped and non-piped water supply in urban India over recent years. Water adequacy is measured with reported sufficiency through the year and exclusive user right on water facility. Designing "Diversification Indices" the study examined distribution of piped water facilities across urban India over three time points (2002, 2012 and 2018) within each social group of households – (i) general / scheduled caste/ scheduled tribe/ other backward caste; (ii) quintiles of consumption groups in quintiles as per marginal per capita expenditure.

In chapter 3 itself, yet another index – "Specification Index" – was designed to explore distribution of different mode of water source in urban India over the years

2002, 2012 and 2020 across Deciles of consumption group of households. Using the Multivariate Logistic Regression Analysis, the study attempted to measure the impact of critical socio-economic factors on access to piped water facility across urban India in 2018 (NSSO 76th round).

Chapter 4 examined the present condition and depth of Water Poverty in urban India in its various aspects and its relation to gender inequality. The Distance-driven Poverty Index has been designed to measure intensity of poverty across each State. A composite Distance Access Facility index – namely, DAF Index was designed to measure poverty based on three criteria – distance to water source from dwelling, piped water accessibility and user right over water facility. The DAF Index narrated poverty in each State over 2002, 2012 and 2020. In the same chapter, using a Multivariate Logistic Regression the study attempted to identify major socio-economic factors for Gender Inequality in water arrangement across urban households.

Chapter 5 assessed public expenditure pattern in each State on water supply and sanitation from 1990s till recent times as per availability of data. In the first instance, priority of social service in States' expenditure as well as priority of Water and sanitation Services within Social service were examined and average expenditure and variability across States were found out. Pattern of States' investments on operation and maintenance vis-a vis capital investments on creation of water infrastructure were studied in detail over 26 years. The study analysed the growth in both capital and revenue expenditure. Decomposition of revenue expenditure on water supply and sanitation over the same period brought out the importance of Centrally sponsored schemes in the head of revenue expenditure. A Macro-model was designed to assess the impact of Public Expenditure on accessibility of households to piped water service.

The present study considers both aspects of water - as a public good and an economic good. The study organized chapters 3, 4, and 5 based on water's public good characteristics, while chapter 6 deals with water as a pure economic good or semi-public good. In Chapter 6 various forms of participation of non-public (mainly private) sectors in provisioning of drinking water were analysed. The transforming nature of water from a public good to a semi-public good is discussed in the context

of PPP taking the specific case in Karnataka. Institutional arrangements and were looked into.

In chapter 6, “Difference in Differences Regression Model” was used to estimate changes over different time before and after PPP project across PPP and non-PPP regions. That chapter also looks at water's changing characteristic into a pure economic good in urban Indian household. Private sector entry through market mechanism to respond to the failure in public service to provide quality was discussed with analysis of rising usage of water purifier. Separately, commercial provision of bottled water was analysed. In both cases (water purifier and bottled water) dependency of urban households were examined across Deciles of consumption groups as per marginal per capita household expenditure as well as various social groups in different States. Logistic Regression Model was used to determine major socio-economic factors for dependency on bottled water as the principal source of drinking water.

Finally, Chapter 7 reflected on the findings of chapters 2, 3, 4, 5, and 6, and then outlined recommendations for policymaking taking into account SDGs to address various manifestations of inadequacy, inequality and quality of drinking water supply through institutional reforms and budgetary measures.

Chapter 2: Existing Water Laws and Policies on Drinking Water: Institutional Arrangements and Inequality

2.1 Introduction

The United Nations declared in the United Nations Water Conference (UNWC) in 1977, that all people, whatever their stage of development and their social and economic conditions, have the right to access drinking water in quantity and quality, satisfying basic needs. This concern for water was strengthened by conceptualizing '1981-1991 as the 'International Drinking Water Supply and Sanitation Decade' (IDWSSD) of action. This decade started with emphasizing on replacing old with improved technologies for better supply service. The effort was followed by new epoch of liberalization and economic reforms. The 1981-1991 effect led the government to be more attentive in expanding water supply facility especially to the rural area keeping 40 litres per capita per day benchmark.

Investments on drinking water came under attention through schemes like National Drinking Water Mission started in 1986 and later Swajaldhara initiated in 1999. India's first National Water Policy was announced in 1987 during IDWSSD. National Water Policy has been announced and renewed respectively in India in 1987, 2002 and 2012. India also has its National Water Mission as part of eight-fold National Action Plan for Climate Change in 2011.

The Convention of the Rights of the Child in1989 in Article 24 noted Children's right to clean drinking water, among other provisions for health. In 2010, the 'UN General Assembly' recognized the "human right to safe and clean drinking water and sanitation"[16] during the international decade of action "Water for Life" from 2005 to 2015. The United Nations General Assembly announced 2018-2028 as the "International Decade for Action on Water for Sustainable Development" to harness water resources in a sustainable way. Such attempt needed provision of adequate drinking water in a sustainable manner.

16 With a majority of votes at 122 out of 163 UN member States.

Emphasis on sustainability of water resources and India's diminishing per capita availability of water brought drinking water issue and issues on water in general into sharp focus. The average annual water availability per person in India is estimated at 1340 cubic metres in 2024 and expected to reduce to 1140 cubic metres in 2050 (MoWRRDGR, 2018). The per capita availability is depleting over time: 1816 cubic meters and 1545 cubic meters in 2001 and 2011, respectively (ibid.). The following section will analyse in detail existing benchmarks for availability of water.

2.2 Benchmark for Drinking Water Access to Improved Source

Though India had traditionally rich surface water resources, stock needs to get enriched with annual precipitation and replenishment of groundwater. The present climatic change and erratic pattern of rainfall aggravates the existing problem of water resource. Besides, India witnesses fast growing water demands. Urban expansion contributes to this demand in various ways - higher industrial demand from its internal and external needs, added domestic demand due to rise of population and commercial demand due to entertainment and other needs.

Table 2.1 outlines India's estimated water demand as per the Ministry of Water Resource and the Integrated Water Resources Development of National Water Mission. As per the Ministry of Water Resource, economic progress including industrial growth and rise in use of energy, increases water demand. Estimated rise in demand for industrial water will be from 2.1% in 2010 to 4.4 % in 2025. Energy sector accounts for 7.6% of share of water use (from 1.4% in 2010 to 9% in 2025). Share of drinking water is nearly 7% of total water demand, but the component's average annual compound growth rate is estimated as 1.78% during 2010-2025 and 1.35% during 2025-2050 (Table 2.1).

Table 2.1 Projected Water Demand (in BCM[17])									
Purpose of use	Percentage Share to Total								
	MoWR[18]			NCIWRD[19]					
	2010	2025	2050	2010		2025		2050	
				Low	High	Low	High	Low	High
Irrigation	83.3	74.1	78.2	78.5	71.6	72.5	64.5	68.4	83.3
Drinking Water	6.7	7.0	6.1	6.1	7.0	7.4	9.2	9.4	**6.7**
Industry	2.1	4.4	5.3	5.2	8.5	7.9	8.3	6.9	2.1
Energy	1.4	9.0	2.6	2.7	4.0	3.9	6.5	5.9	1.4
Other	6.6	5.5	7.8	7.6	8.9	8.3	11.4	9.4	6.6
Average Annual Compound Growth Rate (%)									
Total Demand	___	1.99 (2010-2025)	1.13 (2025-2050)	_	_	0.8 (2010-2025)	1.2 (2010-2025)	0.9 (2025-2050)	1.4 (2025-2050)
Drinking -Water		1.78	1.35	_	_	3.4	2.5	2	2.4
Basic Source[20]: Basin Planning Directorate, Central Water Commission, XI Plan Document, accessed in Ministry of Statistics and Program Implementation (MoSPI), Government of India, and Report of the Standing Sub-Committee on "Assessment of Availability & requirement of Water for Diverse uses-2000."									

Water requirement for a person per day to maintain hygiene standard, good health and proper sanitation is not easily quantifiable or straightforward. The aggravated demand for drinking water in urban area is mainly driven by expansion of human settlements concentrated mainly in urban pockets.

However, the amount of water required by a household varies widely from country to country, region to region and as par weather changes. Still, standardization of quantity of water requires a number on 'how much'. Clean water as a fundamental right was estimated to be 50 litres per capita per day (lpcd) as the minimal amount to perform all daily requirements and maintain hygiene standards (Gleick, 1996). The minimum recommended amount by WHO is substantially more – 180 to 200 lpcd in urban areas. Except for water-stressed countries, most people in the world use much

17 Billion Cubic Meter
18 Ministry of Water Recourse, Standing sub-Committee.
19 National Commission on Integrated Water Resources Development
20 http://mospi.nic.in/sites/default/files/reports_and_publication/statistical_publication/social_statistics/comp_SECTION%206_16mar16.pdf

more than 50 lpcd (Chan et al., 2016); the lpcd consumption across the developed and developing economies is much higher (like 11 times higher in the USA, 7.5 times in Japan, China 1.6 times). Deprivation of right to adequate water, is a global issue which is rather common in India.

After independence, since 1960s, multiple attempts were made through different frameworks to regulate the quantitative provision of water supply per person. These aimed at providing with guidelines to the service providers - local governments, or para-statal bodies, or independent water agency. Minimum levels of per capita supply as recommended by different authorities vary widely and prominent recommendations are as following.

- Zarkaria Committee (1963): 157.5 to 270 lpcd depending on the urban centres.
- Ministry of Works and Housing (1973): 70 to 200 lpcd
- World Health Organization: 180 to 200 lpcd in all urban centres.
- Master Plan (India), International Drinking Water Supply, and Sanitation Decade (1981): 70 to 250 lpcd with an average of 140 lpcd.
- National Commission on Urbanization (1988): Minimum 70 lpcd and maximum 100 lpcd (for all classes of towns)
- The National Drinking Water Mission (NDWM) in the late 1980s fixed 140 lpcd as the norm.
- Tenth five-year plan: Piped water supply with sewerage: 135 to 150 lpcd; piped water supply without sewerage 70 lpcd; public stand posts in the low-income settlements with a minimum supply of 40 lpcd.

The stipulated norms did not consider factors such as social needs, demographic compositions of different urban centres, climate variance or altitude difference. If factors like age, sex ratio, and people's social habits are taken into account, such norms would have to be revised. Indian cities are supposed to confirm to the standards laid down in the Manual on Water Supply and Treatment by Central Public Health and Environmental Engineering Organisation (CPHEEO) in 1999 supervised by the Ministry of Housing and Urban Affairs. It states that 40 lpcd as a basic requirement for the urban population relying on public standpipes across cities with sewer line where as cities without sewer lines are supposed to be provided 70 lpcd. The Manual maintains that non-metro towns and cities with existing or proposed

sewer lines should receive 135 lpcd and cities with more than 1 million population with existing or proposed sewer lines (such as metropolitan and megacities equipped with sewerage systems) should receive 150 lpcd. In each case, 15% more is added to account for leakages. The basic minimum service level considered for rural water supply is 40 lpcd[21] as per National Rural Drinking Water Programme (NRDWP, 2010) guidelines. The biggest concern is that most cities do not achieve the quantum of water according to per capita norms.

The Ministry of Urban Development carries responsibility for urban water supply and sanitation activities for setting standards and accordance between states. The water supply's residential limit has been assigned to between 70 to 100 lpcd for urban communities' domestic needs[22], apart from non-domestic needs such as flushing requirements (BIS[23], 2010). The following table (Table 2.2) presents a quick glance on the existing water situation in urban India given the above discussed provisioning norms and standards.

Table 2.2 Overview of Urban Water Supply, India, 2010

Indicator	Benchmark	Average
Coverage of Water Supply connections (%)	100	50
Per Capita Supply of Water (lpcd)	135	69.2
Extent of Non-revenue Water (%)	15	33
Extent of Metering (%)	100	13
Continuity of Water supplied (in hours)	24	3.1
Quality of Water Supplied (%)	100	82
Lpcd: litres per capita per day; Sample Size: 1400 cities		
Source[24]: Ministry of Urban Development, 2010		

[21] As per Government of India norms, 40 litres are divided into: 3 for drinking; 5 for cooking; 15 for bathing; 7 for washing utensils & house; and 10 for ablution

[22] The limits extend to 100 to 150 lpcd for urban communities with 20,000 to 100,000 together with a full flushing system and 150 to 200 lpcd for communities with a population above 100,000 together flushing system. Such a requirement is based on the assumption of 45 lpcd for flushing requirements.

[23] Bureau of Indian Standards; retrieved in https://law.resource.org/pub/in/bis/S03/is.1172.1993.html

[24] Urban Water Supply and Sanitation in India by Indian Institute for Human Settlements at http://iihs.co.in/knowledge-gateway/wp-content/uploads/2015/08/RF-WATSAN_reduced_sized.pdf

This section requires an ideal complementation with a short review on Indian water laws. How much support the benchmark standard could be applicable links with the existing legislative framework.

2.3 Drinking Water - Laws and Policies

The first consumer-centric water law in British India was the Easements Act of 1882. This law empowered the landowner to access groundwater beneath it. This law was not intended to benefit the citizens by securing drinking water to them. It was for the benefit of Zamindars - those who were assigned large chunk of land by the Colonial Administration. Still, the provision led indirectly to access to drinking water through the tube well or other sources. The law relating to surface water essentially empowered users' right to the landowners or Zaminders. From the citizens' point of view, there was no assurance, no care, or provision from the government. The Regulation of Water Act, 1949, reasserted that all sorts of rights on the water or any natural supply source shall vest in the provincial Government.

The State ownership on surface water vested since the Government of India Act, 1935 shifted peoples' reliance more on groundwater. While public tube wells or hand pumps were the primary reliance for the urban poor, the relatively affluent urban population depended on privately arranged tube well or hand pumps in many cases.

The Environment Protection Act (1986) envisaged development and management of groundwater resources on which more than 50% of Indian households depended for drinking. The following year, the National Water Policy was announced with a focus on water resources development and conservation. The policy prioritized drinking water before irrigation, hydro-power, navigation and industrial and other uses. For the first time in Indian history, drinking water was declared the first privileged purpose of use.

2.3.1 Water Laws and Policies for Access

Inequality is measured mainly by disparity in access. The gap can be bridged either by demand management practices or continuing the traditional supply-driven approach or both. The supply can be strengthened by addressing to the need of expansion of network and systemic bottlenecks like leakage, repair and overhaul of dysfunctional systems. The other management method is demand regulation and

control by tightening over-usage, preventing wastage and enforcing sustainable techniques (Gupta, 2008; Vaidyanathan, 2014; Majumder, 2015; Tortajada et al., 2019; Mishra et al., 2020). The tool for this approach is metering for proportional pricing or increasing the slab for fixed incremental block pricing. In this 'demand-driven' approach, the focus is on the demand, which determines the nature and volume of supply for sustainability of supply.

It is the National Water Policy 2002 that first mentioned the principle of equity while discussing on pricing of water. NWP 2012 admitted the problems regarding the availability of safe water for domestic uses. The policy also referred to the possibility of social discontent or dissatisfaction from inequality in availability of water across regions and different sections of society. The policy mentions about the unreliability and intermittency of public water supply system.

Equity in water and sanitation services means that charges are designed to treat similar customers equally and that customers in different situations are not treated in the same way[25]. Every consumer is not equally capable of paying charges due to economic disparity especially in the developing world. Therefore, subsidized water arrangement is critical for service providers dealing with marginalized segments.

Any subsidized system must ensure adequate water for sustenance of disadvantaged section and affordable connection of water up to dwelling unit. Subsidy can lead to wastage and therefore, there must be in-built safeguard to discourage wastage and progressive pricing for high consumption. An example is irrigation, where subsidized electricity led to massive water extraction in the field, often disproportionate to needs (Niti Aayog[26], 2018).

In urban India, where poor and rich live side by side and where planned and unplanned settlement are located next to each other, it is extremely challenging to design system with progressive and differential pricing. Progressive pricing often leads to cross subsidy, which is opposed by the elite.

25 http://mohua.gov.in/upload/uploadfiles/files/TERI_UC_Report26.pdf

[26] National Institution for Transforming India (NITI) Aayog is most important 'think tank' of Government of India where stakeholders from all States, Union Governments and Central government in terms of providing both assistance and inputs of policies.

The NWP 2012 drew attention to the requirements of potable water with a minimum quantity of safe water necessary for health and hygiene of people. On the distance to cover for collecting drinking water, NWP 2012 only mentioned the need of "easy reach of the household". NWP 2012 understated the burden, sacrifice and loss of opportunities by women in arranging of water for their household.

India's National Water Mission emphasized on water equity through the introduction of concept on Integrated Water Resource Management. The Integrated Water Resource Management envisaged actions on promoting water efficiency and conservation of this resource. Such an approach benefits the availability of drinking water for all sections of society.

AMRUT, Swachh Bharat Mission, Jal Jeevan Mission are the directly focused schemes for drinking water provision across diversified regions of rural and urban India. These schemes address regional inequality among States. These initiatives encompass programme in schools and Anganwari centres.

Some works on water sector in India showed that market-based systems may bring in efficiency and transparency but they cannot always ensure equity and sustainability in access to water (Brown & Ingram, 1987; Dinar, et al., 1997).

2.3.2 Water Laws and Inequality

The SDG 6 called for “affordable” and adequate water for all. The inclusion of affordability into this Goal clearly expresses that the concept of water as ‘pure public’ and ‘free’ good is changing. The NWP 2002 recommended differential pricing as response to call for affordable drinking water considered in SDG 6.1 in 2000. Commercially viable services and the support of rational tariffs/ prices often enhance the efficiency gains that benefit the customers more than subsidies (Gupta, 2011).

It was the Ninth 5-year Plan during 1997-2002, which first recognized water (water as a whole; not only drinking water) as an economic good beyond its identity as a social good so far. Following such transformative signal, the NWP 2002 introduced the concept of fair pricing of domestic water. The NWP 2012 has continued emphasizing “affordability” of water. The NWP 2012 mentioned about an equity-sensitive fair pricing of water. The objective was to ensure water on pre-emptive uses to all. The

NWP 2012 reaffirmed the priority of “safe water for drinking and sanitation” as pre-emptive needs and “high priority” allocations. Gender and school focused Jal Jeevan Mission, Nal pe Jal for all India, rural centric Har Ghar pe Jal are the Central Government’s initiative reflecting NWP 2012.

A minimum quantity of safe water should be linked to household sizes, geographical location and availability of water. With low per capita income, Indian drinking water service has to be designed with subsidization by government – preferably targeted subsidization. Admittedly, targeted subsidization is difficult to implement in India because of variety of reasons, including (i) distributed settlements of marginalized sections across urban areas, (ii) poverty in certain households, which cannot pay even after heavy subsidy, (iii) will require metered connection for volumetric control, given the increasing water stress. Significant subsidization often led to irresponsibly high use of water. Unfortunately, public awareness seems to be the only practical means to address this. The present initiative of 'Har Ghar pe Jal' is in the right direction because piped water connection to (rural) households will enable equity and targeted subsidy, if the Authority decides so in future.

2.4 Water Policy and Institutional Framework

Subsequent to international recognition of water as a human right and NWP 2012, water supply and sanitation received high attention by the Centre and the States. Pressure to achieve MDG by 2015 also played its part. The State initiatives were supported by higher devolution of resources from Centre to States through financing of schemes. Following the legacy of JNNURM, which was limited to 63 cities, drinking water has been the priority in the centrally sponsored schemes in urban India. From 2012 onwards, drinking water and sanitation were prime concern in the National water and sanitation centric programs like AMRUT, Swachh Bharat Mission, Jal Jeevan Mission. Central schemes are playing the role of 'big push' to drinking water services of India to achieve full coverage and equity of access. Since 1987, the National Water Policy indicated the need for valuation of water. To understand the implications of water wastage, usage pattern and economize the usages, imputed value of water must be taken into account. However, the NWP 2002 envisaged pricing of water (as a general, not necessarily drinking water) which should be under the regulatory control. NWP 2002 suggested fair pricing under the principle

of equity. The NWP 2012 reiterated the principle of differential pricing for water and sanitation keeping in mind access and equity.

Though the objective of cost recovery is included in the service provision of water supply across countries to achieve sustainability, in the developing world goal of universal access to improved water and equity take clear precedence. It is challenging to introduce a differential tariff structure to achieve objectives of economic efficiency, equity, affordability and supplement to public budget together (Singh et al., 2005). Such a challenge further intensifies in a water-stressed country like India where there is great geographical diversity and differences in water usages (Shiao et al, 2015). Demand management by volume-based pricing seems necessary to ensure responsible use and adequate water resources for universal access.

Table 2.3 provides consumption group-wise information on metered connections across urban households from the 76th round of NSSO. Out of all urban households covered by tapped water, only 19.9% of households are having metered connection. A cross-section intra-consumption group analysis across the households with piped connections within dwellings or premises indicates that each of the lower deciles of consumption groups has over 40% non-metered connections. Situation in the top 4 Decile consumption groups is even worse, because 47% to 50% of their connections are non-metered. Tapped water being subsidized, its benefits are being disproportionately reaped by high consumption groups.

Simultaneously, the existing water pricing structure reveals that there is not much significant difference between the lowest or highest decile consumption groups. About 27.7%, 40.3%, and 45.4% households, respectively, from 3 highest deciles consumption groups reap the benefit of paying water charge as low as less than Indian Rupees (INR) 100 per month. This analysis helps us to reconfirm the innate inequality across urban households on even when public water is supplied through meters.

Table 2.3 Urban Households having Principal piped water Source into dwelling/ plot and Water Charges

MPCE Decile (1= lowest; 10 = highest MPCE)	% of Households Non-Metered Connection	% of Households Metered Connection	Distribution of Monthly Water Charges (in INR) across Households connected with Piped Water into Dwelling or Yard			
			<100	>100<=200	>200<=500	>500
1	39.5	5.2	59.4	27.1	12.4	1.1
2	40.5	5.3	59	28.3	11	1.7
3	42.7	9.4	55.2	28.9	13.4	2.6
4	44.6	7.4	60	27.8	10.1	2.2
5	45.7	13.3	52.8	29.5	14.3	3.4
6	47.6	13.5	51.8	29.6	15.7	2.9
7	48.1	16.1	47.3	32.2	16.5	4
8	47.2	18.6	45.4	32.7	17.2	4.7
9	50.2	22.2	40.3	31.6	22.5	5.6
10	48.7	29.8	27.7	31.3	31	10
Urban India	47.6	19.9	41.1	31.1	21.8	6

Source: NSSO, 76th Round, 2018

2.4.1 Institutional Arrangement and Public provision

The existing institutional framework across public water utilities in urban India is complex and continuation of colonial system. Constitution of India has delegated the responsibilities of water provisioning to the States. Within their competence States follow their traditional practices. States follow their distinct feature in servicing bodies' existing structure, urban local bodies like municipal corporations, municipalities, municipal councils in an urban area, and Zilla Panchayats, Mandal, or taluka panchayats, gram panchayats in the rural area. The following table (Table 2.4) provides glimpses of diverse institutional arrangements in supply of water.

Table 2.4 Water Supply & Sewerage Provisioning Arrangements across States

State	Capital Works	O & M	Revenue Functions
Andhra Pradesh	PHED	M.B.	M.B.
Bihar	PHED	PHED	M.B.
Chhattisgarh	PHED	PHED	M.B.
Gujarat (Except big cities like Ahmedabad)	GWSSB, M.B.	M.B.	M.B.
Himachal Pradesh	PHED	PHED	M.B.
Karnataka	GWSSB, KUWSSB, M.B.	M.B.	M.B.
Kerala	KWA	KWA	KWA
Madhya Pradesh	PHED, M.B.	M.B.	M.B.
Maharashtra	M.J.P.,M.B.	M.B.	M.B.
Orissa	PHED	PHED	PHED
Rajasthan	PHED	PHED	PHED
Uttar Pradesh	Jal Nigam, M.B.	Jal Sans than, M.B.	Jal Sans than, M.B.
City & Institution	Capital Works	O & M	Revenue Functions
Ahmedabad (Ahmedabad Municipal Corporation)	PHED	AMC	AMC
Raipur (Raipur Municipal Corporation)	RMC	RMC	RMC
Chennai (CMWSSB)	CMWSSB	CMWSSB	CMWSSB (tariff approved by State)
Hyderabad (HMWSSB)	HMWSSB	HMWSSB	HMWSSB
Bangalore (BWSSB)	BWSSB	BWSSB	BWSSB
Delhi: Delhi Jal Board (DJB) (Bulk Supplier to others two)	DJB	DJB	DJB*
New Delhi Municipal Council (NDMC)	NDMC	NDMC	NDMC
Delhi Cantonment Board (DJB)	DJB	DJB	DJB

Source: assembled;

Abbreviation list-

M.B.	Municipal Bodies
M.J.P.	Maharashtra Jeevan Pradhikaran
O & M	Operation and Maintenances
PHED	Public Health Engineering Department
BWSSB	BANGALORE Water Supply and Sewerage Board
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
HMWSSB	Hyderabad Metropolitan Water Supply and Sewerage Board
GWSSB	Gujarat Water Supply and Sewerage Board
KUWSSB	Karnataka Urban Water Supply and Drainage Board
KWA	Kerala Water Authority

*Price approved by elected representatives by State governments

The parastatal body PHED is given the full responsibility of water supply and revenue collection in States like Orissa, Rajasthan. PHED holds partial responsibilities with municipal bodies in States like Bihar, Andhra Pradesh, Chhattisgarh and Himachal Pradesh. There is complex structure of disbursement of responsibilities within city service delivery. Different parts of cities are linked with different service providers. Delhi, the capital city of India, is a good example on this. There are several cities where water supply, sewerage is delivered by water board. Responsibilities of capital, operational works along with revenue collection entirely are on these boards. Since there is no single structure, the different styles of management, inter-conflicts are the problems. Heterogeneous institutional arrangements need to be integrated as the first strategy besides others (Narain, 2000).

The Central government also participates into this service in an indirect manner. The federal government was entitled since colonial era, to legislate on specific issues like shipping, navigation, inter-State use of water[27] and management & conservation of entire water resources, retention of environmental quality and, most importantly, inter-State disputes through the Inter-State Dispute Act of 1956. The central government institutional structure of water supply service is divisible among more than one ministries of central government directly (Table 2.5). The distributed responsibilities rest with the Central Water Commission and Central Ground Water Board, Ministry of Environment and Forests, National River Conservation through Central Pollution Control Board, Ministry of Urban Development through the Central Public Health Environmental Organization, Ministry of Health and Family Welfare.

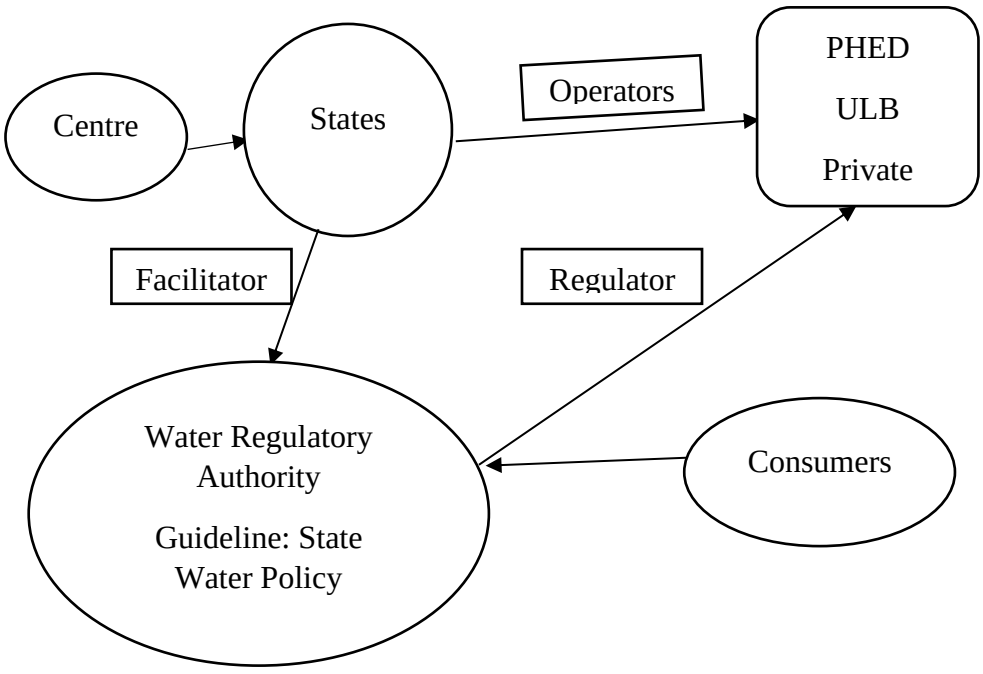
The Constitutional Amendment Act, 1992, at the macro level, was the devolution of responsibilities in form of 18 added functions to third tier Governments (For details, refer to Appendix 3). These added responsibilities enhance the demand for substantial finance for which the local government were not ready with self-generated resource strength. In the arena of drinking water supply, States still overpowers the third-tier governments.

27 Schedule 7; Constitution of India, 1947

Table2.5 Central Ministries Directly involved in Water Supply & Sewerage Provisioning Arrangements			
Central	Responsibility	Responsibility	Achievement
Ministry of Jal Shakti[28]	On State Governments/ Union Territories	Technical guidance, scrutiny, clearance and monitoring of the irrigation, flood control and multi-purpose projects	Initiation of the National Water Policy of 1987, 2002 and 2012
Ministry of Housing and Urban Affairs	On State Governments/ Union Territories	formulation of broad policies and programs in water supply and sanitation sector, and financing	Initiation of the National Urban Policy including the 74th Constitutional Amendment Act of 1992
Source: Formed			

The NWP 2002 envisaged water resource management and development with community involvement as a key factor for better water supply framework. The NWP 2012 proposed community participation inclusive of all stakeholders.

Figure 2.1 New Model on Institutional Arrangements



28 Formed in 2019 by merging Ministry of Water Resources, River Development & Ganga Rejuvenation and Ministry of Drinking Water and Sanitation

In this respect, the policy is closer to the global trend. NWP 2012 suggested creation of neutral regulatory authority to oversee over multiplex institutions and also the water pricing mechanism. Regulatory authority should be protected by appropriate legislations of the State. The model on emergence of water regulatory authority based on each State's water policy is depicted in the following diagram (Figure 2.1).

Along with appropriate water budgeting to ensure universal access to safe drinking water, States are required to adopt water policies for the agriculture, industry and domestic sector. As India is facing problems in the water stress zones, a justified allocation for these three distinct sectors is essential.

2.4.2 Institutional Arrangement for non-Public Provision

The NWP 2012 opened up the possibility of private sector participation in water provisioning and water delivery. For better provisioning of water supply in urban sector, the NWP 2002 explicitly proposed private sector participation with State Governments and other urban local bodies. The NWP 2002 advised consideration of PPP model based on Build-Own-Operate. It also proposed leasing of water resources. The NWP 2012 observed that a PPP should be formed on sustainable and pro-poor basis. NWP 2012 suggested penalty charges in case of failure of PPP and full accountability of PPP to all stakeholders. It also calls for regulatory control by the nodal bodies on water prices as well as on service standards.

2.5 Conclusion

National Water Policies 1987, 2002 and 2012 outlined general policies on water including drinking water. Drinking water has always enjoyed priority in India’s water policies. There is no comprehensive drinking water specific law in India for provisioning of adequate, equitable and safe drinking water. Also India lacks a robust regulatory system to regulate drinking water sector.

Delivery of drinking water in India is a subject under the State and executed by the third tier of government. The administrative, legal and financial arrangements for water supply are multi-tiered and extremely complex. Though India is party to SDG, present scenario in access to safe and adequate drinking water is not very encouraging. States do not have enough resources to substantially increase allocation on water supply and related infrastructure as well as maintenance. Metered

connections in urban India are limited. At any rate, benefit from the subsidized provision of water supply is disproportionately enjoyed by richer sections of urban households.

Chapter 3: Water Accessibility and Inequality in India

3.1 Provisioning Standard and Overview of Inequality in access to improved source of Drinking Water

In the previous chapter the study has gone through the evolution of Indian laws and policies on drinking water and the progress of the concept of right to water. Right to drinking water covers domestic usage including drinking, cooking, preparation of food and use for personal hygiene (JMP, 2017b).

We will see in this study that India is progressing well in covering more population with access to improved water source. There are different sources of improved water in India - piped water, hand pump, tube well, protected well, unprotected well, mobile water tanks, and other surface water sources. Out of these, piped water is least vulnerable to contamination. As a thumb rule, access to piped water has been considered as access to the most improved source of drinking water. Piped water requires extensive physical infrastructure. Such infrastructure and its operation and maintenance are responsibility of service provider – whether public or private (WHO, 2000).

Out of the poorest quartile of India's urban population 82% do not have access to piped water and 53% do not have sanitary flush or pit toilet access in major cities of India (Agarwal, 2011). Out of piped water dependent urban households, as per Census of India, 2011, only 54.1% have within premises facility, 13.2% near premises facility and 3.3 % from away piped sources. India's fundamental disparity in drinking water service is mainly between the richest and the poorest quintile. The disparity is not as much when we compare accessibility differences between urban and rural areas (JMP, 2019). The study of disparity across urban households in access to water supply is the focus area of this chapter.

The present public policy on water focuses on accessibility coverage through potable piped water. Though the public policies encourage widening of the number of water points, quality of water through those points and inequality in quantity remain our challenges (Water Aid, 2005). Piped water requires substantial investment to lay down the network and is government subsidized. Public investment in piped water infrastructure is practiced as a policy all over the world. Targeted subsidization in

water supply is an applied policy tool across developing countries. Such policy has a positive impact on equity and socio-economic well-being of the marginalized sections (Komives et al., 2005 & 2008). Public funds spent on water and sanitation often flows disproportionately to the non-poor, contrary to government intention and stated policy (Banerjee et al, 2008). Despite high subsidization through grants and capital-intensive projects financing on public water supply system in India's urban area, the system is not significantly biased towards the households from lower consumption groups (Kundu, 1991). Citing huge financial gap, questions were raised if India would achieve MDG goal on water supply and sanitation in the urban area. it was also observed that progress towards MDG had not been pro-poor (Water Aid, 2005). Poor urban population ends up paying disproportionately for water due to failure in appropriate targeting. Water supply and sanitation - these two services are closely considered as a single composite. India's urban sanitation service also faces vertical and horizontal inequalities, as borne out from NSSO 2012 (Bhol, 2017). Exclusion of the poor from the urban infrastructure is a factor that impedes urban economic growth (Dreze & Sen,1999; Démurger, 2001).

Understanding inequality and inequity are crucial to public policy on water supply and related transfer of resources for the service. The chapter analyses present water supply scenario in urban India from equity and inequality angles. The intra-urban disparity is studied through two micro parameters - consumption group and social group. For the first parameter, household's marginal per capita expenditure is used as proxy for income vis-à-vis consumption affordable to that household. The second one is the social group which is a derived outcome of the households' caste system and socio-economic backwardness. The Indian caste system is embedded in the basic principles of hierarchy and categorized as 'pure' and 'impure' in social interaction and everyday activities (Dumont, 1980). The study from social group inequality angle is in accordance with SDG 8, which emphasizes inclusivity as the foundation of economic growth. Therefore, social group consideration in existing water supply setting is appropriate and very much relevant in Indian context.

This chapter discusses standardized norms related to water supply for domestic purpose, present status of accessibility of drinking water in urban India and focuses on the differential issues regarding inequality of accessibility. The inequality issues are analysed through a cross-section of households as per different consumption

expenditure and social group, piped water accessibility, water adequacy and in-premise provision of water. The chapter considers water for drinking purposes. This chapter ends with identifying socio-economic factors for existing disparity in drinking water accessibility across urban households.

3.2 Existing Situation vis-a-vis Benchmarks

Water is under-supplied across urban areas of India. A study by the Indian Institute of Human Settlement on Service Label Benchmark indicators for water supply based on data from 1400 cities clearly illustrates that cities receive only 69 lpcd instead of the norm of 135 lpcd (Table 2.2). Some larger cities like Delhi provide supply substantially above the norm (Narain, 2012a). Another extreme example is city of Mumbai, where Narain (2012b) estimated 46% of population use 95% of the water since 54% of population officially live in slums and consumes only about 5% of supplied water. But these high averages in quantity does not reveal huge equities within the system as the affluent area gets significantly higher supply than average (Water Aid, 2005). In addition to inadequate quantity, the water supply in almost all cities is intermittent and often of questionable quality (Shaban & Sharma, 2007; Narain, 2012a). Almost no city in India provides 24-hour water supply. A four-to-five-hour water supply in a day seems to be the norm (McKenzie & Ray, 2009; Narain, 2012a). General picture across urban areas is underachievement in quantity and quality of water supply. However, for post-MDG monitoring, the WASHCost countries have been given recommended to work on contain norms. The target to India is for 40lpcd of acceptable quality from improved sources (Moriarty et al., 2011).

In India, the drinking water quality standard is provided by BIS. A water source free from physical, chemical, bacteriological and biological contamination and following the Bureau of Indian Standards (BIS) satisfies the norm on quality. The broad definition by WHO and UNICEF in JMP considers water supply ‘safe’ when sources and transmission are free from the possible faecal-oral disease contamination (JMP, 2017b). Indian cities grapple with the problem of quality of water. As per the Government of India norms, improved and protected water sources refer to a household connection, public stand pipe, tube well, safe borehole (not irrigation pumps), protected (dug) wells or spring, and rainwater collection. In contrast,

unimproved sources include vendors, carts, tankers, unprotected (dug) wells and springs, surface water (river, dam, lake, pond, stream, canal, irrigation channels), and bottled water. Bottled drinking water is not considered a satisfactory source because of its high unit costs and, therefore, usually is not an option for poorer people. Norms on water quality merits review as per scientific evidence and standards and be enforced. Intermittency, disruptions, leakages, non-accounted water- are various areas relating problems and issues whose nature, degree and intensity vary across cities.

3.3 Various Sources of Drinking Water

The scope of the study is water accessibility through piped network. Therefore, access to alternative sources of piped water is examined to understand the disparity between the piped and non-piped water access across households. There is some informal arrangement of water supply which includes alternative water delivery mechanisms and practices, mostly unregulated by the state[29] (Burt & Ray, 2014). The analysis considers dependence across urban households of India on different sources of drinking water to compare the piped and non-piped accessibility using 76th Round, NSSO conducted in 2018[30].

Table 3.1 presents the status of dependence on different drinking water sources across urban households. About 1.49% of urban households rely on surface sources. Surface water includes sources like protected or unprotected spring, rainwater collection, pond, tank, river, dam, stream, canal, lake, cart with small tank or drum and others. In contrast, tube well and hand pump are the resort to about 18.93% and wells among 5.32% of urban households. In recent times bottled water has come up as a major source of drinking water catering to 8.99% of urban households.

About 6.96% urban households depend on public tap in urban India. Approximately, 24.25% of urban households depend for drinking water on groundwater sources like hand pump or tube well, on which restrictions are imposed to preserve ground water level[31]. The urban dependence on groundwater is relatively less than that in rural India (58.49% rural households and 44.07% Indian households). The 24.25% signifies that

[29] http://www.water-alternatives.org/index.php/alldoc/articles/vol7/v7issue1/236-a7-1-7/file
[30] based on a primary survey of 43,102 urban households (and 63,736 rural households)
31 The No Objection Certificate will be given to domestic users with less than 1-inch diameter delivery pipe.

almost one out of every four urban households depend on ground water like hand pump, tube well or protected/unprotected well.

Table 3.1 Present Situation of Drinking Water Dependence Across Urban Households, 2018

State	Bottled	Piped Water (into yard, into dwelling, from neighbour)	Public tap/stand pipe	Tube well/Hand Pump	Well (protected and unprotected)	Tanker (public and private) including cart with small tanks, drums etc.
Non-special Category States						
Andhra Pradesh	2.11	20.26	5.04	21.32	1.33	1.20
Bihar	6.05	19.67	1.46	72.83	0.00	0.00
Chhattisgarh	0.13	45.45	9.48	41.61	3.2	0.00
Goa	3.33	11.66	0.00	0.00	0.83	0.00
Gujarat	9.77	79.8	2.77	7.33	0.16	0.04
Jharkhand	5.10	30.47	10.3	43.52	10.5	0.00
Haryana	11.05	74.41	1.54	12.29	0.00	0.72
Karnataka	24.72	58.06	6.63	6.13	3.79	0.66
Kerala	1.00	25.48	2.13	6.03	65.31	0.06
Madhya Pradesh	29.49	45.76	14.08	8.47	0.07	2.00
Maharashtra	2.80	88.80	2.37	3.99	1.34	0.67
Odisha	0.00	38.67	15.63	39.12	6.59	0.00
Punjab	0.09	74.26	0.35	25.30	0.00	0.00
Rajasthan	3.93	83.40	2.10	6.31	0.59	0.65
Tamil Nadu	21.95	46.78	17.35	8.86	1.27	3.73
Telangana	33.65	38.84	4.99	2.67	0.07	0.55
Uttar Pradesh	8.57	44.69	2.53	43.68	0.22	0.27
West Bengal	7.05	39.65	25.05	26	0.50	0.60
Special Category States						
Arunachal Pradesh	0.00	89.84	0.26	8.07	1.30	0.00
Assam	1.74	24.07	1.74	62.73	7.64	0.35
Himachal Pradesh	0.64	88.78	2.88	4.48	0.32	0.32
Jammu& Kashmir	0.00	81.19	3.34	7.11	1.39	1.11
Manipur	2.5	41.67	11.67	0.10	7.40	10.84
Meghalaya	0.23	57.86	11.11	3.01	9.03	6.94
Mizoram	0.00	93.5	5.17	0.00	0.17	0.00
Nagaland	0.00	34.17	1.11	10.56	34.44	0.00
Sikkim	0.00	91.67	0.00	0.00	0.00	0.00
Tripura	0.00	44.71	6.19	45.49	3.04	0.00
Uttarakhand	0.00	83.06	0.28	11.11	0.00	0.00
Urban India	8.99	58.31	6.96	18.93	5.32	1.49
Rural India	4.00	25.2	10.35	49.64	8.85	1.96
All India	6.8	38.55	8.98	37.34	6.73	1.60
Source: 76th Round, NSSO						

Ground water dependence across rural household in 2018 is about 2.45 times higher than that across urban households. As expected, urban household's direct dependency on direct surface water usage is comparatively less (1.49%).

