Project 02

Availability, Accessibility, and Inequalities of Water, Sanitation, and Hygiene (WASH) Services in Indian Metro Cities

Ayushman Anupam (bmat2006)
Kush Muzunder (bmat2011)
Priyansh Pankaj (bmat2017)
Utpalraj Kemprai (bmat2032)

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Contents

Highlights

- Importance of wash
- Wash conditions in India and reasons for such disparity
- Wash availability and accessibility in 2004-05 and 2011-12.
- Data, Methods and Background variables
- Inter-city and Intra-city inequality comparison
- Intracity-inequality, its attribute and reasons
- WASH as a human right

Abstract

WASH is related to any country's concern in relation to the health of their people. It becomes the right of the citizen to acquire safe water, sanitation and hygiene measures. WASH are among the most crucial for human to create healthy life. The paper is about availability and accessibility of water, sanitation, and hygiene (WASH), and the overall 'WASH' performance in terms of levels, trends and inequality across the six major cities (Mumbai, Delhi, Chennai, Bangalore, Kolkata, and Hyderabad) of India using data from two rounds of the India Human Development Survey conducted during 2004-05 and 2011-12. Report tells us that accessibility, availability and overall WASH performance during 2011-12 were better than that of 2004-05 but the change is not so significant and not uniform over all the cities , this one-sided asperity is traceable to literacy, housing condition, economic stability ,categorical status , etc. Organisation of WASH fulfilment within people should be more sustainable for metropolitan development as adequate water, sanitation and hygiene are essential components of providing basis health services and is a basic human right.
Through this report we intend to reproduce and extend the results of the paper through the the data from IHDS conducted in 2004-05 and 2011-12

1 Introduction

Growing up in a clean and safe environment is every one's right. Access to clean water, basic toilets, and good hygiene practices not only keeps children thriving, but also gives them a healthier start in life. Today, 2 billion people lack access to safely managed drinking water services and 3.6 billion people lack safely managed sanitation services. Unsafe hygiene practices are widespread, compounding the effects on people's health. To address and solve these problems the concept of WASH groups together water supply, sanitation, and hygiene was introduced since the impact of deficiencies in each area overlap strongly.Addressing these deficiencies together can achieve a strong positive impact on public health.

As we have seen WASH for "water, sanitation and hygiene". Universal, affordable and sustainable access to WASH is a key public health issue within international development and is the focus of the first two targets of Sustainable Development Goal 6 (SDG 6). Targets 6.1 and 6.2 aim at equitable and accessible water and sanitation for all. "Access to WASH" includes safe water, adequate sanitation and hygiene education. Improving access to WASH services can improve health, life expectancy, student learning, gender equality, and other important issues of international development. This can reduce illness and death, and also affect poverty reduction and socio-economic development. Challenges include providing services to urban slums, improper management of water distribution systems, failures of WASH systems over time, providing equitable access to drinking water supply and gender issues. WASH services have to be provided to household locations but also to schools, healthcare facilities, work places, markets, prisons, train stations, public locations etc.

The fact that WASH is the subject of dedicated targets within the Sustainable Development Goal (SDG 6) is testament to its fundamental role in public health and therefore in the future of sustainable development. Indeed, access to safe water and sanitation are human rights, as recognized in 2010 by the United Nations General Assembly. For universal fulfilment of these rights to become reality, we will need the right systems: well-resourced, capable institutions delivering services and changing behaviour in resilient and appropriate ways.In 2015 the World Health Organization (WHO) estimated that "1 in 3 people, or 2.4 billion, are still without sanitation facilities" while 663 million people still lack access to safe and clean drinking water. In 2017, this estimate changed to

2.3 billion people without sanitation facilities and 844 million people without access to safe and clean drinking water. Lack of sanitation contributes to about 700,000 child deaths every year due to diarrhea , mainly in developing countries. Chronic diarrhea can have long-term negative effects on children, in terms of both physical and cognitive development. In addition, lack of WASH facilities at schools can prevent students (especially girls) from attending school, and reduce their educational achievements and later work productivity.

In the Indian context, according to the Census of India (2011), almost 31.2 % of the Indian population (more than 377 million) live in cities. According to the Office of the Registrar General Census Commissioner, India (ORGI) 2011, about 42.6% (160.7 million) of the urban population lives in the 53 Million-Plus Urban Agglomerations/ cities (each has a population of one million or above). Among them, largest six urban agglomerations are Greater Mumbai (18.4 million), Delhi (16.3 million), Kolkata (14.1 million), Chennai (8.7 million), Bangalore (8.5 million), and Hyderabad (7.7 million), which also dominate India's economic landscape (Kumar 2015; Ministry of Housing and Urban Affairs , 2019). Despite the fact that Bangalore, Chennai, Delhi, Mumbai, and Kolkata were ranked high in "prosperity index" among the Indian districts for their performance based on poverty, productivity and growth (Ellis Roberts, 2016), almost two-thirds of urban households do not have access to water in the household premises and 85 million of the urban population lack basic sanitation facilities, and around 3–4 million (1% of the urban population) are homeless (India's Smart Cities Mission, 2018)

Over the last decade and more, most of the city-specific plans, such as the Master Plan and Jawaharlal Nehru National Urban Renewal Mission (JNNURM), were not efficient at solving the issues of water and sanitation facilities in the urban areas. After more than six decades of planning, the basic rights of urban-dwellers in the form of safe drinking water and improved sanitation remain undersupplied. The Smart Cities Mission aims to promote housing opportunities for all and at introducing smart solutions to improve the basic infrastructure, including the universal supply of water and sanitation facilities in 109 selected cities in India by 2019 . Clean India mission or Swachh Bharat Mission launched in India on 2nd October 2014 aims to end open defecation in India by October 2019. The SBM aims to construct 11 crore toilets in 5 years, to be able to achieve its goal.However, it has a limited focus for the

marginalised urban dwellers who cannot afford high-priced services.