The study also looks into performances of both special as well as non-special category States. The special category States concept was initiated since the 5th Finance Commission of India in 1969 (Gadgil formula) taking into account non-viable state finance, low per capita income, economic and infrastructural backwardness, location, population density and certain other indices. Though the categorization was done away with in the 14th Finance Commission, the present study follows the classification to understand the situation of water supply. The study follows the Reserve Bank of India's categorization[32] of States as 18 non-special category States and 11 special category States.

3.4 Piped Water in Urban India – An Analysis

3.4.1 Inter-temporal Changes in Coverage by Piped Water

Here we will examine overtime expansion of piped water accessibility. The inter-temporal analysis captures public sector's efficiency and accountability towards improving the piped system from a non-piped one.

Table 3.2 considers 5 NSSO rounds covering the time period from 1993 to 2018, i.e., up to 25 years across urban India. The table describes the inter-temporal changes across urban part of sub-Nationals in India. The point to notice is the growth of piped water accessibility is not equally spread over all States. The States which witnessed noticeable increase in the level of urban accessibility of piped water is Goa, Madhya Pradesh and Punjab. States like Bihar, West Bengal, Rajasthan, Maharashtra, and Orissa among the non-Special category States have seen comparatively modest growth in piped water supply network.

32 https://www.rbi.org.in/scripts/PublicationsView.aspx?id=12090

Table 3.2 Availability of Tapped/Piped* water for drinking by Urban Households across the Indian States: As Per NSSO Rounds							
States	Rounds with Years					Annual Compound Growth (%)	
	49th, 1993	58th , 2002	65th , 2009	69th , 2012	76th , 2018	During 2018-1993	During 2018-2009
Non-special Category States							
Andhra Pradesh	74.4	78.33	75.4	74.1	60.2	-0.8	-2.5
Bihar	14.1	28.5	29	11.4	19.9	1.4	-4.1
Chhattisgarh	_	64.37	60.5	74.6	65.9		1.0
Goa	89.9	83.64	87.7	99.6	96.7	0.3	1.1
Gujarat	85.4	91.7	83.8	81.2	78.8	-0.3	-0.7
Jharkhand	_	57.67	49.1	39.3	49.2		0.0
Haryana	81.8	77.26	76.9	80.9	78.4	-0.2	0.2
Karnataka	74.8	88.49	91.3	76.2	60.9	-0.8	-4.4
Kerala	40.3	42.61	41.6	44.8	27.8	-1.5	-4.4
Madhya Pradesh	66.2	63.69	66.8	64.3	75.1	0.5	1.3
Maharashtra	90.9	91.73	88.9	89.8	91.7	0.0	0.3
Odisha	48	55.41	63.6	64.3	49.9	0.2	-2.7
Punjab	67.6	78.4	82.1	69	77.1	0.5	-0.7
Rajasthan	83.7	84.91	86.6	79.4	87	0.2	0.1
Tamil Nadu	67.1	83.3	81.4	71.6	59	-0.5	-3.5
Uttar Pradesh	54.1	48.67	47.3	37.7	46.4	-0.6	-0.2
West Bengal	61	59.6	70.4	65.4	64.6	0.2	-1.0
Special Category States							
Arunachal Pradesh	100	90.21	87.2	89.1	83.7	-0.7	-0.5
Assam	43.6	35.66	36.6	22	32.7	-1.1	-1.2
Himachal Pradesh	95.4	95.72	88.5	94.3	92.1	-0.1	0.4
Jammu & Kashmir	92.5	94.35	90.9	91	83.4	-0.4	-1.0
Manipur	68.4	63.43	65.6	63.9	58	-0.7	-1.4
Meghalaya	85.4	88.78	95.6	87.9	72	-0.7	-3.1
Mizoram	32.8	59.93	72	91.5	99.1	4.5	3.6
Nagaland	81.4	57.8	25.7	52.6	45.1	-2.3	6.4
Sikkim	97.7	99.25	98.2	98.8	92.7	-0.2	-0.6
Tripura	66.8	83.3	60.6	56.3	52.9	-0.9	-1.5
Uttarakhand	_	79.77	75	84.1	78.8		0.6
Urban India	70.4	73.65	74.3	69.1	65.27	-0.3	-1.4
Source: Various NSSOs Rounds; * including public tap							

A noticeable number of States have experienced a decrease in coverage of accessibility to piped water over last two decades. During this period (from 2002 to 2018), urban households in some non-special category States non-piped water replaced piped water as principal source of drinking water. A substantial part of urban household switched to bottled water or packed water. Bottled water as principal drinking water source is coming up fast in urban areas in the last decade. This study has analysed bottled water source in Chapter 6 while discussing public-private participation in the water sector. Significant depletion of piped water as a principal source for drinking in the household sector was noticed in 11 special category States except for Mizoram, Nagaland and Assam.

One of the major reasons for bottled water dependence is that at the point of consumption, consumers do not trust the quality standard of drinking water. While there could be genuine concerns on quality, exact depth and extent of problems of water quality across urban India is not known.

The States having a relatively better existing framework of piped connections are Goa and Maharashtra. In Goa, piped water accessibility across urban households is 96.7%. In Maharashtra 91.7% urban households are covered by piped water (Table 3.2). In Gujarat, Karnataka, about six urban households are without piped connections out of every 30 households. The situation worsens in states like Tamil Nadu, Telangana, Rajasthan and Punjab. It further worsens to the level of severity in Madhya Pradesh, Haryana, and Chhattisgarh. The states who have underachieved piped connection to households are Jharkhand, Kerala, Odisha, Uttar Pradesh, and West Bengal among non-special category States.

Maps through Figure 3.1 and Figure 3.2 highlight the intensity of changes on piped water accessibility across urban India during last decade - respectively in 2009 and 2018 for comparison. Sharp changes over a decade in many places are evident.

Figure 3.1 Piped Water Coverage in Urban India, 2009

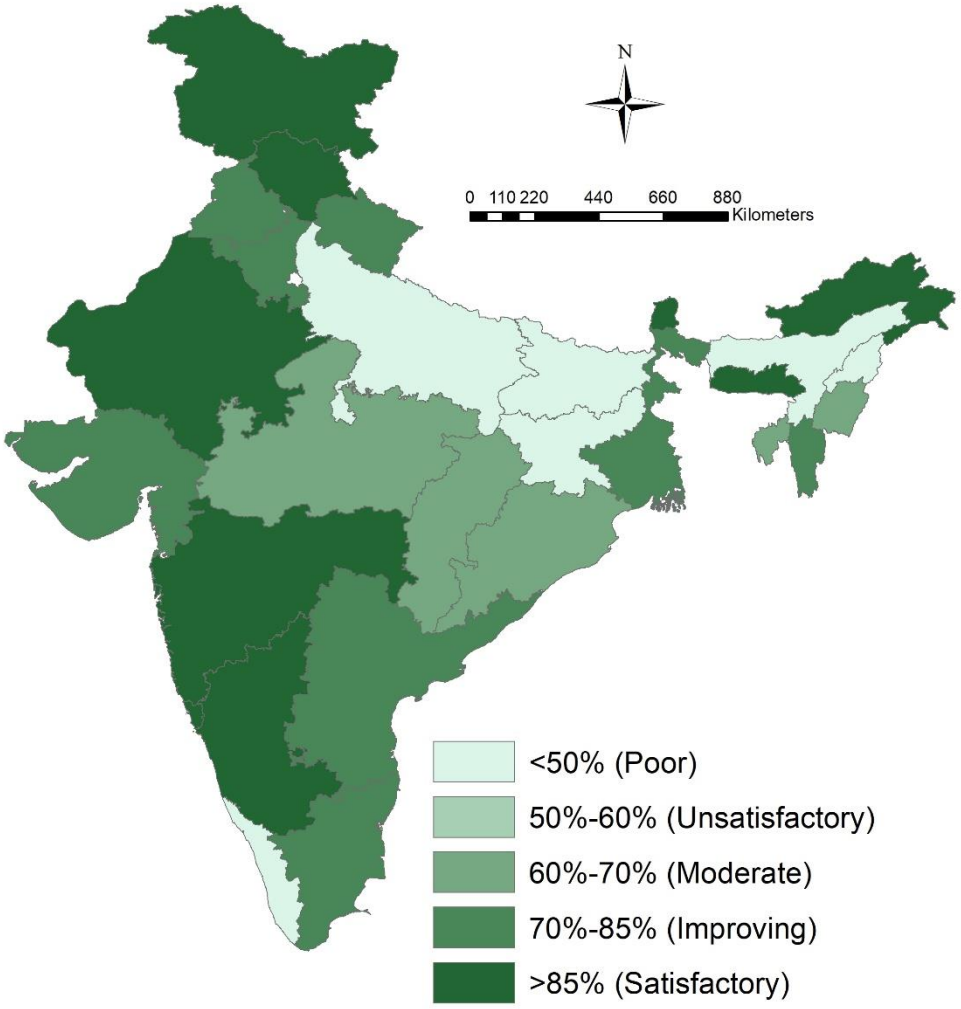


Figure 3.2 Piped Water Coverage in Urban India, 2018

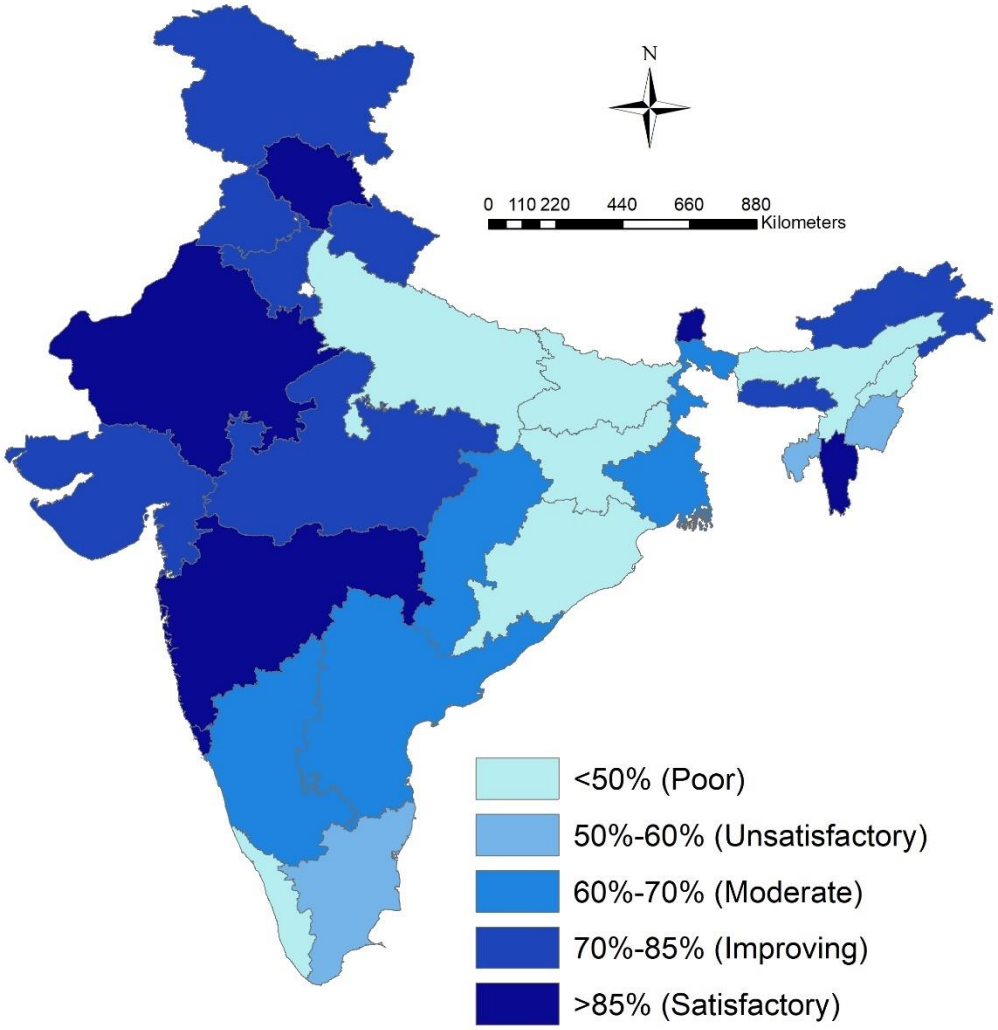


Figure 3.1 and Figure 3.2 clearly exhibit that during 2009 to 2018, there is noticeable shrinkage in piped water accessibility as principal source of drinking water across urban households in India. The coverage of piped water accessibility as principal source of drinking water has greatly reduced across urban households in States like Karnataka, Andhra, Tamil Nadu, Pradesh Kerala and Bihar from non-special category, Tripura, Meghalaya, Assam and Jammu & Kashmir from special category in 2018 compared to 2009.

Robust network of pipeline construction with capital investment is necessary for piped connections and there is a good scope of participation in the piped water supply for the private sector. Scope of private participation is supported by other studies too. All over India piped water access is declining and the urban population without adequate water services is increasing. Governments and Service Provider continue to focus their limited capital only on expanding pipe networks (Mishra, 2018).

The growth of piped water accessibility is not equitable across Indian States. The growth over time was analysed over two periods. A comparison of tapped drinking water accessibility as principal sources across Indian urban households between 1993 to 2018 reveals that only a few States like Bihar, Mizoram, Goa, Madhya Pradesh, Orissa, Punjab, Rajasthan and West Bengal have higher percentage coverage of piped water as principal source for drinking (Table 3.2). In the period 2009-2018 only 10 out of 28 States considered have seen positive annual compound growth of piped water coverage (as principal source of drinking) across Indian urban households. Out of those 10 States, only 4 States, namely Haryana, Maharashtra and Himachal Pradesh, Uttarakhand, have more than 1% average annual compound growth rate. The progress of piped water accessibility shows an inequitable feature across urban part of the States.

The Gini coefficients for urban household coverage having tap water across 34 major urban cities over three consecutive censuses of India, 1991, 2001 and 2011, are increasing signifying increasing inequality for urban India and more for entire India (Malakar et al., 2018). The present analysis of inter-temporal NSSO surveys identifies that Urban India is retarding in its pace of growth for on-grid water supply. Water sources like public tap, tube well, hand pump are easier to install and required less investment than piped network. Globally expansion of off-grid source of

drinking water has increased in response to the MDG and later SDG (Misra & Kingdom, 2019). This increasing reliance on the off-grid sources runs contrary to the SDG 6.1 requirement of 'universal' and 'equitable' access to safe and affordable drinking water for all. The definition of JMP on "access to safe water and basic sanitation" includes boreholes, protected wells, pit latrines and septic tanks. These involve less cost and therefore discourage financing expansion of the water supply and sewerage network, especially in low and middle-income areas (Lewis, 2004; Zawahri et al. 2011; Satterthwaite, 2016; Weststrate et al., 2019). Such a scenario generates a worrying point for the sustainability of universal and equitable accessibility of drinking water.

Within-premises facilities of drinking water, either by piped or non-piped modes, enjoyed by 70.28% of Indian urban households in 2002, increased to 77.51% in 2012 to 75.15% in 2018 (For details, refer to Appendix 4). The improvement over 16 years is much lower than 10% for urban India, whereas rural India has marked significant progress accessibility within premises water facility. The within premises facility was among 37.29% rural households in 2002, increasing to 46.32% in 2012 and 58.06% in 2018. With these, all India within the premises water facility is observed about 65.73% in 2018. This figure signifies an average annual increase in the facility's expansion within premises at a growth of 1.19%.

3.4.2 Access to Piped Water – Within and Outside Premises

Accessibility to piped water does not mean an equal type of facility to all households. Some households are access to piped water within premises while others depend on sources outside premises. In this section, the study looks into the facility of tapped connected households received utility within and outside premises (Table 3.3). Piped water could be within dwelling, into plot, from neighbours or from public tap. All such facilities do not provide equal utility to all.

The most convenient is on demand availability of piped water within premises than other forms which require time, energy and labour. Besides the non-piped sources like hand pump, tube well, other piped source like public tap, neighbour's tap- are inconvenient and out of physical accessibility for the physically challenged or disabled persons. These are not a disability-inclusive device. As per the 2011 census,

India has about 2.68 crores of the population comprising 2.21% as disabled[33]. So, accessibility of within premises piped water associates with disabled-inclusive development of physical infrastructure which support equity and inclusivity principle. Table 3.3 helps to understand the overtime improvement scenario of piped water within premises across urban households.

Table 3.3 shows the spread or concentration of facilities across urban households connected to piped water. It is crucial to note that the questionnaire of NSSO does not have any specific question to provide information on whether households who are principally dependent on bottled water for drinking purposes have also piped connection. There is an increase in percentage of urban households having piped water source within premises from 2002 to 2018 by 12.99 (=87.14-74.15) %. The within premises facility are significantly low in Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, and Uttarakhand. In urban areas of States like Chhattisgarh, Karnataka, Madhya Pradesh, Tamil Nadu, and Maharashtra there have been visible improvement in piped water accessibility in 2012-18. In States like West Bengal, Tamil Nadu, Chhattisgarh among all non-special category States, large number of urban households are not accessing water within premises. All special category States, except Manipur, achieved more than 90% coverage of piped water within dwelling.

[33] Among the disabled population 56% (1.5 Cr) are males and 44% (1.18 Cr) are females. A total of 69% disabled are from rural areas while the remaining 31% resided in urban areas. (Census, 2011)

Table 3.3 Tapped (Piped) Water Access across Urban Households with Within Premises Facility						
States	2002		2012		2018	
	Within Premises	Outside Premises	Within Premises	Outside Premises	Within Premises	Outside Premises
Andhra Pradesh	84.30	15.7	80.7	19.3	73.53	26.47
Bihar	87.75	12.25	84.41	15.59	92.43	7.57
Chhattisgarh	63.79	36.21	67.35	32.65	75.25	24.75
Goa	68.44	31.56	100	0.00	99.29	0.71
Gujarat	88.30	11.7	90.25	9.75	96.94	3.06
Jharkhand	60.14	39.86	69.15	30.85	99.62	0.38
Haryana	88.14	11.86	97.52	2.48	97.73	2.27
Karnataka	58.91	41.09	82.83	17.17	90.24	9.76
Kerala	21.02	78.98	79.08	20.92	88.97	11.03
Madhya Pradesh	64.07	35.93	79.15	20.85	90.63	9.37
Maharashtra	80.44	19.56	90.01	9.99	95.06	4.94
Odisha	66.88	33.12	79.20	20.80	80.80	19.20
Punjab	94.18	5.82	96.18	3.82	99.33	0.67
Rajasthan	88.90	11.1	88.50	11.50	96.32	3.68
Tamil Nadu	65.94	34.06	61.99	38.01	71.48	28.52
Uttar Pradesh	90.46	9.54	84.46	15.54	93.54	6.46
West Bengal	55.91	44.09	53.46	46.54	58.83	41.17
Arunachal Pradesh	84.3	15.7	92.94	7.06	99.14	0.86
Assam	85.61	14.39	72.76	27.24	94.53	5.47
Himachal Pradesh	93.63	6.37	95.00	5.00	94.80	5.20
Jammu & Kashmir	91.89	8.11	95.95	4.05	96.56	3.44
Manipur	67.41	32.59	48.14	51.86	73.05	26.95
Meghalaya	72.38	27.62	66.92	33.08	83.71	16.29
Mizoram	88.48	11.52	83.99	16.01	96.39	3.61
Nagaland	82.54	17.46	89.98	10.02	97.07	2.93
Sikkim	90.88	9.12	96.11	3.89	100.0	0.00
Tripura	66.77	33.23	76.78	23.22	87.69	12.31
Uttarakhand	88.95	11.05	90.62	9.38	99.62	0.38
Urban India	74.15	25.85	80.7	19.3	87.14	12.86
Source: Computed, Basic Source: 58th, 69th and 76th Rounds						

3.4.3 Access to Piped Water – Capital Cities and Rest of Urban Areas in States

Besides the differences on modes of accessibility in urban areas, disparity is noticeable within urban cities. The study notices on piped water accessibility as a study parameter. Considering that, the following table (Table 3.4) shows the differences in piped water accessibility across capital cities vis-à-vis the urban part of a State.

Piped water accessibility through personal connection- either within dwelling or within the yard or from a neighbour - is higher across districts with capital cities. The average accessibility of piped water by private connection across such districts is 62.06% urban households in 2018. Such a facility is confined to 57.47% of urban households of the State. Districts with capital cities have only 5.83% household coverage of public tap for principal source of drinking, when the figure is 7.16% for the entire State. Both together (private piped water connections and public tap) account for 67.24% for capital cities and 63.83% for the States' urban population on an average.

Point to mark is the variability much higher across capital cities than States' urban areas in general. The variability of public tap dependence as principal source of drinking water is 167.21% across capital cities. The NSSO survey did not find any public tap dependence within the districts of capital cities in Goa, Haryana, Chhattisgarh, and Gujarat. At the same time, in State like West Bengal there is high dependence on public tap for drinking across urban households in capital city districts (37.77%). The variability of public tap dependence is about 100% higher than the variability of piped water accessibility through private connections or on gross piped accessibility in the States' urban area. It implies that the accessibility of piped water across cities is heterogeneous. Variability is even higher across the urban area of the districts retaining capital cities of the major States. To sum up, the State-capital cities of India do not offer a uniform picture or standard of piped water accessibility.

Table 3.4 Piped Water Supply in Urban area: Capital City Districts, 2018						
States	District with Capital city	Total State	District with Capital city	Total State	District with Capital city	Total State
	All Piped		Piped water by personal connection		Piped water by public tap	
Andhra Pradesh	52.92	60.18	34.2	46.21	18.72	13.97
Bihar	20.04	19.89	17.08	18.43	2.96	1.46
Chhattisgarh	50.72	65.92	43.98	53.65	6.74	12.27
Goa	94.45	96.75	94.45	96.75		
Gujarat	100	78.73	100	76.76	0	1.97
Haryana	100	76.6	100	76.6		
Jharkhand	15.91	49.21	7.47	35.27	8.44	13.94
Karnataka	50.06	60.79	48.03	56.23	2.03	4.56
Kerala	60.46	27.81	59.34	25.5	1.12	2.31
Madhya Pradesh	81.67	75.03	80.2	70.14	1.47	4.89
Maharashtra	98.52	91.59	97.79	89.34	0.73	2.25
Odisha	49.25	49.8	46.63	40.84	2.62	8.96
Punjab	73.76	77.14	73.76	76.76	0	0.38
Rajasthan	93.28	87.04	91.73	85.27	1.55	1.77
Tamil Nadu	15.15	59.02	12.7	43.43	2.45	15.59
Telangana	93.57	62.42	93.57	59.79	0	2.63
Uttar Pradesh	77.64	46.37	70.92	44	6.72	2.37
West Bengal	82.99	64.6	45.22	39.4	37.77	25.2
Descriptive Statistics						
Average	67.24	63.83	62.06	57.47	5.83	7.16
Standard Deviation	29.27	20.4	31.52	22.71	9.75	7.1
Coefficient of Variation	43.52	31.97	50.79	39.53	167.21	99.16
Source: 76th Round, NSSO						

3.5 Water Inadequacy across Urban Households – Analysis of NSSO data

We considered two variables for accessing the 'Access to Improved Drinking Water' in India based on the following two questions asked in the survey viz. –

(a) ‘Whether the availability of water is sufficient throughout the year?’ and

(b) ‘Facility of drinking water?’

For question (a), the options recorded were ‘yes’ or ‘no.’ On the other hand, three broad options were available for question (b). These are (i) household’s exclusive use, (ii) common use of households in the building, and (iii) community use. A common use of water source refers to a water access point for common use by households living in the same premise or building and also from neighbour's source. A community use of water point means public source open to community or any unrestricted public source, or private restricted or unrestricted sources for a particular community or area. As noted earlier in (a), if a household does not have sufficient drinking water availability throughout the year, we consider it one with inadequate drinking water facilities. Also, if a household avails of the facility of drinking water from a community or common source, then the source of drinking water is not available for the household's exclusive use. This is also considered as not having adequate access to drinking water.

Households should meet the sufficiency of drinking water throughout whole year as the primary consideration for ‘adequacy’ parameter. ‘DD’ is the line of demarcation between sufficiency zone (to the left) and insufficiency zone (to the right). If this necessary condition satisfies, then it is been checked whether the households are access to an exclusive use of water access point as sufficient condition to secure water adequacy. The subset ‘A’ to the left of DD – the demarcation line of the following Venn diagram presents the concept of water adequacy. The subset ‘I’ represents water inadequacy irrespective of in-sufficiency existed with exclusive use of water point or not.

Figure 3.3 Venn Diagram on Concept of Water Adequacy

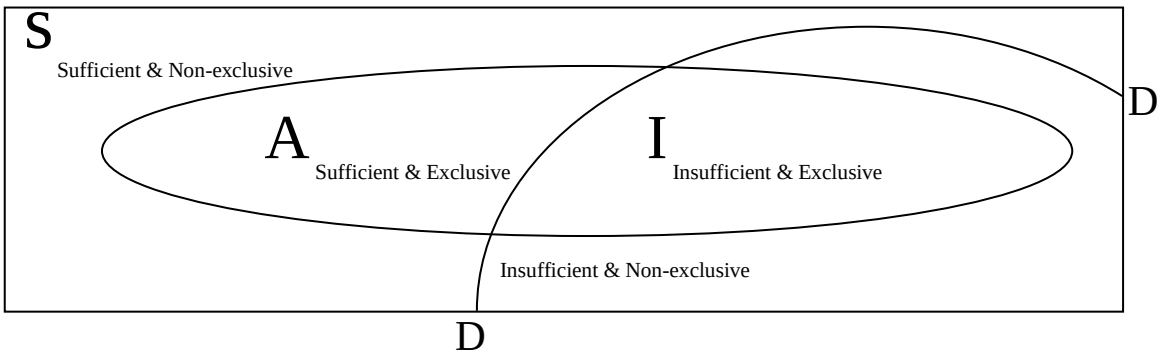


Table 3.5 shows households' distribution on water adequacy with access to exclusive drinking water facilities, combining sufficiency and access factors.

Table 3.5 Adequacy of drinking water accessibility across Households, Urban India

States/UTs	Inadequate 2002	Adequate 2002	Inadequate 2012	Adequate 2012	Inadequate 2018	Adequate 2018
Non-special Category States						
Andhra Pradesh	78.07	21.93	72.35	27.65	74.5	25.5
Bihar	54	46	58.43	41.57	35.08	64.92
Chhattisgarh	55.36	44.64	51.79	48.21	33.3	66.7
Goa	68.3	31.7	9.38	90.62	15.55	84.45
Gujarat	33.14	66.86	34.9	65.1	27.91	72.09
Jharkhand	62.18	37.82	57.23	42.77	53.08	46.92
Haryana	46.99	53.01	36.89	63.11	32.96	67.04
Karnataka	62.4	37.6	58.26	41.74	47.77	52.23
Kerala	37.76	62.24	34.74	65.26	15.22	84.78
Madhya Pradesh	62.58	37.42	55.78	44.22	32.43	67.57
Maharashtra	43.72	56.28	32.44	67.56	21.99	78.01
Odisha	66.21	33.79	60.64	39.36	46.55	53.45
Punjab	37.82	62.18	46.8	53.2	18.67	81.33
Rajasthan	54.06	45.94	57.22	42.78	34.04	65.96
Tamil Nadu	69.87	30.13	71.97	28.03	63.76	36.24
Uttar Pradesh	43.69	56.31	50.43	49.57	40.58	59.42
West Bengal	69.31	30.69	69.45	30.55	62.12	37.88
Special Category States						
Arunachal Pradesh	51.78	48.22	40.77	59.23	13.51	86.49
Assam	44.11	55.89	41.81	58.19	26.53	73.47
Himachal Pradesh	34.36	65.64	30.19	69.81	47.56	52.44
Jammu & Kashmir	29.62	70.38	36.53	63.47	23.18	76.82
Manipur	83.53	16.47	69.83	30.17	67	33
Meghalaya	82.32	17.68	48.33	51.67	53.31	46.69
Mizoram	65.25	34.75	28.84	71.16	10.68	89.32
Nagaland	41.41	58.59	46.05	53.95	38.76	61.24
Sikkim	53.94	46.06	46.49	53.51	17.75	82.25
Tripura	68.95	31.05	57.07	42.93	35.71	64.29
Uttarakhand	41.26	58.74	45.72	54.28	9.47	90.53
Urban India	54.42	45.58	52.64	47.36	42.53	57.47
Rural India	73.52	26.48	65.02	34.98	49.57	50.43
All India	68.09	31.91	60.99	39.01	47.1	52.9

Source: 58th, 69th and 76th Rounds, NSSO

About 10.42% of the urban households and around 14.23% of the rural households have reported receiving insufficient drinking water throughout the year in 2012 (69th Round, NSSO). This level of insufficiency was reduced respectively to 9.07% and 12 % subsequently in 2018 (76th Round, NSSO).

Apart from insufficiency, households those do not have exclusive drinking water facility dependent on non-exclusive uses like common use among households in one premises or building, neighbour's sources or on facility assigned to a community or on public source with unrestricted use, or any private source restricted or unrestricted for any particular community fall into the category of inadequacy. Exclusive water use facility in urban India is growing at slow pace. The percentage of urban households having exclusive access to drinking water was 34.8% in 1988-89 (as per NSSO, 44th Round), 40.2% in 1993 (as per NSSO 48th Round), 41.3% in 1998 (as per 54th Round of NSSO), 43.78% in 2002 (as per 58th Round, NSSO), 46.78% (as per 69th Round on 2012) and 57.52% (as per 76th Round in 2018).

In contrast, water sufficiency with exclusive use facility marks the household access to adequate water facilities. These households would constitute the most deprived in terms of drinking water availability. This group constitutes about 42.53% in urban households and 49.57% across rural households in 2018. The figures were higher at 52.64% in urban and 65.02% in rural in 2012. There are large variations in the percentage of households receiving adequate drinking water across the States. More than 60% of urban households in Andhra Pradesh, Tamil Nadu, and West Bengal among the non-special category states and Manipur, Meghalaya among the special category States in 2018 are lacking sources within the premises of the household along with the problem of water insufficiency.

This study shows that water adequacy is reported by more than 80% across urban households in 2018 in States like Punjab, Kerala, Goa among the non-special category States and Mizoram, Uttarakhand, Sikkim, Arunachal Pradesh among the special category States. Most of the States are also improving in this respect from 2012 to 2018. The limit of water adequacy has been extended across urban households from 47.36% in 2012 to 57.47% in 2018. The adequacy parameter identifies that about 42.53% urban Indian households in 2018 are still with inadequate supply of drinking water.

Only a small percentage of households with exclusive access to water sources have reported not receiving sufficient drinking water in urban India. Over 16 years from 2002 to 2018 an additional 11.89% households in urban India have attained water adequacy. In terms of adequacy, therefore, inequality existing in urban India is going down.

3.6 Drinking Water Access in Urban India and the Marginalized Sections

Inequity is the absence of avoidable or remediable differences among groups of people. Inequity (or inequality) in accessing water supply and sanitation is linked with the existent caste system and affordability in terms of monthly expenditure. Attainment of equity may be seen as situation when no one is made worse off in water supply and its accessibility. Concentration of facility or access is opposite to the concept of equity. The counterpart of concentration measures diversification. It is likely that less wealthy households get disconnected or have less access to the service because of non-affordability or lesser affordability. This study will examine equity in terms of diversification index across social groups and affordability is measured by the household's monthly expenditure.

3.6.1 Existing Inequality

In this part we will examine inequity in access to different drinking water sources among different income group. The income of households is captured by the per capita consumption expenditure. As the household sizes vary widely in India, the study considers the marginal per capita expenditure of a household. The variable is expressed as MPCE= (Average Monthly Expenditure of Household)/(Household Size).

As per NSSO, 2018, (Table 3.6), the top decile consumer group across urban households are privileged by highest exclusive use facility (13.99%) for drinking purpose, whereas the corresponding figure for the lowest deciles is as low as 5.25 %. Across the bottom 30% of urban consumer groups, piped water into dwelling is limited to 19% to 32% of urban households. This facility across top 30% consumer groups ranges from 43% till 55%. These figures exclude the households covered by bottled water as their principal sources of drinking water.

Table 3.6 Type and Access to Principal Source of Drinking Water: Urban India, 2018

MPCE Decile*	Types Within A Particular Decile							Access Across Facility Type		
	Bottled	Piped water into dwelling	Piped water into yard/plot	Piped water from a neighbour	Public tap/standpipe	Tube well/ Hand pump	Others	Exclusive	Common	Community
	Section A							Section B		
1	10.76	19.54	27.58	1.48	12.41	23.45	4.78	5.25	23.6	13.97
2	12.05	23.9	22.81	2.06	12.18	20.98	6.02	6.65	13.28	13.13
3	10.05	32.18	20.16	2.14	11.48	18.23	5.76	8.28	12.47	11.8
4	10.95	34	18.43	1.23	9.94	19.34	6.11	9.3	11.05	10.82
5	10.76	37.45	17.88	0.98	9.03	17.68	6.22	10.92	10.78	10.98
6	11.82	40.95	16.09	1.04	7.39	17.02	5.69	9.32	7.78	9.55
7	12.06	43.83	15.26	0.59	6.42	15.96	5.88	11.08	7.69	9.13
8	13.45	42.92	15.37	0.7	5.23	16.3	6.03	14.07	7.11	8.99
9	14.97	44.62	13.02	1.19	4.79	16.16	5.25	11.15	4.03	6.46
10	12.8	55.08	9.63	0.2	2.86	14.11	5.32	13.99	2.21	5.17

Source: 76th Round, NSSO; * MPCE 1= lowest; MPCE 10 = highest;

For public tap, the dependency across bottom 40% urban household consumer groups, is around 9.94% to 12.41%; whereas this less adventitious piped water facility contributes as principal source of drinking water among top 30% consumption rich urban households is by 2.86% to 5.23%.

Hand pump/tube well dependency is seen remarkably strong across lower sections of society. On an average about 30% from bottom 4 deciles of urban households depend on hand pump (23.45%, 200.98%, 18.23% and 19.34% respectively from bottom). This range varies from 14% to 16% across the top 4 consumption deciles of urban households.

Self-installation of a tube well or hand pump is expensive and in recent times there have been various restrictions on sinking hand (or motor) pumps to preserve ground water level as per the Ground Water Act of India. In fact, water access is generally based on local groundwater resources and the diversion of water from lakes, ponds, rivers and tanks in the early stages of urban development (Lundqvist et al., 2003; Mukherjee et al. 2010). Local governments mostly own the tube well or hand pump in urban area.

The report on World Water Development, 2015[34] by United Nations, identifies poverty as one of the main contributing reasons behind the groundwater or tube well revolution In India. The report source also reveals that the total number of mechanized wells and tube wells increased from less than 1 million in 1960 to 19 million in 2000. This trend is continuing. In 2018, about 24.25% of urban households (18.93% of urban households on tube well/hand pump; 5.32% on well) were dependent on groundwater sources as their principal sources for drinking water[35] (Table 3.1). A high dependence on ground water stresses sustainability of ground water and also puts into question the viability of SDG 15 in a country like India.

Besides the types of sources, it is imperative to observe the right to access. The distribution of exclusive, common and community sources of drinking water exhibits in the section B of the Table 3.6. The access to water supply for exclusive use concentrates among higher deciles of households. Among the top 40% of income fractiles of urban households has the right of access over exclusive use of water source by 50.29%, which expectedly wanes to about 29.48% for the corresponding bottom 40 percent. Households with the lowest 10% monthly expenditure have only 5.25% accessibility out of total exclusive water use points. Bottom 40% and bottom 60% of the urban Households together, by income, use nearly 60.4% and 79% of the facilities of common water source respectively. The same trend gets detected for the community use of water points. On the whole, more than 70% of water service utility for common as well as community use are concentrated among the 40% of the bottom

[34] https://sustainabledevelopment.un.org/content/documents/1711Water%20for%20a%20Sustainable%20World.pdf

[35] Such fact regarding dependence corresponds to around 57.01% of the rural households (49.64% on tube well/hand pump; 8.85% on well) and 43.39% of Indian households (37.34% on tube well/hand pump; 6.73% on well).

range of consumer expenditure extracted from NSSO 76th Round. Overall, there is a strong linkage of Household income to access to improved source of drinking water.

Table 3.7 Distribution of Piped Water Accessibility across Social Groups (%)

Area	Year	ST	SC	OBC	General
Urban India	2002	3.00	14.48	34.39	48.37
Urban India	2012	3.61	13.51	39.08	43.08
Urban India	2018	3.82	13.65	40.39	42.14
Rural India	2018	9.47	22.78	45.01	22.74
All India	2018	6.61	18.16	42.67	32.57

Piped water= Tapped water within, outside premises, from neighbours, including public taps. Row total=100%

Source: 58th, 69th and 76th Rounds of NSSO

Caste is a significant dimension in understanding the existing inequality in water accessibility. Table 3.7 shows that the general category holds the privilege share by 42.14%, whereas other social groups like scheduled caste, scheduled tribes and other backward castes are facilitated by 3.82%, 13.65% and 40.39%.

Over years there is a sure and steady movement in equitable distribution of piped drinking water up to dwelling premises among general caste, OBC, Scheduled Caste and Scheduled Tribe Households in urban India. Similarly, equity in distribution among caste groups of piped drinking water is evident in rural as well.

Table 3.8 provides decomposed tapped water accessibility in urban India across each social group in 2018. The tapped water access is more for non-drinking purpose across every social groups of urban households. The tapped water availability across urban households is 64.97% for drinking and 66.55% for non-drinking. The piped water coverage for non-drinking purpose is around 61.99% across the scheduled tribes and increases to 71.44% among the general category. For drinking purposes, the piped water coverage shrinks to 57.29% for scheduled tribes and 69.52% for general caste.

The tapped water disparity across social caste groups is marginal as may be seen from this table. However, the fact of disparity in supply of both drinking and non-drinking piped water is remarkable across the urban and rural parts of India. A total of 64.99% of urban households rely on piped or tapped water, while 32.91% of rural households receive this facility. On the whole, about 43.86% of Indian households arrange water through various forms of taps for drinking purposes.

Table 3.8 Distribution of Piped Water Usage across Social Groups, Urban India, 2018

Drinking purpose				
Types	Piped Water into Dwelling & Yard/plot	Piped Water from a neighbour	Public tap/standpipe	Total Tapped
ST	46.92	1.28	9.09	57.29
SC	52.25	1.38	11.44	65.07
OBC	53.22	1.22	7.08	61.52
General	63.59	0.54	5.39	69.52
Urban India	56.92	0.98	7.09	64.97
Rural India	21.68	0.95	10.28	32.91
All India	33.71	0.96	9.19	43.86
Non-drinking purpose				
Types	Piped Water into Dwelling & Yard/plot	Piped Water from a neighbour	Public tap/standpipe	Total Tapped
ST	53.24	1.31	7.44	61.99
SC	56.29	1.40	9.23	66.92
OBC	55.23	1.08	6.07	62.38
General	67.58	0.48	3.38	71.44
Urban India	60.15	0.90	5.50	66.55
Rural India	24.31	0.98	8.33	33.62
All India	36.57	0.95	7.36	44.88

Source: 76th Round, NSSO

Table 3.9 infers that the dependence of urban, rural and Indian households on piped water supply is higher than for drinking purpose. Despite access to piped water,

significant number of households opts for bottled water as they do not trust quality of piped water supply.