Despite several steps by government and several institution, WASH availability and accessibility remains an unsolved problem for both Indian urban and rural region. To tackle this problem effectively there is a need for effective policies and extensive research of inequality in WASH. Although inter-city inequality in basic facility is decreasing, but intra-city inequality still a big problem in India. There is a need for city-based policies which aims to solve the problems specific to that city and aims to resolve the inequality in living condition of people living in the city.

1.1 In current situation of Covid19

Safely managed water, sanitation, and hygiene (WASH) services are an essential part of preventing and protecting human health during infectious disease outbreaks, including the current COVID-19 pandemic. One of the most cost-effective strategies for increasing pandemic preparedness, especially in resource-constrained settings, is investing in core public health infrastructure, including water and sanitation systems. Good WASH and waste management practices, that are consistently applied, serve as barriers to human-to-human transmission of the COVID-19 virus in homes, communities, health care facilities, schools, and other public spaces. Current WHO recommendations on preventing the transmission of SARS promote good hygiene, especially regular hand washing with clean water and soap. In addition, WHO recommends social distancing practices, wearing of face mask in public places and situations where social distancing is not possible, and the use of personal protective equipment by frontline health service providers. Wearing of masks prevents the wearer from transmitting SARS to others and the practice may provide some protection to the wearer. Given that transmission of SARS can occur through contaminated surfaces and contaminated hands, proper hand hygiene is extremely important to stop transmission.

1.2 Background and Reasoning

The colonial interest in public sanitation sadly, remained restricted to the needs of the military and the elite, rather than the whole population. Most municipal reforms were focused on eradication of epidemics and construction of estates, but no programme addressed the sanitation needs of Indians. By 1947, the Indian population which was more than 30 crores, had less than 1% sanitation coverage and this statistic did not improve for a long time.

"During the colonial rule in India, public health and sanitation were never given priority. Despite the population being in manageable numbers, rural sanitation, water supply were issues never taken up by the administration. This disinterest in India's sanitation scenario is a reason why improving sanitation conditions today is a Herculean task"
Said , Professor Kumar Jyoti Nath
President Institution of Public Health Engineers, India

After independence first few "five years plans" was development and industrialisation, Sanitation and hygiene was not questioned as disposal happened at a distance from the homestead, odours dissipated in the open, and there were no nuisances to contend with. As a result, sanitation has been commonly perceived as sweeping and heaping of household refuse, keeping streets clean and maintaining channels for drainage and excess water flow, which had grown to a big problem.

One more major reason for poor WASH conditions in India is migration of people from rural area to urban area in search of better lifestyle. In data from census of 2011 showed that it is rural to urban migration and not the natural growth that is driving urban population growth over the last decade. The shift towards urban occupation was not uniform, it was mostly to poor incomed profession such as daily paid workers, street vendors, etc. such urbanisation of rural poverty caused many problems to local authority, especially to the civic bodies, which are responsible for providing basic amenities and services, and the creation of sustainable cities. Such migration need many basic facilities but lack of proper rental regulation resulted in high rents at the hands of private owners which was excess in some metropolitan cities (Bangalore, Delhi, Bombay, etc).

As a result, large population of such migrants were pushed to accommodate in dark, cheap and planned settlements, which are usually located in the unauthorised lands and forms unauthorised colonies. These colonies are usually called slums and are devoid of basic facilities such as proper water-source, drainage-system, etc. The government of India has tried to curb the problem of water and sanitation in cities. However, the slum dwellers and other categories of urban poor, such as homeless and housing-shelter dwellers, have witnessed little improvements in their living conditions.

Despite the articulated 'inclusive urban planning', the socio-economic and spatial exclusion in accessing to WASH is still widespread in unplanned settlements, which tends threaten the health of urban poor. Implementation of several policies and programes by government has helped to curb these issues but the status of WASH remained unpleasant for the urban poor. According to many analyst these policies and programes improves the WASH condition as a whole but are not able not focus on the inequality in WASH within and between cities. There is a strong need to measure and document the problems and trends in WASH conditions especially at intra-city level resolving the problems associating to specific Urban area.

2 Data and Methods

2.1 Data

The data in the paper is from the first and second rounds of the India Human Development Surveys (IHDSs). These two rounds of surveys were conducted in 2004–05 (IHDS-I) and 2011–12 (IHDS-II), with the collaboration of the University of Maryland by the National Council of Applied Economic Research (NCAER), New Delhi. IHDS has covered a multi-topic panel survey of 41,554 households in 1,503 villages and 971 urban blocks of 276 towns and cities (Desai et al., 2010). In these surveys, a special representative sample design is adopted for the six largest populated cities in India *i.e*- Mumbai, Delhi, Bangalore, Hyderabad, Chennai and Kolkata.

The study is limited to these six cities due to data availability, but the sample sizes allow us to conduct an suitable statistical analysis. The surveys collected information on income, consumption, the standard of living, employment, education, and various aspects of gender and family relationships. The surveys also collected information on water, sanitation, and hygiene, as well as the educational, medical, and village infrastructure. The select six cities represent four geographical regions: Mumbai from the West, Delhi from the North, Kolkata from the East and Chennai, Bangalore and Hyderabad from the South. Thus, the sample estimates the geographical variation in the urban characteristics of the country.

2.2 Sample

The sample size of data for the selected cities in 2004-05 [N = 4133] and 2011-12 [N = 3912] with distribution as for Delhi, Kolkata, Mumbai, Hyderabad, Bangalore, and Chennai respectively.

Table 1
Descriptive statistics of the data for six Metro cities.

Metro cities	2004–05		2011–12	
	n	Percent	n	Percent
Mumbai	585	14.15	524	13.39
Delhi	1326	32.08	1266	32.36
Kolkata	1114	26.95	1079	27.58
Chennai	291	07.04	259	06.62
Bangalore	360	08.71	351	08.97
Hyderabad	457	11.06	433	11.07
Total	4133	100	3912	100

Source: IHDS-I & IHDS-II Round survey.

2.3 Background Variables

In this study, WASH availability, accessibility, and overall performance have been estimated using a good range of Background-Variables **as shown in Table 2**

Table 2 : Background Variables

Background Characteristics	Delhi		Kolkata		Mumbai		Hydrabad		Bangalore		Chennai		Total	
	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12
Education level of the head of the family														
Illiterate	47.82	54.11	39.77	42.63	29.56	27.86	79.43	78.75	25.00	62.39	47.42	37.83	44.83	50.60
Primary	5.05	3.95	13.65	16.68	27.17	26.53	6.13	4.85	11.67	5.98	3.78	3.47	11.24	10.24
Secondary	37.93	32.39	32.94	31.51	36.58	38.17	11.38	12.93	53.61	24.79	40.55	45.95	35.50	30.95
Higher	9.20	9.56	13.65	9.17	6.67	7.44	3.06	3.46	9.72	6.84	8.25	12.74	8.42	8.20
Economic Status														
Poor	10.2	7.42	12.84	10.38	13.16	0.57	7.44	5.54	3.33	4.84	5.84	10.04	8.40	6.46
Non-Poor	89.80	92.58	87.16	89.62	86.84	99.43	92.56	94.56	96.67	95.16	94.16	89.96	91.60	93.54
Occupation of head of the household														
Primary	38.54	40.84	36.54	35.59	37.44	59.54	63.68	67.21	36.94	39.60	41.24	20.46	42.40	43.87
Secondary	13.27	24.09	15.44	28.92	11.80	10.50	10.50	14.32	14.17	24.50	12.75	46.33	12.98	24.78
Tertiary	33.18	33.1	35.55	34.20	43.08	27.29	18.82	17.55	38.89	33.62	28.52	27.41	33.00	28.86
No-Occupation	15.01	01.97	12.48	01.30	7.69	2.67	7.00	0.92	10.00	2.28	17.53	5.79	11.62	2.49
Social-Categories														
General	37.18	30.57	48.38	49.68	43.42	48.28	14.22	11.32	27.78	11.68	7.90	5.79	29.82	26.22
OBC	22.93	23.46	10.23	5.93	27.01	28.05	52.52	51.27	40.00	51.28	47.77	45.17	33.41	34.20
SC	18.40	24.41	19.93	24.28	17.95	15.46	24.29	27.02	11.67	20.51	35.40	39.38	21.27	25.18
ST	0.45	1.15	2.24	1.21	1.03	0.95	0.44	1.39	0.83	2.85	0.00	0.00	0.83	1.26
Muslims	17.42	17.61	18.94	18.63	5.64	3.63	6.56	7.85	8.61	7.69	3.78	4.25	10.16	9.94
Others	3.62	2.76	0.27	0.29	4.96	3.44	1.97	1.15	11.11	5.70	5.15	5.02	4.51	03.06
Total n	1326	1266	1114	1079	585	524	457	433	360	351	291	259	4133	3912

2.4 Outcome indicators

To measure the WASH availability, indicators use are : a source of drinking water, sanitation facility, and materials used for the hygienic condition in the household(**as in Table 3**).

While WASH accessibility comprises location and reach-ability to drinking water sources, sanitation facilities and hygienic practices, the hygienic practices are defined as whether the household uses the separate kitchen, persons living per room and hygienic storage of water and hand wash after defecation. The variables selected for the availability and accessibility indexes were dichotomized as 0 for disadvantageous and 1 for the advantageous group to convert them into the generalised linear form(**as in Table 4**).