Table 3.9 Percentage of Piped Water Coverage as Principal Source of Drinking Across Consumer Groups: Urban India			
MPCE Decile*	NSSO Rounds		
	58th (2002)	69th (2012)	76th (2018)
1	55.86	49.25	61.01
2	49.09	50.52	60.95
3	54.25	54.72	65.96
4	62.95	61.49	63.60
5	66.9	62.56	65.34
6	71.81	66.76	65.47
7	72.48	70.09	66.10
8	73.74	72.19	64.22
9	76.66	73.42	63.62
10	84.08	72.51	67.77
Source: NSSO Rounds			

Table 3.2 has inferred us that across urban areas in different States, coverage of households by pipe water as the principal source for drinking water actually shrank over 1993-2018. However, when we analyse piped water dependence among lower declies of marginal income households, we notice that dependency of piped water has significantly increasing in the lowest 4 declies from 2012-2018. On the other hand, dependency on piped water remained either stagnant or decreased in high marginal income Deciles of urban households. This change during 2012 to 2018 is remarkable – essentially telling us that the lower income groups are primary beneficiaries of expansion of piped water facilities.

3.6.2 Inequity through Diversification Index

The diversification index helps to measure the equities of drinking water sources to understand the intra-group variations. It implies the opposite of concentration. Herfindahl Index tests the concentration of market power in the industrial economy vis-à-vis- concentration of facility in social service utility. One can apply this index successfully to measure drinking water sources' inequities among different social

castes and consumption groups. Herfindahl index, by its computational simplicity, has been transformed in literature to measure the disparity issues and impacts due to inlaid diversified assets and activities (Barrett & Reardon, 2000). Through "Diversification index", which is one less of the "Herfindahl index", intra-group inequality of drinking water sources could be measured for different consumer groups and social groups (Mishra, 2009; Tiwari, 2017).

The index is based on state variations over 18 non-special category States[36] and 11 special category States[37]. Table 3.10 helps us to demonstrate that intra-group equity is increasing over time. The drinking water sources include municipal piped water within a dwelling or to a yard, public tap for determining the Herfindahl index.

The diversification index representing inter-State variations of intra-quintile consumer groups are 0.927 and 0.923 for quintile two and quintile three, respectively in 2018. It implies that the concentration of piped water facility within group across bottom sections is lower than top consumption groups. The diversification index values are 0.933 and 0.932 for scheduled caste and scheduled tribe in 2018, higher than other backward caste and general categories. The intra-group concentration of facility is lower across SCs and STs than general groups.

Over time, the diversification index's value increases intra-group variations for social groups and all five consumer groups' quintiles. Over time, increase in diversification index indicates that instead of the concentration of piped water facility within a particular group (marked by social status or consumption capability), the benefit is getting dispersed within groups. Such finding supports the regional analysis of Uttar Pradesh water supply in its capital city Lucknow vis-a-vis in Kanpur as a non-capital city where the respective diversification indices confirm "diversities over access to drinking water sources" as per different income classes and social groups (Tiwari, 2017).

[36] New State Telangana is excluded as the study covers from 2002 to 2018.
[37] The index calculation does not consider Union Territories (UTs).

Table 3.10 Diversification Index: Piped Water Facility, Urban India						
Groups	2002		2012		2018	
	HI	DI	HI	DI	HI	DI
Marginal Per Capita Expenditure						
Q1	0.092	0.908	0.084	0.916	0.079	0.921
Q2	0.096	0.904	0.083	0.917	0.073	0.927
Q3	0.095	0.905	0.093	0.907	0.077	0.923
Q4	0.091	0.909	0.09	0.91	0.084	0.916
Q5	0.096	0.904	0.094	0.906	0.097	0.903
Social Group						
SC	0.085	0.915	0.080	0.920	0.067	0.933
ST	0.090	0.910	0.089	0.911	0.068	0.932
OBC	0.124	0.876	0.117	0.883	0.094	0.906
General	0.109	0.891	0.098	0.902	0.097	0.903
Overall	0.091	0.909	0.086	0.914	0.074	0.926
HI=Herfindahl Index; DI=Diversification Index; Q1=Lowest quintile;						

The diversification index discussed above has certain limitations. Its simplistic measure fails to capture existing complexities of diversities across different consumption groups. This limitation stems from the socio-economic diversity across consumption or social groups. There may be a better-suited parameter. Variables like the distance between usage point and access point and nature of right over water access facility - have not been discussed in making such an index on diversification. However, this diversification index confirms the intra-group disparity in the accessibility of piped water at the State level.

3.6.3 Inequality through Specification Index

The specialization index for different drinking water sources indicates the relative dependence of people in a particular income group on piped vis-à-vis non-piped water out of the total water accessibility by that source to all groups. The index is expressed by dividing the percentage share of each group in the total number of households

using that particular source by the share of that group in the total number of urban households.

The Specification Index for the i-th group and the j-th source of drinking water =

$$\frac{\text{(Households in the ith group using j-th source / All Households using the j-th source)}}{\text{(Number of Households in the i-th group / Total number of Households)}}$$

Table 3.11 and 3.12 give specification indices for piped water as well as for non-piped water used as the principal source for drinking among the urban households.

Table 3.11 shows that index values for tap water increase smoothly from lower to higher groups as per the household's marginal per capita expenditure. Such finding signifies that the average accessibility of tapped water is higher for the top deciles of households while tube well, hand pump and other improved sources are predominantly consumed by the lower deciles of households.

Table 3.11 Percentage of Urban Households Using Piped Water for Drinking to Total Households over that MPCE Group: Specialization Index

	2002	2012			2018		
MPCE	Tap	Piped water into Dwelling	Tapped water into yard	Public tap/ standpipe	Piped water into yard and dwelling	Piped water from a neighbour	Public tap/ standpipe
1	0.877	0.458	1.428	1.241	0.830	1.742	1.704
2	0.955	0.613	1.100	1.438	0.818	2.212	1.700
3	0.913	0.681	1.214	1.300	0.878	1.559	1.580
4	0.915	0.873	1.109	1.197	0.915	1.358	1.325
5	0.924	0.977	1.006	1.231	0.955	1.014	1.259
6	0.960	0.924	0.948	1.188	0.965	0.832	0.912
7	1.005	1.082	0.934	0.910	1.044	0.642	0.632
8	1.020	1.107	0.878	0.987	1.121	0.476	0.389
9	1.075	1.222	0.874	0.797	1.188	0.045	0.346
10	1.146	1.376	0.841	0.478	1.301	0.062	0.105

Source: 58th, 69th, and 76th NSSO Rounds; MPCE 1=Lowest; MPCE 10=Highest;

Table 3.12 Percentage of Urban Households Using Non-piped Water for Drinking to Total Households over that MPCE Group: Specialization Index						
	2002		2012		2018	
MPCE	Tube well/hand pump	Surface water /Others	Tube well/ Borehole	Surface water /Others	Tube well/ Hand pump	Surface water /Others
1	1.475	0.965	1.452	0.844	1.307	0.857
2	1.117	1.150	1.316	0.872	1.154	1.048
3	1.306	1.064	1.204	0.948	1.240	1.014
4	1.276	1.127	0.965	1.141	1.130	1.223
5	1.278	1.025	0.917	1.056	1.070	1.187
6	1.016	1.385	1.026	1.124	0.963	1.203
7	0.931	1.149	0.871	1.196	0.898	1.017
8	0.908	1.049	0.965	0.982	0.832	0.924
9	0.760	0.879	0.924	1.094	0.693	0.940
10	0.621	0.507	0.787	0.807	0.670	0.596
Source: 58th, 69th and 76th NSSO Rounds; MPCE 1=Lowest; MPCE 10=Highest;						

The households belonging to the higher MPCE group have an advantage in their access to tap (piped) water over those in the lower MPCE group (Table 3.11). The index values for piped water into a dwelling exceed unity form 7th decile onwards. The index of tapped water was 1.146 in 2002 for the 10th decile, i.e., top 10% consumer group, following 1.376 in 2012 and 1.301 in 2018 for piped water within dwelling. For all other drinking water sources like hand pump, tube well, pucca well, open surface sources, etc., the pattern is just the opposite. Thus, the more impoverished people obtain water from sources that are generally less hygienic, less reliable and more expensive.

The specification index for tube well, hand pump was as high as 1.475 in 2002, 1.375 in 2012, and 1.307 in 2018 for the first decile group, i.e. the bottom 10% consumer group (Table 3.12). The intensity of the specification index for tube well, hand pump or other surface sources across the bottom group is higher than the values of specification index for piped water facility across wealthiest group in 2002 and 2012. The tube well or hand pump usage is distinct up to the bottom 50% or 60%

consumption groups throughout all three time periods. The reduction in specification index for lowest consumption group depending on tube well/hand pump from 1.475 in 2002 to 1.452 in 2012 to 1.307 in 2018 highlights that the public policy has been gradually closer to pro-poor and higher investments for access to piped water.

Table 3.13 exhibits the specialization index across consumption groups for non-drinking purposes. The accessibility of tapped (piped) water into a dwelling is increasing across the higher profile consumption groups, while the concentration of public tap dependence is high across the lower profile of consumption groups. The pattern is same as mode of accessibility of drinking water.

Both in Table 3.11 and Table 3.13 specification index for piped water, individually for drinking purpose and non-drinking purpose, is more than unity for top 20% consumer groups. The top 20% consumption groups depend on piped water into dwelling and yard for both drinking and non-drinking purposes. Across deciles covering over 60% consumer groups from bottom the specification index values on piped water accessibility come out to be less than unity both for drinking and non-drinking purposes. It implies that piped water facility concentration within yard or dwelling is relatively less among the bottom 60% consumer groups.

Table 3.13 Piped Water Usage across Urban Households for Non-drinking purpose, Specialization Index, 2018

Types	Piped Water into Dwelling & Yard/plot	Piped Water from neighbour	Public tap/standpipe	Total Tapped
MPCE Profile				
1	0.776	1.078	1.664	0.854
2	0.798	1.622	1.900	0.901
3	0.890	1.900	1.544	0.958
4	0.852	2.033	1.595	0.929
5	0.915	1.811	1.500	0.975
6	0.945	1.256	1.456	0.992
7	0.939	1.100	1.109	0.955
8	0.987	1.033	0.855	0.977
9	1.094	0.633	0.600	1.047
10	1.200	0.156	0.238	1.106

Round: 76th Round, NSSO; MPCE 1=Lowest; 10=Highest;

The specification index for middle consumer groups consisting of seventh and eighth deciles reveals some unique characteristic. These groups of consumers have high (more than one) value as per specification index like 1.044 and 1.121 respectively for drinking water by piped water facility into yard or dwelling, but have less than one value of specification index like 0.939 and 0.987 respectively, for non-drinking purpose. The present study indicates that the middle-income classes or the sixth and seventh deciles of consumption group though receive a steady source of piped water supply for drinking purpose but, depend less on such source for non-drinking purposes. It indicates that piped water facilities are not adequate for middle income groups ranging from 60% to 80% across consumption categories.

Transformation of the entire existing system into a piped one is nearly impossible task given the existing limitation of resources. However, expansion of piped water facility has the potential of revenue generation. In the present scenario, off-grid/ non-piped service delivery arrangements complement piped systems – not as a sub-optimal solution but as an acceptable alternative that will ensure all urban residents have "equitable access to safe and affordable drinking water."

The coexistence of tankers, private vendors and bottled water for drinking plays a cooperative role for the government with its limited capacity. Some African countries like Ghana and Zambia also experience such limited but significant private vendors (Rouse & Achi, 2019). However, these measures are 'short-term,' even diminish to some extent the incentive to progress on piped water supply system. Piped water is the best viable option of continuous water supply, especially in the urban area, to support the pressure of urbanization to maintain quality standard with safe and continuous water supply. In the case of piped supply constant monitoring on the existing network and timely repair, overhaul and maintenance is necessary. Unfortunately, this is not the case even in many developed countries.

The United Kingdom water distribution system urgently called for replacing the old system working since the industrial revolution. The government's reluctance led to significant cases of pipe burst and the sewer system collapsed in the early 1980s. Finally, full privatization followed to rescue the system. Opposite to this, strong political will behind Ethiopia's One Wash National Program on sanitation in

financing and consistently observing rural and urban water, sanitation and hygiene (WASH) and institutional WASH led to remarkable (yet keeping the scope of improvement) outcome (UNICEF, 2018). Given the inter-State variation across urban India policymakers should formulate people-centred policies rather than target-oriented ones.

3.7 Socio-economic Factors Influencing the Source of Drinking Water

Choice of the Household for drinking water supply depends on certain socio-economic factors and limitations. Households with lesser consumption affordability are generally seen to be more adversely affected by lower levels of water supply and sanitation facilities (Agarwal, 2011). Based on this hypothesis and the questionnaire of the NSSO survey, this study tries to gauge the possible explanatory factors. The study frames a multinomial logit model to explore the factors affecting the probability of using the drinking water's principal source. This model can help determine the fundamental socio-economic factors that have influenced piped water accessibility across urban households through the NSSO primary data survey at the household level.

Multinomial logistic regression is a procedure by which we can obtain estimates of the net effects of a set of predictor-variables on all dependent variable contrasts (Morgan & Teachman, 1988). The mean of a dummy variable is always in the interval (0,1). It represents the proportion or percentage of cases that have a value of 1 for that variable. If the reference category and outcome category follow equal likeliness, then the probability will turn out as 'one'. In the present work dependent variable consists of four categories of principal sources: 1) piped water within dwelling and yard and from neighbour, 2) public tap, 3) tube well, and hand-pump and 4) the rest is included as “others” in a single category. The study classified piped water into premises as reference category and public tap, other sources are in the outcome categories.

In multivariate analysis, several independent variables such as households' size, maximum level of education attained by the household, monthly per capita expenditure level, and control variables have been used to study the drinking water

source determinants. Income and education are the primary independent and control variables. Occupation, caste and size of the family are other vital variables. The primary interest is to compare the likelihood of using piped water, access to public tap and tanks, hand pump and tube wells, or bore-well vis-à-vis using other miscellaneous sources of drinking purpose.

The model has some restrictions. Firstly, no household has been considered from the NSSO sample with "no dwelling" status and "no latrine" facility because their extreme nature can direct the model into biased estimation. Secondly, the questionnaire of NSSO does not make it clear if a Household uses both bottled and piped water – which seem to be common practice by significant section of households.

The study's objective is to identify the socio-economic factors across urban households impacting their drinking water accessibility. Besides multiple factors from different dimensions, it is important to look specifically at female participation in the workforce. As per the Periodic Labour Force Survey, July 2017- June 2018 by MoSPI, 15.9% of the urban females were in the labour force in the usual principal status and subsidiary status.

Household's distribution of work and the nature of water accessibility or its arrangement changes with the pattern, nature, stability and regularity of women's' participation in work. The model bases this as one of its assumptions. This assumption leads the study to analyse those urban households with at least one female member holding principal activity status as employed. Thus, the model has four assumptions as following-

1) Household does not depend on bottled water as their principal source for drinking water
2) Household has at least some facility of latrine
3) Household has at least a dwelling place to reside
4) At least one female member of the household must be employed in gainful work.

The first variable considered was household size. A significant statistical association is found between the size of the family and principal sources of drinking water. The inter-temporal census studies reveal that the household size structure changes across

India in non- uniform way, given spatial and social content (Nayak & Behera, 2014). Thus, there are inter-State variations in the average household sizes in India. The ibid study finds that India's average household size is 4.91 (approximately 5) persons as per the 2011 Census of India. Household are categorized into three as per size based on the NSSO, 76th Round (For details, refer to Appendix 5). The small size represents households with a maximum of less than five regular residents, and the big size stands for more than nine persons.

The medium is referred to as households from five to nine regular residents. The reference category in the model is small household. The results indicate that medium or large households are more likely to obtain their drinking water from a hand pump/tube well than a small family, relative to other principal sources. As the household size increases- from small to medium it seems to be more likely to depend on public tap than piped connection. On the other hand, the big households tend to use less of public tap compared to small households.

The regression results are put in Table 3.14. The odd ratios found mostly are of statistical significance. Simultaneously, the degree of dependence on tube well is largely observed among middle-sized households compared to a small one. However, the marginal probability for the big sized household on tube well dependence goes up in relation to households using piped water as a principal water source. However, the coefficient is not of statistical significance at a 90% level of confidence.

The model considers accessibility of latrine as one of the independent variables. The variable is classified into three categories as exclusive use, common and community. A common latrine for household means a latrine used commonly by the households in a building. A community latrine stands for public latrine with or without payment and others. Given other variables constant, as the household's sanitation access for nonexclusive use increases, the tendency of a household or use public tap as a principal source of drinking water increases by 1.585 times, use of hand pump/tube well by 1.45 times and other (well/ tanker/ spring etc) by 1.53 times, as compared to the reference group. Such observation supports the fact that sanitation facility for exclusive use is concentrated around piped connected households. The NSSO 76th round reveals the following to support the finding.

Table 3.14 Logistic Regression Analysis on Nature of Access to Drinking Water Accessibility across Urban Households (Odd Ratios)

Variables	Public tap (/Stand pipe)		Tube well (/Hand Pump)		Others /well, tanker, spring, surface water	
Household Size	>5<=9	>9	>5<=9	>9	>5<=9	>9
Ref: <5	1.059 (0.112)	0.589*(0.313)	1.387***(0.091)	1.325(0.197)	0.998(0.108)	0.959(0.233)
Female Education	Primary to Secondary	>Secondary	Primary to Secondary	>Secondary	Primary to Secondary	>Secondary
Till Primary	0.71*** (0.098)	0.276*** (0.144)	0.798*** (0.096)	0.903 (0.111)	1.741*** (0.119)	2.157*** (0.137)
Principal activity status of female	Regular	Casual	Regular	Casual	Regular	Casual
Ref: Self Employed	1.257** (0.108)	1.626*** (0.111)	0.97 (0.089)	1.108 (0.105)	0.833*** (0.101)	0.68*** (0.133)
MPCE	Middle	Rich	Middle	Rich	Middle	Rich
Ref: Low	0.76*** (0.109)	0.538*** (0.118)	0.674*** (0.103)	0.474*** (0.106)	1.067 (0.133)	1.004 (0.134)
Social Group	OBC	General	OBC	General	OBC	General
Ref: SC/ST	0.969 (0.98)	0.862 (0.115)	1.128 (0.091)	1.559*** (0.095)	1.104 (0.100)	0.737*** (0.117)
Tenurial Status	Hired	Others	Hired	Others	Hired	Others
Ref: Owned	0.952 (0.107)	0.775 (0.257)	0.729*** (0.098)	0.730 (0.276)	0.853 (0.118)	0.642 (0.373)
Type of dwelling	Flat	Others	Flat	Others	Flat	Others
Ref: Residential	0.581*** (0.129)	1.143 (0.138)	0.446*** (0.108)	1.007 (0.138)	0.255*** (0.152)	0.689** (0.182)
Type of Sanitation infrastructure	Pit Latrine	Others	Pit Latrine	Others	Pit Latrine	Others
Ref: Septic Tanks	2.544*** (0.108)	5.016*** (0.289)	3.248*** (.091)	1.131 (0.405)	6.537*** (0.098)	7.094*** (0.319)
Accessibility to latrine	Non-exclusive Use		Non-exclusive Use		Non-exclusive Use	
Ref: Exclusive Use	1.588*** (0.11)		1.453*** (0.108)		1.528*** (0.135)	
Location	Slum		Slum		Slum	
Ref: Non-Slum	0.359***(0.113)		2.376***(0.181)		1.295***(0.101)	
Age of the head of the household	Middle	Old	Middle	Old	Middle	Old
Ref: Young	0.994 (0.105)	1.183 (0.21)	0.737*** (0.081)	0.572*** (0.216)	1.286*** (0.101)	2.001*** (0.218)
Intercept	0.663*** (0.185)		0.163***(0.222)		0.057***(0.253)	

Number of observations = 7,323; LR $Chi^2(60)$=1,773.46; Probability > Chi^2 = 0.000; Pseudo R^2 =0.119; Standard Errors are in the parentheses; ***: 1%, **: 5%; *: 10% level of significance

The accessibility of a household to sanitation infrastructure has an important implication on their water accessibility status. The latrine type has been categorized into three categories - septic tank or flush toilet comprising the highest levels of improved category, pit latrine as other improved categories, and "others" as rest types of latrine facility. Households with pit latrine and latrine types other than the reference category, i.e., septic tank/flush, there is more likelihood of use public tap increases relative to a piped connection. This likeliness increases by (6.557-3.216=) 3.341 times towards usage of pit latrine or similar. All the coefficients towards pit latrine have high statistical significance in this case.

Interestingly, the Household head's age plays a significant and robust role in access to drinking water on-premises. The study divides household-head into three categories where young implies till 30 years; middle implies more than 30 years till 60 years, and elder age means more than 60 years (Refer Appendix 6). Such categorization is based on the distribution of the Household head's age as available from the NSSO survey, 76th round. The household more likely to use a public tap (than individual piped connection) as the age of head of the Household increases. Indeed elderly heads tend to decide in favour of public tap and sources other than hand-pump in a statistically significant way.

Nevertheless, an increase in the age of the head of the household leads to less likeliness of reliance on tube well as the principal source of drinking water. The physical exertion in using a tube well may be a cause. Similarly, the probability of using drinking water sources like surface water, well, etc. is 23% lower for a household whose head falls in the elderly category.

Household's dwelling's location appears in the study as one of the very significant factors for willingness to access piped water. A household's willingness to use public tap as their principal source compared to a piped connection to dwelling unit decreases by 64% as it moves to slum area. The likelihood of depending on tube well/hand pump, well & other surface sources is higher (2.376 times and 1295 times) across slum area dwellers than non-slum dwellers. The proneness for accessibility of tube well increases by 138% (= (2.38-1)*100) within a household connected by pipe as the location of the dwelling changed from slum to non-slum area. Both these findings are significant at a 100% level of confidence. Tenancy based urban

households has lesser dependency on public tap, tube well and also other sources is lesser than piped water.

The location of the existing infrastructure and its facility influences accessibility to have a piped water connection, but the type of dwellings like residential house / multi-storey flat matters influence significantly access to piped water source for drinking.

Highest educational standard attained by a female household member has been considered as one of the variables to explain the piped water accessibility. This study finds that as the level of education attained by a female in a household increases, the willingness to move to public tap and tube well decreases. The odd is 3.13 times higher than that for the secondary level of education. The coefficient is significant at a 100% confidence level. As the level of female education in a household increases, the households becomes prone to depend less on public tap or tube well or hand pump as their principal source for drinking water. This is not true for other sources like well, tanker provided, spring or other surface water. Manual labour, time consumption in arranging water required for public tap, tube well or hand pump based water arrangement seem to be indirectly linked to female education in an inverse manner.

The participation of females in the workforce is an important variable to consider the household's probability of accessing piped water. Based on the NSSO survey and the usual activity status, the study categorizes three groups as self-employed, casual and regular works for female[38]. As we move from self-employment to regular employment to casual engagements of female member in a Household there is more proclivity to use public tap, tube well and hand pump as compared to piped water to the dwelling. The drinking water source analysis indicates a gradual reduction across households in dependency on tube well or other groundwater sources as principal sources in the urban area. This reinforces national efforts to preserve and replenish ground water (as discussed in Chapter 2).

As the level of consumption affordability of household, measured by MPEC, increases (from MPCE I to MPCE II to MPCE III) household's willingness to use

[38] Self-employed has been considered as worked in household enterprise either as own account worker or as employer along with worker as helper in such enterprise (unpaid family worker). Casual working status corresponds to casual wage labor in public works or in other types of work.

public tap as well as tube well decreases compared to piped water accessibility. In other word, the different types of piped water access either within the yard, within a dwelling, or from neighbour are mostly for households with relatively high monthly expenditure.

The next variable that has been considered here is the social group. Traditional castes in the Indian social system are hierarchical and endogamous (in-marrying) groups, in which membership is only by birth. Each caste is part of a local interdependent system linked through economic, ritual, and social relationships (Beteille, 1996). The notions of purity and impurity are central to caste's principle and determine the respective civil and religious privileges or disabilities of the different groups (Ghurye, 1969; Dumont, 1980).

As the social group of a household increases to a higher caste category, (i.e., to other backward caste and to the general category with the reference of a scheduled caste or scheduled tribe), the urban Household of India seems to be less likely to use public tap given the base category of pied water accessibility. The general category is more likely to use tube wells but less likely to use other sources and public tap as principal sources of drinking water given the piped water into dwellings or plots as base category and scheduled caste or scheduled tribe as the reference group. It is least likely that a household coming from a scheduled caste or tribe, to be dependent on groundwater as a principal source for drinking in urban areas, as opposed to piped water into premises. Household from general category is least likely to depend on surface and other sources than a household with SC/ST or OBC group. However, almost all these coefficients are found not statistically significant.

The model examines location of household dwelling by slum and non-slum categories. Slum area can be "notified slum", "non-notified slums" and "squatter settlements" as classified by NSSO, 76th Round. The other area represents as non-slum area. There is higher tendency by 138% (= (2.376-1)*100) of using hand pump/tube well across urban slums than urban non-slums compared to a piped connection within premises. The urban slum's proneness to depend on miscellaneous other sources excluding tube well, hand pump is also about 29.5% higher than non-slum urban households. The interesting point to note is that incidence of urban slums on public tap dependency is 64% (=1-0.359) lesser than that in non-slum urban areas.

It indicates that the public-tap expansion is inadequately available to the slum households to rely on this source. Illegal settlements of urban slums could be one of the explanatory reasons for less public tap dependency in urban slum areas as public tap connectivity is generally unavailable if settlement is illegal. The odd ratios are significant for ground water like tube well/ hand pump and for public tap.

Overall, the empirical analysis suggests that factors significantly affecting drinking water availability within premises are location and type of dwelling, female members' education and employment, income level of Household and Household size. The other contributing socio-economic factors that have been identified are the age structure of the Head of the households, Tenurial status of dwelling, and the existing sanitation infrastructure. Need for social investment is reminded by the strong connections between female education and improved source of drinking water. Similarly, economic empowerment of women also found to be significantly linked to progress towards improved drinking water choice. The significance of latrine infrastructure brings out complementarily between water supply and sanitation, i.e., WASH infrastructure. The results suggest that policymakers could formulate people-oriented policies than target-oriented ones in the supply of drinking water and related issues.

3.8 Conclusion

Piped water is best contamination controlled and considered main improved source of drinking water throughout the world. Dependence on piped water as main source of drinking water is declined in urban India from 69.1% (2009), 65.27% (2018). The finding is from NSSO rounds on housing condition, which put fairly direct question on principal source of drinking water for the households. Figures across the States support the decline (Table 3.2). States like Maharashtra and Goa are in a better position among the non-special category States' while urban Mizoram, Sikkim performed better among the special category States. The fact that dependency on piped water for principal source of drinking as percentage of households has gone down in urban India in about last one decade is a matter of concern. Later in Chapter 6 of this study will show how the decrease in dependency on piped water has given entry to non-public/ private provisioning of drinking water in urban India.

The case for expansion of piped water is strengthened when we notice (Table 3.9) that between 69th and 76th round of NSSO respectively in 2012 and 2018, the lowest four Deciles of urban households in terms of marginal per capita expenditure, have significantly enhanced their dependency on piped water, whereas overall such dependency in urban India has decreased.

The chapter attempted to measure the extent of drinking water adequacy by combining supply sufficiency throughout the year and the status of the right to use the water point for exclusive purpose. About 57.47% of urban households enjoyed water adequacy as per an NSSO survey in 2018 (Table 3.5). This is again a matter of high concerns. The fact that 11.89 (=57.47-45.58) % of more urban households joined the group of 'adequate' between 2002 and 2018 shows a slow progress in addressing inequality in access to adequate water.

The chapter also examined disparity through "Diversification index". As per the values of the index, inequity is decreasing over time both within different social groups and within consumption classes. The diversification indices are high, indicating that inequity is going down. However, there is scope of improvement to address the within-group inequities. Thus, a group-specific policy may be explored to achieve the targeted result.

The study also measures the disparity in water accessibility through the lens of consumption using the tool of "Specification index". Analysis based on this index point to the fact that the subsidized piped water provision is mostly concentrated among higher consumption groups. In contrast, tube-well /hand pump and other improved but non-piped (tapped) drinking water sources are centred among lower consumption groups. The finding through specification index across social groups supports that the coverage of piped water accessibility is higher among general category group compared to households from scheduled castes or scheduled tribes and other backward castes.

The study empirically analysed factors affecting the availability of drinking water within premises using Logistic Regression Analysis. The regression analysis strongly indicated that education of female and income levels of the households are important socio-economic factors affecting drinking water source accessibility within premises.

However, occupation and family size and caste are also other important factors which have significant potential to influence the probability within premises water connection facility.

As the consumption status improves, households are more inclined to access the facility of piped water. Tube well/hand-pump usage intensity is seen to be more among the urban households who are residing in the slum area. Woman in Household with self-employment or steady income or higher level of education led to greater chances of piped water accessibility. Such a result signals a connection of women's education and economic empowerment in family to demand for improved household amenities and conditions. The other identified influencing factors include the age of the Head of Household, tenurial status of dwelling unit, location of the dwelling and the existing sanitation infrastructure. Households dependent on tube well or hand pump seem to be more inclined to use pit latrines and other less developed sanitation systems than septic tanks.

To achieve SDG 6 Goal, we must ensure water adequacy and remove inequity within groups and inequality across groups and States in accessibility of public water access through tap what is considered modern, contamination-controlled and available on demand. SDG 6 needs to be indirectly complemented with the requirements of inclusive economic growth as delineated in SDG 8.

CHAPTER 4: WATER POVERTY - DISTANCE COVERED TO FETCH WATER AND GENDER INEQUALITY IN URBAN INDIA

4.1 Water Poverty – Current Scenario

Water poverty is marked by economic and physical un-affordability, where a nation or region cannot afford the cost of sustainable clean water to all people at all times (Feitelson & Chenoweth, 2002). Water poverty index can be used to devise a 'holistic' policy instrument (Sullivan, 2002). There is a strong association of such an index with human development. Across the country, water poverty indices incorporate variables like water resources, water access, water capacity, water use and water environment by the method of differential weighing. The index has a high negative correlation with human poverty and positive correlation with human development (Cho, Ogwang & Opio, 2010).

Water deprivation is offending to human rights and dignity. Combining infrastructure investments with effective public policy and action to promote health consciousness and reduction of income poverty help address water poverty as well (Ravallion & Jalan, 1999). Any measure of income poverty without consideration of water poverty (Sullivan, 2002), among other issues, is not complete. Time required for fetching of water and other limitations related to water poverty does contribute to income poverty. Inter household disparities due to water arrangement activities which is mainly generated from lack of proper physical public infrastructure is often overlooked while framing macro policies (Chakraborty, 2008). The MDG gives a rather liberal target but acknowledges positive contribution of saving productive time in accessing water sources and sanitation facilities. The problem of time-consuming and arduous fetching of water has a substantial indirect relation to MDGs' attainment to eliminate poverty and hunger. It is not a problem unique to India - rather a common characteristic of underdevelopment.

Publicly provided water service in India aims at higher coverage to attain the MDG, especially MDG 7. However, besides mere accessibility, the other important attributes in drinking water supply, need to be studied and addressed to. Distance

travelled to the source of drinking water is one such attribute. Whether the source is shared with other households or community or for households' exclusive use (65th Round, NSSO) is another important aspect.

Disproportionate burden of collection (fetching) of water falls on women and children across developing regions (Curtis, 1986). Women and children are put in harm's by making them travel long distances with overweight water pots. Water source easily accessible by women was recognized as a need in the United Nations Water Conference in Mar del Plata, Argentina in 1977 (UNESCO, 2003). Today, improved, reliable, safe, close-to-home and convenient water source is recognized globally as one of the women's basic needs (ibid.). Water fetching is an important component of care economy. Gender mainstreaming approach to water management is critical to success (Lewis, 2004).

Participation of women and girls in water collection/ fetching is 60% more than that of male members in the family (Water Aid, 2009). This activity imposes a significant burden on women and girls who, on average, have about 2.5 times more involvement in terms of time on unpaid care and domestic work compared to men (ILO, 2017). There is hardly any study assigning a value or cost by way of women's productive time for water collection. Neither there is any accounting exercise explicitly in public economic analysis by policymakers. Though there is some estimate available on rural households in this respect (Sullivan, 2002; Sullivan et al., 2003), in the urban context there is no imputation of value to domestic labour.

The severity of time involvement is as steep in some rural areas as women spending about 25% of their productive time on water arrangement (Carney, 1998; Scoones, 1998). Though time devoted to extra domestic work is a long-time issue of discussion in the social economy (Becker, 1965), the magnitude of unpaid care work is estimated only in recent attempts (Charmes, 2019). An involvement of nearly 54% rural women and adolescent girls into water fetching activity as experienced in India for 35 minutes per day, impacts on an equivalent loss of wages by 27 days annually (UNICEF, 2017). Physical cost or health hazard in terms of body damage and injuries, risks on maternal mortality and transmitted risks to the foetus due to water carrying is unexplored.

The cost of fetching water spreads beyond public health - on caloric expenditure, quality of life etc. However, in measuring the progress towards MDG, the full cost of fetching of water should be accounted for (Sorenson et al., 2011). It has been recognized worldwide that distance between water source and point of consumption and time for drinking water arrangement for household are critical parameters to monitor inequalities in access (JMP, 2019). So far, scarcely any attention is paid to the burden of household work (Bartram et al., 2014).

The international Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) in 1970 by the United Nations General Assembly made an explicit reference to women's water rights. Focusing on rural development, this Convention called for eliminating discrimination against women and declared that women have the right to access adequate living conditions incorporating water supply and sanitation (UN, 1979, Article 14(2))[39]. This was reinforced indirectly in later period in General Comments (15) of the UN in 2002, where the human right to water for domestic uses was accorded priority. This was considered necessary because of its multiple interconnected benefits (Hellum, 2014). Water has a vital role in realizing other human rights such as the right to food and livelihoods.

Several trips involved and the hours consumed in this challenging physical work negatively impact households' consumption levels vis-à-vis earnable income (Hall et al., 2014). Water fetching constraints the amount of time a person otherwise would dedicate to income-generating, educational or recreational activities. Long and arduous hours on arrangements of water buttress the vicious circle of disease, poor education and low human development (Hailu et al. 2012).

Better infrastructural investment on water sector would release to women and girls time for economic or educational activity recordable in National accounts. The opportunity cost of investment balances with an addition to National accounts by economic participation through saving and devoting time from water arrangement. The Statistical Division of United Nations endeavours to extend this activity in the System of National Account (seen in Chakraborty, 2008). Besides, water supply within domestic premises, promotes the ‘domestic-plus services supporting a wide range of productive household activities.

[39] http://www.un.org/womenwatch/daw/cedaw/text/econvention.htm#article

Therefore, programs like ‘Har Ghar pe Jal’ initiative, which puts priority on clean and safe drinking water, has ‘multiple-use’ effects on domestic life. In the previous chapter the study has examined piped water accessibility from equity and equality point of view. This chapter extends the study on accessibility from distance and facility angles. Estimation of a water poverty index considers all these three issues (distance, inequality in accessibility and inequity in facility for use of water) in the first section. Following this, the study tries to establish the increasingly unequal burden on women on water fetching with time involvement and identify the socio-economic factors to determine this aspect of gender inequality.

4.2 Distance of Water Source from Household

Covering distances of various lengths daily for household's water procurement is common in the developing world. The Census of India classifies the distances[40] from household's premises (i.e., water-use point and water collection point) into three groups. A water point for urban areas is considered 'within' households if the source is within 100 meters, 'near premises' for a water source more than 100 meter but less than 500 meters and 'away' from household for beyond 500 metres (WHO, 2018).

This definition is different for the rural area. A distance within 500 meters is defined as near the premises while 1 kilometre from the user’s place is considered 'away from' the premises. It considers improved water source if accessibility is less than 1 kilometre[41] (WHO, 2018). The source assigns water source as improved if "total fetching time of 30 minutes or less for a round-trip, including queuing.” [42]

Norms for WASHCost countries envisage maximum 1.6 kilometres for horizontal distance and maximum 100 metre for hilly area. India is placed in the “intermediate service category” under these norms (Moriarty et al., 2011). The population coverage as per the norms is less than 250 people per hand pump /standpipe. Distance is measured into water scarcity, but the extent of poverty with distance has not been taken into account.

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40 https://censusindia.gov.in/2011census/hlo/Data_sheet/Andhra_Pradesh/Houselisting_and_Housing_Census-A.P.pdf

41 Water Supply and Sanitation Collaborative Council . WASH Post-2015: Proposed Targets and Indicators for Drinking-Water, Sanitation and Hygiene. 2014

42 Ibid.

4.3 Accessibility of Water from Off-premises Source

In 2018 in India 19.3% of urban households depended on out-house drinking water sources (Table 4.1). This figure is 42.2% in rural India. This feature is not uncommon across the world. Around 13% of the world (i.e., 884 million people) lives in households where water is fetched from beyond 500 meters – mostly unprotected sources (JMP, 2019).

Table 4.1 Percentage of Households based on Distance from the Principal Source of Drinking Water

Round	Survey period	<0.2 km	>0.2km; <0.5km	<0.5km	>0.5km	Total
Rural		Outside Premise at Distance				
44th	July'88-June'89			72.4	4.4	76.8
49th	Jan-June 1993	54.4	8.1	62.5	3.2	65.7
54th	Jan-June 1998	60.4	5.6	66	2.8	68.8
58th	July-Dec 2002	50.93	8.98	59.91	2.8	62.71
65th	July 2008-June2009	48.08	9.2	57.2	2.16	59.36
69th	July-Dec 2012	40.9	9.3	50.1	3.8	53.69
76th	July-Dec 2018	30.4	8.4	39.2	3	42.2
Urban		Outside Premise at Distance				
44th	July'88-June'89			40.1	1.6	41.7
49th	Jan-June 1993	30.4	2.5	32.9	1	33.9
54th	Jan-June 1998	31.5	1.7	33.2	1.1	34.3
58th	July-Dec 2002	26.03	2.89	28.9	_0.8	29.7
65th	July 2008-June2009	22.79	1.97	24.76	0.72	25.48
69th	July-Dec 2012	18.38	2.93	21.31	0.61	22.49
76th	July-Dec 2018	13.8	3.2	17	2.3	19.3

Source: NSSO Report Numbers 376, 429, 449,489, 535, 556, 584 from 44th, 49th, 54th, 58th, 65th, 69th, 76th Rounds respectively.

The distance measured in fetching water by NSSOs varies across NSSO rounds. Table 4.1 presents a full picture since the pre-1990s in rural as well as urban areas. The table comprises the 44th, 49th, 54th, 58th, 65th, 69th, and the 76th rounds. The

study reveals that at the latest period distance dependent water collection decreased since 1990s. Table 4.1 informs that in 1989 about 42% urban households used to access water outside their premises. In this respect, it is clear that here water source implies either a tap, tube well, hand pump, well (protected or unprotected) or any other sources. It does not consider the households who are dependent on bottled water as their principal source for drinking water (as specified in NSSO questionnaires).

The reduction in distance-dependency is higher in the rural area during the last three decades (by 34.6%) than in urban India (about 22.4%). The long-distance dependency is much less but shorter distance dependency (within 200 meters) have gone up in the rural households. Until the end of the previous decade, about 50% of rural households depended on out-house water as their principal source for drinking water.

About one out of about every six urban households (=17%) had to rely on an outside source within a 500-meter radius to bring water in 2008. The situation is more severe in rural areas than urban areas. About 17% of urban households do arrange water within the periphery of 500 meters in 2018. Nearly 2.3% urban households do travel beyond 500 meters to reach the access point as their principal source of drinking water in 2018 despite all the efforts. However, within premises, coverage in terms of percentage is increasing.

Table 4.2 depicts scenario of water fetching in India as per 76th NSSO rounds. The rural households spend, on an average, around 87 minutes daily, while urban households spend around 58 minutes. The study reports that carrying water adversely affect women's health in the form of spinal injury, neck pain, spontaneous abortion from heavy and awkward workloads and caloric expenditure (Kayser et al., 2019). Long-distance carrying of heavy weights has long term effects on pregnancy, childbirth and even later prevalence of gynaecological distresses. Girls fetching water from long distances lose out on time for studies. It is clearly expressed that it is girls and women who took the maximum burden of fetching water (JMP, 2017a). Above all, water from unsafe sources like rivers holes streams etc is a great health risk. At the same time, difficult access to water leads to other problems of hygiene and healthy life (Water Aid, 2005).

According to WHO, basic access means maximum water hauling round trip of 30 minutes (JMP, 2017a). Urban India spends almost double the time as prescribed by WHO and UNICEF but rural India spends about thrice the accepted times (Table 4.2).

Table 4.2 Drinking Water Fetching Scenario in India, 2018		
Gender Inequality in Fetching Water		
Category	Urban India	Rural India
Male: Below 18 years	0.5	0.8
Male: Above 18 years	6.5	8.2
Female: Below 18 years	0.3	1.1
Female: Above 18 years	9.7	30.9
Hired Labour and others	2.3	1.2
Total	19.3%	41.4%
Weighted Average of Non-monetised Time Involvement in Water Fetching (in Minutes)		
Single trip	12	12
Waiting per trip	5	5
Number trip	2	3
Time per day	58	87
Average time involved per day =(2*12+5)*2=58 minutes in urban India		
Source: 76th Round, NSSO		

The maximum burden of carrying water falls on women over 18 years old. In the urban area about 10 (~ 9.7%) households are dependent on women more than 18 years to fetch drinking water. The figure is more than three times (~30.9%) in the case of rural India. From the above table, it is evident that the maximum onus is on women for getting water. This reinforces the patriarchal structure of Indian society.

The table also informs that higher intensity of women's involvement in rural areas, where women (adults in 30.9% households and non-adult in 1.1% households) travel a long distance to get water for drinking, cooking, and other household chores. Sometimes the distance is as long or more than 1 kilometre. Thus, they spend hours in a day in getting water.

4.4 Distance Driven Water Poverty Index

Time involvement in water fetching is an important parameter which is closely connected with water poverty as well as economic poverty. All over the world, expansion of access to improved source is felicitated by expansion of piped water. While limitations in physical infrastructure in water accessibility is well acknowledged, social cost of distant water fetching has not been sufficiently paid attention to (Crow & McPike. 2009).

In this part we attempt to find the intensity of water poverty as related to the distance of procuring water. The implicit assumption is that any household that has access to water supply within the dwelling is out of water scarcity or water poverty.

The existing literature considers water collection time as important variable to be considered on water poverty. The water poverty estimation approach uses water resource availability, efficiency, productivity, water accessibility through GIS method along with time dimension (Sullivan, 2002; Molle & Mollinga, 2003).

The latest picture of distance driven water arrangement as per NSSO brings forth the fact that nearly 20% of urban households and about 41% of urban households at present in India depend on distance driven water arrangement.

The intensity of poverty has been linked with various situations using index-based distance-driven poverty as a proportion of households cover distance to zero-distance water accessibility. Zero distance implies water source within the dwelling. Water poverty is captured by the distance (one-way trip from dwelling to source) including outside dwelling but within premises. State-wise poverty indices are seen as deviation from minimum value and maximum value out of the state-wise proportions urban households dependent on various distance-driven sources for procurement of drinking water to urban households having within premises water facility. Based on these proportions, positional rankings have been computed against each State. The 'positional rank' of the i-th State is expressed in the following manner. Obviously, a computed positional rank closer to "0" indicates a better position or less of water poverty measured by distance.

$$\sum [\{\text{Observation}_{\text{Dist}}(i,j) - \text{Minimum}_{\text{Dist}}(j)\} / \{\text{Maximum}_{\text{Dist}}(j) - \text{Minimum}_{\text{Dist}}(j)\}] \quad \text{.....(A)}$$

Where, Observation (i,j) = Proportion of urban household in the i-th State dependent on water source outside the premises at a distance category j to urban households with water source within premises;

Minimum (j) = Minimum of above proportion of j-th distance category out of all 28 States;

Maximum (j) = Maximum of above proportion of j-th distance category out of all 28 States;

i = 1.2,...28 States[43]

j = mild (0<distance ≤ Outside dwelling but within premises), severe (Outside premises<distance≤200m), extreme (distance>200 metre)

These figures represent distance driven water poverty index (Table 4.3). The maximum value of such index does not define any specific value against the maximum proportion and minimum value is "0" against the minimum observation. The lower is the value of index, implies lesser intensity of dependence of households on off-premise water arrangement given a category out of the three - mild, severe and extreme. The three categories of poverty- mild, severe and extreme - are classified on the basis of different distances. The intensity of water poverty based on a short distance cannot be the same with that from a far distance. In today's world, it is not an over-expectation to have access to drinking water within the household. Therefore, a situation when drinking water is not available within household/dwelling, but accessible within the premises or yard, then, the study considers it as Mild Poverty. The situation when households have to fetch water from not only outside the premises but also from a distance up to 200 metre then the study has considered it as Severe Poverty. The study deduces from the NSSO 76th Round that Mild, Severe and Extreme poverty in urban India is observed among around 24.53%, 13.80% and 5.46% in 2018.

Drinking water source is considered 'away' from the premises by Census if it is located beyond the range of 100 metres from the point of use[44] (Census of India, 2011). As within 100 metres is considered as 'in' premises, the study broadens the periphery to 200 metres from zero distance to denote a mild degree of poverty in water accessibility.

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[43] Excluding the newest State Telangana appeared in 2014

44 https://censusindia.gov.in/2011census/hlo/Data_sheet/delhi/5Drinking_water.pdf

Table 4.3 Distance Derived Urban Poverty Index: Averages over 2002, 2012 & 2018

States	Mild	States	Severe	States	Extreme
Sikkim	0.018	Sikkim	0.006	Goa	0.013
Uttar Pradesh	0.03	Arunachal Pradesh	0.013	Himachal Pradesh	0.025
Haryana	0.033	Punjab	0.013	Arunachal Pradesh	0.029
Jammu & Kashmir	0.039	Jammu & Kashmir	0.017	Bihar	0.034
Himachal Pradesh	0.042	Himachal Pradesh	0.027	Uttarakhand	0.038
Mizoram	0.048	Haryana	0.031	Nagaland	0.039
Gujarat	0.054	Uttarakhand	0.035	Sikkim	0.04
Uttarakhand	0.059	Gujarat	0.041	Tripura	0.051
Bihar	0.065	Rajasthan	0.052	Kerala	0.063
Arunachal Pradesh	0.068	Bihar	0.056	Uttar Pradesh	0.066
Punjab	0.072	Assam	0.059	Punjab	0.069
Maharashtra	0.102	Maharashtra	0.065	Haryana	0.088
Rajasthan	0.104	Uttar Pradesh	0.072	Gujarat	0.089
Madhya Pradesh	0.108	Mizoram	0.101	Maharashtra	0.092
Goa	0.119	Goa	0.12	Assam	0.102
West Bengal	0.133	Nagaland	0.128	Jammu & Kashmir	0.115
Jharkhand	0.157	Kerala	0.144	Meghalaya	0.125
Chhattisgarh	0.199	Karnataka	0.181	Mizoram	0.134
Odisha	0.201	Madhya Pradesh	0.188	Chhattisgarh	0.166
Karnataka	0.204	Jharkhand	0.225	Odisha	0.194
Tamil Nadu	0.209	Odisha	0.247	Karnataka	0.222
Meghalaya	0.256	Meghalaya	0.255	Rajasthan	0.237
Nagaland	0.318	Tripura	0.275	Madhya Pradesh	0.279
Andhra Pradesh	0.344	Tamil Nadu	0.311	Tamil Nadu	0.339
Kerala	0.362	Chhattisgarh	0.314	Andhra Pradesh	0.445
Assam	0.468	Andhra Pradesh	0.374	Jharkhand	0.448
Tripura	0.699	West Bengal	0.43	West Bengal	0.51
Manipur	0.843	Manipur	1.000	Manipur	0.975
Total	0.100	Total	0.117	Total	0.174

Source: Computed; Basic source: NSSO Rounds, 58th, 69th and 76th.

Poverty is aggravated to moderate and extreme if collection point more than 200 metres till 1 kilometre and beyond 1 kilometre respectively. The value of the index indicates the extent of deprivation in relative terms. The three indices are calculated on three-time points covering about 16 years, explaining a lower value implying lesser intensity of poverty on inter-temporal analysis.

Extreme poverty is most prevalent. The index value over combined 28 States is 0.174 for Extreme poverty while the Mild poverty is 0.100 (Refer to Table 4.3). Comparatively higher value of Severe poverty signals the requirement of higher investments on public taps closer to household settlements or up to dwelling units. Severe poverty is 0.117 for urban India on a scale of $(0, \infty)$ referring (minimum, maximum). Both Mild, Severe and Extreme poverty are looming large at its maximum in Manipur at nearly 1, which coexists with 0.795 in case of mild poverty in Manipur. West Bengal experiences prominent Severe and Extreme poverty. States like Tamil Nadu, Meghalaya, Andhra Pradesh, Mizoram, Rajasthan and Tripura are noticeably water poverty affected in their respective urban household sector.

The 4 States showing low dependency on outside dwelling but within premises water accessibility against Mild poverty is Sikkim, followed by Uttar Pradesh, Haryana, Jammu & Kashmir and Himachal Pradesh. The Extreme water poverty is mild among Goa, Himachal Pradesh, Arunachal Pradesh, Jharkhand and Bihar.

These findings indicate the local water supply arrangement in urban India is not evenly distributed. Arrangement of water points needs to be located in more thoughtful and well-designed manner notwithstanding the unplanned nature of urbanization.

Though distance of water source is a critical factor in measuring water poverty, distance cannot encompass all aspects of water poverty. The following section discusses ways of more comprehensive consideration in deciding water poverty index.

4.5 Distance, Accessibility, Facility (DAF) - A Composite Water Poverty Index

Water poverty should encompass broad dimension like water's regional resource strength, groundwater replacement rate and capacity, structure (Sullivan, 2002) along rate of urbanization, growth of industrialization, governance performance index. This study attempts to calculate a composite water poverty index for households' access to water based on household survey data.

The Water Poverty Index used in the present study is based on mainly three dimensions – 1) distance from water access point, 2) access to piped water and, 3) nature of user right over facility in order. The order of these three variables has been considered by their degree of contributions in measuring water poverty.

The proposed water poverty index considers distance as the first dimension to measure the depth of water poverty. The distance criterion considers the respective State wise average of Mild, Severe, and Extreme water poverty index[45] for a given year. The averages appear like proportions in expression (A) and thus form the first variable of the index.

Piped water is relatively least contaminated or best contamination-controlled. The first variable of the index is based on non-piped vis-a-vis piped water accessibility. The State wise proportions of urban household's dependence on non-piped water access, to piped access are placed as second variable after computing their positional rankings as mentioned in the earlier section. This dimension of the index indicates inequality in access to quality water. This variable is computed as below-

$$\sum [\{\text{Observation}_{\text{Access}}(i) - \text{Minimum}_{\text{Access}}\} / \{\text{Maximum}_{\text{Access}} - \text{Minimum}_{\text{Access}}\}] \quad \text{.....(B)}$$

Where, Observation (i) = Proportion of urban household in the i-th State dependent on non-piped water source to proportion of urban household having piped water source for principal source of drinking;

[45] Applying $1/3 \sum [\{\text{Observation}(i) - \text{Minimum}(i)\} / \{\text{Maximum}(i) - \text{Minimum}(i)\}]$

Minimum = Minimum of above proportion of non-piped coverage of urban households to piped coverage of urban households out of all 28 States[46];

Maximum = Maximum of above proportion of non-piped coverage of urban households to piped coverage of urban households out of all 28.

i = 1, 2,.....28 States

The third and last aspect emphasise ownership of user rights. Whether water and its source are available unconstrained on-demand on urgency is an essential dimension for satisfaction vis-à-vis dissatisfaction. This dimension measures the inequity of facility aspect in water poverty. It is formed by the ratio of percentage of urban household dependent on non-exclusive i.e. common/community or shared source of water points to percentage of urban households with exclusive water point for use. A lower value of this ratio indicates a better position of the State in equity of provision. On the contrary a higher value on this ratio adds to an increase in the value of the poverty index. The variable is formed as-

$$\sum [\{\text{Observation}_{\text{Facility}}(i) - \text{Minimum}_{\text{Facility}}\} / \{\text{Maximum}_{\text{Facility}} - \text{Minimum}_{\text{Facility}}\}] \ldots\ldots\ldots\ldots\ldots\ldots ...(C)$$

Where, Observation (i) = Proportion of urban household in the i-th State dependent on non-exclusive right on water access point to exclusive right on water access point for principal source of drinking;

Minimum = Minimum of above proportion of non-exclusive facility of urban households to exclusive use facility of urban households out of all 28 States;

Maximum = Maximum of above proportion of non-exclusive facility of urban households to exclusive use facility of urban households out of all 28 States;

Where i = 1, 2...,28;

Then, weights are assigned to each of the three variables-outside premises water accessibility to within premises, non-piped to piped accessibility and non-exclusive user right to exclusive right at 0.5, 0.3, and 0.2, respectively. Weighted average of

[46] Excluding Telangana

(A), (B), and (C) of respective State gives Distance Access Facility (DAF) water poverty index. Higher DAF index denotes higher poverty in Table 4.4.

Table 4.4 DAF - Water Poverty Index, Urban India

States	2002	States	2012	States	2018
Himachal Pradesh	0.013	Goa	-0.002	Mizoram	0.003
Jammu &Kashmir	0.023	Himachal Pradesh	0.008	Goa	0.013
Gujarat	0.032	Arunachal Pradesh	0.034	Uttarakhand	0.024
Sikkim	0.036	Haryana	0.04	Arunachal Pradesh	0.026
Punjab	0.051	Sikkim	0.045	Sikkim	0.026
Uttarakhand	0.056	Maharashtra	0.058	Maharashtra	0.031
Arunachal Pradesh	0.072	Mizoram	0.058	Jammu & Kashmir	0.038
Haryana	0.078	Gujarat	0.067	Punjab	0.04
Maharashtra	0.09	Jammu & Kashmir	0.068	Rajasthan	0.047
Rajasthan	0.127	Uttarakhand	0.092	Gujarat	0.054
Goa	0.154	Meghalaya	0.101	Himachal Pradesh	0.059
Uttar Pradesh	0.161	Nagaland	0.105	Haryana	0.064
Nagaland	0.205	Punjab	0.111	Madhya Pradesh	0.066
Karnataka	0.216	Kerala	0.139	Uttar Pradesh	0.134
Chhattisgarh	0.22	Uttar Pradesh	0.151	Chhattisgarh	0.135
Mizoram	0.228	Karnataka	0.168	Meghalaya	0.141
Tripura	0.27	Rajasthan	0.185	Karnataka	0.142
Kerala	0.283	Madhya Pradesh	0.198	Jharkhand	0.176
Madhya Pradesh	0.284	Chhattisgarh	0.226	Tamil Nadu	0.176
Jharkhand	0.302	Odisha	0.228	Odisha	0.178
West Bengal	0.303	Assam	0.287	Nagaland	0.206
Tamil Nadu	0.304	Andhra Pradesh	0.348	Assam	0.212
Odisha	0.312	Tripura	0.348	West Bengal	0.225
Bihar	0.368	Jharkhand	0.353	Tripura	0.233
Meghalaya	0.369	Tamil Nadu	0.372	Kerala	0.284
Assam	0.374	Bihar	0.405	Bihar	0.329
Andhra Pradesh	0.39	West Bengal	0.445	Andhra Pradesh	0.347
Manipur	0.768	Manipur	0.603	Manipur	0.607
Urban India	0.155	Urban India	0.148	Urban India	0.108
Coefficient of Variation	75.046	Coefficient of Variation	82.398	Coefficient of Variation	93.619

Source: Computed; Basic source: NSSO Rounds, 58th, 69th and 76th.

The most striking feature is that urban India's DAF water poverty index is decreasing over years. States like Kerala, Andhra Pradesh, Bihar, West Bengal and Special Category State like Manipur, Tripura are highly stressed by inequity in urban water supply. In 2018, while the urban India DAF index comes out as 0.108, Manipur has very high DAF poverty index at 0.607. This poverty index is comprehensive. Gujarat, Uttarakhand, Haryana are better positioned by holding relatively lower values. These States' positions were not so in terms of distance driven poverty index discussed above.

The inter-State variability of the index is around 93.62% in 2018. Yet it is seen to increase slowly from 75.05% in 2002, 82.40% in 2012. The index signals that policymakers need to consider all three variables considered in the index construction. The ultimate panacea is piped water connection into each and every household. The present initiative of "Har Ghar pe Jal" centring rural India is the right approach. However, it needs to be expanded to urban area to reap an comprehensive outcome. The implementation and sustainability of such initiative is not beyond question.

The distance driven water poverty index is seen to increase over time from 2002 gradually with its value at 0.100 in 2002, 0.117 in 2012 and 0.174 in 2018. During the same period, the DAF water poverty index is decreasing from 0.155 (in 2002), 0.148 (in 2012) and 0.108 in (in 2018).

4.6 Gender Inequality and Fetching of Water

Using the support of section 4.3, the following analysis further examines burden of water arrangement on women in households. The analysis has been through two sub-sections. The first section will see the latest inter-State variation of gender-biased water arrangement with support of NSSO, 76th Round for 2018. The second section tries to formulate and identify the socio-economic factors.

4.6.1 Water Arrangement Burden on Female across States

Table 4.5 in the following shows the inter-State gender in equal burden for distance derived water arrangement for their respective households.

Table 4.5 Percentage of Burden for Water Fetching on Female across States, 2018					
State	Urban India	State	Rural India	State	All India
Sikkim	0.00	Sikkim	0.00	Sikkim	0.00
Telangana	17.95	Punjab	35.35	Punjab	36.22
Goa	21.23	Nagaland	40.34	Telangana	37.52
Karnataka	24.89	Telangana	45.32	Nagaland	39.29
Gujarat	25.04	Meghalaya	49.44	Karnataka	43.62
Nagaland	25.67	Karnataka	51.95	Meghalaya	48.32
Haryana	32.54	Haryana	54.80	Haryana	49.97
Meghalaya	37.43	Andhra Pradesh	56.81	Andhra Pradesh	54.79
Himachal Pradesh	37.45	Kerala	61.46	Goa	56.16
Bihar	38.38	Mizoram	66.49	Kerala	62.60
Punjab	39.08	Jammu & Kashmir	70.92	Gujarat	65.82
Assam	39.31	Bihar	71.52	Mizoram	66.17
Arunachal Pradesh	39.50	Manipur	71.71	Jammu & Kashmir	68.92
Uttar Pradesh	40.44	Maharashtra	71.95	Manipur	69.31
Andhra Pradesh	47.75	Uttarakhand	74.10	Bihar	69.32
Jammu & Kashmir	53.35	Uttar Pradesh	75.94	Uttar Pradesh	70.44
Mizoram	61.15	Madhya Pradesh	76.52	Maharashtra	71.24
Manipur	62.00	Arunachal Pradesh	77.18	Uttarakhand	74.14
Jharkhand	63.44	Himachal Pradesh	78.83	Madhya Pradesh	75.66
West Bengal	63.93	Assam	80.15	Arunachal Pradesh	75.97
Kerala	64.65	Gujarat	82.50	Himachal Pradesh	76.69
Madhya Pradesh	66.05	Jharkhand	83.58	Assam	77.60
Maharashtra	66.98	Chhattisgarh	85.12	Tamil Nadu	79.91
Tamil Nadu	67.43	Tamil Nadu	85.45	West Bengal	81.38
Rajasthan	67.51	Rajasthan	87.03	Jharkhand	81.51
Uttarakhand	73.94	West Bengal	88.66	Chhattisgarh	85.28
Chhattisgarh	86.70	Tripura	91.83	Rajasthan	86.19
Tripura	90.24	Odisha	94.79	Tripura	91.70
Odisha	95.83	Goa	100.00	Odisha	94.85
Urban India	52.10%	Rural India	76.42%	All India	71.70%
Source: 76th Round, 2018					

The burden on women of water arrangement for household across States generates a diverse picture. In about 52% of urban households women, in 36% households men and in 12% urban households, hired labour get involved in regular arrangement of drinking water as per the 76th round of NSSO in 2018. In States like Uttarakhand, Chhattisgarh, Tripura and Orissa, the burden on urban women is most biased. Rural and urban combined, the States like Tamil Nadu, West Bengal, Jharkhand, Chhattisgarh, Rajasthan, Tripura and Orissa experience most unequal gender bias on women for fetching water.

4.6.2 Logistic Regression in Explaining Gender Inequality

The applied logit model attempts to identify crucial socio-economic factors contributing to the probability of in-premises drinking water sources. The objective of this model is to identify socio-economic factors for gender inequality in water arrangement, given an unchanged condition of access to water. The model shows that level of education attained by a female member (adult and non-adult) and income level increases the probability of non-female (adult & non-adult male; and hired labourers) participation in the arrangement of drinking water.

The analysis attempts to identify differential response of socio-economic factors influencing on-premises water availability in urban India as well as across special and non-special category States. This model exercise might not talk about water provisioning per se; yet it hinges on socio-economic factors which have indirect impact on derived gender inequality in water fetching activity and therefore, is relevant in policy making.

The likelihood ratios of three regression-models indicate that the explanatory variables for drinking water facility within premises, provides a fairly good-fit model based on 13,382 urban households' surveys (Table 4.6).

Three regressions are computed with variable as discussed in following paragraphs. The first one is on urban India comprising the urban areas of all 29 States and 7 Union territories. The second and the third ones are respectively for 11 Special category States and 18 non-special category States.

Table 4.6 Multinomial Logistic Regression on Socio Economic Factors behind Water Fetching

State Category		All States		Special Category States		Non-Special category States	
Reference category		Male	Others	Male	Others	Male	Others
Variables		Odd Ratio		Odd Ratio		Odd Ratio	
Within premises	Outside premises	4.491*** (0.05)	10.614*** (0.67)	2.593*** (.124)	7.01*** (.153)	5.296*** (.053)	13.066*** (.077)
Household Size Ref: Low	Middle	1.741*** (0.63)	1.055 (0.10)	1.371* (.197)	1.311 (.255)	1.789*** (0.069)	0.951 (0.116)
	Rich	2.55*** (0.061)	2.299*** (0.09)	2.124*** (.186)	2.902*** (.242)	2.542*** (.067)	2.005*** (.106)
Social Group Ref: SC/ST	OBC	1.165** (0.051)	1.097 (0.09)	0.921 (0.141)	2.907*** (.161)	1.072 (.059)	1.001 (.1)
	General	1.114*** (0.06)	1.295*** (0.08)	0.727** (.153)	0.482*** (.234)	1.088 (0.12)	1.574*** (.101)
Location of Dwelling Ref: Slum	Non-slum	1.201** (0.07)	2.491*** (0.138)	0.417*** (.263)	7.389 (547.3)	1.389*** (.075)	3.593 (.179)
Female work status Ref: Employed	Unemployed	1.169*** (0.06)	0.817*** (0.09)	0.721** (0.171)	0.214*** (.179)	1.288*** (.071)	1.262** (.116)
Female Education Ref: Till Primary	Primary to secondary	0.946*** (0.05)	1.165** (0.07)	1.083 (.537)	1.088 (.168)	0.951 (0.052)	1.15 (0.117)
	More than Secondary	1.342*** (0.06)	2.202*** (0.08)	1.485*** (.017)	1.883*** (.201)	1.325*** (.066)	2.266*** (.097)
Sanitation access Ref: Exclusive use	Common	0.848*** (0.06)	0.699*** (0.10)	1.354** (0.16)	1.253 (.204)	0.751*** (.069)	0.61*** (.122)
	Community	1.049 (0.09)	0.77 (0.187)	0 (108)	8.657*** (0.5)	1.079 (0.095)	0.531*** (.244)
Time Square		0.947*** (0.005)	0.823*** (0.005)	0.941*** (.021)	0.989 (0.016)	0.941*** (.005)	0.689*** (.032)
Constant		0.135*** (.103)	0.026*** (0.181)	0.578 (0.35)	0 (547.2)	0.114*** (.112)	0.013*** (.23)
Number of Observations & Pseudo R square		13,382 & 0.1295		1,937 & 0.1283		10,943 & 0.1556	

Dependent Variables: Various Groups of Participants – 1) Female, 2) Male & 3) Hired Labourers

*** , **, * implies 1 %, 5% and 10% level of statistical significance respectively

The dependent variable contains three categories: (i) female participation in water fetching as its reference category, (ii) male participation as an outcome category, (iii) hired labours as another outcome category. The category variables' multivariate characteristics are analysed by multinomial-logistic regression in an m-logit model.

The following discussion is on the set of explanatory variables used in the model. The set of independent variables marginal per capita expenditure, social group, area of the dwelling, engagement of a female member with gainful economic activity, highest level of female education in household, time spent on water fetching, and access to sanitation infrastructure. Overall fitness of the model is determined by the Pseudo R square and log likelihood ratio.

Prolonging and escalating of women's' working hours and time in domestic labour are primarily under-discussed in macroeconomic models despite their direct impact on the well-being of women and the development of children (Floro, 1995). Marginal productivity of female labour at household diminishes as hours put in by her increase (Gronau, 1977). Water arrangement is a prominent household activity in the time basket of women in developing countries and the marginal utility of time diminishes. Thus, it impacts inversely on economically productive time in terms of opportunity lost (Chakraborty, 2008).

The analysis starts with the introduction of off-distance study variable with reference to households dependent from within premises water source. Within premises facility refers to within dwelling facility and outside dwelling but within premises water facility. The first Regressor (variable is distance between source to point of use) is designed to capture rate of participation of male member of household or hired labour in fetching water when water resource is outside premises. Analysis through this model indicates that there is significant participation of male members and hired labours in arranging water when source is outside the premises. Likeliness of male participation is significantly lower than that by hired labours. Such finding is unanimously observed for all States, special category States and non-Special States. However, the intensity of participation by a male member is relatively lower across urban area of special category States in compared to urban India and urban area of non-special category States.

The odds of male participation in fetching water from outside premises increases by 4.491 times compared to within premise situation. For outside premises water arrangement, tendency to hire labour increases by 10.614 times than water arrangement by female. In the case of special category States, the proneness of male participation, as well as the involvement of hired labourers, is quite higher than non-special category States (5.296 times and 2.593 times respectively for male member's involvement and 13.066 times & 7.01 times respectively for hired labourers' involvement).

Present analysis considers total time involved in water fetching as the first explanatory variable. Time Square is considered a variable to convey the non-linear relationship between females' time and water arrangement involvement.

The model considers water arrangement into two broad categories- within premises and outside premises. There are multiple classifications on distances covered to reach the water points in the data sets of NSSO. Within premises, a water source is classified into within dwelling and outside dwelling but within the premises.

Outside premises, water sources are classified in NSSO data into following: less than 200 metres, 200 to 500 metres, 500 metres to 1 kilometre, 1 kilometre to 1.5 kilometre and beyond 1.5 kilometres. In this study water collection time is the proxy for distances covered for off-premises water arrangement. Longer the distance implies a lengthy water collection time. The total time involvement is calculated as time of round trip (including waiting in queue at the water source) multiplied by the number of trips daily. The time square (squared value of time in minutes converted into hours) is considered as the first variable. Involvement in fetching of water by male members and hired labour sharply decreases with the first variable. In other words, as time (as such distance) for fetching water increases, and therefore the chore becomes more arduous and expensive to arrange by hired labour, the Regression shows that responsibility of fetching water increasingly shifts towards female members of Household. For example, as time increases by one hour, the involvement of a male member decreases by about 5% and the figure is 18% for others or hired labours in urban households of all States.

Such reverse relation is observed for all States, the special category and the non special category States separately. The coefficients of each category are statistically significant with 5% or lesser level of significance. The finding supports the finding of the above table that female members in the family are overburdened across States.

The urban households' income group or consumption status plays an essential role and led to significant findings in this discussion. The likelihood of a female member of a more affluent household participating in water fetching activity is lesser than that in a low-income household. The behaviour of the variable is the not much different in special category and non special category States. However, for special category States, the coefficients are not significant.

Given other variables constant, in an all-States study, when marginal per capita expenditure increases as defined from low-income group to middle-income group to richer group of households, the male participation in fetching water is respectively 1.74 times and 2.55 times more likely than a lower income households. The likelihood of outsourcing labour in fetching water increases 1.05 times more for the middle-income group and 2.30 times more for the richer income group. The tendency of male participation in special category States is higher by 1.37 times and 1.78 times across middle-income and high-income households than a low-income one. This tendency is even higher across non-special category States where the respective numbers are 1.79 times and 2.54 times. All the coefficients of the variable are significant.

India's social hierarchy is unavoidable in a discussion of the socio-economic behaviour of the households. Social groups can be categorized as SC/ST, OBC and general category. Impact of social category on male or hired labour participation appears significant in all States keeping all other variables constant. The likelihood of a male or hired persons fetching water relative to a female member increases along with the households' upward social status, except in special category States, where impact of caste/ tribe categorization seems to be rather feeble. The coefficients of social groups against special category states are not statistically significant.

The location of the dwelling is categorized into two - slum and non-slum. Slum areas are notified slums as well as non-notified slum and squatter settlement. Given other

variables constant, compared to slum areas the likelihood of male participation in water fetching in non-slum areas increases by 20% for all States, 40% for non-special category States with statistical significance. The likelihood of hiring labours is high in the non-slum area than the slum area as may be expected. Non-slum households are 149% more dependent compared to slum areas on hired labours for all States. For the non-special category States, the likelihood is not statistically significant. On the whole, male involvement in fetching water compared to female is significantly higher in non-slum area than slum area.

The next variable considers the household's position in terms of participation in economic activity by female members. If at least one female member of the household is engaged in any sort of financial engagement as defined by NSSO activity status47, then "1" has been assigned against that household's female workforce participation dummy; otherwise=0. The study finds that male participation in water fetching activity increases by 1.17 times as more female members get employed in economically gainful activity. The likeliness of hiring a labour or others in arranging water is 0.82 times lower in a family where no female member is employed. The odds or risks ratio and coefficient are highly significant.

The female household members' level of education plays an important role in their involvement in a non-monetized activity like water fetching. Attainment of a higher level of education by a female reduces household work's unequal burden. This variable is categorized into the primary, above primary to secondary, and above secondary education. The above-secondary category's coefficients are statistically significant, while changes from primary to secondary education do not seem to influence burden shifting in statistically significant manner. Male participation increases by 1.342 times in households with above-secondary educated female compared to households with primary or less educated female. As the female's education increases from primary to secondary, it is 1.165 times more likely to appoint hired labour; the same likelihood increases to 2.202 times as female education

47 Employed status of a female is assigned against their participation in the following type of economic activities like working in household enterprise, employer, worked as helper in household enterprise as unpaid family worker, worked as regular salaried/wage employees, casual labour in public works or other works. On the other hand, unemployed status gets defined as not working but sacking for work, attending educational institutions, performing household duties along with or without free collection of goods like vegetables, firewood, cattle etc, sewing, tailoring or weaving for household use, receiving rents, pensions, remittances etc, not working due to disability etc.

reaches above secondary level in 29 States. In simpler terms as females get higher education the burden of fetching water shifts more evenly by way of male participation or by outsourcing of hired labour.

The probable explanation could be opportunity cost of non-monetized chores by the women member. For the non-special category States, the tendency of male participation and the involvement of hired labourers in same situation increases respectively by 1.325 and 2.266 times as the level of female education increases from primary to higher than secondary level- affirming a statistical significance. In the case of special category States, these coefficients are not statistically significant.

Quality of sanitation infrastructure is a variable to understand the unequal burden on a female in fetching water for the entire household. A shared sanitation facility for common or community use -is reasonably susceptible to increase exposure to health risks. It raises serious concern about its negative effect on privacy, safety, dignity, and proneness to harassment, especially for women and girls and disabled people lacking mobility. Exclusive and quality sanitation facility has a positive impact on Household, particularly the women. All over UN-defined SDG regions community sanitation are recommended to be female-friendly.

In all States, as households' dependency on common sanitation increases male participation in fetching water decreases by about 15%; while for community sanitation facility male participation in water carrying become 1.049 times higher than reference category (exclusive sanitation facility). In all States and non-Special category States, outsourcing of hired labour decreases as dependency on common or community sanitation increases. These findings are statistically significant not significant, except for the Special category States. The behaviour of participation in water fetching by hired labourers across special category States are somewhat different. In such States, households connected to community sanitation are seen to depend vary significantly on hired labours for water arrangement. However, the male participation is undefined by a zero-odd ratio. Thus, this particular domestic work is outsourced across the urban households dependent on community sanitation. Involvement of women in economic activity to support their households could be a reason.

4.7 Conclusion

The distance dependent drinking water collection is reduced across 22.4% urban households during the last three decades from 1989 to 2018. This implies a rate of reduction by 2.69% as average annual compound rate. The reduction is lower than same across rural households during the same period. On an average the distance dependent urban households spent nearly one hour per day in fetching water in 2018 as per NSSO 76th Round. Out of off-premises drinking water dependent urban households, 13.8% arranged water from or within 200 metres and 17% from or within 500 metres in 2018. The Survey inferred that both in rural and urban the burden of household's drinking water is highly on adult female members. Among the 19.3% distance dependent urban households, adult women contribute to 9.2% cases, rest being by men, underage and outsourced labour.

The study measured water poverty based on intensity of distances for water procurement. The distance is between water consumption point and water access point. The distance is classified into three categories as Mild, Severe and Extreme and used in index as such. The study showed that Extreme poverty index covering a distance of water fetching more than 200 metres for one-way trip is more prominent in urban India than Severe poverty index covering water source beyond premises but within 200 metre. The values of the index vary widely from 0.018 to 0.843 in Mild Water poverty, 0.006 to 1.000 for Severe water poverty and 0.013 to 0.975 for Extreme water poverty. Rajasthan among the non-special category States has lower position for Mild and Severe poverty (index values for those 0.104 and 0.052 respectively), but its position on Extreme poverty is quite high at 0.237. Manipur and Sikkim from special category States have maximum and minimum of mild poverty.

Considering three parameters - (i) Distance from procurement point to user point, (ii) Ratio of percent of households with non-piped supply to percent of households with piped water supply, and (iii) Ratio of percent of non-exclusive water point users across urban households to percent of households with exclusive water supply, the study formulated DAF water poverty index for three time points during last two decades. The relatively inclusive index worked out to be 0.108 in 2018. This shows a decrease over its values in 2002 and 2012 from 0.155 and 0.148 respectively. The increasing value of DAF index indicated decreasing water poverty in urban India.

The inter-State variability based on this index is around 93.62% in 2018, and it is increasing gradually. The study recommends for more focused policy by the States to address inaccessibility, burden of distance and inequity in facility for quality drinking water. Though there is a decrease in piped water dependency across urban households as their principal source for drinking, improvement of within-premises water facility (by other mode) resulted an improvement as per DAF index value.

Lastly, the chapter introduced a multivariate Logit model to examine the socio-economic indicators in unequal burden on female for water arrangement. Examination using the model points to marked gender inequality keeping female category as the reference level of the explained variable. As households improve economic position in the society, find better location of dwelling (from slum to non-slum) the male participation in drinking water increases significantly sharing burden of female members of household. Similarly, caste ladder has also an impact – the lower the strata more is the burden on females in the household for fetching water. In general, there is lesser involvement of male in household work in marginalized households. The intensity of involvement of hired labourers is higher compared to a male member in urban households. As the time length of involvement increases, or as this activity becomes more strenuous, involvement of male or hired labour becomes less likely. The ultimate burden transfers to women disproportionately.

The gender inequality in distance driven water arrangement diminishes as female members of Household receives higher education or are engaged in economically gainful activities. With the progress of education among females across urban households, the off-premises drinking water arrangement becomes less gender unequal. Employment of hired labour for residential water arrangement enhances with attainment of higher education of females.

Nature of sanitation facility also seems to influence male participation in water procurement. Male participation increases when there is community sanitation and decreases if there is common-use sanitation latrine facility. However, the male participation behaviour is not same across common sanitation dependent urban households across Special category States.

As family size increases, the higher volume of demand for drinking water demands male participation besides women in arranging water from far. To satisfy the household demand, hired labourers are significantly seen to participate across such households. The behaviour is unanimously same across special and non-special category States.

Identification of the above mentioned set of socio economic factors in Chapter 3 and Chapter 4 either in finding the accessibility of drinking water sources or the heavy off-premises water arrangement pressure certainly have impact on socio-economic development of urban India. These factors have to be taken into account in drawing up the policy outline and public expenditure for the expansion of access to improved source of water.

Chapter 3 and 4 of this study have found that the public water supply across States, social groups and consumer groups in urban India are neither equitable not equal. While water supply is largely State Subject and public expenditure is the primary means of provisioning of public service, in order to give a complete shape of the study, the next chapter concentrates on finding the nature, form and behaviour of public expenditure across States on access to water.

CHAPTER 5: REGIONAL INEQUALITY IN PUBLIC PROVISIONING OF WATER SUPPLY SERVICE: PUBLIC EXPENDITURE ANALYSIS

5.1 Introduction

It is established that social sector expenditure has a robust impact on economic growth. Expenditure on social services in Indian public finance comprises Education, Sports, Art, and Culture; Medical and Public Health; Family Welfare, Water Supply and Sanitation; Housing, Urban Development; Welfare of SC, ST & OBCs, Labour and Labour welfare, Social Security and welfare, Nutrition, Expenditure on Natural calamities and others. It is necessary to increase public spending effectively on social services to promote socio-economic development. Simultaneously, the social sector's expenditure efficiency is influenced by the quality of governance and economic growth (Mohanty & Bhanumurthy, 2018).

Studies suggest that significant policy measures towards social sectors and economic infrastructure and change in the transfer design from the centre to States can address the existing large resource gap across the States (Rajmal, 2006; Rao, 2002). In this respect, whether on social service or on economic service - the public spending needs to be designed across various services to maximize social welfare, including the impact on the poor (Pradhan, 1996). Cash subsidies are recommended policy instrument for bettering urban poor life, while public infrastructure investment is its complement (Dreze & Sen, 2011).

Water supply and sanitation is State subject, depends on State initiatives, supported by centrally sponsored schemes and finance transfer. However, empirical evidence supports that state allocation of resources on various sectors has consistent linkage with maximizing growth and strengthening local democracy, whereas central dependent allocation on development as well as non-developmental projects promotes regional growth in the Indian context (Smith, 1996; Zhang & Zou, 1997). On the other hand, moving from a model of central provision to that of decentralization to local governments creates a new correspondence between national and local level policy decisions, which not always led to outcome a better service delivery (Ahmed et

al., 2005; Ahmed & Brosio, 2009; Bohlken, 2010; Devarajan et al,, 2009; Chhatre, 2007), or better economic growth (Martinez-Vazquez & McNab, 2003). Indian local governments' revenue base has hardly ever been adequate since the 90s (Mathur, 1993; Mathur & Thakur, 2004; Mohanty et al., 2007; Rao & Bird, 2010; Bandyopadhyay, 2014). Transfer of resources from States to urban local bodies is inadequate and discretionary in India (Rao & Bird, 2014).

The 'highly unsatisfactory' resource base and growing pressure of urbanization affect India's growth and 'development trajectory' adversely influencing the transfer of resources through grant-in-aid from Finance Commissions (Mathur, 2014). Along with decentralization, the FRBM Act, 2003, can have an unequal fiscal impact on the States. Prescribed implementation of fiscal discipline and pressure of cost recovery by FRBM on State governments concentrated decentralization in relatively developed States and larger cities (Bagchi & Chattopadhyay, 2004). Amidst variety of opinions and debate what is lost is the moot question how best urban infrastructure and service can be delivered to people. Question on the ways of allocation to different tiers of government is secondary. Fiscal implication of urbanization is an important point to consider (Mathur, 2014). This chapter will examine nature, pattern, trend and inherent challenges of public expenditure on WSS service by empirical testing.

Existing literature on cost estimation for water, sanitation, and hygiene (WASH) service in India is limited. There have been attempts to estimate the cost/expenses required under various norms such as WASHCost India, WHO/UNICEF, National Institute of Urban Affairs (NIUA). Actual cost of creation of infrastructure turns out to be several times higher than estimated in WASHCost India (Reddy & Kumar, 2011). Local governments largely depend on States' financial support in performing multiple obligations along with broader set of responsibilities after the 74th Constitutional Amendment Act (CAA).

Financial stringency is often identified as a factor for substandard delivery of public services (WHO, 2014). Public expenditure review on water supply and sanitation over 15 countries of Africa finds that it is ineffectiveness, not insufficiency of public expenditure which causes unsatisfactory water supply and sanitation (Manghee & Berg, 2012). Governance is an important parameter beside public expenditure -

ineffectiveness of water supply service is a derived outcome of poor water governance.

Inequality in sanitation service is essentially a result of ineffective social and political governance (Bayu et al., 2020). In contrast, economic factor in governance influences basic water provisions more (ibid.). The allocation of funds in the WSS sector is increasing across developing world, but executing and financing large volumes of projects pose fiscal challenges to the governments (Mahalingam, 2013). The trend of under-performance is continuing across many developing countries.

Latest studies divulge that in country like Tanzania where despite a four-fold hike in the budget allocation[48] in the water sector (water supply, sanitation and hygiene) over 12 years the outcome is not satisfactory. It resulted in 40% non-functional water points in rural areas and an estimated 25% broken water points within two years of construction, thus aggravating horizontal and vertical inequality (Joseph et al., 2018). There are opposite examples too. Ethiopia has recorded increase in investment and also showed improvement in access to improved drinking-water supply from 13% to 52% from 1990 to 2012 and improved sanitation from 2% to 24% (JMP, 2015).