Table 3 : WASH Availability index

Variables	Delhi		Kolkata		Mumbai		Hydrabad		Bangalore		Chennai		Total	
	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12
Source of drinking water														
(1) Piped, bottled,hand pump	93.67	84.54	99.46	95.52	98.97	89.40	95.19	86.21	98.89	88.89	92.78	85.57	96.49	88.35
(0) river,pond,others	6.34	15.46	0.54	4.49	1.03	10.60	04.81	13.79	01.11	11.11	7.22	14.43	03.51	11.65
Time of water supply														
(1)> 1 hour	65.69	54.90	47.22	46.77	71.45	38.63	21.23	41.79	30.00	68.06	36.43	39.52	45.34	48.28
(0) < 1 hour	34.31	45.10	52.78	53.23	28.55	61.37	78.78	58.21	70.00	31.94	63.57	60.48	54.67	51.72
Toilet Facility available														
(1) Proper defecation	79.56	78.28	69.30	88.15	45.13	77.61	62.14	57.11	97.78	91.67	74.91	69.76	71.47	77.10
(0) Open defecation	20.44	21.72	30.70	11.85	54.87	22.39	37.86	42.89	02.22	08.33	25.09	30.24	28.53	22.90
Hand wash after defecation														
(1) Yes	87.41	86.50	73.16	78.01	93.68	86.84	51.20	56.46	97.22	75.83	38.83	53.61	73.58	72.87
(0) No	12.59	13.50	26.84	21.99	6.32	13.16	48.80	43.54	2.78	24.17	61.17	46.39	26.42	27.13
drinking water storage														
(1) Hygienic storage	86.73	68.17	88.33	85.28	98.46	82.05	98.91	70.90	50.28	83.06	98.63	74.57	86.89	77.34
(0) Unhygienic storage	13.27	31.83	11.67	14.72	01.54	17.95	01.09	29.10	49.72	16.94	1.37	25.43	13.11	22.66
Housing spaces														
(1) 3 or less persons per room	71.42	65.46	84.83	73.97	71.28	84.62	79.	75.71	81.94	83.89	74.57	78.69	77.28	77.06
(0) More than 3 persons per room	28.58	34.54	15.17	26.03	28.72	15.39	20.35	24.29	18.06	16.11	25.43	21.31	22.72	22.94
Kitchen (Cooking place)														
(1) Separate from living area	72.62	59.20	66.07	65.80	65.47	65.98	57.99	54.71	96.94	91.39	76.29	74.23	72.56	68.55
(0) Within living area	27.38	40.80	33.93	34.20	34.53	34.02	42.01	45.30	3.06	8.61	23.71	25.77	27.44	31.45
Type of house														
(1) Pucca	69.91	78.21	49.73	56.37	60.86	76.92	9.85	50.33	69.44	75.83	67.01	71.82	54.47	68.25
(0) Kutcha	30.09	21.79	50.27	43.63	39.14	23.08	90.15	49.67	30.56	24.17	32.99	28.18	45.53	31.75
Total n	1326	1266	1114	1079	585	524	457	433	360	351	291	259	4133	3912

Table 4 : WASH Accessibility index

Variables	Delhi		Kolkata		Mumbai		Hydrabad		Bangalore		Chennai		Total	
	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12
Time taken to access to water														
(1)> 30min hour	79.11	48.34	61.04	29.71	91.62	83.42	46.61	54.7	97.22	63.89	55.67	40.55	71.88	53.44
(0) < 30 min	20.89	51.66	38.96	70.29	8.38	16.58	53.39	45.30	2.78	36.11	44.33	59.45	28.12	46.57
Location of toilet														
(1) proper defecation	27.91	26.94	24.38	24.5	13.98	12.4	9.60	6.79	8.60	8.38	5.85	5.31	15.05	14.05
(0) Open defecation	72.09	73.06	75.62	75.5	86.02	87.6	90.4	93.21	91.4	91.62	94.15	94.69	84.95	85.95
The material used for hand wash														
(1) Soap	87.41	86.5	73.16	78.	93.68	86.84	51.2	56.46	97.22	75.83	38.83	53.61	73.58	72.88
(0) Ash, mud, water only	12.59	13.5	26.84	21.99	6.32	13.16	48.8	43.54	2.78	24.17	61.17	46.39	26.42	27.12
Purification of drinking water														
(1) Always	13.27	18.7	12.21	11.04	13.85	22.39	11.6	23.63	2.22	20.83	1.37	10.65	9.09	17.87
(0) Rarely, sometimes, never	86.73	81.3	87.79	88.96	86.15	77.61	88.4	76.37	97.78	79.17	98.63	89.35	90.91	82.13
Method of Pouring water														
(1) Long ladle or tap	58.52	40.57	26.03	21.1	31.11	31.45	1.97	6.78	6.11	39.72	4.47	2.06	21.37	23.61
(0) Cups, utensils, hand	41.48	59.43	73.97	78.9	68.89	68.55	98.03	93.22	93.89	60.28	95.53	97.94	78.63	76.39
Type of fuel used in cooking														
(0) Firewood, cow dung,etc	8.9	5.28	28.99	33.75	16.75	34.53	13.13	21.23	3.89	19.44	9.28	14.09	13.49	21.39
(1) LPG and kerosene	91.1	94.72	71.01	66.25	83.25	65.47	86.87	78.77	96.11	80.56	90.72	85.91	86.51	78.61
Total n	1326	1266	1114	1079	585	524	457	433	360	351	291	259	4133	3912

2.5 Statistical analysis

The scores for availability, accessibility, and overall performance have been ranked in ascending order and divided into two equal proportions for both the rounds of the survey **as in Table 3 and 4**. Thus, the city-wise levels of availability, accessibility, and overall performance of WASH are estimated for both rounds of the survey (2004–05 and 2011–12). The items used for the construction of both availability and accessibility were tested for their validity, reliability, and suitability. Here, level refers to the distribution of WASH services in the six selected cities, while trends were drawn to show the change in the distribution of WASH services between 2004–05 and 2011–12.