A cross country study across Asian countries indicates that poor water governance is the prime reason for public service provision like water supply, not the shortage of water (Araral & Yu, 2013). Thus, beyond the limit of financial stringency, India's water sector experiences problems due to non-financial factors like the differences in opinions between State and local administration on 'what policy' targets and 'how' is to be executed, resulting in bureaucratic blockages in the system (Water Aid, 2005; Redhouse, 2005). Despite the potential for sizeable returns on investment and sustainable finance levels of service remain substandard in terms of quality, reliability, acceptability, lower usage coverage and sometimes service end in permanent failure (Connor, 2015; Bhatt, 2011; Water Aid, 2008; Barnard et al., 2013).

Such background studies led us to the following analysis of WSS allocation in order to understand effectiveness of public expenditure in terms of its pattern and growth and empirical estimation in influencing piped water accessibility across households.

[48] Through enhanced coordination and commitments by donors to achieve the MDG for water.

Water supply and sanitation comprise two complementary services in WASH sector. Responsibilities involving these two services are generally imposed through same public departments. Generally same budget head accounts for the two services. As public expenditure of States on water supply and sanitation is presented in a consolidated manner for rural and urban areas, the study considers the total public expenditure.

5.2 Public Expenditure Pattern and Disparity in Water Supply

5.2.1 Pattern of Social Service Expenditure across States

The Indian Constitution has devolved many responsibilities to States such as agricultural development, public health, public order, water resource supply and sanitation, land development, mines, fisheries. Furthermore, there are subjects in concurrent lists like education, electricity, social planning, family planning etc. These extensive responsibilities assigned to States require high level of public expenditure. The share of (province) States' aggregate expenditure in total Government sector expenditure (Centre plus States) in India is higher than that in several other countries such as Australia, Denmark, Argentina the USA and Germany (World Bank, 2005). The expenditure by the States is allocated on social service, economic service and public service. Water supply and sanitation are a subsection of social service budgeted through capital and revenue heads.

The allocations for capital and recurrent expenditure is essential arena for analysis as per sector and programs (Pradhan, 1996). State-wise decomposition of revenue and capital account on social services is not distributed equally across sectors. The combined revenue account across States and Union Territory (UT) accounts for about 40% average on social services, whereas capital account totals around 25% (For details, refer Appendix 7 & Appendix 8).

The ratio of social service expenditure to Gross State Domestic Product (GSDP) is an indicator of priority of State given to social development. About 10% of GSDP are spent on social services by the 29 States in 2017-18. The actual percentage of GSDP spent on social service during 2017-18 was, on an average, at 7.86% for the non-Special Category States, 14.6% for the Special Category States and 10.01% on average across all States and Union Territories (Table 5.1).

Table 5.1 Descriptive Statistics on Social Service Expenditure to GSDP				
Year	2017-18	2018-19 (BE)	2018-19 (RE)	2019-20 (BE)
Non-special Category States				
Average	7.86	8.95	8.98	8.74
Standard Deviation	2.95	3.47	6.86	3.91
Highest	14.1	17.8	19.7	19.4
Lowest	3.6	4.7	4.7	4.6
(Highest/Lowest) ratio	3.92	3.79	4.19	4.22
Special Category States				
Average	14.6	15.5	17.5	16
Standard Deviation	5.7	5.4	6.9	6
Highest	24.8	24.7	31.2	27.9
Lowest	7.2	8.1	7.4	7.7
(Highest/Lowest) ratio	3.4	3	4.2	3.6
All States				
Average	10.01	11.13	11.72	11.06
Standard Deviation	5.19	5.34	6.54	5.83
Highest	24.8	24.7	31.2	27.9
Lowest	3.2	4.1	3.6	4
(Highest/Lowest) ratio	7.75	6.02	8.67	6.98
Source: RBI: State Finances: A Study of Budgets of 2019-20; Basic Source: Budget documents of the state governments.				

State's social service expenditure as a percentage of GSDP could be about eight times (=7.75) higher in a State with maximum social service expenditure compared to the lowest. This signals great disparity in developing the social bases across State.

Within social services, the expenditure accruing to urban development and Housing received increased attention (by proportion) during the latest period (Table 5.2). The allocations on water supply and sanitation (WSS) are seen to be almost stuck at 6% to 7% since 2015.

Table 5.2 Composition of Expenditure on Social Services (%)					
Item	2015-16	2016-17	2017-18	2018-19 (RE)	2019-20 (BE)
Expenditure on Social Services	100	100	100	100	100
Education, Sports, Art and Culture	44	43	42.9	40.5	41.5
Medical and Public Health	11.6	11.8	12.3	11.9	11.8
Family Welfare	2	1.9	2	2	2
Water Supply and Sanitation	6.1	6.5	7	6.5	6.7
Housing	2.9	3.2	3.8	4.5	3.8
Urban Development	6.5	8	7.6	8.7	8.8
Welfare of SCs, STs and OBCs	7	6.9	7.4	7	6.9
Labour and Labour Welfare	0.9	0.8	0.9	1	1.1
Social Security and Welfare	11.4	10.9	10.4	11.5	11.6
Nutrition	2.6	2.4	2.3	2.2	2.2
Expenditure on Natural Calamities	3.9	2.9	1.6	2.8	2
Others	1.1	1.6	1.8	1.5	1.5
Source: RBI State Finances, 2019-20, page 29					

To understand the commitment and consistency of social service out of total expenditure responsibilities across States across revenue and capital accounts, the Table 5.3 presents proportion of social service expenditure in revenue account and capital account across Indian States. Social services share on an average 38.10% of total expenditure incurred combined by States and UTs during the latest decade from 2009 to 2017. Out of that, in revenue account the proportion of combined social service expenditure channelizes is about 45(=44.63)% on average, while the corresponding figure for capital outlay recorded in capital account stands at 36.22%.

Proportions of social services expenditure to total disbursements across States follow a moderate coefficient of variation at about 20 (~19.87)% during 2009-2016 (Table 5.3). The inter-temporal variability of capital expenditure across States is about 46%, which is about 1.5 times higher than variability on revenue expenditure (=30.26%). The social service expenditure across States is, therefore, not uniform and overtime it witnessed fluctuation as proportions to total expenditure.

Table 5.3 Trend of Proportions of Social Service Expenditure to Total Expenditure (%)			
Year	Revenue Expenditure	Capital Expenditure	Social Service Expenditure
2009	35.85	23.64	27.79
2010	36.93	23.19	33.79
2011	37.41	42.41	38.58
2012	37.21	40.75	38.26
2013	41.23	48.07	43.95
2014	70.76	72.41	54.41
2015	38.44	22.04	33.25
2016	38.19	26.13	35.02
2017	65.64	27.34	37.87
Average	44.63	36.22	38.10
Coefficient of Variation (for variability)	30.26	45.98	19.87
Source: Computed, Basic data: RBI State Finances			

As a general trend expenditure on Social services has gone down as proportion of total expenditure of State governments. FRBM Act, 2003 to maintain fiscal discipline in States' (revenue deficit at zero, fiscal deficit at 3% and outstanding liabilities at 20% of GSDP) led to resource crunch and pressure on disbursements. Compression of expenditure, mainly for discretionary development purpose has been widely noticed among States to obey the target limits of deficits (Chakraborty & Dash, 2013). Capital investment across States has been over cautious due to its negative relationship between the FRBM rules (Chakraborty, 2017). Investments and expenditure in social sector are primary casualty in over-cautious States or States with genuine fiscal problem, which avoid allocation and disbursement on social heads for fear of breaching FRBM regulations.

5.2.2 Pattern of Water Supply and Sanitation Expenditure

Water supply and sanitation received an allocation of over 6% of total expenditure on social services on combined revenue and capital accounts (Table 5.2). Precisely, the proportions were 6.1% in 2015-16, 6.5% in FY 2016-17, 7% in 2017-18, 6.5% in

2018-19RE and 6.7% as per the budget proposals of 2019-20 (RBI, 2019)[49]. The States' latest actual allocations on water supply and sanitation in proportion to total revenue and capital expenditure of States is 0.64% in 2017-18 (Table 5.4). The figure changes to 0.93 % in 2018-19 BE, 0.87% in 2018-19 RE, 0.94% as per as in 2019-2020 budget proposal. Average of this percentage allocation on water supply and sanitation is 0.86% for non-special category States, while it is slightly better at 1.22% for special category States.

Out of the States' total revenue expenditure, the share of water supply, and sanitation 1.67 % in 2017-18, 1.59% as per 2018-19 RE, 1.47% in 2019-20 BE (Details Appendix 9). On the capital expenditure side, the share of water supply and sanitation expenditure was 0.32 percent in 2017-18 for all States combined. This has subsequently increased slightly to 0.48% in 2018-19RE and 0.61% in 2019-20BE (Details in Appendix 10).

Among the non-special category States, Goa invested maximum in water and sanitation at 2.08% and among Special Category States Manipur invested maximum at 2.54% in FY 2017-18. The non-special category States allocate on an average 0.42% of their total capital allocation on water supply and sanitation in 2017-18, which subsequently increased to 0.93% in 2018-19 RE and 0.93% in 2019-20BE. The average proportion of allocations across Special category States is higher at 0.91% in 2017-18, increasing further to 1.33% in 2018-19RE and 1.42% in 2019-20BE. Capital expenditure calls for urgent and substantial augmentation because expansion of physical infrastructure of pipeline and sanitation facilities is capital intensive.

[49] Basic source : Budget documents of the state governments.

Table 5.4 Percentage of Water Supply and Sanitation Expenditure to Total Expenditure of the State				
States	2017-18	2018-19 (BE)	2018-19 (RE)	2019-20 (BE)
Andhra Pradesh	0.64	1.16	0.36	0.69
Bihar	0.71	3.73	3.86	3.79
Chhattisgarh	0.67	0.81	0.72	0.57
Goa	2.08	3.42	3.42	2.88
Gujarat	0.63	1.19	1.55	1.6
Haryana	1.4	1.06	1.44	1.31
Jharkhand	0.79	1.16	0.75	0.84
Karnataka	0.57	0.73	0.65	0.65
Kerala	0.79	1.16	0.75	0.84
Madhya Pradesh	1.16	0.68	1.2	0.83
Maharashtra	1.08	1.23	1.23	0.97
Odisha	1.51	1.54	1.35	1.45
Punjab	0.87	1.37	1.34	1.69
Rajasthan	0.32	0.46	0.35	0.4
Tamil Nadu	0.97	1.36	1.34	0.33
Uttar Pradesh	0.17	0.45	0.46	1.07
West Bengal	0.34	0.40	0.30	0.29
Arunachal Pradesh	1.34	1.80	0.62	0.60
Assam	1.06	0.75	1.21	0.85
Himachal Pradesh	1.60	3.51	3.38	3.73
Jammu & Kashmir	1.81	1.87	1.97	2.00
Manipur	2.54	0.95	1.74	1.21
Meghalaya	0.84	0.79	0.95	0.92
Mizoram	0.72	1.11	1.29	1.38
Nagaland	0.58	0.96	0.56	0.83
Sikkim	0.87	1.37	1.34	1.69
Tripura	1.01	1.75	1.57	1.37
Uttarakhand	1.01	1.75	1.57	1.37
All-States	0.64	0.93	0.87	0.94
All States and UTs	0.59	0.90	0.81	0.87
Non-Special Category	0.86	1.29	1.24	1.19
Special Category	1.22	1.51	1.47	1.45

Source: RBI, State Finance, 2019-20; Basic Source: Budget Documents of States;
Total Expenditure= Revenue Expenditure + Capital Disbursement;
BE: Budget estimates; RE: Revised estimates;

The proportion of WSS to GSDP of the States indicates the State's dedication towards this service responsibly. Some of the estimates at the global level suggest that the overall allocations on the water connections to Households as percentage of Gross Domestic Product (GDP) ranges between 0.03% and 6.29% for the Korea Republic

and Congo Democratic Republic respectively (Hall & Lobina, 2010). The average of States' proportions of water supply and sanitation expenditure to GSDP, over nearly 30 years (from 1987 to 2016), across the sub-Nationals have been 0.44% (Table 5.5). The percentages work out to be 0.38 for non-Special category States and 1.36 for special category States over 1987 to 2016.

In order to attain SDG 6.1 and SDG 6.2 on 100% coverage of water supply and sanitation respectively, the estimated percentage of necessary allocation towards WASH is 0.64% of Indian GDP based on the growth rates during the 2010s (Hall & Lobina, 2010). This measure considers costs for building infrastructure only. If the operation and maintenance cost on 'water supply security' would be added, the proportion will increase.

These finding are supported by other literature. In estimating public expenditure on health, it reveals 1.1% of India's gross domestic product in 2010- 11, which increases to only 1.5% after the inclusion of expenditure on water supply and sanitation (Choudhury & Nath, 2012). Therefore, the marginal contribution provided water supply, and sanitation to total expenditure is as small as 0.4% for 2010-11. It necessitates an improvement over the transfer of resources structure towards water and sanitation, specifically on India's WASH sector. The Special category States need to be in the prioritized arena in this respect.

Table 5.5 also presents the variability in spending of States on water supply and sanitation as proportion to their GSDPs. The analysis is inter-temporal, covering a long period from 1987 to 2016. The descriptive statistics consider as the average of all States combined spends only 0.32% of GSDP on water supply and sanitation services during 2011 to 2016 (0.29% for non-special category States and 0.81% for special category States) which is a depletion in allocation compared previous last decade, i.e. over 2000 to 2010.

Table 5.5 Inter-State Variations in Expenditure on Water supply and Sanitation to GSDPs (%)						
States	Average over 1987 to 2016	Average over 2000 to 2016	Average over 2011 to 2016	Coefficient of Variations for the period		
				1987 to 2016	2000 to 2016	2011 to 2016
Andhra Pradesh	0.38	0.36	0.21	38.12	45.9	24.2
Bihar	0.45	0.39	0.38	27.92	29.5	32.7
Chhattisgarh	0.39	0.39	0.34	34.63	34.6	51.8
Goa	1.39	1.16	0.85	32.25	33.2	6.3
Gujarat	0.38	0.37	0.25	45.19	49.5	23.5
Jharkhand	1.27	1.27	1.19	15.00	15.0	10.8
Haryana	0.37	0.22	0.22	56.95	29.5	23.9
Karnataka	0.34	0.33	0.28	23.15	21.7	24.8
Kerala	0.26	0.18	0.16	47.74	21.8	14.9
Madhya Pradesh	0.57	0.46	0.43	28.05	15.7	17.9
Maharashtra	0.24	0.19	0.11	42.17	47.0	28.5
Odisha	0.52	0.49	0.52	26.80	33.5	45.9
Punjab	0.23	0.24	0.19	18.53	20.8	12.5
Rajasthan	1.26	1.12	0.83	25.05	27.1	24.2
Tamil Nadu	0.35	0.28	0.20	45.83	52.3	11.9
Uttar Pradesh	0.24	0.21	0.22	28.74	28.1	27.4
West Bengal	0.20	0.21	0.21	24.18	26.9	24.7
Arunachal Pradesh	3.07	3.10	2.25	25.86	29.3	23.3
Assam	0.57	0.52	0.50	32.13	28.8	37.6
Himachal Pradesh	1.98	1.72	1.06	29.47	34.6	8.1
Jammu & Kashmir	2.09	1.73	1.21	28.68	26.5	13.7
Manipur	1.94	1.94	1.24	33.14	41.2	20.6
Meghalaya	2.06	1.68	1.34	27.99	19.8	7.6
Mizoram	3.41	2.94	1.73	32.15	35.6	21.4
Nagaland	2.00	1.09	0.78	73.36	41.5	30.7
Sikkim	3.02	2.09	0.58	53.04	65.9	17.2
Tripura	1.23	1.04	1.13	25.91	18.8	18.1
Uttarakhand	0.60	0.60	0.39	52.55	52.6	24.8
All States (no UTs; no Telangana)	0.44	0.40	0.32	18.90	19.0	16.1
Non-special category States	0.38	0.35	0.29	18.69	18.4	17.2
Special category States	1.36	1.13	0.81	26.67	24.9	12.9
Source: Computed; Basic Source: Finance Accounts, India						

Average WSS allocation as proportion of GSDP does not show very wide variation over years. The latest average of proportions of WSS to GSDP is 0.32% during 2011 to 2016. Coefficient of variations over all States during 2011 to 2016 is 16.1%, - which is not high. During 2000-2016, the States witnessed average variability of 19.0 % as minimum out of other periods considered in this analysis. During this period, the variability of the statistic across 11 special category States (24.9%) is seen higher compared to 17 non-special category States (18.4%). The degree of expenditure consistency is more across the special category States than the non-special category States.

On the whole, WSS allocation as proportion of GDP of India is substantially lower than necessary to timely achieve SDG goals 6.1 and 6.2 regarding WSS. There is no systematic movement to augment allocation across the States over years. Inter-temporal variability of WSS is often erratic. Progress and expansion in WSS demand systematic arrangements in investment, expenditure, implementation and continuation on technology upgrade.

5.2.3 Growth analysis of Public Expenditure on Water Supply and Sanitation

Here the growth of individual State's allocation on WSS is examined. While Haryana, Chhattisgarh, Uttarakhand have experienced high growth rates like 29.2%, 21.3% and 45.6% during 2000-2016. The growth rate of WSS allocation as proportion of GSDP in the States like Goa, Maharashtra, Rajasthan, Punjab, Uttar Pradesh and West Bengal has been less than 10% over 2000 to 2016 (Table 5.6). The annual compound growth of expenditure on WSS was around 12 (~11.7) %. The average growth in capital expenditure and revenue expenditure are almost same (12.1% and 12.7%).

However, some states like Assam, West Bengal and Kerala, which hardly marks any growth in capital expenditure on water supply from 2000 to 2016. The growth rate of revenue expenditure on water supply is noticed in Uttarakhand as a maximum of around 48%, followed by Haryana 30.3%. The highest to lowest ratio is as high as 21.83 for capital expenditure on WSS. The capital expenditure on water supply follows more volatile movement across the States compared to revenue expenditure, which accounts for administration, operation and maintenance expenses.

Table 5.6 Average Annual Compound Growth of Expenditure in Water Sector: 2000-2016			
States	Revenue Expenditure	Capital Expenditure	Total Expenditure
Non-special Category States			
Andhra Pradesh	8.6	6.3	10.1
Bihar	15.3	24.8	11.7
Chhattisgarh	22.9	76.2	21.3
Goa	7.9	8.5	7.5
Gujarat	7.8	6.1	12.9
Jharkhand	12.8	12.6	12.9
Haryana	30.3	62.1	29.2
Karnataka	15.6	8.1	17.2
Kerala	12.1	~ 0	10.8
Madhya Pradesh	12.9	49.9	11.4
Maharashtra	7.9	13.6	7.8
Odisha	17.1	17.9	16.8
Punjab	10.6		5.1
Rajasthan	11.3	14.2	8.4
Tamil Nadu	8.3	5.8	12.5
Uttar Pradesh	15.4	38.4	2.8
West Bengal	10.2	~ 0	9.8
Special Category States			
Arunachal Pradesh	14.8	16.7	14.4
Assam	14.8	~ 0	9.8
Himachal Pradesh	9.3	7.1	10.3
Jammu & Kashmir	9.2	6.4	10.9
Manipur	12.7	12.8	12.5
Meghalaya	8.6	7.6	9.8
Mizoram	7.2	3.5	9.2
Nagaland	8.5	8.2	9.1
Sikkim	8.4	8.5	8.3
Tripura	9.9	7.9	14.6
Uttarakhand	48.2	45.8	45.6
Overall	12.1	12.7	11.7
Highest to Lowest	6.72	21.83	16.29
Source: Computed; Basic Source: Finance Accounts, India			

The growth of revenue and capital expenditure on every five years' interval has been calculated (Table 5.7). Average growth figures over short intervals show that the

growth does not follow any regular pattern. The growth rate of WSS expenditure is lower for Special category States than non-special category States. Out of the five growth points, the highest is from 2011 to 2016. The growth differences across special and non-special category States indicate government spending on WSS service increased in economically sound States. Government spending of a municipality, measured by the resident population, is non-linearly linked with its size (De Mello, 2002).

Table 5.7 Average Growth of Expenditure on Water Supply & Sanitation

Growth during	1987 to 1990	1991 to 2000	2001 to 2004	2005 to 2010	2011 to 2016
Of All States					
Capital Expenditure	-6.66	14.74	44.16	15.60	23.41
Revenue Expenditure	7.37	11.30	6.00	11.10	16.10
Revenue and Capital Expenditure	4.73	12.70	10.00	7.06	16.87
Of Non-special Category States					
Capital Expenditure	-9.60	17.46	62.19	21.78	28.40
Revenue Expenditure	5.74	11.37	4.01	11.01	18.90
Revenue and Capital Expenditure	3.78	13.67	9.29	11.52	19.27
Of Special Category States					
Capital Expenditure	-3.14	11.71	14.36	3.62	15.25
Revenue Expenditure	9.81	11.19	36.70	8.99	18.69
Revenue and Capital Expenditure	6.15	11.26	40.37	5.44	12.96

Source: Computed; Basic Source: Finance Accounts, India

Through the average annual growth for revenue expenditure is almost same across special and non special category States (18.69% and 18.90%) during 2011-2016, the growth of capital expenditure on WSS is quite higher across non-special category States for different periods, including the latest decade for 2011-2016. Increase in volume of transferred expenditure towards special category States could be one of the explanatory reasons.

The growth of capital expenditure attributed to WSS service increases across special and non-special category States from 2011 to 2016 compared to previous time periods as depicted in Table 5.7. Such improvement in growth is supported by the initiative of AMRUT. This centrally-sponsored initiative plays the role of a big push to urban development with core focus on water supply and sanitation. Besides the growth of capital expenditure, the revenue expenditure also marks some growth across the Indian States during 2011-2016. On the whole, however, allocation is inadequate for timely achievement of SDG related to WSS.

5.2.4 Ratio Analysis: Pattern of Revenue and Capital Expenditure

Water supply sector in general demands an intensive foundation of physical infrastructure – therefore, robust capital investment. The inherent relation between capital invest vis-a-vis the regular revenue expenditure is important for understanding the State government's commitment to incur capital investment.

Table 5.8 shows the average ratio (ratio of revenue to capital expenditure, as well as, capital investment in Crore for every 100 Crore revenue expenditure on WSS) across India. There is significant hike in relative Capital Expenditure. It appears, therefore, that importance of Capital investment to create WSS infrastructure has been recognised as opposed to revenue expenditure - predominantly for operation and maintenance, wages and salaries and other liabilities. Based on the time series data for 28 States (excluding Telangana), one can see that revenue expenditure is higher in proportion on an average by 1.37 times from 2001 to 2016, adjusted by GSDP deflators. The capital investment in the water supply sector was relatively small in size during the pre-2000 years. The ratio was about INR 29 against per INR 100 revenue expenditure. The ratio appears as INR 73 per INR 100 revenue expenditure.

There has been a remarkable change in the post-2000 period. There is an emphasis on Capital expenditure. The capital expenditure per INR 100 revenue expenditure ratio is about 2.5 times for the last two decades from 2001 to 2016.

Table 5.8 Relation between Revenue Expenditure and Capital Expenditure on Water Supply and Sanitation in all States

Year	Ratio of Revenue Expenditure to Capital expenditure	Capital Expenditure per INR100 of Revenue Expenditure
1987-88	3.203	31
1988-89	3.388	30
1989-90	3.805	26
1990-91	4.355	23
1991-92	3.403	29
1992-93	3.564	28
1993-94	3.765	27
1994-95	3.292	30
1995-96	3.407	29
1996-97	3.333	30
1997-98	3.963	25
1998-99	3.182	31
1999-2000	3.095	32
2000-2001	1.816	55
2001-2002	2.096	48
2002-2003	1.571	64
2003-2004	1.834	55
2004-2005	1.349	74
2005-2006	1.608	62
2006-2007	1.294	77
2007-2008	1.089	92
2008-2009	0.917	109
2009-2010	1.045	96
2010-2011	1.329	75
2011-2012	1.439	70
2012-2013	1.096	91
2013-2014	1.090	92
2014-2015	1.098	91
2015 - 2016	1.449	69
2016-2017	1.549	65
Average		
1987 to 2016	2.314	43
1987 to 2000	3.398	29
2001 to2016	1.366	73

Source: Computed; Basic source: Finance Accounts, Government of India

5.2.5 Decomposition of Revenue Expenditure

The study shows that revenue expenditure on WSS across States does not fallow a systematic movement which we can expect for an essential public service such as WSS. Public spending should be consistent with the macroeconomic framework (Pradhan, 1996). Here revenue expenditure in its various components has been analysed. Such analysis is essential to understand the nature of revenue expenditure.

Decomposition of expenditure on WSS on revenue accounts are derived from the budgetary heads and sub-heads. The study classifies the WSS expenditure into five categories - Administration, Operation, Scheme Expenditure, transfer to third-tier government & para-Statal bodies and Miscellaneous (For details refer to Appendix 11).

Table 5.9 Average Nature of Decomposition of Total Expenditure on Water Supply and Sanitation

Budget description	Averages Over				
	1987-1991	1992-2000	2001-2007	2008-2012	2013-17
Administration	6.4	8.2	8.2	11.0	9.0
Operational	2.4	3.8	1.9	2.0	6.1
Scheme Expenditure	74.3	70.4	69.9	70.9	72.1
Miscellaneous	7.8	7.2	7.2	9.4	7.6
Transfer to third-tier government and para-Statal bodies	9.2	10.5	12.8	6.7	6.7
Total	100.0	100.0	100.0	100.0	100.0
Water Supply	95.4	93.2	94.4	91.9	87.0
Sewerage and Sanitation	4.6	6.8	5.6	8.1	13.0

Source: Finance Accounts of Various Years, Government of India

Table 5.9 gives details of revenue WSS expenditure under five categories. Figures indicate that sanitation service was paid attention on more since 2013. Even as sanitation is a semi-private infrastructure, the base of the infrastructure depends on public provisions. For example, from 2001 to 2007 the average yearly expenses

on sanitation were less than 6 (~5.6)% of the total WSS allocation, i.e., under numbers '4215' and '2215' of the budget heads of India. However, it stands at 13% at the end of 2017-18.

The administration cost, including salaries, constitutes around 11% from 2008 to 2012 and 9% from 2013 to 2017. Operation and administration cost together needed 13% to 15% respectively in these two periods. This finding is analogous to the WASHCost India study in 2011. That study found that there was increase in plan expenditure on WASH sector through the priority for new schemes during 2009-2014 (Reddy & Kumar, 2011).

An increasing trend is observed in the States' expenditure devolutions on combined averages of administration expenditure and operational ground. The combined percentage value was at 8.8 % from 1987 to 1991, 10.1% from 2001 to 2007 and 15.1% from 2013 to 2017. However, the component on operational cost is minimal, around 2%, on average till 2012. The operational expenditure increased to 6.1% as average annual during 2013-17 from 2% during 2008-2012. Such an increase implies greater attention to the resource protection costs. Such recurring investments are expected to ensure sustainability of assets created.

The component study also reveals that the average transfer of States to third-tier government and para-Statal bodies for WSS service is not improving. The annual average of such transfers from 2001 to 2007 was the highest in the post decentralization era. The respective figure itself is only at about 13(~12.8) %. The average annual figure on this allocation was 9.2% during approximately mid 1980s, and 10.5% during 1990s. So, the improvement in terms of percentage post 2000 is not significant. This meagre improvement rather puts question mark on the effectiveness of decentralization through the Constitutional Amendment Act, 1992. The third tier governments are losing the ability to self-implementing programs on WSS. Major component of WSS revenue expenditure is scheme-specific expenditure. The model-like AMRUT programs envisages partial decentralization at the design selection level but not on finance.

5.3 Regional Disparity: Per Capita Public Expenditure on Water Supply and Sanitation

The study has used the projected population figures from the Ministry of Health and Family Welfare (MoHFW) published in 2019. The reference source applies accepted scientific way of population projection. The source signifies the country's expected population growth rate at 1% annually during 2011-2036 based on certain assumptions using previous data (MoHFW, 2019). This population scenario implies India will experience have a population of 151.8 Crore in 2036 (from 121.1 Crore in 2011). For the inter-temporal census years, 2002 to 2010 and 1992 to 2000 the study uses average annual growth rates based on population decadal growth rate and relevant census figures.

The inter-State pattern of public expenditures on WSS is essential to understand through expenditure per capita. This study shows that the average per capita WSS expenditure per annum over 16 years from 2001 till 2016 was INR 875.12 for special category States, higher than that for non-special category States by about 2.4 times (Table 5.10). The per capita expenditure is all at current prices. The per capita WSS variability is 113.69% across States. The inter-State disparity over time is relatively higher at 148.71% for non-Special category States, while lower variability is observed among special category States at 75.80%. However, the overall variation implies that there is no orderly structure in per capita WSS expenditure. The average of the highest-to-lowest ratio indicates a quick estimate regarding disparity. Such ratios for per capita WSS expenditure are higher for Special category States than non-Special category States.

Table 5.10 Per Capita Water Supply Expenditure at Current Prices: 2001-02 to 2016-17

Statistic	Category of States		
	All	Non-Special	Special
Mean (in INR)	565.1	364.5	875.12
Standard Deviation (in INR)	642.46	542.06	663.38
Coefficient of Variation (%)	113.69	148.71	75.80
Average of Highest to Lowest Ratio (Number)	101.39	29.11	99.27

Source: Computed; Basic Source: Finance Accounts, India

The highest to lowest ratios reveal significant differences. This study aims to understand trend in allocating public expenditure on WSS. The extent of diversification across the Special Category States is more than among the non-Special category States. The geographical diversity of water resources and States' differential fiscal capabilities could partially explain this variability. To understand the inter-temporal movement across 16 years in last two decades, Table 5.11 provided annual per capita WSS expenditure on combined States and UTs. The variability of per capita expenditure on WSS across the States was around or higher than 100% since 2001. After 2011 variability decreased marginally.

The study used Gini coefficient, coefficvient of variation and highest to lowest ratio- to throw light on the inequality in public expenditure on WSS per capita terms (Table 5.11). The study applies the Gini coefficient to measure the inequality between per capita WSS expenditure relative to the State's respective population burden. Gini coefficient assigns a numerical value to curve of inequality (Lorenz Curve) and useful to compare inter-temporally. This analysis finds that the Gini coefficients on per capita State expenditure on WSS across States are going down slowly in the last two decades as the coefficient values are found to be 0.873 in 2001 to 0.824 in 2016. This is accompanied by a simultaneous depleion in yearwise coefficient of variations. This also indicates indirectly increasingly higher attentions on WSS service in State budgets. As a contrast, Gini coefficient applied on urban household coverage by Piped (tap) water in India shows upward trend over time (Malakar et al., 2018). This supports the findings of the present study in Chapter 3.

The year wise coefficient of variation across States are shown quite high nearly almost 100% (Table 5.11). There is no much noticeable change on this statistic since 2001. The coefficient of variation appears as high as 112.25% against 2004, 102.91 for 2010 and 100.29 against 2013. This is a noticeable observation to understand the relative regional diversity in terms of per capita WSS expenditure commitment of Indian States.

Table 5.11 Disparity in Per Capita Public Expenditure on Water Supply and Sanitation: Inter-temporal Analysis			
Year	Ratio of Highest to Lowest	Coefficient of Variation (%)	Gini Coefficient
2001	95.82	107.47	0.873
2002	112.76	104.75	0.871
2003	129.38	108.57	0.87
2004	79.08	112.25	0.874
2005	96.28	108.13	0.867
2006	98.5	105.84	0.876
2007	108.93	107.27	0.864
2008	107.97	104.83	0.880
2009	110.18	103.98	0.879
2010	88.41	102.91	0.868
2011	115.71	103.6	0.866
2012	79.31	99.42	0.849
2013	82.04	100.29	0.830
2014	63.69	96.49	0.824
2015	136.05	98.78	0.850
2016	118.12	99.64	0.824
Source: Computed; Basic Source: Finance Accounts, India			

Even as the WSS expenditure is inadequate at less than 0.5% of GSDP and at 7% of social service expenditure, in per capita term the WSS expenditure is seen to have increased with lower variability across States. Such increase in per capita expenditure was not enough to achieve desired coverage of piped water. Thus, we need to examine the role of public expenditure on WSS on the expansion of access to piped water. A model in macro-framework, the following study attempted an estimation of the effectiveness of WSS expenditure on piped water across households in India.

5.4 Macro Factors for Piped Water Accessibility: Pooled Regression Model

The model is based on 83 observations across 29 Indian States. Public expenditure on WSS (consolidated for rural and urban) has been considered in the model. The model considers three-time points covering the period 2002 to 2018. The outcome variable is the household's accessibility of piped water.

5.4.1 Description of variables

Gross State Domestic Product is an indicator of the economic development of the State. WSS expenditure as percentage of GSDP is an essential indicator regarding the welfare of people and the government's concern for the essential social service. Therefore, the model recognizes public expenditure on WSS as a percentage of GSDP as the first independent variable.

The next two are dummy variables - first, for 'special' category States and the second one, for 'Big' States. The special category States' dummy is formed by putting non-special category States as outcome group with reference to special category. The 'Big States' dummy is formed by putting all other States in the reference category except the 9 Big States. The study has followed the categorization of 'Big' States as per the Reserve Bank of India specifications. Per capita GSDP of a State as per the 2011 census is used to determine 'Big' States. The Big states[50] are those with per capita GSDP (at current prices) higher than ₹ (INR) 75,000 in 2011 (Kaur et al., 2013). These include 9 States - Andhra Pradesh, Goa, Gujarat, Haryana, Karnataka, Kerala, Maharashtra, Punjab and Tamil Nadu.

The next important variable is female workforce participation rate. The female workforce participation rate is the proportion of female employed to total number of female in the working age (16-64 years). The coefficient the variable is positive and statistically significant. It has been seen in Chapter 3, that when female participation in gainful employment increases, the household's accessibility, affordability and necessity towards tapped water supply increase. The employment and unemployment survey of 61st round, NSSO in 2004-05, 68th round in 2011-12 and Periodic Labour

[50] https://www.rbi.org.in/scripts/bs_viewcontent.aspx?Id=3050

Force Survey in 2017-18 by the Ministry of Statistics and Program Implementation provided data for this variable.

Urbanization leads to higher level of economic activities and diversity of economic activity in the State. On the other hand, higher urbanization strengthens the States' resource bases with wider earning prosperities for people. High revenue base helps the State governments in financing basic public services. Creation of piped water supply infrastructure – thereby higher coverage of improved water supply – is one of most important social service essential for urban (as well as rural) population. The level of urbanization, thus, is expected to impact on piped water supply positively.

The effectiveness of WSS depends on good governance and strength of institutions, including provisioning of adequate financial resources. Good governance and institutional strength are critical for distributing service across all sections of people, especially the poorest, to receive water effectively to serve their needs (Hardoy et al., 2005; Bakker & Krooy, 2007; Jones et al., 2014). Good governance is necessary to attend to accessibility of essential services like water supply and control of diarrhoea[51]. To observe the impact of good governance on WSS, two variables have been considered in the study.

The first one is to see effectiveness of governance through expenditure on WSS. The variable is 'per capita WSS expenditure'. Public expenditure has a multiplier and time-lagging effect on its outcome. WSS expenditure per capita is the average of expenditures over t-1, t-2, and t-3 so as to understand the outcome at a time point in t-th year. Average of per capita WSS expenditure in three previous consecutive years has been used to examine the effect on piped water accessibility at time t. Per capita is justified as the States of different sizes are with vastly different population sizes.

The second one is to evaluate the governance through raising awareness and hygiene study across households. The use of water in hygiene is an important preventive measure of public awareness. Contaminated water is the most critically responsible factor behind diarrhoea's prevalence. Even as creation of piped network is responsibility of government, bringing the actual connection to the household for its

[51] Diarrhoea is a symptom of infection caused by a host of bacterial, viral and parasitic organisms most of which can be spread by contaminated water.

exclusive or shared use is a choice of Households and a payment of connection cost is necessary. Therefore, households' willingness and affordability are important determinants in studying the accessibility of tapped water in India.

The model hypothesizes that the outbreak of diarrhoea impacts positively on the level of crucial hygiene awareness across households. The study has discussed the importance of water supply in saving lives of children who died from waterborne diseases - predominantly from diarrhoea. Out of different waterborne diseases, diarrhoea accounts for about 85% on an average over the period 2013 to 2017 in India (Details in Appendix 12). The variable studied for this aspect is number of registered acute diarrhoea cases annually per thousand populations.

The prevalence of diarrhoea is a push factor for household's dependency on piped connection as a safer and more dependable source of water lowering chances of water-borne diseases. Awareness as a result of reports of diseases leads Household to decide in favour of piped water. The present model considered the past three years' average of the prevalence of registered diarrhoea cases as one of the independent variables. Source of data is the Central Bureau of Health Intelligence, Ministry of Health and Family Welfare.

5.4.2 Analysis

The result of the model is presented in Table 5.12. Goodness of the pooled regression is tested with adjusted r-square and probability of F ratio in the model. The variable on the proportion of water supply expenditure to GSDP is positive. A value of the coefficient at 3.865 implies that WSS expenditure to GSDP seems to have positive impact on expanded drinking water accessibility through pipes. However, its statistical significance is questionable.

Table 5.12 Importance of Public Expenditure on Accessibility to Piped Water: Pooled Regression				
Pooled Regression: time points: 2001-02, 2011-12, 2017-18				
Variable	Coefficient	Standard Error	t	P>t
Constant	-8.394	7.176	-1.17	0.246
WSS Expenditure to GSDP	3.865	2.866	1.35	0.182
Dummy of Special Category States (Reference (0)=Non-special)	15.760	5.838	2.70	0.009
Dummy of Big Category States (Reference (0)=Non-big)	22.385	6.080	3.68	0.000
Level of Urbanization	0.745	0.189	3.95	0.000
Female Workforce Participation Rate	0.439	0.200	2.20	0.031
Per Capita Water Supply Expenditure	0.001	0.001	1.67	0.100
Acute Diarrhoea Cases (‘000 Persons)	0.342	0.123	2.79	0.007
R^2 = 0.5992; Adjusted R^2 = 0.5618; Degrees of freedom=82				
Dependent Variable: Accessibility of Tapped Water				
Number of Observation=83; Root Mean Square Error=16.404; Probability> F=0;				

Both the dummies-special category and Big State - show their statistical significance with a positive relation to the piped water accessibility by households. The two dummies represent two sorts of States – (i) relatively affluent States in per capita income, i.e., ‘Big’ States and (ii) Special category States. The coefficient of special category dummy at 15.760 implies that due to change from a non-special category State to a special category State, piped water accessibility across the household sector increases by 7.366 times. Similarly, the coefficient of 'Big state' dummy at 22.385 states that in the relatively prosperous States piped water accessibility is significantly higher than other States. Both the coefficients are statistically significant. Both the dummies are significant with almost 100% level of confidence.

The model also infers that 'Big' States have better connectivity of piped water than other non-'Big' States. As the level of urbanization in a State goes up, the piped water accessibility across households of that State increases. Female workforce participation has a significant positive impact on piped water accessibility. Our results demonstrate that if one hundred females enter into gainful employment then there is a chance that about 44 new tap water connections will be demanded.

Increased opportunity cost of time seems to be the main factor for this strong influence of female work participation on demand for piped water accessibility.

Urbanization creates demand for better water infrastructure. India experiences a noticeable rate of urbanization globally and in Asia. The model has identified a positive effect of urbanization on piped water accessibility across households in India with high statistical significance. As a State gets further urbanized by 1%, piped water facility to households goes up by about 0.745%.

The variable on acute prevalence of diarrhoea per thousand populations proves to be significant and positive. The value of the coefficient 0.342 implies that the prevalence of every 100 diarrhoea cases impacts on increasing the level of awareness, which in turn results in additional 34 household with access to piped drinking water.

5.5 Conclusion

The percentage of social service expenditure is around 38% on an average of total expenditure by States of India. These percentages varied widely across States from 3% to 25% with a highest to lowest ratio around 5 over a time period of about 30 years till 2016. This is signal of great disparity in social service allocation by Indian States. Proportion of expenditure on Water and Sanitary Service (WSS) to total allocation on social service is around 6%. Of late, emphasis shifted on sanitation as compared to water supply. Though water supply is a State subject, it is significantly supported by Centre through schemes. On an average only 0.40% of States' GSDP went for water supply in FY 2017-18.

All these together implied that the average expenditure allocation on water supply and sanitation service as percentage of GSDP was only 0.40% of all States' accumulated GSDPs during 2001 to 2016. This figure goes down to 0.29% for non-special category States during 2011-2016 and to 1.13% for special category States. Allocation on WSS, as a whole, requires improvement across States.

The average annual compound growth of revenue and capital expenditure on water supply from 2000-2016 is almost equal at 12% both. The average ratio of revenue expenditure to capital expenditure is 1.37. The emphasis on capital expenditure

on water supply is increasing during latest decades compared to pre 2000. Detailed scrutiny revealed that during last decade, there was significant progress in average growth of capital expenditure, especially for non-special category States. During 2011-2016, the revenue expenditure on water supply across special category States grew annually at 18.69% on an average what is higher than growth of capital expenditure. On the contrary, non-special category States experienced a higher growth in capital expenditure than in revenue expenditure.

Within revenue expenditure, the prevalence of operational expenditure is increasing. Together operation and administration constitute about 15% of total revenue expenditure on water supply and sanitation. A significant improvement was noted in scheme specific expenditure. Direct transfer of financial resources on WSS to third-tier local government or para-Statal bodies have gone down as percentage from 2008 onward, primarily because most of scheme-linked expenses are incurred directly. Decentralization happened in selection of spots for water points, maintenance and certain non-financial area of WSS services.

Policy initiatives such as acceptance in 2010 of access to water as a human right, Har Ghar pe Jal in rural India, AMRUT scheme for urban India from 2014 and other factors led to higher annual growth in revenue and capital expenditure in per capita terms on WSS in recent years. In terms of per capita, WSS expenditure is improving, but there are distinctly different pictures between the special category and non-special category States.

The macro model brings out the fact that good water governance is more critical than greater allocation of budget in improved WSS. The analysis applied time pooled regression technique and identified that not only public expenditure as per capita basis or percentage of their respective Gross Sates Domestic Product, there are some macro-economic factors which influence water infrastructure represented by piped water accessibility. States' economic positions are indicated by respective levels of urbanization and per capita income (studied by the behaviour of dummy against ‘Big’ States) and it is seen to have noticeable effect on piped water accessibility. Public awareness and women’s economic participation are other two important variables to influence accessibility piped water. While government allocation on WSS as percentage of GSDP in 2017-18 remains far

from desired level across States, the study shows that marginal impact of additional financial allocation is minimal on expanding accessibility of piped water.

As the relevant coefficient in the Pooled Regression Model in section 5.4 showed, marginal impact of per capita public expenditure on WSS on expansion of piped water accessibility is rather low (0.001 in a scale of 0 to 1). First of all, majority of expenses goes to revenue heads and not for capital investments on expansion of piped network. Moreover, experiences in developing countries have revealed out that emphasis in MDG and later in SDG on expansion of water supply coverage, particularly in backward areas, led to higher expenditure on localised off-grid supply solutions such as tube well, hand pump or bore hole etc. instead of creation of more expensive physical infrastructure of pipeline for water supply and treatment. This seems to be a critical reason why even significant increase in per capita WSS hardly impacted piped water accessibility.

The initiative of Har Ghar pe Jal in rural India and its urban counterpart programme through AMRUT rightly brought the policy focus back on public expenditure on expansion of accessibility of piped water. India's water poverty and inequality can be best addressed and SDG best achieved by piped water access to all. Lack of public investments in piped water has led to the creation and entry of a robust non-public structure in water provisioning. The downstream job of public provisioning drinking water – namely, refining and distributing water to the access point – have been taken up by private players on commercial terms through provision of bottled water and installation of domestic purifier. In the next chapter these aspects have been examined in detail.

CHAPTER 6: SCOPE OF NON-PUBLIC PROVISIONING OF WATER SUPPLY IN INDIA - PPP MODEL AND BOTTLED WATER

6.1 Introduction

Responsibility of Government or local Public Authority for water provisioning cannot be underestimated – particularly in developing countries. Access to clean drinking water and sanitation are accepted as human rights (UNGA[52] resolution 64/292 of July 2010). Also, there are strong interconnections among water, public health, women's well being and environment. This chapter attempts to assess the role of private participation to strengthen infrastructure and institutional arrangement to ensure robust WSS services.

By latest, in 2018, private participation in regular water provision is seen through participation of private tankers and sale of cart with small tank or drum etc. In urban India, as per NSSO 76th Round, presence of such delivery sources of drinking water solves the needs of 0.65% of households. Water supply provided to the poor by government tanker satisfies the principal need of drinking water across 0.78% of urban households. Though in percentage terms the figure is small, but in absolute number it is not insignificant. These small sources solve the purpose of principal source of drinking water of about 606,734 (estimated) urban households (NSSO, 2018). This is a small existence of mixed sector where public and private providers are distinctly exists across different regions to different consumers.

Private sector is also seen to participate in two formats - (i) along with public sector, (ii) independent of public/ government framework for WSS service. The chapter will first examine PPP models. Independent private participation in India is demand driven and these are mainly in bottled drinking water and water purifier for domestic use. Obviously, perceived or real inadequacy in quality of drinking water through public supply provided room for private participation by way of bottled water and purifier. The findings in Chapter 3 – namely, water quality, inequality and inequity in piped water inaccessibility - also reinforce prevalence of recourse to private solution

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for drinking water. Such commoditization and commercialization of drinking water changes the nature of drinking water slowly from public or social good to economic good to a significant measure.

6.2 Private Sector Partnership with Public sector

6.2.1 Concept and Scopes in India

The public private partnership (PPP) promotes potential delivery models in infrastructure services in various sectors (Mahalingam & Seddon, 2012). PPPs on urban water utilities have a positive contribution to improving the population's coverage by widening the accessibility net and it has also positive impact on quality and efficiency in operating these services (Marin, 2009). Improved efficiency, better accountability to the users and improved awareness are other positive outcomes of PPP.

PPP is defined as a contractual agreement made by a regulatory agency, government or a statutory entity and appoints a private sector organization to provide an infrastructure service on payment of user charges from the consumers (MoF, 2019). Many services that were earlier managed by the public sector now managed by shared participation along with private sector interest and investment subject to government regulations in this regard. For instance, telecommunication, energy generation, airports, airlines have drawn extensive PPP investments. PPPs do not necessarily require the transfer of ownership (For details, refer to Appendix 13).

Though location of privatization in water sector is pre-decided by water resource base and the forms and structure of privatization of water service is discretionary for local regulatory Urban Body (ULBs) subject to State’s water policy and regulation. To understand appropriateness of a PPP model, it is essential to understand the institutional framework of the authority which conducts the public-private participation.

A PPP should be based on 'sustainability criteria' (Bennett, 1998) both for private and public operators. In delegation of management contract, lease, build-operate-transfer in a model PPP, normally there is no transfer of assets ownership in India. PPP is an instrument to bridge the gap between general ineffectiveness and inadequacy in public service and demand and expectation of beneficiaries.

PPPs to work in developing countries, the public authority should first understand the commercial viability of engaging the private sector entities, as no private investor would invest in a project unlikely to return profits. Both the private and public sectors are expected to engage in a long-term partnership to develop a facility and provide services to the people (Gunawansa & Bhullar, 2011). On the other hand, all groups of beneficiaries, including civil society organizations, workers' unions, extensive media coverage, sometimes are seen to resist a PPP from performing. Such conflict arises due to rise in water tariff and sometimes their incapability to remould attitude regarding ongoing concept that water is a social good and thus free from the pricing. Indian is familiar with paying the price for drinking water since the 1990s through accepting bottled water (Van Dijk, 2008). Indian households also are accustomed to buy water from private tankers and form cart with small tanks, drums.

The present emphasis on 'affordable' water in SDG 6 indirectly indicates the requirement of full or partial cost recovery. There is recognition of full operation and maintenance cost recovery in Indian WSS benchmarking criteria. Presently Indian urban public water delivery sector hardly makes satisfactory operation and maintenance recovery with a few exceptional cases. One assessment suggests that only about 10% of the cost per connection in Maharashtra is recovered (Singh et al., 2005). Delhi's public water supply loses 40-70% of the piped water due to physical and financial leakages. As per same source, the average recovery of operation and maintenance costs across the urban water supply is 30-40% (Mishra & Kingdom, 2012).

On the other hand, cost recovery leads to creditworthiness. Assured revenue generation is the most important value, for which the private sector participates in PPP. There are many urban areas where implementation of PPP has not been possible despite political decision and institutional support with finance. The reason is strong resistance to change in water tariff, which is necessary for commercial viability and full cost recovery for operation and maintenance.

Under-priced water and leakage affect State economies costing them 0.3-0.4% of their GSDPs (MoUD, 2010). Since 2002 the Indian policy regime encouraged PPP in Indian household water sector. There is political difficulty in introducing appropriate water pricing to recover expenses. In case of PPP tariff increase is viewed as private

profiteering for a service which government should ensure. Opposition in local political politics exploit public sentiments (Llanto, 2016). This is very often irrational and this impedes privatization and its consequent benefits (Hall, Lobina & Motte, 2005). Raising water tariffs remains a severe constraint aggravated by management and governance problems (Van Dijk, 2008).

In developing countries, where people generally end up spending more of disposable income in percentage terms on WSS services compared to people in industrialized countries, 3 to 5% of disposable income was claimed to be maximum limits (Smets, 2009). The PPP based provisioning usually demands volumetric tariffs for its sustainability (Mathur & Thakur, 2003; Houqe & Wichelns, 2013; Tiwari & Nayak, 2014). Such an arrangement requires support of community based on awareness (Budds, 2000; Van Dijk, 2008). However, in Indian cities water is under-priced and therefore cost of provision is not recovered (Sridhar et al., 2006; MoUD, 2010). Pricing structure in Indian cities remains arbitrary.

6.2.2 Debates on PPP and Household Water Supply Sector

Privatization of water is a debated topic in academic research. The subject of the discussion encompasses the problems of access, quality and price. However, PPPs, when well-designed and adequately implemented, have improved utilities' performance (Estache & Fay, 2007). Privatization brought significant improvement in access to piped water in Thailand, including improved quality and price. The better service indirectly impacts the households' tenure status in unregistered urban areas (Zaki & Amin, 2009). While East Asia and Pacific, particularly China, marks a significant development of PPP in the water sector with World Bank support, there are several prematurely called-off or renegotiated PPP projects in Latin America and Caribbean region (Lobina & Hall, 2007b). In these cases, the main reason behind failure is tariff revision during the long term concession period, opposed by consumers. Failure to complete project on time causing cost escalation and consequent tariff hike, premature closure of PPP projects due to public unrest and litigation thereupon seeking compensation, discriminatory pricing are some of reasons of conflict in South American countries (Gunawansa & Hoque, 2012).

As per the database of Private Participation in Infrastructure by World Bank only 20 projects, contributing 1.81% of all WB-financed PPP projects were in WSS sector by

the end of 2017. By investment it was only 0.41% of total investments by WB. Private investment size in the water sector is going down during this decade after a peak in the previous decade.

The debate on PPP in the water sector is highly politicized. Opponents of private sector participation in the water sector do not accept it as participation. They view PPP as privatization suggesting that it is a neo-liberal solution leading to sell-off of public stakes in the service, but with limited chances of success. Others claim that private sector involvement (PSI) is expensive, encourages corruption, leads to staff layoffs, tariff increase and environmental stress.

However, it is proven that a well-designed PPP can help poorly performing public utilities to perform better (Mathews, 2003). A more critical role for the private sector also means that the industry needs to be regulated more closely. Developing of public institutions and regulatory tools are vital. Pure privatization without regulation exposes WSS sector to corporate over indulgences (Hall & Lobina, 2004), which is harmful for the public. In France, where PPP generated much public unrest accusing corruption, government had to enforce regulations vigorously (Burnham, 2001).

The water sector has some markedly different features from other infrastructure sectors. The sector requires much closer partnership and participation by all stakeholders besides policymakers, donors, especially in countries like India, where there is no standardized water law across the country (Jones, 2004). Regulatory infrastructure with an appropriate privatization process can make a PPP success in developing countries (Estrin & Pelletier, 2018). The water sector can be considered as "transitionally public" good, which has the potential to be shifted to the private sector within an appropriately enforced regulatory and institutional framework (World Bank, 1996).

Like some countries in the Asia-pacific region, India experienced fall in public investment in infrastructure during the 1990s (Briceno-Garmendia et al., 2004). Investment in infrastructure dropped from 4% of GDP in 1990 to 3% in 1998 (ibid.). During this period, private sector financing on infrastructure increased, but its contribution was not significant to offset the fall in public investment (ibid). Government of India has since the early 2000s attempted to develop PPPs as part of

national priorities for WSS when the concept was initiated by the NWP, 2002, which announced PPP as a means for better public service delivery. The NWP 2002 encouraged private participation in planning with its innovative ideas and financial support.

Afterwards, the National Water Policy of 2012 reiterated the importance of private participation in the water supply and sanitation sector to solve the water issues in Urban India. Estimates indicate that more than 25% of India's entire water supply is from the unorganized sector (Van Dijk, 2008). Since 2015 the Ministry of Urban Development took the initiative of AMRUT opening up provisioning of the essential urban services for community and private sector participation.

The PPP projects exhibit the same inequity in access and marginalization of the poor. There is increasing evidence that all the risks are borne by the Government (Bhaduri & Kejriwal, 2005; Datta, 2009). This demands public education on PPP and strong community support. In many cases in India it is difficult to educate public that water supply requires tariff without which supply is not sustainable (HPEC, 2011). The tariff setting structures are non-uniform across States. For instance, Maharashtra, Rajasthan and Haryana have almost equal coverage of piped water supply yet experience different cost recovery levels 80%, 35%, and 11% (Misra & Kingdom, 2012). Phnom Penh's success has shown that cost recovery is possible to achieve even in a developing country[53] (Rouse, 2020). Certain fundamentals, such as tariff revision and the creation of effective Arnold regulatory systems are difficult to implement but critical to success of PPP. Given Indian context, it is crucial to understand how much, where and when private sector help is required to support water supply.

PPP can be formed without substantial investment. Various other responsibilities like an expansion of coverage, revenue earning, computerization of billing, training and upgrading, maintenance of water distribution system, bill collection and distribution are useful for public private participation (Arnold, 2005). There is no set model of PPP. A PPP model's success depends on many factors like availability of resources, local institutional arrangements, political will and beneficiaries' acceptability.

[53] https://iahr.tandfonline.com/doi/full/10.1080/07900627.2019.1685952#.XpcQecgzY2w

The national government has established several funding schemes to boost investor confidence in infrastructure PPPs, including WSS; for example, the Viability Gap Fund (VGF) with a maximum viability gap up to 20% and an agency within the Department of Economic Affairs (DEA) charged with supporting PPP projects that are economically justifiable but commercially unviable. Despite project support and funding schemes, however, development of PPP in India's WSS sector has been much slower than expected. Private Participation in Infrastructure (PPI) Database recorded only 13 PPP projects (1.8% of the total) in the water and sanitation sector by 2014. The share of total investments was even less, merely 0.2% of the total national investments in PPP projects (PPP cell, GOI).

Instead of getting involved into the debate of a private sector predominance over public or loosing of public control over private, it is better to look at PPP as a general tool of development for public infrastructure. Even share of risk in project is necessary. Risks from operation, revenue generation, debt-servicing, exchange rate fluctuations, political disinterest, dispute resolution mechanism, applied technology and environment have to be taken into consideration. Any foreign or local participant looks for certain security besides profit opportunities. Some of these non-profit factors are political stability, economic growth, fiscal strength of the economy, a reliable and neutral regulatory system, effective and neutral dispute resolution institutions (Delmon, 2015).

6.2.3 PPP Experience in Water sector: International scenario

Adequacy of natural resources, sufficient information to the private providers, objective specific and region-specific PPP design, financial sustainability are some that cannot be ignored (World Bank, 2018). Any premature closure of PPP badly affect the system - public and private both stakeholders. Since late 1980s, PPPs have also been tried WSS sector, first by several developed countries and then gradually in developing countries. Manila achieved expansion of WSS service and uninterrupted 24-hour water supply in the 1990s through PPP with involvement of International donors and competitive bidding process (USAID, 2005). The achievement was not without challenges. The construction period witnessed the Asian Financial Crisis. A considerable devaluation of the currency exposed private operators to financial

uncertainties, but local private players could overcome challenges. The following table (Table 6.1) shows distribution of PPP with World Bank finance.

Table 6.1 Distribution of Public-Private Participation in Water and Sewerage Sector		
Region	Number of Project	Percent of total projects
East Asia and Pacific	570	65.7
Europe and Central Asia	37	4.3
Latin America and the Caribbean	196	22.6
Middle East and North Africa	24	2.8
South Asia	22	2.5
Sub-Saharan Africa	18	2.1
Grand Total	867	100
India	19	2.2
China	537	61.9
Description of The PPP Model applied in China by External Assistance from World Bank		
Build, operate, and transfer	341	63.5
Build, own, and operate	6	1.1
Build, rehabilitate, operate, and transfer	21	3.9
Management contract	40	7.4
Partial	17	3.2
Rehabilitate, operate, and transfer	112	20.9
Source: Private Participation in Infrastructure (PPI) Database, World Bank, https://ppi.worldbank.org/en/customquery		

Table 6.1 shows significant share (65.7% out of total) of WB's PPP allocations in WSS in East Asia and Pacific with high bias to China (61.9%). In nearly 64% cases in WSS sector China adopted Build-Operate-Transfer (BOT) and in 21% ceases adopted Rehabilitate-Operate-Transfer (ROT) model.

In India, premature termination of contract is a common occurrence. It is essential to understand PPP's pros and cons in the Indian WSS context from every stakeholder's viewpoint. An ideal PPP model incorporates and retains all stakeholders' interests with differential weightage (Refer Table 6.2).

Table 6.2 Distribution of Interests among Stakeholders in Public Private Participation		
Public authority	Private sector	General public
A successful PPP leads to popular support on ground of good governance.	PPP is new business opportunity in WSS, so far kept out of private sector. Scope of substantial profit	The public expect reliable, efficient, affordable, user-friendly service, free from corruption and harassment
Is an opportunity to introduce innovation & technology upgrade in public services for more efficiency and convenience. Greater accountability than bureaucracy.	Opportunity to gain experience and bolster image in public service, opportunity for which is otherwise not available to private players.	Better service with innovation and technology upgrade, including Internet enabled billing, lodging and processing complaints, payment etc.
Outsource services on public-government interface; thereby reduce petty corruption and harassment of consumers	Brand building through successful PPP for expansion of business in or related sectors.	Gainful employment for public in tasks such as management, billing, collection of charges, repair works etc
Saving of capital and man-power, this can be used in other essential tasks of the government.	_	_
Source: Computed		

Nevertheless, there is no suitable model of PPP applicable to all situations. BOT and ROT are commonly applied models in China. Western and Central Africa implemented PPP successfully in WSS with long term contracts, leasing, or long-term management contracts (Fall and others, 2009). In France, the municipal government delegated water supply and wastewater treatment services to private sector through full privatization on leasing contracts at the beginning of the 90s (Loë, 1993). This was one of the most extensive privatizations of the water utility reaching up to country's 4/5th population and wastewater to half its population.

Privatization led to stiff tariff escalation. Subsequently, there have been cases of reverse-privatization when privatised services have returned to PPP model with better efficiency, accountability and tariff control (Lobina & Hall, 2007a). Return of public

participation led to transparency and accountability in the water service system in France. AMRUT initiative in India following this trend is more public dependent. Proper community participation has the full potential to establish accountability in WSS services in India.

6.3 PPP in India's Water Supply Service

Private participation in water supply in India started in 1980s. Non-official agencies were responsible for about 28.5 % of India's total water supply besides the government arrangement of 71.47% (46th Round, NSSO, 1990). The surveys revealed that public sector provides water mainly through tap while the non-governmental agencies' participation are predominantly by groundwater extraction by hand/ machine pumps, tube wells, pucca wells, tanks and ponds (Table 6.3).

Table 6.3 Source of water supply as per method, 1991: Urban India

Method of supply	Government	Non-government
Tap	86.87	13.12
Hand pump/Tube Well	35.42	64.58
Pucca Well	17.86	81.13
Tank/ Pond	26.96	73.04
Tankers	79.05	20.95

Source: Amitabh Kundu, 1991. accessed in Mulkh Raj, Financing of Urban Infrastructure in India, Nagar Lok, Volume 23, Number 1, 1993

The local bodies' responsibility is often seen to be restricted in supplying through public stand posts or delivering through ad hoc arrangements such as water tankers. In India, although some PPPs in the water sector were called off their initial stages in the past, recent data show that PPPs are gaining momentum for water supply and sewerage treatment. Many of these projects have just started operation, and it may be too early to judge their effectiveness. Given the sheer size of the population, the number of megacities and the increasing number of people living in urban areas, India has immense potential for developing PPPs in the water sector.

World Bank and other international players have been active since 1990s to promote PPP in India. Since 2000, the private sector is more involved in Water Treatment Plants and Sewerage Treatment Plants. Post-2005, some PPP projects have seen

success providing momentum. Several new projects were coming up (MoF, GoI, 2009). Besides international players, prominent private companies[54] got involved in PPPs.

Table 6.4 Public Private Participation Projects in India with World Bank, 1990-2017

Sector	Subsector	Projects in		Total Investments	
		Number	%	Amount in $ Million	%
Energy	Electricity	449	40.71	1,49,942	48.95
	Natural gas	5	0.45	831	0.27
Telecom	ICT	25	2.27	3,272	1.07
Integrated MSW*	–	29	2.63	3,272	1.07
Transport	Airports	15	1.36	10,475	3.42
	Railroads	10	0.91	7,958	2.6
	Roads	486	44.06	89,975	29.37
	Seaports	44	3.99	9,585	3.13
	Collection & transport	6	0.54	18	0.01
Water and sewerage	Treatment plant	14	1.27	372	0.12
	Utility[55]	20	1.81	1,258	0.41
	Sub Total	34	3.08	1,630	0.53
Total		1,103	100	3,06,325	100

Source: PPI Database, World Bank, 2017[56]; * Municipal Solid Waste since 2008

Table 6.4 above outlines PPP projects in India across various sectors. Energy (49.22%) and transport (38.53%) account for 92.02% of the total number of PPPs and 87.75% percentage of investment volume involving PPPs in India supported by World Bank. Hardly 3.08 % of total projects and $1.63 billion (0.53% of funding) out of total investments in PPP were in WSS sector in 27 years (1990-2017).

This implies an addition of 21 additional projects of World Bank supported PPP in India over its water and sewerage sector. The area of PPP support in total, is becoming sound as 378 new projects have been initiated during 2012-2017 (Refer to Table 6.4 along with Appendix 14 for comparison). In terms of the relative financial position of

[54] such as Jamshedpur Utilities & Services Company Ltd. (JUSCO), IVRCL, and SPML
[55] without sewerage
[56] https://ppi.worldbank.org/en/snapshots/country/india

water sector in total investment size of the World Bank induced PPP in India, it is around 0.33 percentage point increase, on water and sewerage sector.

The PPP involvement in WSS sector has increased in the last decade as per the Government of India's database on infrastructure. As per PPP Cell, Ministry of Finance a total of 9,242 PPP projects are there in India, with an estimated total investment of INR 68,130,080 Million[57].

The report contains a sector-wise classification of different PPP projects taken over different periods. The water supply and sanitation sector accounts for 1,558 projects as per the PPP Cell. The report divides infrastructure projects on water supply and sanitation into four categories according to the stage of development of PPP. They are (i) completed, (ii) pre-construction stage, (iii) under construction, (iv) operation & maintenance stage. Present study considered only completed projects. Out of the completed PPP projects piped water network and water supply constitute 40.2 % of total number (Table 6.5).

Table 6.5 Public and Private Participation in Water Sector, India, 2019

Category	Types of PPPs in Water Sector	Number	%
1	Irrigation	147	34.8
2	Sewerage collection, treatment and disposal	80	18.9
3	Strom water drainage	26	6.1
4	Piped Water Network and Water Supply	170	40.2
Total	Completed	423	100

Source: Computed; Basic Source: PPP Cell, Ministry of Finance, Government of India

Success of PPP in India depends on a proper blend of ownership, pricing and governance (Shah, 2019). Model can differ within parameters of Private Sector Participation (PSP), Public Sector Partnership (PPP) and Private Finance Initiatives (PFI). These forms have significant differences in operational frameworks, public oversight and financial liabilities. Belgaum, Hubli-Dharwad, Gulbarga, Mysore in Karnataka, Nagpur, Latur, Bhiwandi Nizampur city, Aurangabad, Pune in Maharashtra, Chennai, Madurai and Tirupur in Tamil Nadu, Haldia, Sector-V Salt

[57] https://www.pppinindia.gov.in/ppp-project-data

Lake, Kolkata in West Bengal, Dewas, Khandwa in Madhya Pradesh, Naya Raipur in Chhattisgarh and Ahmedabad in Gujarat are some of prominent examples of PPP in water supply and sewerage.

Fragmentation of responsibility and lack of ownership for solutions to the problem in India is not conducive to optimal planning, project conceptualization and implementation. There are obstacles to raise awareness on good practices and systems among agencies in different jurisdictions (Wu et al., 2016). The desirable approach at present in PPP projects in WSS services should be to start with assigning limited roles (operational management, technology up-gradation and conduct of billing, collection of fees, quick repair and maintenance etc) and limited financial risks to the private sector and primary capital investment, ownership, oversight and responsibility with the public authority.

6.4 Case Study of PPP in India: Water Supply Utility

6.4.1 Project Description

Karnataka is one of the frontline States in terms policy measures and legislation on drinking water & sanitation policy besides initiatives on various water projects since 2002. In 2005, the Government of Karnataka (GoK), with assistance from WB, initiated program to improve water supply with private sector participation at the local level on three ULBs of Belgaum, Gulbarga, and Hubli-Dharwad. Hubli-Dharwad is a class-1 city with projected population 1,.085 million in 2020.

Belgaum, Gulbarga, and Dharwad- all the three districts are located in inland northern Karnataka region. The level of percentage of urban population in Dharwad district is far above than the National level of urbanization as per 2011 census. Dharwad experiences a level of urbanization at 56.82% as per Census, 2011 by which it shows the highest state of urbanization in the northern Karnataka geographical region. Gulburga experiences almost same level of urbanization at National level at 32.56% where as Belgaum denotes its urbanization at 25.34% by Census, 2011 (For details, Appendix 15).

The PPP project in the twin cities Hubli and Dharwad under the Karnataka Urban Water Sector Improvement Project (KUWASIP) was given the National Urban Water

Awards 2009[58]. The award was mainly for non-intermittent and continuous piped water supply. The project's achievement in ensuring better availability, quality, continuity, consistency of water supply throughout the year was praiseworthy (Ray et al., 2018). Such a project has the potential for replication in other similar cities.

Prior to the PPP project, Hubli-Dharwad faced inadequate water supply. Demand for water in this city was mainly (about 95%) from the household sector. The absence of bulk industrial demand for water ruled out possibilities of substantial cross-subsidization of water tariffs (Sangameswaran et al., 2008). Inequity in distribution and lack of frequent water supply was considerable challenge to the twin cities. We notice analogous features of inequity and inadequacy in urban water supply in India.

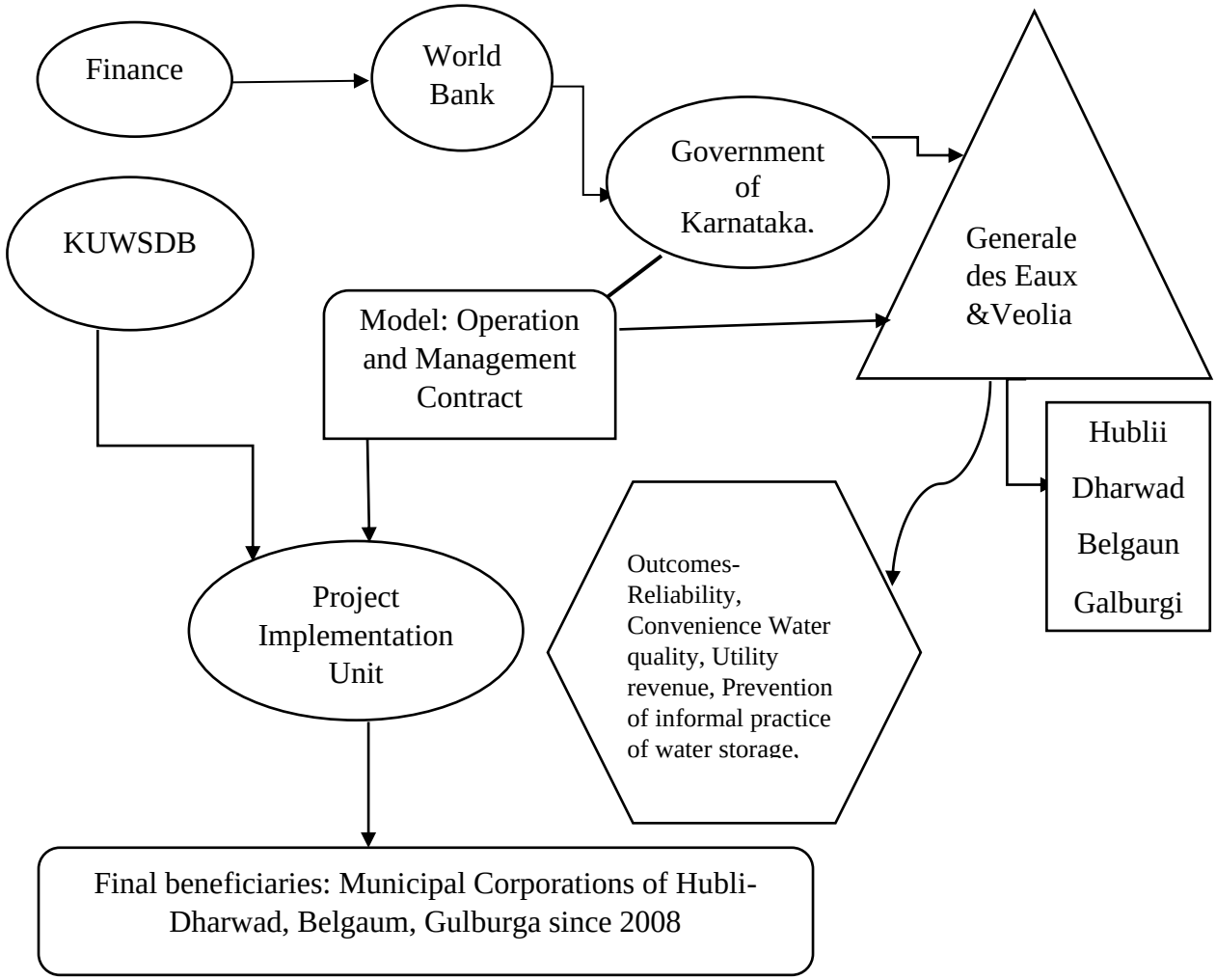
The experience of PPP initiative was part of a larger project developed by the Government of Karnataka to improve urban water supply. The capital investment for overhaul of existing infrastructure was from WB through Karnataka Urban Infrastructfure Development and Finance Corporation (KUIDFC). The private developer was appointed for a fee in undertaking the operation and maintenance activities. Project was three years and six months. The following Figure 6.1 expresses the structure of PPP.

The PPP, termed as 'Karnataka Urban Water Sector Improvement Project' (KUWASIP), was designed and implemented with the private operator Veolia Eau-Compagnie Générale des Eaux of France as both operator and consultant. The first two years were the base period for improving the distribution system, bill collection and designing over the existing infrastructure. The private agent's role was not as Constructor but a Procuring agent of KUIDFC. A partial linkage of private operator’s remuneration with performance (40%) besides a fixed payment (60%) contributed to the success in the PPP model. Civil works included 238 km in the distribution network, 25,640 new connections and repair of water meters of households. Revamped billing and collection resulted in cost recovery by more than 100% and a sharp reduction in water loss due to technical faults (Shah, 2019).

[58] http://www.uddkar.gov.in/en/KWASIP%20EAP%28WBA%29

Figure 6.1 Project Structure of PPP

Karnataka Urban Water Supply Improvement Project (KUWSIP)



The three ULBs - Belgaum Gulbarga and Hubli-Dharwad - belong to districts Belgaum, Gulbarga Dharwad in Northern Karnataka region as described in 76th NSSO. There are 14 districts in "Inland Northern Karnataka region". PPP region implies urban part of districts - Belgaum, Dharwad, Yadgir and Gulbarga and the non-PPP region comprises ten districts - Bagalkot, Bijapur, Bidar, Raichur, Koppal, Gadag, Haveri, Ballery, Chitradurga, and Davangere. Yadgir was carved out of Gulbarga in 2010. For post-2010 study Yadgir and Gulbarga together have been considered as old Gulbarga district.

6.4.2 Outcomes

The study examined piped water accessibility from 2002 till 2018 based on 58th, 69th and 76th NSSO rounds. In PPP districts only urban wards were covered under PPP

projects, leaving out large population of those districts uncovered. Out of the total within premises piped dependent households of the entire Northern Karnataka Region, only 9.75% of households are covered by metered connection, while 34.85% urban households across PPP districts have metered connected piped water (Table 6.6). Dharwad district where PPP project covered relatively wider area, about 56.59% of urban households have meter connected water supply.

The weighted average per month water expenditure of Household in the PPP region is INR 157.75 and for the non-PPP region it is INR 130.71. The mean difference is statistically significant at a 100% level of statistical confidence. The average dependency of urban households on the non-piped source of drinking water including bottled water is observed more (by 16.94%) on the districts not experienced any water sector PPP compared to PPP districts in 2018 (12.92%) (Refer to Table 6.6).

Table 6.6 Metering of Water: Northern Karnataka Region, Urban, 2018

Region	Non-payable	% of Households Metered	% of Households non-Metered	Amount per month (INR) weighted mean
PPP	12.92	34.85	52.24	157.75
Non PPP	16.94	9.81	73.25	130.71
Total Region	15.34	9.75	64.91	144.85
Dharwad	1.81	56.59	41.61	141.67
Two-sample t-test with equal variances: Difference = Mean(Non-PPP) - Mean(PPP); t = -3.3926; Degrees of freedom=409;				
Ho[59]: Mean Difference = 0; Ha: Mean Difference<0; Ha: Mean Difference≠; Ha: Difference>0 against Pr (T < t) = 0.000, Pr (T > t) = 0.0008, Pr (T > t) = 0.9996 respectively where Pr=probability				
Source: 76th Round, NSSO				

PPP in Karnataka impacted positively on lives of people in households saving toil and time for water fetching. Table 6.7 indicates a noticeable difference between distance driven water arrangement of the PPP region (i.e., four districts) and the non-PPP region (i.e., across ten districts) in northern Karnataka region in 2018. Such a comparative presentation is necessary to understand the PPP derived impact on distance-driven water poverty and gender-specific implications thereupon.

[59] Ho: Null Hypothesis; Ha: Alternative Hypothesis

The water supply system was crippled before PPP initiation over PPP regions. During 2002-2008, the within premises facility was only among 35.47% as a noticeable deterioration from 71.55% in 2002 (Table 6.7) around PPP region. A remarkable improvement is noticed on this same area within 9 years during 2009 to 2018. The on-premises water supply facility widens its coverage over 74.87% of households in 2018. It implies that 39.40% additional urban households in the urban area of this region have been accessed to within premises facility.

This is important to note that in the non-PPP region also experience an improved coverage of within premise facility in terms of an improvement of in premises facility of water across urban households from 72.48% in 2008 to 83.72% in 2018. This shows an improvement by 11.24% over this region over the last decade, specifically during 2008 to 2018. However, the extent of additional coverage of in premises facility in non-PPP region is lower compared to what happened as additional coverage (39.40%) of piped water accessibility in PPP area.

Table 6.7 Distance Driven Arrangement of Drinking Water: Comparison between PPP & non-PPP Region: Inland Northern Region, Karnataka

Year	Within premises		Outside premises	
	Non-PPP	PPP	Non-PPP	PPP
2002	62.40	71.55	37.60	28.45
2008	72.48	35.47	27.52	64.53
2012	82.65	69.43	17.35	30.57
2018	83.72	74.87	16.28	25.13

Source: NSSO Rounds-58th, 65th, 69th, 76th

6.4.3 Evaluation by Difference in Differences Regression Model

Here in this section we will use Difference in Differences Regression Model to estimate the effect of public-private participation as the treatment variable (implementation of PPP is the 'treatment') involving policy shift. The accessibility of piped water supply for urban households is considered the outcome variable. Piped water accessibility means availability within household premises or from a neighbour or through a community tap.

The objective is to look at differences between the average outcome in the control group vis-à-vis the treatment group, before and after the treatment (implementation of PPP in water supply). The estimation process applied is the 'Difference in Differences' model and the treatment effect is the effect of public-private participation in PPP districts. The estimation method of the model takes into account both times as well as places. The limitation of the difference in difference estimation is that it does not allow to control of other factors that might cause endogeneity. Piped water supply before and after the PPP project is compared to piped water supply before and after the same time points across non-PPP districts.

By including both areas (PPP and non-PPP) and both years (2002 and 2008; 2002 and 2012; 2008 and 2012; 2008 and 2018) and both piped and non-piped accessibility, the effect of PPP is estimated in the Difference in Differences (DID) regression. To run the difference in differences regression, the percent of households covered by piped water, whether before or after a time point, is the dependent variable. There is a time dummy regarding before and after the PPP time. Next, a dummy has been included based on the location or area denoting whether PPP has taken place and or not.

In general, this area variable will take care of our difference between the treatment and control groups. Finally, we included our interaction terms to understand the estimated treatment effect. This technique helps us look at the differences of the average changes in the control group's means over time, vis-a-vis the average changes in the treatment group's means over time. The difference in the differences model is mainly the difference in the average changes in the control group's differences over time and the treatment group. The variable is Piped-water accessibility (dummy) whether an urban household is covered by piped water for their principal source of drinking water or not. The reference category/group considers whether households depend on other improved and unimproved non-piped sources like tube wells, hand pumps, tanks, ponds, river canal, springs and bottled water.

In this model, if the coefficient estimate of the independent variables is statistically significant in the regression result, then the variable's contribution to explaining piped water accessibility will be statistically significant. The effectiveness of every regression used in this model is justified by Chi-square, Pseudo-R-square and log-likelihood value. The method of logistic regression has been applied on this model. The results are listed in Table 6.8.

Table 6.8 Difference in Differences Model on Tapped Water Utility					
PPP & Non-PPP Districts in Urban Area of Inland Northern Karnataka Region					
Prior to Initiation Effect: 2002 to 2008					
Tap Dummy	Coefficient	Odds Ratio	Standard Error	z	P>z
PPP-District Dummy	.1536	1.166	0.20726	0.86	0.387
Time Dummy	.2480	1.2814	0.2495	1.27	0.203
Interaction Dummy	-.5967	0.5506	0.1481	-2.22	0.027
Constant	2.1079	8.2308	1.0811	16.05	0
Number of observations = 2,471; Log likelihood = -811.16523; Pseudo R2 = 0.0035; LR chi2(3)= 5.66; Probability > chi2=.1297;					
Interim Treatment Effect: 2002 to 2012					
Tap Dummy	Coefficient	Odds Ratio	Standard Error	z	P>z
PPP-District Dummy	.1536	1.166	0.2073	0.86	0.387
Time Dummy	-.4549	0.6345	0.1134	-2.54	0.011
Interaction Dummy	-.2507	0.7783	0.2097	-0.93	0.352
Constant	2.1079	8.2308	1.0811	16.05	0
Number of observations = 2,184; Log likelihood = -805.1266; Pseudo R2 = 0.0122; Likelihood Ratio (LR) chi2(3)=19.84; Probability > Chi^2=0.0002;					
Intermediate Treatment Effect: 2008 to 2012					
Tap Dummy	Coefficient	Odds Ratio	Standard Error	z	P>z
PPP-District Dummy	-.4431	0.642	0.1297	-2.19	0.028
Time Dummy	-.7029	0.495	0.0931	-3.74	0
Interaction Dummy	.3460	1.413	0.4043	1.21	0.226
Constant	2.3559	10.547	1.5159	16.39	0
Number of observations = 1,823; Log likelihood = -694.64415; Pseudo R2 = 0.0139; LR chi2(3)= 19.52; Probability > Chi^2=0.0002;					
Long Term Treatment Effect: 2008 to 2018					
Tap Dummy	Coefficient	Odds Ratio	Standard Error	z	P>z
PPP Dummy	-0.443	0.642	0.13	-2.19	0.028
Time Dummy	-1.862	0.155	0.023	-12.35	0
Interaction Dummy	1.373	3.946	0.982	5.52	0
Constant	2.356	10.547	1.516	16.39	0
Number of observations = 3,454; Log likelihood = -1884.65; Pseudo R2 = 0.0754; LR chi2(3)= 307.55; Probability > Chi^2=0.00					

The model checks the pre-PPP changes of tapped water accessibility in the PPP vis-a-vis non-PPP districts over 2002 to 2008. In 2008, the PPP was formed but not fully functional as it was in its construction stage. The PPP got operational in full since 2009. Thus, in 2008, PPP's effect was not felt by the households. The study found an inverse relationship between district dummy and time dummy. The odd of the interaction dummy is 0.5506, implying that the likeliness of improved piped water coverage was less by 0.5506 times in 2008 within PPP districts compared to non-PPP districts in 2008. The urban zones of Dharwad, Gulburga and Belgaum districts where PPP was applied, the piped water supply was quite sub-standard. The finding satisfies statistical significance at 5% level.