PCA has been used to estimate the score for availability and accessibility separately for both survey rounds. Scree plots from the PCA **displayed in Figs. 1 and 2**. The Eigenvalues in the PCA of WASH availability and accessibility show the deviation between the components. The steep slope between the component 1 and 2 shows that the majority of the variables are explained by the first component, in both the WASH availability and accessibility indexes, for both the rounds. **Table 5** shows the values of the Eigenvalue of components, in which around 50% of the variance is explained by the first two dimensions in the component space.
In paper we take First Principal component score as the WASH Score.

Table 5 : Eigenvalues and Correlation with Data

	2004-05		2011-12	
Component	Eigenvalues	difference	Eigenvalues	difference
WASH availability				
	1.996	0.739	1.848	0.641
	1.256	0.258	1.206	0.235
	0.998	0.072	0.971	0.078
	0.926	0.216	0.893	0.113
	0.710	0.119	0.780	0.075
	0.592	0.068	0.705	0.106
	0.524		0.599	
WASH accessibility				
	1.750	0.691	1.651	0.596
	1.060	0.106	1.055	0.097
	0.954	0.104	0.958	0.084
	0.850	0.118	0.874	0.084
	0.732	0.138	0.791	0.117
	0.594		0.674	

Fig : 1

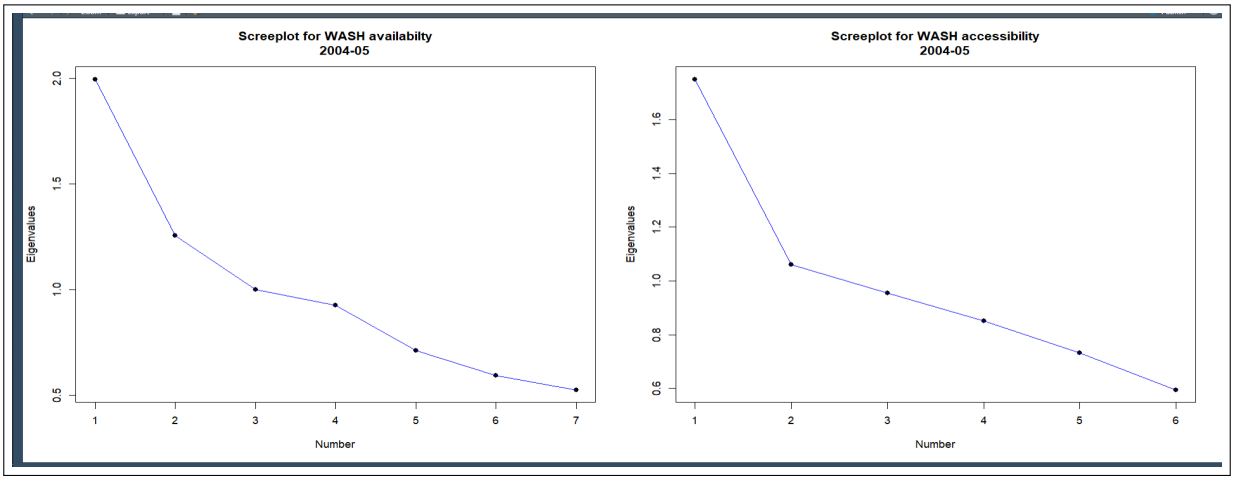
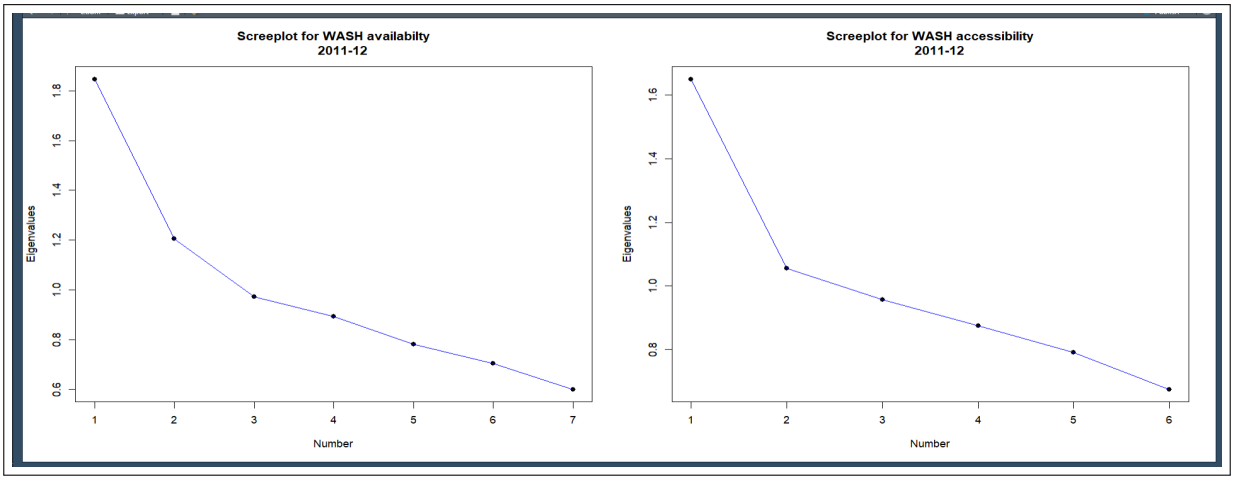


Fig : 2



To measure the inequality in the performance of WASH among and within the six selected metro cities (Mumbai, Delhi, Chennai, Bangalore, Kolkata, and Hyderabad) for both years of survey (2004–05 and 2011–12), the Gini coefficients and the parameters of inter and intra-city inequalities are estimated using Theil and Atkinson methods of decomposition.