In the next step, the model considers two time points 2002 and 2012 to look into intermediate effect. The odds of the interaction of two treatment parameters - time and area- is less than one (0.7783) and statistically insignificant. However, it marks an improvement of significant odd ratio (from 0.5506 for periods over 2002 to 2008). The next regression was to capture PPP's effect after about four years in 2012 since PPP's activation in 2008 to capture short-run or intermediate effect of PPP implementation. The difference in differences between these two-time points reflects a positive coefficient and the more than one odd-ratio.

The positive coefficient supports the hypothesis of improved service delivery through PPP tapped water after 4 years of its implementation. The odd ratio of 1.413 implies that the improvement in coverage is about 41.3% more in PPP districts than the surrounding non-PPP districts in 2012 compared to 2008, though individually the time dummy was statistically significant to 100% confidence. However, this odd is not statistically very significant. A comparison between 2002 and 2012, implies that the PPP does not exhibit a very remarkable significant change in service expansion. Improvement of odds of interaction dummy for 2002-2012 and 2002-2008 increases from 0.5506 and 0.7783 implying that PPP has a positive impact on service delivery in short run over 4 years.

In the final step of this regression study, the difference in differences has been applied to determine the long-term effect of PPP. Under such exercise, the interaction dummy is appeared to be 3.946 times more likely over time periods 2008 to 2018 at 100% confidence level. This means that the urban households of PPP districts were

295% more likely to access tapped water connection for domestic purposes in 2018 than in 2008. Secondly, the lower but more than one (=1.413) value of the odds of interaction dummy over periods 2008 and 2012 suggests that the effect of PPP derived tapped water delivery service gradually improved over time in 2018 compared to 2012 from the benchmark of 2008. This tells that as the impact of PPP is matured over time.

Despite PPP project in Hubli-Dharwad, many households continued accessing water from traditional and informal ways (Burt & Ray, 2014). This finding is supported by the present study as 11.45% of households of the PPP region fetch water from distant source. Thus, the analysis of this section concludes with two observations. Firstly, amidst the long debate of PPP in the water sector, India has high potential for PPP for a better water supply service across urban households. A robust regulatory framework to balance stakeholders' interest is necessary for success of instrument of PPP. A significant effect should be expected only 4 to 5 years after PPP projects come into operation.

6.5 Service on Commercial basis: Water Purifier & its differential usage

Entrance of private sector operators is speeding up across water supply sector in India. In this section of study we will attempt to identify the form of pure private interest entering the domestic water supply sector of India. One such is water purifier – equipment that addresses the felt and real quality issue of drinking water.

The study considers purifier as combination of electric and non-electric appliances. As per the latest NSSO survey on drinking water, 26.38% of urban households use water purifier as method of treatment of drinking water in 2018 (Table 6.9). Simultaneously, about 50.85% of urban households consume water without any treatment. The boiling of water is the second predominant method of treatment of water across 11.06% of urban households. This analysis of water purification by different users in urban India in 2018 finds that 20.84% urban households rely on electric water purifier and 5.54% on non-electric purifier.

The water purifier usage is 4.8% (i.e., 2.36% on electric purifier and 2.46% on non-electric purifier) of rural households and 12.18% **(**i,e, 8.68% on electric purifier and

3.4% on non-electric purifier) across Indian household in 2018. The ratio of urban households consuming drinking water without any treatment to households using water purifier is about 1.93 (=50.85/26.38), implying a nature of disparity. This sort of disparity is higher in rural India (The ratio =15.15). About half of the total urban households (=49.15) depends on various types of water treatment methods, which in turn indicates the perceived or real unreliability of quality of piped water or groundwater accessible by households.

Table 6.9 Use of Electric Water Purifier across Urban Households, 2012 and 2018

Methods	Purifier		Boiling		Miscellaneous		Not treated	
Year	2012	2018	2012	2018	2012	2018	2012	2018
Monthly per capita expenditure(MPCE) of Households								
Q1	6.99	15.46	3.30	7.86	22.47	10.93	67.24	65.75
Q2	4.81	15.15	7.16	11.02	25.47	13.83	62.56	60.00
Q3	7.40	19.32	8.87	12.37	27.42	14.04	56.31	54.27
Q4	14.56	26.06	11.66	12.08	24.62	11.76	49.16	50.10
Q5	37.84	41.26	13.54	10.54	13.94	9.23	34.68	38.97
Social Group								
ST	21.90	24.37	12.43	13.17	26.03	15.39	39.64	47.07
SC	11.72	15.52	8.13	7.85	20.43	12.61	59.72	64.02
OBC	15.63	17.25	14.58	14.55	21.58	12.38	48.21	55.82
General	33.88	40.27	9.20	8.15	18.13	10.25	38.79	41.33
Urban India	22.91	26.38	13.54	11.06	28.87	11.71	34.68	50.85
Rural India	4.46	4.80	5.90	5.93	21.95	16.52	67.69	72.75
All India	10.30	12.18	7.62	7.68	21.38	14.88	60.70	65.26

Source: 69th and 76th Round, NSSO. *Chemically treated alum, chemically treated with beach/chlorine tablets, filtered with cloth, others. Q1: Lowest quintile; Q5: Highest;

In 2018, the highest usage of water purifiers is among the top 20% of income quintiles. About 34.04% urban households from top 20% consumer groups use electric water purifier. The bottom 20% consumption group of the urban households accounts for 12.55% of total domestic electric water purifiers in urban India. Thus, a substantial portion of the marginalized population relies on untreated water

consumption as per NSSO finding in 2018. Compared to 2012, across quintiles of consumption group the dependence on water purifier has increased. Dependence on purifier for lower three quintiles have gone up rapidly.

Table 6.10 provides State-wise urban usage of electric purifier. The water purifier is the equipment catalyzing commercial entry of private sector in drinking water. The application and usage of purifiers are not the same across States. In Haryana (40.5), Uttarakhand (52.3), Punjab (50.4) etc. the usage is very high among urban households. Application of electric purifier is significantly less in States like Arunachal Pradesh (2%), Manipur (3%), Kerala (8.1%) and Tripura (5.3%). Privatization has come in a big way in urban India for water quality correction and converting water into a commercial product. In the next section we examined another means of commercialization of drinking water.

Purifier (as well as bottled water as we will see in the next section) is increasingly popular among consumers particularly in urban India. Dissatisfaction about the quality of supplied water, due to real or perceived lack of standard of potable water, is the primary reason for use of purifier or bottled water.

Table 6.10 Methods of Treatment: Usage of Electric Purifier, Urban India				
States	Purifier	Boiling	Miscellaneous	Not treated
Non-special Category States				
Andhra Pradesh	17.88	10.86	5.51	65.75
Bihar	22.54	0.57	1.77	75.12
Chhattisgarh	15.96	7.03	24.65	52.36
Goa	27.89	60.29	0.36	11.46
Gujarat	28.94	3.91	33.82	33.33
Jharkhand	28.24	10.80	10.67	50.29
Haryana	42.04	1.09	2.31	54.56
Karnataka	30.39	12.17	5.86	51.58
Kerala	8.56	82.87	0.61	7.96
Madhya Pradesh	19.04	1.30	39.15	40.51
Maharashtra	34.08	11.18	27.63	27.11
Odisha	34.66	4.12	4.47	56.75
Punjab	53.18	1.23	0.45	45.14
Rajasthan	23.23	0.33	36.01	40.43
Tamil Nadu	15.24	21.99	2.31	60.46
Telangana	18.32	3.47	10.01	68.20
Uttar Pradesh	17.89	0.73	1.57	79.81
West Bengal	26.29	2.05	4.60	67.06
Special Category States				
Arunachal Pradesh	25.42	59.52	14.25	0.81
Assam	72.36	1.24	8.36	18.04
Himachal Pradesh	38.86	9.97	1.36	49.81
Jammu & Kashmir	32.85	25.98	4.85	36.32
Manipur	19.55	40.11	5.55	34.79
Meghalaya	29.09	69.25	0	1.66
Mizoram	73.63	7.88	10.04	8.45
Nagaland	32.23	63.89	3.38	0.50
Sikkim	34.60	64.08	0.86	0.46
Tripura	82.93	0.19	10.88	6.00
Uttarakhand	57.29	2.11	3.43	37.17
Source: 76th Round, NSSO				

6.6 Water Quality: Households' View

Tapped or piped water does not guarantee a contamination-free supply. Very often in developing countries like Bangladesh, Ethiopia, Tajikistan and Ecuador, piped water was found to be hardly any safer than open pond water and therefore is a threat to people's health. Contamination levels vary dramatically not only by country but also by location and household. In some locations, piped water was found more contaminated than non-piped supply. In Bangladesh, 80 percent of piped water gets contaminated with E. Coli, like surface water[60] (World Bank Group, 2017), which can be attributed to an improper water treatment facility at the source of production. Service providers' accountability towards water quality is limited and the consumers' perception is yet to be improved. These problems are not limited to countries named here and situation in pockets of urban India does not seem to be much different as media and anecdotal evidences suggest.

Consumer's acceptability of quality of supplied water is an important factor to understand the trend of mode of supply. About 88% of households in urban India and rural India feel that there is no shortcoming in quality of drinking water (Table 6.11). However, about 15% of the urban households from Goa, Punjab from non-special category States, Jammu, and Kashmir, Arunachal Pradesh as special category States, expressed dissatisfaction regarding water quality on the ground of some other reasons except smell or taste. Interestingly, in Goa, where the maximum urban water supply is through piped or tapped network, only 72.31% of urban households claim no defect on water quality, which is significantly lower than the average "no-defect" identified households in urban India at 87.84%.

[60] https://openknowledge.worldbank.org/bitstream/handle/10986/27831/W17076ov.pdf

Table 6.11 Perception on Accessed Water Quality across Urban Households, 2012: Consumer's Perspective					
States/UTs	Bad in Taste	Bad in Smell	Bad in taste and smell	Bad due to other reasons	No defect
Andhra Pradesh	1.25	0.98	1.48	3.09	93.2
Bihar	2.94	1.54	3.27	7.25	85
Chhattisgarh	0.92	0.68	1.99	6.36	90.06
Goa	0	2.06	10.4	15.24	72.31
Gujarat	7.46	0.82	2.37	6.22	83.13
Jharkhand	3.81	0.14	2.39	9.74	83.91
Haryana	9.32	1.01	9.45	3.1	77.13
Karnataka	2.57	0.86	1.76	2.89	91.92
Kerala	2.06	2.28	1.48	3.97	90.2
Madhya Pradesh	4.05	1.22	1.89	4.3	88.54
Maharashtra	1.89	1.24	1.85	2.45	92.57
Odisha	0.56	3.18	0.63	4.17	91.47
Punjab	1.35	3.11	8.03	14.63	72.87
Rajasthan	3.29	0.5	1.49	7.6	87.13
Tamil Nadu	4.74	0.9	1.83	4.16	88.37
Uttar Pradesh	3.26	0.76	4.24	4.71	87.03
West Bengal	0.96	0.82	2.03	7.2	89
Arunachal Pradesh	2.6	0.18	0.2	14.14	82.88
Assam	6.87	2.07	12.53	14.7	63.84
Himachal Pradesh	4.15	0.86	2.13	4.12	88.74
Jammu & Kashmir	5.28	0.94	14.2	13.97	65.61
Manipur	0	0.03	0.09	0.28	99.6
Meghalaya	2.29	0.81	0.07	0.34	96.49
Mizoram	0	0	0	0	100
Nagaland	0.95	0.32	0	1.65	97.08
Sikkim	0	0.45	0.22	2.82	96.51
Tripura	3.36	3.95	0.85	7.21	84.63
Uttarakhand	4.16	1.55	6.45	2.3	85.55
Urban India	3.16	1.1	2.77	4.83	88.14
Rural India	2.95	1.08	2.46	5.81	87.7
All India	3.02	1.09	2.56	5.5	87.84
Source: 69th Round, NSSO					

6.7 Water Supply on Commercial basis: Bottled water

Bottled water is the drinking water sealed in bottles of different sizes/sachets. Generally this is considered 'safer' than tap water (Parag & Opher, 2011) though such a claim can be questioned. Bottled water consumption reflects urban consumers' risk aversion from the perceived risks on health from tap water (Hu et al., 2011). About 40-60% of total bottled water production is reprocessed tap water (Canadean, 2004; Parag & Opher, 2011). Thus, this public resource-dependent industry reaps enormous private profits in a competitive market. Substandard water quality, reports of pollution and infrequent and intermittent water supply encouraged private space for supply of bottled water. Mainly soft-drink manufacturers with large purifying infrastructure entered the market, which, in the beginning, was an oligopolistic set up. Thus, weak public infrastructure and government's inadequacy in provision of drinking water on one hand and the robust marketing strategies by private participators specially designed for urban areas, promoted bottled drinking water market. Bottled water is not only treated as a substitute for piped water, but also beverage.

The worldwide bottled water industry is impressively growing annually with a double-digit (around 11.4%) (Bhushan, 2006; The table also informs of et al.,2012). The bottled water usage pattern is not unique. It varies across regions and countries due to variables like ethnic group, age, income, occupation, and gender (Abrahams et al., 2000; Ferrier, 2001). Within India, bottled water consumption is higher in a relatively prosperous western region than the eastern region (40% and 10%, respectively) (Kumar, 2014).

6.7.1 Development of Consumers in India

Bottled water emerged as one of India's principal sources of drinking water for household in NSSO 2008. The average consumption of bottled water is increasing at a rate 7% annually despite relative high cost (Kumar, 2014). Though India ranked 10th highest consumer of bottled water globally (Bhushan, 2006), its per capita consumption is expectedly much lower than the global average at 29 litres per year (Kumar, 2014). Since 2013 bottled water enjoyed a compound annual growth[61] rate

[61] https://www.business-standard.com/article/news-ani/india-s-packaged-bottled-water-industry-to-reach-rs-160-billion-by-2018-114050800490_1.html

of 22%. On the other hand, the unit costs for bottled water and unorganized sector tankers are much higher than those of municipal supply (JMP, 1999) and much of this water gets used by non-proportionately by the urban poor as drinking water-poverty is most prevalent with them (Van Dijk, 2008).

Bottled water is a form of privatization of drinking water supply, on which the dependency of urban households is increasing. Bottled water prevails as the principal source of drinking water across 6.8% of all India (as per NSSO Report, 2018). In 2009, 2.7% of urban households depended on bottled water (Table 6.12). In 2018, over 9 years since then, the percentage of urban households dependent on bottled water increased more than three times - from 2.7% to 8.9%. The all India, expansion is a nearly 6 times - from 1.2% in 2009 to 6.8% in 2018.

Table 6.12 Development of Bottled Water Usage as Principal Source of Drinking Water (%) of Urban Households

Types	Bottled	Tap	Bottled	Tap	Bottled	Tap
Year	2009	2009	2012	2012	2018	2018
Rural India	0.5	27.5	1.6	31.2	4.0	35.55
Urban India	2.7	74.3	5.2	69.1	8.9	65.27
All-India	1.2	43.1	2.8	43.1	6.8	47.53

Source: 65th, 69th, and 75th Rounds of NSSO.

In the following Table 6.13, the level of dependency of Indian households has been analyzed by studying the households' remarks on the non-availability of any supplementary source of drinking water who expressed bottled water as their first principal source of drinking water. This analysis concentrates on the 76th Round, NSSO conducted in 2018.

The nature of dependency across the States is different. The nature of dependency is seen to be varied across rural and urban areas. For example, States like Andhra Pradesh, Gujarat, Kerala, Maharashtra, Tamil Nadu, Uttar Pradesh, West Bengal, Telangana etc showed high levels of dependency in their respective urban areas. Chhattisgarh, Odisha, Punjab along with Uttarakhand, Meghalaya, Manipur, Nagaland, Sikkim, Tripura have low dependency on bottled water as there is

sufficient existence of supplementary source of drinking water across respective urban households.

Table 6.13 Level of Dependency on Bottled Water by Households using it as Principal Source of Drinking Water

State/UT	Urban	Rural	Rural & Urban
Non-special Category States			
Andhra Pradesh	High	High	High
Bihar	Moderate	Low	Moderate
Chhattisgarh	Low	Low	Low
Goa	Moderate	Low	Moderate
Gujarat	High	Moderate	Moderate
Jharkhand	Moderate	Moderate	Moderate
Haryana	Moderate	Moderate	Moderate
Karnataka	Moderate	Moderate	Moderate
Kerala	High	High	High
Madhya Pradesh	Moderate	Low	Moderate
Maharashtra	High	Moderate	High
Odisha	Low	Low	Low
Punjab	Low	Low	Low
Rajasthan	Moderate	Moderate	Moderate
Tamil Nadu	High	Moderate	High
Uttar Pradesh	High	Moderate	High
West Bengal	High	High	High
Telangana	Moderate	Moderate	Moderate
Special Category States			
Arunachal Pradesh	Low	Low	Low
Assam	Moderate	Low	Moderate
Jammu & Kashmir	Low	Low	Low
Himachal Pradesh	Moderate	Low	Moderate
Manipur	High	High	High
Meghalaya	Low	Low	Low
Mizoram	Low	Low	Low
Nagaland	Low	Low	Low
Sikkim	Low	Low	Low
Tripura	Low	High	High
Uttarakhand	Low	Low	Low

Low: Out of those urban households using bottled water as principal source of drinking, from 0% till 20% do not have any other alternative/supplementary source for drinking water; Moderate: For >20 %, <60 %; High: >60%

Source: Computed; Basic Source: NSSO: 76th Round, Report No. 584

Moderate dependency is observed among urban households of Bihar, Jharkhand, Haryana, Karnataka and Madhya Pradesh. The level of dependency over urban area in using bottled water as the principal source is seen very high across Maharashtra, Tamil Nadu and Kerala. In those areas, more than 80% of urban households who primarily depend on bottled water as their principal source of water consumption, claim for absence of any other supplementary source for drinking.

A significant rural-urban disparity is observed. For example, against the high dependency of urban households in Goa on bottled water as a principal drinking source, the rural part has shown the absence of such dependency. In Kerala, Telangana and Karnataka use of bottled water is high both in rural and urban areas. Except for Himachal Pradesh and Manipur, all other special category States have lower or no bottled water reliance as principal source of drinking water.

6.7.2 Bottled Water: Differential Usage across Consumer Groups

The urban households are reducing their dependence on tapped water for principal source of drinking at an average annual rate of 1.5%. Other than low trust in quality of supplied piped water, high connection cost, leakages, infrequent, intermittent water supply etc are concerns for urban households

Table 6.14 Development of Bottled Water among Urban Households as per Social Groups

Social Group, Urban India	Distribution of Usage across Social Groups, NSSO Rounds			Annual Compound Growth Rates in %	
	65th Round, 2009	69th Round, 2012	76th Round, 2018	From 2012 to 2008	From 2018 to 2012
ST	3.70	2.51	4.56	17.00	30.50
SC	6.06	8.24	13.68	47.40	28.60
OBC	36.27	49.84	47.58	48.00	17.20
General	53.97	39.40	34.18	19.80	15.40
Total/Urban India	100	100	100	24.42	9.37

Source: Computed; Basic Source: NSSO: 58th, 69th and 76th Rounds

At present, nearly 7 (~6.8) % of Indian households (urban area 8.9%, rural 4%) depend on bottled water as their principal source of drinking water. This implies a robust development of the commercial market of bottled water production, distribution, and sale. This market indicates a pure privatization of drinking water. However, the average annual growth of bottled water as principal source for drinking across urban India has been 24.42% during 2012 to 2009 (Table 6.14). This growth is 9.37% for 2012 to 2018. Emergence of bottled water may partially explain relative decrease of piped water coverage during the last decade (Chapter 3). The following table shows bottle water dependence among social groups of urban households.

Households from the general category were the major bottled users in 2009. In the later period, in 2012 and 2018, the usage has been more diversified across various social groups. For example, about 13.68% of the scheduled caste population depended on bottled water as a principal source in 2018 which was 6.06% in 2009. The other backward caste and general category people together form about 90% of bottled water consumers in 2009. The increasing trend of bottled water among ST is marginal.

Table 6.15 Development of Bottled Water among Urban Households as per MPCE

MPCE (Decile)	Bottled Water as First principal Source for Drinking within i-th Decile (% of Households)			Annual Compound Growth Rates in %			Decomposition of the total Bottled water Market in Urban India, 2018 (%)
	65th Round, 2009	69th Round, 2012	76th Round, 2018	From 2012 to 2009	From 2018 to 2012	From 2009 to 2018	
1	3.03	2.8	2.78	-2.60	-0.12	-0.95	0.51
2	0.71	2.63	3.95	54.73	7.01	21.01	0.93
3	0.74	4.69	4.42	85.06	-0.98	21.97	1.41
4	0.97	4.18	6.09	62.73	6.47	22.64	2.05
5	1.13	4.2	6.72	54.90	8.15	21.91	3.48
6	1.33	3.05	7.7	31.87	16.69	21.55	5.41
7	1.12	4.66	9.1	60.84	11.80	26.21	9.07
8	1.39	5.18	11.63	55.04	14.43	26.62	11.07
9	2.65	6.84	15.22	37.17	14.26	21.44	24.57
10	5.49	6.95	17.93	8.18	17.11	14.05	41.51

Source: Various rounds of NSSO; MPCE 1: Lowest; MPCE 10: Highest;

Taking marginal per capita expenditure (MPCE) as a proxy of income group among households we notice sharp increase in dependence of bottled water with rise in MPCE (Table 6.15). The critical point is to notice that in 2012 only 2.8 % of people in the lowest MPCE category used to rely on bottled water consumption, while about 6.95% of the top MPCE category used to depend on this source.

A phenomenal growth in bottled water happened since 2012. From 2009 till 2018, there is not much change observed for the lowest fractile, but the low 10-20% and 20-30% income groups experience bottled water growth at more than 21% annually during 2009 to 2018 – which is more than 14.05 % annually among the top 10% of income fractile. Thus the dependence of lower income urban households on bottled water as principal source of drinking is growing very fast.

Households at the lower end of society seem to pay a relatively high burden for drinking water. Thus, the analysis signals that disparity in provision of drinking water is increasing, giving space for commercial player to cater to essential service like drinking water. Across consumption level or social position, bottled water appears to be a new reality in urban Indian households.

6.7.3 Determinants of Bottled Water Use: Socio-Economic Analysis

In this section factors determining consumption of bottled water have been examined. Logistic regression is applied as the binary dependent variable considers whether households using bottled water as the principal source for drinking water consumption (if bottled is the principal source of drinking water then the dummy = 1; otherwise =0). The regression focuses on 2018 as the period of analysis.

The first variable chosen as the determinant is household size. The reference category in the model is small sized households (up to 5 members). It reveals that the consumption of bottled water tends to be higher in the case of small size households than a medium (6-8 members) or big sized (9 or more members) household. The big and medium-sized households use bottled water a lesser by about 15 to 18.2% compared to small-sized households in urban India.

Bottled water consumption is more linked to the affordability and economic condition of the households. As seen in last section, regression here gives same result - bottled

water consumption increases across high income group among urban household (total households are numerically divided into high, middle and low income). The middle-income and high-income households use about 9.9% and 35.8% more bottled water as primary source for drinking than the low-income households.

Table 6.16 Determinants of Bottled Water Usage across Urban Households, 2018 Logistic Regression Analysis

Variable	Reference Category	Outcome Category	Odd Ratio
Household Size	<=5	>5<=9	0.818***(0.017)
		>9	0.854***(.033)
Distance of drinking water source	Within dwelling	Outside dwelling but within premises	0.436***(0.01)
		Outside premises	0.845***(0.056)
Female education	Till primary	Primary to secondary	0.981(0.021)
		Above secondary	0.923***(.022)
Marginal per capita expenditure	Low	Middle	1.099***(3.01)
		High	1.358***(10.11)
Social Group	SC/ ST	OBC	0.711***(-13.88)
		General	0.892***(-4.39)
Area of dwelling	Slum	Non-slum	0.322***(-24.07)
Ownership	Owned	Non-owned	1.663***(20.04)
Age of the head of the household	Young	Middle	1.087***(4.33)
		Old	1.132***(3.49)
Access to drinking water	Exclusive	Common	0.57***(-18.34)
		Community	0.012***(-71.66)
Type of dwelling	Residential house	Flat	2.409***(31.82)
		Others	1.332***(7.5)
Constant	_	_	9.464***(.058)
Number of observations= 83,367; Likelihood Ratio= -37876.438; Pseudo R2 = .3298			
Dependent variable: Households considers bottled water as the principal source of drinking=1; Otherwise=0.			

Table 6.16 on bottled water consumption as per social groups indicated that bottled water consumption growth is fastest among the SC/ST category people. The study reveals that the propensity for bottled water consumption for drinking among the general category and other backward caste is lower than that for SC/ST. The respective odds ratios are significant. The general category people have about 10% lower chance of using bottled water consumption compared to the reference group,

i.e., scheduled caste and scheduled tribes. The least bottled water usage is observed among the other backward classes.

The study also reveals that urban households in India, despite access to the principal source of drinking water within the dwelling, consume bottled water at most than the households having access to drinking water outside dwelling but within premises (56.4%) and outside premises (15.5%). People who rely on principal water sources outside their premises are less dependent on bottled water for drinking purposes than those who have the principal source of water supply within premises but outside dwelling.

Female education is considered in the model as a proxy for hygiene awareness in the households. Variable is the highest level of education attained by female household members. This has been categorized into three groups - till primary, above primary to secondary and above secondary. Compared to the reference category of till primary education, the usage of bottled water as primary source of drinking water is marginally reduced for the two higher education categories. The rate of reduction is not statistically significant.

Location, type and ownership of the dwelling - are three important influencing variables in determining the bottled water consumption across urban households. With the improvement from slum to non-slum area, non-owned to owned house - the bottled water usage tendency increases significantly. Households residing in urban slums are much less prone to bottled water consumption. On the other side, if residents own the dwelling, bottled water consumption is much lower than the households staying as a tenant or as non-owner. Perhaps, the owner's willingness for a permanent arrangement in the household is the explanation in Indian context.

The flat residents use about 140.9% more bottled water for daily use than households dwelling in separate houses (and others, e.g. government or non-government service quarters). The model finds out that others including residents of government or non-government service quarters tend to use bottled water 1.332 times higher than that of the reference category - residents of stand-alone separate houses. All the variables considered here are statistically significant, except the female education category above the primary and secondary levels.

Higher the age of the head of the households greater is the chance to use bottled water as primary source of drinking water. The inclination of awareness level of water-derived health problems and the related convenience may be probable explanations. Bottled water consumption is considered a source of potable water, but also a symbol of status.

The variable on the facility of access to drinking water is divided into three categories - exclusive for a household, typical across few households or community use. Surprisingly, households with access to piped water for exclusive use tend to have more dependence on bottled water consumption as the principal source of drinking. Households with shared piped connections have 0.43 lesser odds to use bottled water than the reference category - exclusive users, which is statistically significant. The odds of bottled water consumption for drinking among the households who depend on community use for drinking water are 0.99 times lower than the households having piped connection for exclusive use.

Social groups, income, household size, age of the head of the households, location, type of dwelling and tenurial status of the households are essential determinants. Urban households, despite their exclusive access to the use of water supply, are prone to use bottled water.

India's bottled water industry is mostly dependent on groundwater sources (Down to Earth, 2018) where it is easy availability could explain the primary reason for private ownership. The industry needs to acquire prior permission from CGWA against Water Conservation Fee. Bottled water is not a sustained means to provide accessible and affordable water to all under SDG 6.1, especially in low and middle-income countries. The most viable way is a well-designed sustained investment through centralized and community utilities to achieve safe water to all (Cohen & Ray, 2018).

6.8 Conclusion

PPP is a new form of decentralization, which is tested in different situation all over the world. Sectors like transport, road and telecommunication exemplify successful application of PPP in India. Global experience is that high level of Government oversight and robust, effective and neutral regulatory framework are necessary to balance the interests of public, government and private participants in PPP projects.

There have been cases around the world when full privatization of public service was reversed due to private sector excesses and complaint of corruption, leading to public unrest.

In India there have been attempts to implement PPP to a limited extent in WSS. Many of them were aborted and only some proved successful. PPP in water sector of India is not relatively matured. Out of the completed PPP projects on water and sewerage sector by the end of 2018 with Government of India initiative, 40.2% is attributed to piped water network and water supply utility dispersed across a few States like Andhra Pradesh, Karnataka, TN, Maharashtra, Madhya Pradesh, West Bengal and Chhattisgarh. This chapter studied in detail a successful case that has applicability to other regions of India. This case study showed the significant positive impact of PPP projects in WSS in long term by applying the Difference in Differences Regression Technique.

This finding, even in limited Indian context, reaffirms the global lesson that a robust regulation by public authority is necessary for successful PPP. The interaction coefficient against long term effect of PPP over 2008 to 2018 is significant at 100% level of confidence. The odd ratio of interaction dummy reflects that the likelihood of the urban PPP region having piped water accessibility in 2018 was 3.946 times higher than what it was in 2008 compared to the improvement measured in non-PPP urban region in time period. A positive interaction dummy coefficient over 2008 and 2012 reflects on the short run effect of PPP in deriving beneficial effect to the urban part of applied region. It implies that the extent of benefit is about 1.413 times higher across PPP region in compared to non-PPP region on piped water accessibility. The discussion also brought out the positive long-term impact of PPP's accessibility coverage of tapped water on social life by cutting down the time involvement for water fetching compared to the surrounding area (i.e., districts in the same region) where PPP in piped water utility was not implemented.

National Water Policies in 2002 and 2012 envisaged PPP model as one of means for provisioning of water supply. The AMRUT projects also supported PPP model. Obviously experience is drawn from other sectors of infrastructure where PPP worked well in the background of vast demands of resources that Governments alone cannot provide under various competing needs and budgetary constraints. The challenge of

having PPP in India is complex given India's multiple points of decision makings by more than one institution and complex form of disbursement of finance and geographical diversity of available water resources across States.

Scope of PPP in the water sector is diverse and multidimensional. PPP in WSS in India, to begin with, could include water billing, collection of the tariff, computerization of customer base and elimination of illegal connections. In bigger project and where private participants has experience of global standards, expansion of infrastructure, sewerage network, water treatment, management contract and designing Technology can come from private vendors. However, government must continue with its primary responsibility of finance for hard infrastructure expansion, oversight of quality and equity and creation of independent and robust regulatory framework.

While PPP is only one instrument of harnessing private initiative, technology and finance into WSS, inadequate and under-quality water supply opened space to commoditization of drinking water by non-public entities. The study analysed recourse to various types of purifier and bottled water as primary source of drinking water. Both are direct commercialization of the essentially public good of water, though for purifier one needs water supplied from some source – very often piped water supplied by local government – and then domestically value add on commercially supplied means.

Bottled water is becoming increasingly crucial within the Indian urban household sector, where every Decile of households by marginal per capita income, except for the lowest, has witnessed increase in recent years of the percentage coverage of bottled water as a principal source. Bottled water available with a high unit cost is a burden on lower strata of urban population and yet the dependency is on the rise. The annual compound growth of bottled water usage across the urban household sector followed a double-digit figure (24.42 % during 2009-12; 9.37% during 2012-18).

The analysis identified socio-economic factors such as household size, social (caste) group, marginal per capita expenditure of household, age of the head of household and the dwelling's location as crucial factors in explaining the propensity of usage of bottled water. The higher likelihood for bottled water usage despite piped water facility available within premises compared to households with outside drinking water

facility implied that not the accessibility of piped water, but its non-reliable quality is the critical reason why households are increasingly dependent on bottled water.

Above finding is further reinforced by the high usage of water purifiers across urban households including the richer households. It is shown that Indian household sector is increasingly inclined to purchase water quality despite water accessibility in many cases. Following the SDG guidelines, AMRUT has emphasized water coverage, but the quality of public water supply, which is a critical issue, should also be robustly addressed. Besides the water supply network, water treatment plant is still an under-attended area for PPP in India.

Over time, the country needs to harness private sector in appropriately designed PPP projects for expansion of piped water for adequate and quality supply which is a socio-economic requirement and important towards achieving various SDG Goals. Water is and must remain a public good in the world's largest democracy. Characteristics of drinking water have changed from merit good to quasi-public good. Private participation in public sector service has the potential to introduce efficient management, new technology, citizen-friendly quality service and finance to supplement government's efforts.

The promising trajectory of country's economic growth could play a positive role in raising international and indigenous private sector interest. Notwithstanding private sector participation in water and sewerage utility, government's cardinal role in good water governance, formulation of people-centric policies, allocation of finance for capital investments and creation of effective regulatory regime cannot be underestimated.

CHAPTER 7: CONCLUSION AND POLICY IMPLICATIONS

7.1 Findings

India adopted National Water Policies in 1987 and thereafter reviewed it twice in 2002 and 2012. Drinking water was given priority in India's water policy. While India is party to SDG 2030 and UN has recognised the right to water as human right, there is no law as such in India on provisioning of adequate, equitable and safe drinking water. Given the status of India's regional diversity of water resource and nature of heterogeneous framework, India lacks an unified homogeneous system to provide drinking water.

Delivery of drinking water in India is a State subject, the service being actually delivered by the third-tier of government. The administrative, legal and financial arrangements for water supply are multi-tiered and highly complex. States do not have enough resources to substantially increase allocation on water supply and sanitation, both of which require public spending for expansion of physical infrastructure. There is a need for equitable water supply service in India which can target benefit of water subsidies to the needy and at the same time can manage demands to avoid wastage and overuse of the precious natural resource, which are depleting at alarming rates. It is important to examine situation in India in the context of Sustainable Development Goals, which called for Universal and Equitable Access to Safe and Affordable Drinking Water for All.

The present study examined different types of Inequality across urban Households in their access to improved drinking water. Universal Access leaves no room for exclusion of vulnerable and disadvantaged section of population from public service. Without elimination of inequalities among various sections of population we cannot ensure an equitable public service. Appropriate Access demands sufficiency in availability of water to all Households. Affordability, which also finds place in the SDG Statement, is a critical question in the Indian reality of low per capita income and underdevelopment. With the SDG in the background, therefore, Equitability and Equity remained a recurring theme connecting all Chapters.

The 76th NSSO round in 2018 suggested that 86.15% of urban Households had access to improved water source for drinking. Out of total 86.15% with improved source, piped water within dwelling or within premises but outside the dwelling or through public tap caters to 65.27% Households. 20.88% Urban Households depend on other sources of improved water, namely - bore hole or tube well, protected well and spring, collected rain water, packaged water and water supplied in tankers. This means, as of 2018, 13.85% of urban Households still depend on unimproved water source for drinking. On the whole, therefore, drinking water supply in urban India is neither Universal nor Equitable, and it is not Safe for all urban households.

Different States in India witnessed different levels of dependence on tapped water as household's principal source of drinking water in their respective urban areas. Maharashtra (91.7%) and Goa (96.7%), Punjab (77.14%), Madhya Pradesh (75.1%) among others, did well from non-Special category States' while urban Mizoram (99.1%), Sikkim (92.7%) from the special category States have made noteworthy progress. Using NSSO 49th, 58th, 65th, 69th and 76th rounds the study has arrived at the conclusion that far from increasing, urban India has decreased in percentage terms dependency on piped water supply out of total supply from all sources for drinking purpose. The diminishing dependency on piped water as principal source, which is globally accepted as the safest and most dependable mode of drinking water supply, is a negative trend for safety and equitability.

Access is determined by availability of adequate (there is no universally accepted quantity to denote adequacy) drinking water at the household. In the study we measured drinking water Adequacy by combining supply sufficiency throughout the year and the status of the right to use the water point for exclusive use. From NSSO survey in 2018, it has been derived that 52.25% of urban households had water adequacy. Other than inadequate quantity of drinking water in nearly half of India Household (in 2018), more than 95% urban households in 2012 reported dissatisfaction on quality of water. Trust deficit on quality of supplied piped water seems to continue unabated raising concerns on Safety aspect of SDG. We see growing reliance on commercially available bottled water and application of filters for supplied water. Relative decline of piped water coverage has led to increasing dependence on bottled water as principal source of drinking.

To understand the extent of universal access, we examined disparity within and across groups. Using “Diversification Index”, we measured piped water accessibility to a particular urban social group across States. The high values of the index indicated substantial intra-group inequity. However, such disparity is shown to be decreasing both within the individual caste groups and intra-quintile consumer groups during the period 2002 to 2018 through three study points. Using Specification index across social groups it was reconfirmed that urban households belonging to general category social group enjoys greater access to piped water than Scheduled Castes / Scheduled Tribes and other Backward Caste groups. Thus, a well-designed and targeted policy is an imperative for addressing inequalities existing in India.

The study estimated economic disparity in access to drinking water with the tool of "Specification Index". The index is based on consumption groups divided into 10 deciles of urban households as per respective marginal per capita consumption expenditure. This index indicated relative position of each consumer group in accessing particular source of drinking water. Specification Index analysis indicates that higher consumption groups in urban India corner more than their due from the subsidized provision of piped water. The analysis showed that lower consumption groups in urban areas are more dependent on improved but non-piped source for drinking water, such as tube-well and hand pump. Both reconfirmed the need of more equitable service of urban water supply in India.

Logistic Regression analysis of urban India’s NSSO data from 76th Round showed level of education of female in the household and level of household income have statistically significant positive linkages to on-premises piped drinking water accessibility. It could be that the supply networks are more extensive or facilitates more in socio-economically upward localities, household from where have higher chances of supporting female education. Similarly, the Analysis showed that female member’s gainful engagement in economic activity, caste and family size are other factors which are important for access to drinking water within premises. Households with at least one female member employed are more likely to have piped water accessibility within premises. Nature of female employment into three categories (self-employed, regular employee and casual) also influences attitude to drinking water sources. With the reference category of self-employed status,

households with casual or regularly employed female members are more inclined to depend on public tap or tube well/hand pump.

The study tried to identify a few socio-economic factors influencing the source of drinking water accessibility (excluding bottled water) as well as in explain the nature of gender-unequal burden in off-premises water arrangement for regular consumption of households. These factors might not be found very strong as direct explanatory variables in controlling water accessibility. However, identifications of such factors are important to understand the piped vis-a-vis non-piped residential water demand. Such base of understanding has conducive and valuable role to policy makers.

The study finds that with an increase of female education standard, households statistically become less likely to be dependent on public tap or tube well/hand pump. Investments on human capital formation and women's economic empowerment in household are, therefore, critical and play the role of powerful stimuli to improve household amenities and condition. The larger households in urban India are less likely to depend on public tap but more on tube well or hand pump, compared to small sized households.

The study through a multivariate regression analysis also showed that household's income level on consumption standard is positively linked to their on–premises piped water accessibility. On the other hand, tube well/hand-pump usage is more in households from the relatively less income households, as well as in slum areas. Interestingly, multivariate regression indicated that age of the head of household, tenurial status (tenant or owner of dwelling), type of the dwelling and the existing sanitation infrastructure are other important factors with statistical significance for dependency on piped water. Households dependent on tube well or hand pump are seemed to be more inclined to use pit latrines and other less developed sanitation systems than septic tanks. The households headed by younger people seem to have significant and distinct lower tendency of depending on tube well/ hand pump like ground water resources for drinking water. However, their tendency of dependence on other sources like well, tanker and various surface sources are significantly higher than piped water within premises.

After identifying the important socio-economic factors, the study looks further on the form and extent of Water Poverty in urban India using distance to water sources from the household, accessibility to piped water and exclusive user right of water supply facility as variables. An indexation of water poverty helps to assign number to discern the severity and depth of water poverty.

Distance driven water arrangement has been considered as main dimension of water poverty. The distance dependent drinking water fetching in urban India has gone down by 2.69% on an average annual compound rate in the last three decades. However, on an average the distance dependent urban households spent nearly 58 minutes per day in fetching water in 2019. Out of off-premises drinking water dependent urban households, 13.8% arrange water from or within 200 metres and 17% from or within 500 metres in 2018. Analysis of distance-driven water poverty was carried out designing an Index (Mild poverty = outside dwelling but inside premises; Severe Poverty = Outside premises but within 200 metre; Extreme Poverty = Water source beyond 200 metre). The index varied across States widely from 0.018 to 0.843 in Mild Water poverty, 0.006 to 1.000 for Severe water poverty and 0.013 to 0.975 for Extreme water poverty. The Index here expressed proportion of household in respective distance group per unit of household in reference category with drinking water available within household. The highest value of the Extreme poverty index out of the three types of distance driven water poverty implies that Indian urban households majorly experience the burden of water fetching within the range of 200 metres till 1 kilometre.

After discussing on distance driven water poverty, the study extends the area of water poverty over pervasive dimensions. In the study water poverty due to limitations in access has been examined using DAF index, which has been computed by three parameters - (i) Distance from procurement point to user point, (ii) Ratio of percent of households with Access to non-piped supply to percent of households with piped water supply, and (iii) Ratio of percent of non-exclusive water point users across urban households to percent of households with exclusive water supply Facility. DAF water poverty index has been estimated for three time points during last two decades. This relatively inclusive was 0.388 in value in 2018, which was 0.200 in 2002 and 0.251 in 2012. The increasing value of DAF index indicates growing water poverty in

urban India, which is a failure of State intervention. Among the States, coefficient of variation of DAF index is approximately 60%. The inter-State variability is rising. The study points to the imperative of focused policy and programme by the States to address the problems of inaccessibility of water within the households and consequent burden of water collection from distant sources. It is also essential to secure the household an exclusive access to water source for drinking at a subsequent stage.

Deduction from 76th round of NSSO inferred that both in rural and urban areas distance-driven water poverty led to disproportionately higher burden of labour on the adult female members. The study assessed from the 76th round that 19.3% of urban households are distance dependent for water. Out of distance-dependent urban Households in 48% adult women perform the task of water fetching, rest being done respectively by 36% adult and under age male, 4% by underage female and 12% by outsourced labour.

The tool of Multivariate Logistic Regression model has been applied to assess extent of unequal burden on female in the household to fetch water. Examination using the model pointed to statistically very significant gender inequality (keeping female category as the reference level of the explained variable). With economic progress and better location of residence (slum to non-slum) the male participation in drinking water significantly rises with corresponding relief to the women folk.

The study showed that relative position in caste hierarchy has a relation with female participation in fetching of water – the lower in the strata more is the burden on females in the household. The general trend seems to be that the male participation in fetching water is less in socially marginalized households. The intensity of involvement of hired labourers is higher compared to a male member of an urban household. The study also showed as the distance for water source increases both male participation and deployment of hired labour decreases transferring the burden on female. In essence, in most circumstances, disproportionate burden on women is a reality of inequality in urban India.

As seen in Chapter 3, examination in Chapter 4 also led to the conclusion that with higher education, burden on women for fetching water statistically diminishes. Interestingly, male participation in fetching water increases if access is to community

sanitation and decreases if there is common-use latrine facility. Across Special category States male behaviour in similar situation is not the same indicating perhaps certain other social factors. In bigger households amount of water required is more. Male participation in arrangement of water is found to be higher in bigger households. The intensity of deploying hired labourers is also more in bigger households. These trends of bigger household is same across Special and non-Special category States in urban India.

Chapter 5 examined how Indian States' public expenditure worked in terms of promoting Universal and Equitable Accessibility to Improved (Safe) source of water. The Chapter also attempted to find other Macro Factors which influence Accessibility to water source across States.

Indian States on an average spent 38% of total expenditure on social sector. There is high disparity among States in investments on social sector. Proportion of expenditure on water and sanitation services (WSS) to total allocation on social service is about 6%. Only 0.40% of States' GSDP is allocated on water supply and sanitation in 2017-18, even as water is such a vital and basic requirement and a fundamental goal in SDG. This figure further goes down to 0.29% for non-special category States in 2011-2016 and to 1.13% for special category States. Allocation on WSS, as a whole, demands improvement to different extent across States to progress towards universal access to safe and affordable drinking water.

On an average for 28 States (17 non-special category and 11 special category States) growth of capital expenditure and revenue expenditure incurred by States on water supply in 2000-2016 have been around 12%. The average ratio of revenue expenditure to capital expenditure is 1.37 times during last two decades implying an INR 73 capital expenditure to every INR100 allocated on revenue expenditure. The emphasis on capital expenditure on water supply is increasing compared to pre-2000. Detailed scrutiny reveals that during last decade, there is significant progress in average growth of capital expenditure, especially for non-special category States. During 2011-2016, the revenue expenditure on water supply across special category States grew annually at 18.69% on average, which is higher than growth of capital expenditure. On the contrary, non-special category States experienced a higher capital expenditure growth on water supply than that for revenue expenditure.

Even within revenue expenditure, the prevalence of operational expenditure is increasing. Together operation and administration constitute about 15% of total revenue expenditure on water supply and sanitation. A significant improvement was noted in scheme specific expenditure. Direct transfer of financial resources accruing WSS to third-tier local government or para-Statal bodies have gone down as percentage out of total operational expenditure from 2008 onward, primarily because most of scheme-linked expenses are incurred directly. The scheme expenditure is gaining importance in WSS by its volume.

The pooled regression model over macro perspective brings out the fact that good water governance is as critical as greater allocation of budget for progress towards universal and equitable access to safe drinking water in urban India. The analysis applies time pooled regression technique and identifies that not only public expenditure as per capita basis or percentage of their respective Gross Sates Domestic Product, but also there are some macro-economic factors influencing water infrastructure measured by the parameter of piped water accessibility. Economic performance of States was assessed by level of urbanization and per capita income (big state dummy). It was found that economic performance has a significant positive impact on piped water supply. Public awareness and female economic participation are other two important variables. While government allocation on WSS as percentage of GSDP in 2017-18 remains far from desired level across States, the study shows that marginal impact of additional financial allocation is minimal on expanding accessibility of piped water.

Policy initiatives such as acceptance in 2010 of access to water as a human right, AMRUT scheme for urban India from 2014 and other factors might be the explanatory reasons to higher annual growth in revenue and capital expenditure in per capita terms on WSS in recent years. In terms of per capita, WSS expenditure is improving, but there is a distinct difference between the special category and non-special category States.

The study finds that public expenditure on water supply and sanitation is of wide variety, non-uniform and obeys an erratic pattern in front of the wide multi-staged challenges of SDGs. Besides, the study tries to find solution by discussing the ventures on the nature and scope of non-public participation in access to Drinking

Water in urban India, since such participation is evidently expanding. In many countries Public Private Participation (PPP) in infrastructure has been popular in infrastructure development and the WSS sector is not an exception. In India PPP models in water supply have not been many and experience out of limited PPP cases is mixed. However, as elsewhere, PPP- named as KUWSIP-as a case study for Karnataka reaffirms the importance of a robust and effective regulatory structure for success of PPP in universal and equitable access to safe and affordable drinking water.

The effect of PPP case study has been analysed with the help of "Difference in Differences Regression Model". The interaction coefficient, with time and PPP treatment area as variables in the analysis showed that long term effect, as opposed to short-term effect, of PPP over 2008 to 2018 is significant at 100% level of confidence. The odd ratio of interaction dummy reflects that the likelihood of the PPP region having higher piped water accessibility in 2018 is 3.946 times higher compared to non-PPP region, than what it was in 2008. A positive interaction dummy coefficient over 2008 and 2012 reflects on the short-run effect of PPP for beneficial effect to PPP region. However, statistical confidence in short-run effect is not significant. It implies that the extent of benefit (piped water accessibility) is about 1.413 times higher across PPP region as compared to non-PPP region, with 2008 as the base year when PPP got operational. The case study also revealed that water charges have not escalated due to introduction of PPP. Weighted mean per household per month for PPP area worked out to be INR 157.57 in 2018, which was INR 130.71 for non-PPP urban areas. The difference is statistically insignificant by two-sample t-test.

Non-public participation in drinking water is also witnessed in purely commercial modes of access to drinking water. From the 76th round of NSSO data from 2018, it can be deducted that 8.9% of India's urban households are dependent on bottled water as primary source for drinking purposes. Dependency on various types of water purifier is growing. At present 26.38% of urban households depend on water purifier (20.84% electric purifier, 5.54% non-electric purifier).

Analysis based on NSSO data of 2009, 2012 and 2018 led to the conclusion that dependency on bottled water as principal source for drinking have increased across all, except the lowest of deciles of consumption group of urban households, as per

their marginal per capita expenditure. For example, highest income decile increased dependency from 5.49% in 2009 to 17.93% in 2018, seventh decile group from bottom increased dependency from 1.12% in 2009 to 9.10% in 2018 and second decile from bottom increased dependency from 0.71% in 2009 to 3.95% in 2018. Bottled water at higher unit cost is a financial strain on the urban poor. The annual compound growth of bottled water has been at double-digit. Growth rate of bottled water as principal source was 24.42 % during 2009-12, but slowed down to 9.47% during 2012-18.

The study found that factors such as household size, social (caste) group, marginal per capita expenditure of household, age of the head of household, ownership status of household and the dwelling's location are critical factors which influence inclination to usage of bottled water and all these variables are relevant as per their statistical significance. As households grow in size dependency on bottled water goes down. Bigger household (more than 9 members) is about 15% less likely compared to small household (up to 5 members) to use bottled water as principal source. Households from general category are about 11% less likely to use bottled water as principal source compared to SC and ST category households, which indicates relatively less options for piped/ ground water for the latter.

Non-Slum areas use 68% less of bottled water than Slum areas. This too denotes the high water poverty in terms of access to publicly provided water sources in the Slum area. With increase in per capita marginal expenditure of households dependency on bottled water grows. Compared to lowest one-third of income group, Middle one-third uses 10% more and highest one-third of households use 36% more of bottled water. Households not owning their dwelling units are 66% more dependent on bottled water as principal source compared to households owning their dwelling.

Increasing proportions of India’s urban households are seeking commercial solution for enhancement of water quality for drinking purposes. Failure to ensure water quality – i.e., access to safe drinking water - is the primary reason. Analysis of NSSO data for 2012 and 2018 indicates that across all consumption group quintiles urban household has enhanced their dependencies on bottled water.

The bottom 50% consumer groups in urban India constitutes about 8.38% of entire urban bottled water demand for satisfying household's principal source for drinking. What is more serious is the speed in recent years at which lower expenditure Groups fell into noticeable dependence on purifier for the water they collect. Water purifier usage had been remarkable increased in urban India across bottom 20% consumer groups from 7% to 15.46%, across second slab of 20% consumer group from 4.81% to 15.15% and among third quintile of consumer group from 7.4% to 19.32% during 2012 and 2018. It is a demonstration of lack of confidence in publicly supplied water, or worse - no access to any source of improved water for drinking.

Urban India is still far behind the goal of achieving universal and equitable access to safe drinking water to all. At present India's policies are focussed on expanding the coverage of piped water. There is an imperative of ensuring quality along with piped water coverage for all. Without quality water for drinking the status of drinking water as public good will increasingly come under challenge. As the Indian economy develops, efficient urban water supply management will be critical for sustenance of urban hubs as economic growth engines. Non-public and private sectors' role may continue a supportive role in the supply of the public good. India's National Water Policies are aligned with this view and admit that effective and efficient regulatory mechanisms and fair play must be ensured. Government's fundamental responsibilities will continue to include allocation of adequate resources for strong infrastructure, good water governance and policy and creation of effective regulatory regime for equitable and affordable safe drinking water.

7.2 Scope of Future Research

The study discussed State level disparity in water accessibility in Chapter 3. Indian cities and towns are of different sizes as per the classification in the Census. Basing on Primarily surveys, research on WSS could be explored across different tiers of Indian cities to understand current situation and challenges.

Chapter 4 analysed the DAF index on water across the households relying on three factors – accessibility of piped water, the water source distance and facility over water points. There is potential to enrich the index by extending its dimensions – gross

household income, level of annual precipitation etc. Development of a more comprehensive Water Poverty Index can be an important future academic endeavour.

Chapter 5 keeps the scope open for State level public expenditure review on allocation for water supply and sanitation. There is a strong case for developing a concept of water Supply and sanitation (WSS) budget in the States, given the importance of the topic in the SDGs. A closely related question would be research on availability of sustainable water in urban India and its future implications for water pricing. At any rate, differential water pricing both for targeting subsidy and for encouraging responsible use of water in it is a vast area of challenging research.

Chapter 6 opens the door for extensive studies on public-private participation in water supply service across India's different States. As the present study has suggested there cannot be a sole PPP model for urban India. Extensive research is possible on different models for different tiers of cities, location, resource base and under different financial models. Such studies could also focus on understanding the underlying causes of premature termination of PPP contracts, which happened in significant number of cases. The lessons from successful case studies of PPPs from international arena and their comparative applicability in Indian scenario could be of great interest. Another area of research, which emerges from Chapter 6, is to understand whether quality of water or unavailability of water is the main reason for greater dependence on bottled water.

7.3 Recommendations

Water and sanitation are part of recognized Human Rights and the Sustainable Development Goals, to which India is a party. Delivery of drinking water needs to address existing inadequacy, socio-economic disparities and questions on safety and quality of drinking water. At the same time sustainability of water supply should be ensured. Public policy should promote inclusive development in water accessibility across society, considering disproportionate burden on women and the disabled population. For achieving equity, equal participation of male, female and disabled is necessary in decision making.

The study finds from the latest NSSO round in 2018 that percentage of urban households dependent on tube well, hand pump, 'protected', or 'unprotected' well as

their main source of dependence for drinking water is 24.25%, which is as high as 58.49% in the rural sector. Such dependence represents 44.07% of entire Indian households on groundwater as their principal source for drinking. Central Government and the States must ensure rapid expansion of modern infrastructure to ensure that every household has access to adequate safe piped drinking water at affordable and sustainable price. Such an expansion has to take into account India's diminishing availability of per capita water.

Accessibility of drinking water is not equitably distributed. Through the lens of social group and income capability of household using monthly per capita expenditure, the study indicates that the policy of water provision needs to be more focused and targeted. Though the disparity in accessibility over social group appears as sublime over time, disparity across income groups of urban households is visible and continuing.

In this context, harnessing the private sector may prove necessary to complement available funds and to introduce contemporary technology and efficiency. A rules-based, regulated private participation with public sector is viable in India and it has the potential for expanding access and reducing inequality. However, as the study analysed, the potential of success of a PPP model in water sector is positively linked to an effective State Regulatory System (in Chapter 2). At any rate, current institutional structure and hierarchy in decision making and financing is complex and multi-tiered. Besides the water supply network, water plant for treatment is an area to explore for PPP. Over time, the country needs to develop PPP with domestic, indigenous participators, state-of-the-art technology and practices and pragmatic contract designs. However, to make PPP successful and enhance a better mechanism for equitable water supply provision, coordination is required aiming to curb vertical and horizontal inequality.

The National Water Policy 2012 suggested for State-wise Water Regulatory Authority. Such Regulatory Authority has to draw powers and mandate from State-wise Water Acts. Besides size of current responsibilities, the urban local governments would be facing higher pressure of urbanization. The insufficient resource base of the local government, the pending and recurrent liabilities and bureaucratic procedure through State hierarchy impede progress and efficiency in service.

The supply side management needs to be complemented more by demand control management of water for household sector. The study indicates that India needs water budget in the coming years as it faces increasing water stress. Given the upcoming danger on water crisis, the demand side adjustment appears as an instrument to be used. Water for domestic use is one of the uses among many others, and the country is already under water stress. A distinct plan and budget for drinking water is necessary in each State. India does not have either any consolidated water budget for water on agriculture, industry, domestic sectors, or any sector-specific. The study strongly suggests that India needs water budget at sub-National level in the coming years as it faces increasing water stress.

Such a step is necessary also from the inequality and inequity point of view. If water use for every purpose is not channelized correctly, mismanagement in disbursement will intensify inequality in accessibility as well as wastage of resources. Every sub-National body should patiently and carefully implement budgets with appropriate modernization of system and technological up-gradation. There is a need also for self-evaluation by local governments and PPP projects with community participation and through introduction of State-wise benchmarks. As water supply is incorporated in the jurisdiction of local government since the 74th Constitutional Amendment Act, there is a need for economic empowerment of local governments.

The adoption of water-saving technologies in the domestic sector could be endorsed. It may be understood clearly that piped water to every household will necessitate equally robust physical and institutional infrastructure for treatment of domestic sewage. We cannot postpone investments on sewage and water treatment.

There is no specific policy for urban poor or physically challenged persons or persons residing in challenging areas. The 2012 NWP is silent on accessibility issues of water supply and specially designed sanitation utilities for disabled[62] persons. The disabled population constitute about 2.21% of the total population as per Census of India, 2011. The present attempt of disability-inclusive development is essential in strategic water and sanitation planning for different sections subject to various regional constraints.

[62] Census of India, 2011: Total 1.21 billion population in India, 0.0268 billion disabled persons (1.5 crore males and 1.18 crore females)

Comprehensive approach must include policy design on water supply and sanitation across different class of cities and different consumer groups instead of one model for all. In doing so, the identification of consumers as per their consumption expenditure is a strenuous exercise. The rural-centric initiative like 'Har Ghar pe Jal' or proposed 'Nal pe Jal' is the beginning; the urban India demands for similar type vast initiative. Water pricing - an imputation of value on water - is inevitable to save this precious natural resource from overuse and wastage. A free water connection to the weaker sections against fair but chargeable water consumption is a suitable form of expansion of equitable and affordable safe drinking water to all. Public and community support and stakeholders' participation are needed for upgraded conservation and distribution technologies. The awareness program must drive home the fact that water is a valuable natural resource, which is under stress. This awareness must relate to understanding the core focus of water-related SDGs, the linkage between sanitation and public health and the concept of water stress. The geographical, economic and social diversities on the resources' availability suggest a flexible yet complex policy action. Policymakers must formulate people-cantered policies rather than target-oriented ones in provisioning safe, adequate and affordable 'Water for All.' The socio-economic factors identified in this study may be used as instrument to estimate the effect and medium of operating of policies. Besides these supply side management procedures, it is important to bring vibrancy in demand management arena. Assurance of water for human needs will depend not only on water availability and accessibility, but also on efficiency in use, water productivity and equitable water allocation.

Elements of pure privatization in water sector like bottled water, water purifier is and will exist so far as public provisioning fails to ensure adequate and safe drinking water to all. What is important is to strongly uphold the public provisioning system based on public initiated infrastructure with a clear, distinct alienation of commercialized use of water. If properly controlled, there is no hindrance in participation of private sector in suitable PPP formats to introduce efficiency and contemporary technology and practices for universal and safe drinking water supply.

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APPENDIX

Appendix 1 Classification of Improved and Unimproved Facility Types		
Drinking water		Sanitation
Improved Facilities	Piped Supplies	Networked sanitation
	Tap water in the dwelling, yard or plot	Flush and pour-flush toilets connected to sewers
	Public stand posts	On-site sanitation
	Non-piped supplies	Flush and pour flush toilets or latrines connected to septic tanks or pits
	Borehole/tube wells	Ventilated improved pit latrines
	Protected wells and springs	Pit latrines with slabs
	Rainwater	Composting toilets, including twin pit latrines and container-based systems
	Package water, including bottled water and sachet water	
	Delivered water, including tanker, trucks and small carts	
Unimproved facilities	Non-piped supplies	On-site sanitation
	Unprotected wells and springs	Pit latrine without slabs
		Hanging latrines
		Bucket latrines
No facilities	Surface water	Open defecation
Source: Joint Monitoring Group; WHO and UNICEF, 2019		
Document: 'Progress on household drinking water, sanitation and hygiene, 2000-2017: Special Focus on Inequalities'		

Appendix 2 Improved and Unimproved Water Supply Facility: Urban India, 2018 (% to Total Provision)		
Drinking water		Sanitation
Improved Facilities	Piped Supplies	Networked sanitation
	Tap water in the dwelling, yard or plot= 57.88	Flush and pour-flush toilets connected to sewers = 37.66
	Public stand posts =7.09	On-site sanitation = 0.14
	Non-piped supplies	Flush and pour flush toilets or latrines connected to septic tanks or pits = 47.09
	Borehole/tube wells/hand pumps = 17.09	Ventilated improved pit latrines = 0.39
	Protected wells and springs = 1.72	Pit latrines with slabs = 1.87
	Rainwater = .04; Protected Spring= .05	Composting toilets, including twin pit latrines and container-based systems = 8.31
	Package water, including bottled water and sachet water = 12.24	
	Delivered water, including tanker trucks and small carts = 1.43	
Unimproved facilities	Non-piped supplies	On-site sanitation
	Unprotected wells and springs = 2.41	Pit latrine without slabs =0.06
		Composting latrines = 0.03
		Other latrines = 0.05
No facilities	Surface water = 0.09	Open defecation =0.11
Source: Derived from 76th Round, NSSO, 2018		

Appendix 3 List of 18 items covered under the Twelfth Schedule Article 243W, Constitution of India	
Serial Number	Areas of Responsibilities
1	Regulation of land use and construction of land buildings.
2	Urban planning including the town planning.
3	Planning for economic and social development
4	Urban poverty alleviation
5	Water supply for domestic, industrial and commercial purposes
6	Fire services
7	Public health sanitation, conservancy and solid waste management
8	Slum improvement and up-gradation
9	Safeguarding the interests of the weaker sections of society, including the physically handicapped and mentally unsound
10	Urban forestry, protection of environment and promotion of ecological aspects
11	Construction of roads and bridges
12	Provision of urban amenities and facilities such as parks, gardens and playgrounds
13	Promotion of cultural, educational and aesthetic aspects
14	Burials and burials grounds, cremation and cremation grounds and electric crematoriums
15	Cattle ponds, prevention of cruelty to animals
16	Regulation of slaughter houses and tanneries
17	Public amenities including street lighting, parking spaces, bus stops and public conveniences
18	Vital statistics including registration of births and deaths
Source: Constitution of India	

Appendix 4 Percentage of Within or Outside Premises Drinking Water Facility across Urban Households						
States	2002		2012		2018	
	Within Premises	Outside Premises	Within Premises	Outside Premises	Within Premises	Outside Premises
Andhra Pradesh	56.19	43.81	77.89	22.11	60.2	39.39
Bihar	79.3	20.7	86.28	13.72	95.31	4.69
Chhattisgarh	60.08	39.92	61.9	38.1	73.15	26.85
Goa	61.84	38.16	99.66	0.34	96.75	3.25
Gujarat	87.95	12.05	84.38	15.62	87.74	12.17
Jharkhand	58.53	41.47	66.94	33.06	73.89	26.11
Haryana	84.36	15.64	87.37	12.63	89.15	10.54
Karnataka	65.18	34.82	81.91	18.09	74.44	25.55
Kerala	76.61	23.39	82.04	17.96	92.04	7.96
Madhya Pradesh	57.55	42.45	70.77	29.23	83.06	16.8
Maharashtra	77.12	22.88	87.54	12.46	93.38	6.42
Odisha	61.79	38.21	73.88	26.12	72.13	27.59
Punjab	93.49	6.51	90.06	9.94	96.52	3.48
Rajasthan	76.99	23.01	84.03	15.97	91.27	5.93
Tamil Nadu	55.33	44.67	64.7	35.3	74.1	25.68
Uttar Pradesh	80.8	19.2	80	20	83.61	16.37
West Bengal	50.84	49.16	50.63	49.37	54.26	45.74
Arunachal Pradesh	85.73	14.27	98.08	1.92	98	2
Assam	87.93	12.07	92.59	7.41	95.65	4.35
Himachal Pradesh	90.45	9.55	94.42	5.58	89.72	10.28
Jammu & Kashmir	90.16	9.84	88.41	11.59	91.92	8.06
Manipur	52.95	47.05	48.9	51.1	50.43	34.96
Meghalaya	67.98	32.02	72.27	27.73	66.25	32.58
Mizoram	65.29	34.71	81.99	18.01	95.68	3.8
Nagaland	73.96	26.04	87.51	12.49	91.47	8.53
Sikkim	90.2	9.8	96.48	3.52	92.73	7.27
Tripura	71.43	28.57	82.58	17.42	88.63	11.37
Uttarakhand	87.64	12.36	85.76	14.24	98.58	1.42
Urban India	70.28	29.72	77.51	22.49	80.48	19.26
Rural India	37.29	62.71	46.32	53.68	58.06	41.13
All India	46.64	53.36	56.16	43.84	65.73	33.45
Source: NSSO, 58th, 69th and 76th Rounds						

Appendix 5 Grouping of Size of Households, 2018				
All India				
Number of Members	Household Size	Frequency	Percent	Cumulative Percent
Less than or 5 members	Small	20,89,98,77,185	77.09	77.09
More than 5 but less than 10 members	Medium	5,60,20,72,569	20.66	97.76
10 members or more	Big	60,86,02,762	2.24	100
Rural				
Less than or 5 members	Small	13,11,88,48,619	73.54	73.54
More than 5 but less than 10 members	Medium	4,27,45,96,544	23.96	97.51
10 members or more	Big	44,47,14,140	2.49	100
Urban				
Less than or 5 members	Small	7,78,10,28,566	83.92	83.92
More than 5 but less than 10 members	Medium	1,32,74,76,025	14.32	98.23
10 members or more	Big	16,38,88,622	1.77	100
Source: 76th Round on Drinking Water, Sanitation, Hygiene and Housing Condition				

Appendix 6 Age Structure of Household Head, 2018 (% of Population)			
State	Till 30 years	More than 30 till 60 years	More than 60 years
Andhra Pradesh	15.63	66.27	18.10
Arunachal Pradesh	14.36	81.08	4.55
Assam	8.60	75.24	16.16
Bihar	13.04	75.89	11.07
Chhattisgarh	11.86	72.93	15.21
Goa	8.79	56.70	34.52
Gujarat	15.55	68.43	16.02
Haryana	14.29	66.53	19.17
Himachal Pradesh	7.80	62.75	29.45
Jammu & Kashmir	7.23	73.33	19.44
Jharkhand	14.21	71.77	14.02
Karnataka	13.16	70.18	16.66
Kerala	4.38	63.06	32.56
Madhya Pradesh	14.38	71.63	13.99
Maharashtra	10.73	69.70	19.57
Manipur	6.43	73.67	19.90
Meghalaya	15.73	72.02	12.24
Mizoram	9.65	69.00	21.35
Nagaland	5.40	82.70	11.90
Odisha	14.62	65.94	19.43
Punjab	7.53	72.74	19.74
Rajasthan	14.32	68.92	16.76
Sikkim	12.19	67.07	20.74
Tamil Nadu	13.35	66.79	19.86
Tripura	5.53	77.08	17.39
Uttar Pradesh	14.26	70.46	15.28
Uttarakhand	8.77	72.40	18.83
West Bengal	13.70	67.56	18.74
All India	13.23	69.62	17.15
Urban India	17.69	65.69	16.62
Rural India	10.91	71.67	17.43
Source: 76th Round, NSSO			

Appendix 7 Latest Allocation of States on Social Sector Expenditures out of Total Expenditure (%) in Revenue Account				
Year	2017-18 (Actual)	2018-19 (Budget Estimates)	2018-19 (Revised Estimates)	2019-20 (Budget Estimates)
Non-Special Category States				
Andhra Pradesh	48.81	52.93	50.81	51.58
Bihar	39.41	40.33	40.33	40.10
Chhattisgarh	43.34	41.08	38.61	36.81
Goa	39.41	40.33	40.33	40.10
Gujarat	41.54	41.15	42.43	40.66
Jharkhand	38.42	39.78	39.75	40.40
Haryana	38.31	40.12	38.71	38.32
Karnataka	41.16	42.23	41.97	39.29
Kerala	35.89	33.56	34.56	31.28
Madhya Pradesh	37.88	34.70	39.32	37.93
Maharashtra	38.52	41.10	42.96	44.39
Odisha	41.14	42.58	43.30	42.50
Punjab	24.77	24.68	24.41	25.28
Rajasthan	36.38	38.11	39.45	40.11
Tamil Nadu	35.62	35.61	36.17	33.94
Telangana	43.65	44.13	44.10	37.86
Uttar Pradesh	31.65	34.42	33.38	35.37
West Bengal	42.24	43.16	43.08	43.35
Special Category States				
Arunachal Pradesh	36.24	31.08	37.28	35.78
Assam	43.34	41.08	38.61	36.81
Himachal Pradesh	38.21	38.29	39.41	38.5
Jammu & Kashmir	32.06	29.79	34.96	34.03
Manipur	27.71	27.02	28.1	27.47
Meghalaya	37.37	35.62	35.62	37.56
Mizoram	0.38	0.35	0.39	0.38
Nagaland	25.11	26.81	28.87	27.23
Sikkim	36.9	30.91	37.94	35.44
Tripura	41.99	41.18	42.31	44.14
Uttarakhand	37.58	39.26	37.32	38.04
Union Territories (UTs)				
NCT Delhi	58.07	63.44	59.91	59.6
Pondicherry	38.49	37.2	37.23	35.89
All States and UTs	39.03	40.22	40.45	40.07
Source: RBI State Finance, 2019-20				

Appendix 8 Latest Allocation of States on Social Sector Expenditures out of Total Capital Outlay (%)				
Year	2017-18 (Actual)	2018-19 (Budget Estimates)	2018-19 (Revised Estimates)	2019-20 (Budget Estimates)
Non-Special Category States				
Andhra Pradesh	21.43	16.45	14.04	24.99
Bihar	14.73	15.98	15.41	20.86
Chhattisgarh	26.52	27.06	27.58	27.36
Goa	31.25	39.59	39.59	38.29
Gujarat	25.89	29.20	25.82	26.81
Jharkhand	12.78	15.88	16.99	16.29
Haryana	23.44	30.86	30.10	27.38
Karnataka	28.29	28.07	25.42	30.71
Kerala	16.07	25.48	25.25	15.37
Madhya Pradesh	17.33	25.8	20.32	24.89
Maharashtra	8.45	10.95	13.03	7.65
Odisha	19.90	18.53	15.82	26.00
Punjab	38.97	52.90	49.97	14.03
Rajasthan	35.02	36.55	36.24	42.05
Tamil Nadu	23.42	32.59	29.09	33.06
Telangana	11.93	19.94	21.57	4.04
Uttar Pradesh	29.74	30.23	25.77	28.84
West Bengal	39.27	40.88	41.56	36.04
Special Category States				
Arunachal Pradesh	26.81	24.33	20.51	17.81
Assam	36.99	33.42	28.83	23.22
Himachal Pradesh	30.22	24.94	25.45	27.53
Jammu & Kashmir	26.92	22.17	22.16	21.83
Manipur	46.47	34.31	42.52	33.00
Meghalaya	36.66	35.24	35.24	33.54
Mizoram	30.74	23.69	38.53	15.34
Nagaland	38.10	33.64	28.34	36.45
Sikkim	35.48	28.63	29.71	28.74
Tripura	52.94	51.22	43.84	27.97
Uttarakhand	18.36	27.71	24.5	30.76
Union Territories				
NCT Delhi	48.56	53.62	54.27	61.79
Pondicherry	27.2	29.52	32.89	46.34
All States and UTs	23.58	26.45	24.69	25.27
Source: Computed: Basic Source: RBI State Finances: 2019-20				

Appendix 9 Percentage of Revenue Expenditure on Water Supply and Sanitation				
Year	2017-18 (Actual)	2018-19 (Budget Estimates)	2018-19 (Revised Estimates)	2019-20 (Budget Estimates)
Non-Special Category States				
Andhra Pradesh	2.62	1.48	1.26	0.97
Bihar	2.28	4.09	4.29	3.80
Chhattisgarh	2.45	1.83	1.51	1.09
Goa	3.58	3.13	3.13	3.37
Gujarat	0.82	0.74	1.03	0.85
Jharkhand	3.46	2.82	2.93	2.74
Haryana	2.33	2.27	2.12	2.24
Karnataka	3.34	2.25	1.93	1.32
Kerala	0.70	0.39	0.39	0.41
Madhya Pradesh	2.37	1.99	1.14	0.76
Maharashtra	1.28	2.11	2.21	2.05
Odisha	2.45	2.53	3.57	3.61
Punjab	0.58	0.67	0.59	0.61
Rajasthan	2.06	1.87	2.01	1.89
Tamil Nadu	0.93	0.78	0.76	0.41
Telangana	1.05	0.43	0.45	0.22
Uttar Pradesh	0.43	0.46	0.45	0.88
West Bengal	0.92	0.90	0.85	0.81
Special Category States				
Arunachal Pradesh	6.15	3.95	5.52	5.70
Assam	0.70	1.13	1.11	1.15
Himachal Pradesh	3.63	3.61	3.49	3.27
Jammu & Kashmir	3.18	2.39	2.70	2.60
Manipur	0.67	0.52	0.44	0.52
Meghalaya	2.52	2.08	2.08	1.98
Mizoram	3.10	2.17	2.72	2.44
Nagaland	0.89	0.87	0.88	0.79
Sikkim	0.91	1.24	1.21	1.15
Tripura	1.44	1.38	1.32	1.27
Uttarakhand	1.52	0.84	0.94	0.92
Delhi	3.63	3.40	3.47	3.02
Pondicherry	0.87	1.60	1.38	1.50
All States and UTs	1.67	1.59	1.59	1.47
Source: Computed: Basic Source: RBI State Finances: 2019-20				

Appendix 10 Percentage of Water Supply and Sanitation Expenditure to Total Capital Disbursement				
States	2017-18 (Actual)	2018-19 (Budget Estimates)	2018-19 (Revised Estimates)	2019-20 (Budget Estimates)
Non-Special Category States				
Andhra Pradesh	0.12	0.73	0.11	0.38
Bihar	0.04	0.30	0.30	0.38
Chhattisgarh	0.17	0.35	0.32	0.32
Goa	1.38	3.57	3.57	2.64
Gujarat	0.59	1.48	1.98	2.23
Haryana	1.38	3.57	3.57	2.64
Jharkhand	0.15	0.39	0.21	0.32
Karnataka	0.07	0.28	0.27	0.43
Kerala	0.11	0.4	0.35	0.28
Madhya Pradesh	0.28	0.24	0.25	0.39
Maharashtra	0.00	0.01	0.00	0.00
Odisha	0.40	0.64	0.53	0.81
Punjab	0.59	1.34	0.53	1.03
Rajasthan	1.28	1.40	1.06	1.23
Tamil Nadu	0.15	0.34	0.21	0.39
Uttar Pradesh	0.12	0.45	0.47	1.20
West Bengal	0.24	0.29	0.20	0.20
Special Category States				
Arunachal Pradesh	0.49	1.10	0.25	0.24
Assam	1.17	0.67	1.24	0.74
Himachal Pradesh	0.73	3.21	3.13	5.16
Jammu & Kashmir	0.93	1.34	1.15	1.31
Manipur	1.42	0.75	1.66	1.04
Meghalaya	0.75	0.91	0.91	0.67
Mizoram	1.69	0.3	1.15	0.39
Nagaland	0.8	0.72	1.00	1.03
Sikkim	0.85	1.44	1.42	2.25
Tripura	0.43	0.58	0.97	0.86
Uttarakhand	0.77	3.60	2.98	1.88
All-States	0.61	1.08	1.06	1.13
All-States and UTs	0.32	1.32	2.32	3.32
Non-special Category States	0.42	0.93	0.82	0.93
Special Category States	0.91	1.33	1.44	1.42
Source: Computed: Basic Source: RBI State Finances: 2019-20				

Appendix 11 Categorisation of Expenditure on Water Supply and Sanitation	
Revenue Expenditure	
Name of the Category	Contains the components
Administration	Direction and Administration
	Survey and Investigation
Miscellaneous	General
	Training
	Research
	Transfer to/ from Reserve Funds
	Suspense
	Other Expenditure
	Deduct Recoveries of Overpayments
Operational	Expenditure transferred to other head of Account
	Machinery and Equipment
	Sanitation Services
	Prevention of Air and Water Pollution
Scheme Expenditure	Urban Water Supply Programs
	Rural Water Supply Programs
	Special Component Plan for Scheduled Caste
	Tribal Areas Sub Plan
	Special Component Plan for Scheduled Caste
	Tribal Areas Sub Plan
Transfer to third-tier government and Para-Statal	Assistance to Public Sector and Other Undertakings
	Assistance to Municipal Corporations
	Assistance to Municipalities/Municipal Councils
	Assistance to Nagar Panchayat/ Notified Area Committees
	Assistance to Zilla Parishads/ District level Panchayats
	Assistance to Block Panchayats/ Intermediate level Panchayats
	Assistance to Gram Panchayats
	Assistance to Public Sector and Other Undertakings
	Assistance to Municipal Corporations
	Assistance to Municipalities/Municipal Councils
	Assistance to Nagar Panchayat/ Notified Area Committees
	Assistance to Zilla Parishads/ District level Panchayats
	Assistance to Gram Panchayats
Capital Outlay	
Miscellaneous	Suspense
	Other Expenditure
	Deduct Receipts and Recoveries on Capital Account
	Deduct Recoveries of Overpayment
	Training
Scheme-capital expenditure	Urban Water Supply
	Rural Water Supply
	Special Component Plan for Scheduled Caste
	Special Central Assistance for Tribal Areas Sub Plan
	Tribal Areas Sub Plan
	Urban sanitation services
	Rural Sanitation Services
Transfer to third-tier government and Parastatal	Assistance to Public Sector and Other Undertakings
Source: Computed; Basic Source: Finance Accounts, India	

Appendix 12 Prevalence of Diarrhoea in Water Borne Diseases (%): India					
Year	2013	2014	2015	2016	2017
Diseases	Cases				
Acute Diarrhoeal Diseases	86.63	86.23	86.13	85.71	85.29
Typhoid	12.52	12.75	12.92	13.41	13.80
Viral Hepatitis	0.84	1.02	0.94	0.88	0.91
Cholera	0.01	0.01	0.01	0.00	0.00
Diseases	Deaths				
Acute Diarrhoeal diseases	62.77	57.80	60.29	61.71	59.49
Typhoid	14.91	21.61	20.14	20.28	20.25
Viral Hepatitis	22.12	20.34	19.39	17.90	20.04
Cholera	0.19	0.25	0.18	0.12	0.21
Source: National Health Profile-various years, Central Bureau of Health Intelligence, Ministry of Health & Family Welfare, Government of India.					

Appendix 13 Different Types of PPP formation		
Types	Responsibility of the private sector	Responsibility of the public sector
Build-Operate -Transfer Build transfer operate Build rent operate Rehabilitate operate transfer Lease Develop Transfer Lease Develop Operate BOT-Annuity	Design Construction Operation (For 6. Receives annuity after commercial operation of the project)	Negotiation Regulation Ownership
Build-Own-Operate Buy-Build-Operate	Design Construction Operation Ownership/ Purchase of an asset Rehabilitation, if necessary Expansion, if necessary Operation	Selection Negotiation Regulation, if necessary Supervision, if necessary Facilitation Sale of the asset (depends) Transfer of the asset (depends)
Status of ownership change		
Build own operate transfer Concession[63] Build own operate subsidized transfer	With private-till 15-20 years With private-till 20-30 years With private-till 20-25 years	The shift of ownership from private to public
Contract services		
Operation and maintenances	Operation Maintaining work	Competitive bidding Standardization of rules and regulations Regulation Management
Design-build (entire investment public)	Developing design Construction No management No maintenance	Operation Management Maintenance
Design-build-maintain	Developing design Construction Maintenance	Ownership Operation Management
Design-Build-Operate	Developing design Construction Operation	Ownership Management Regulation
Lease-Develop-Operate Or Build-Develop-Operate	Ownership Investment Design Construction Operation	Management Supervision
Source: Assembled from various sources		

[63] When the contracts expire, the responsibilities of provision return to the public sector, ideally with improved management and infrastructure.

Appendix 14 PPP in India by World Bank Support: 1990-2012					
Sector	Subsector	Number of projects	% of projects	Total Investment in $ million	% of total investment
Energy	Electricity	297	40.97	134.872	44
	Natural gas	5	0.69	831	0.3
	Total energy	302	41.66	965.872	44.3
Telecom	Telecom	37	5.10	89054	29.1
Transport	Airports	7	0.97	4527	1.5
	Railroads	8	1.10	7570	2.5
	Roads	324	44.69	61885	20.2
	Seaports	34	4.69	7116	2.3
	Total transport	373	51.45	81098	26.5
Water and sewerage	Treatment plant	4	0.55	195	0.1
	Utility	9	1.24	276	0.1
	Total water and sewerage	13	1.79	471	0.2
All Total		725	100	171,588.872	100
Source: PPI Database, World Bank, 2014; accessed in Wu, House & Peri (2016) Total investment in PPP amounts to $306,325 million as per the study source. The water sector investment accrues for $941 million, which implies as meagre as 0.4% of total investment.					

Appendix 15 Level of Urbanisation across Districts of Northern Karnataka Region			
Administrative Division & Districts	% Urban Population		
	1991	2001	2011
North Karnataka Region	25.84	27.97	29.39
Gulbarga Division			
Bidar	19.57	22.96	25.01
Raichur	24.56	25.2	25.42
Koppal*	15.46	16.58	16.81
Bellary	31.16	34.87	37.52
Gulbarga	26.98	31.71	32.56
Yadgir**	16.07	17.05	18.79
Belgaum Division			
Belgaum	23.49	24.03	25.34
Bagalkot*	27.68	28.97	31.64
Bijapur	19.77	21.92	23.05
Gadag*	34.68	35.21	35.63
Dharwad	52.53	54.97	56.82
Haveri*	16.05	20.78	22.25
Source: Eswar & Roy, 2018; Basic Source: Computed from Census of India 1991, 2001 and 2011			
*New districts formed after 2001 census; **New districts formed after 2011 census;			

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