Here Gini coefficients give an estimate of the household's level of inequality in the selected cities in simple words which measures the deviation of the income distribution from perfect equality.

Theil's index is the single parameters of the General Entropy class.
In a discrete set of Observations x_i(i= 1 to n) with mean $\bar{x}$,
it is defined as $\frac{1}{n\bar{x}} \sum_{i=1}^{n} x_i log(\frac{x_i}{\bar{x}})$

While the Atkinson index incorporates the social value judgment of the people about inequality in the society,as this parameter increases, more weight is shifted to the distribution at the lower end and vice versa.

Atkinson values represent the proportion of total income that would be needed to achieve an equal level of social welfare if incomes were perfectly distributed. Depending on the value of ϵ, the sample estimate is given by:

$$\hat{A} = \begin{cases} 1 - \frac{1}{\bar{x}} \left(\frac{1}{n} \sum_i x_i^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}}, \text{for } 0 \leq \epsilon < 1 \\ 1 - \frac{1}{\bar{x}} \left(\prod_i x_i \right)^{\frac{1}{n}}, \text{for } \epsilon = 1 \end{cases}$$

Binary logit regression model between the levels of WASH and their socioeconomic factors of the households are used, it was applied since WASH as the outcome variable is categorized into the order of poor (1) and good (2) performance. Regression models were carried out for availability, accessibility, and overall performance of WASH. Housing types, economic status, educational level, sociol-religious groups, and occupational status have been included in the list of independent variables

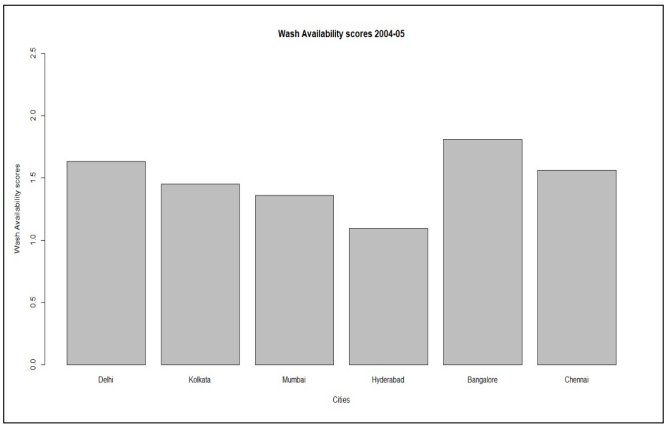
2.5.1 Computation and Errors

All the computatin has been done in R.
package used for calculating Inequality in WASH is "ineq"
Our calculated scores are different from original since there were some missing values in the datasheet, To calculate scores in original paper authors took the missing values which were denoted by "99" as 99 itself.

3 Results

3.1 Level of WASH

Fig : 3 - WASH Availability score



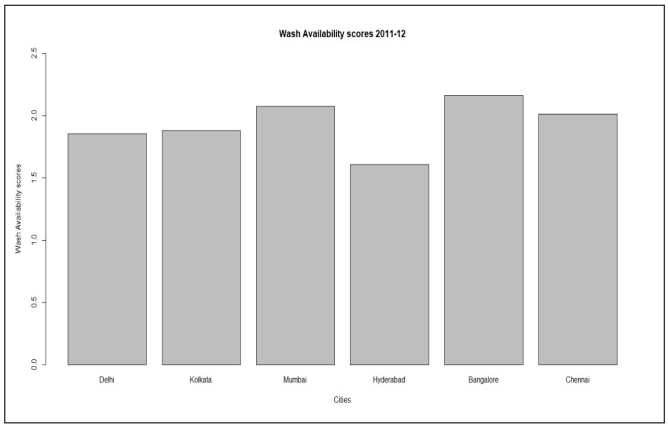
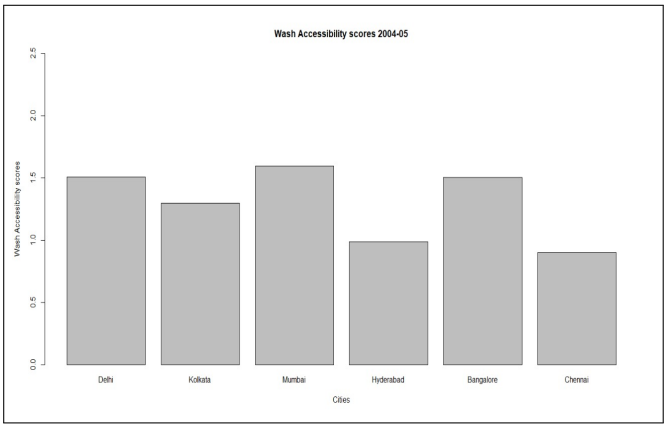


Fig : 4 - WASH Accessibility score



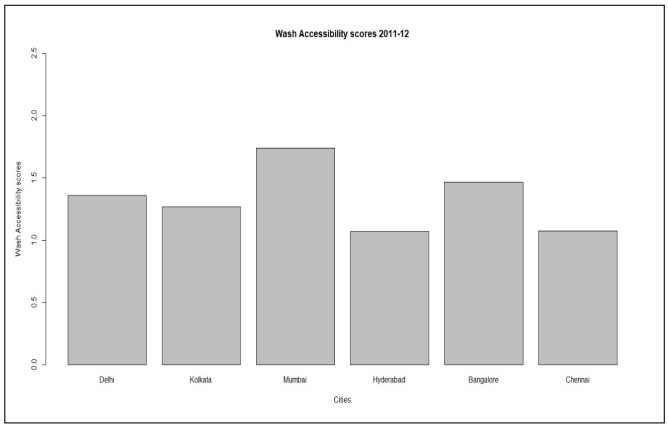
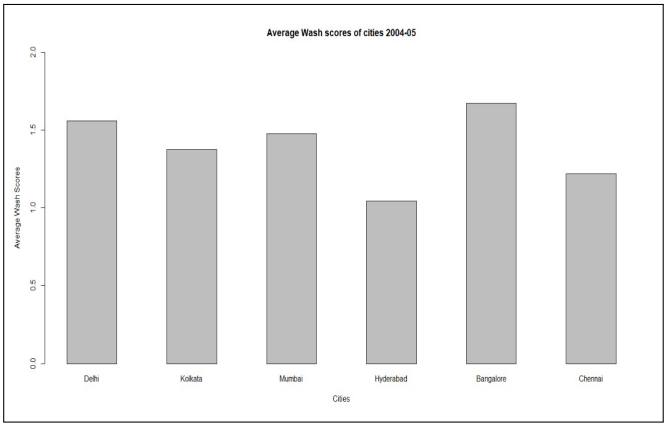
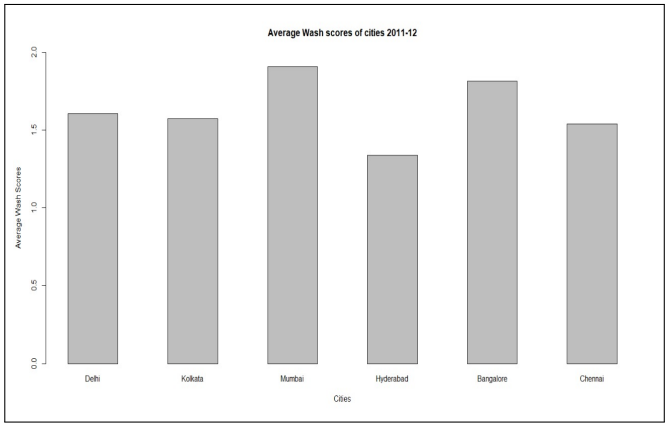


Fig : 5 - WASH Score (Average WASH Score)





WASH Scores

City	WASH Availability Score		WASH Accessibility score		WASH Score	
	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12
Delhi	1.63202879	1.856043	1.509472813	1.359167	1.560324	1.607605
Kolkata	1.452149285	1.879127	1.299194767	1.267424	1.375465	1.573275
Mumbai	1.359575198	2.075693	1.59428972	1.740756	1.476516	1.908225
Hyderabad	1.094508188	1.608847	0.985181506	1.071123	1.043399	1.339985
Bangalore	1.812153448	2.162588	1.502208036	1.46596	1.674278	1.814274
Chennai	1.560882882	2.01183	0.901107391	1.071746	1.219241	1.541788

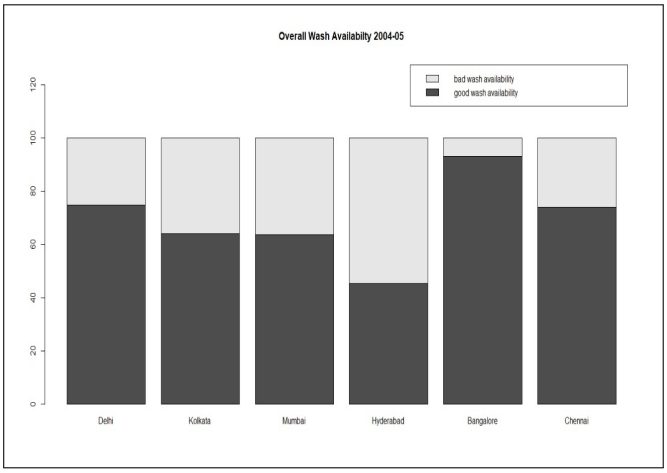
Table and Figure 3 shows that Bangalore had the best performance in WASH availability in both the years. Unlike Bangalore, another city of South India, Hyderabad had the worst performance in WASH availability for both years. In particular, the city had more than 55% of households with poor availability of WASH services in both the survey rounds. Chennai and Mumbai had better performance in WASH compared to Kolkata. The WASH availability in Mumbai was better in 2011-12 than that in 2004-05. Overall WASH availability ha increased in 7 years.

Figure 4 demonstrates the WASH accessibility in the selected cities for 2004-05 and 2011-12. We found that Mumbai was the best city, having approximately 30% and 50% of households in better-off categories in WASH performance for the year 2004-05 and 2011-12, respectively. A. On the contrary, Chennai was the worst-performing city having poor WASH accessibility in 2004-05 and 2011-12, respectively. Similarly, WASH Accessibility has decreased in 7 years.

The overall WASH performance of the selected cities for both the survey years is displayed in Figure 5. The results reveal that Mumbai had improved in terms of overall WASH performance, ranking as the best performing city in 2011-12. Bangalore had better-off in overall WASH performance during the same period. However, in 2004-05, Bangalore ranked better in overall WASH than Mumbai. Hydrabad is the worst performing city in both year followed by kokata.

3.2 Inequalities

Fig : 6 - Inequalities in Availability



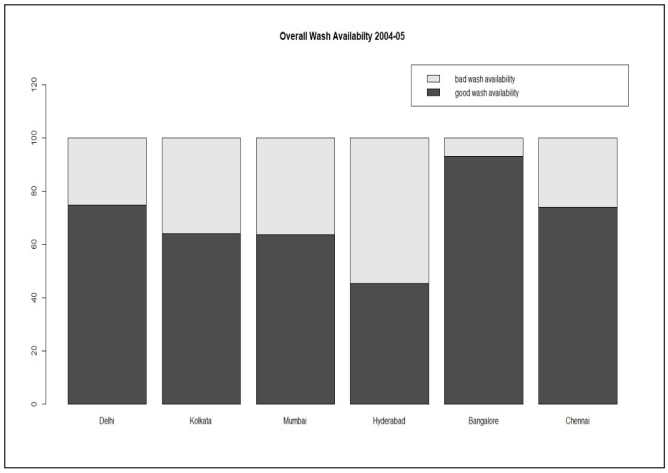
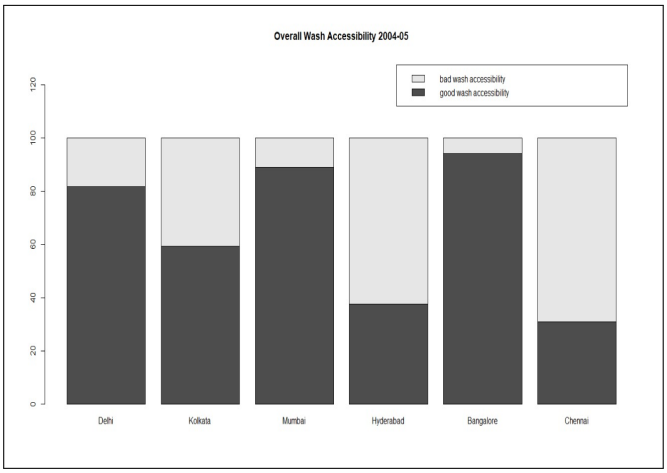


Fig : 7 - Inequalities in Accessibility



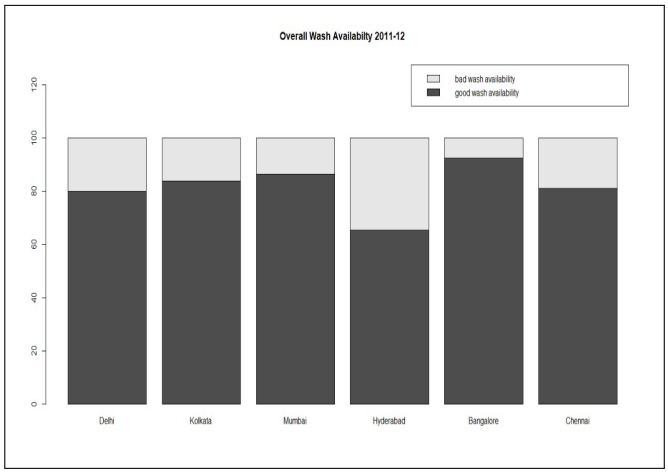
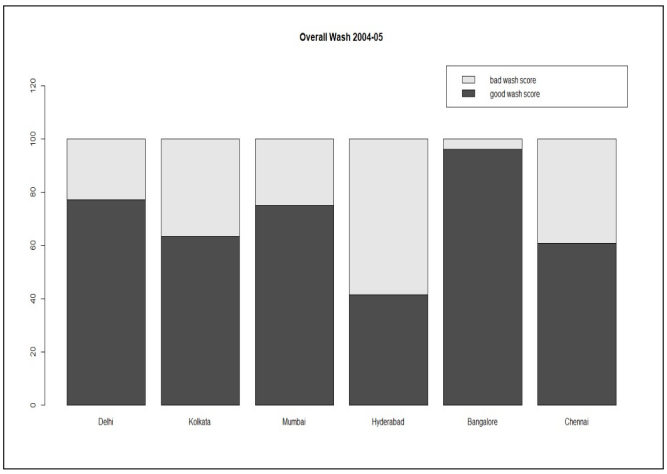
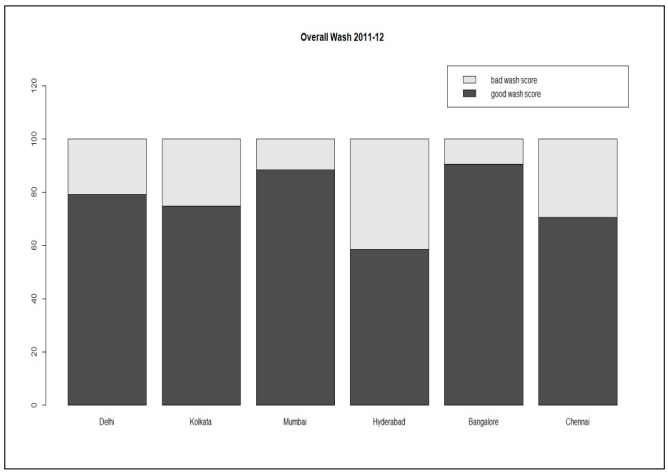


Fig : 8 - Inequalities in overall WASH





Inequalities Index

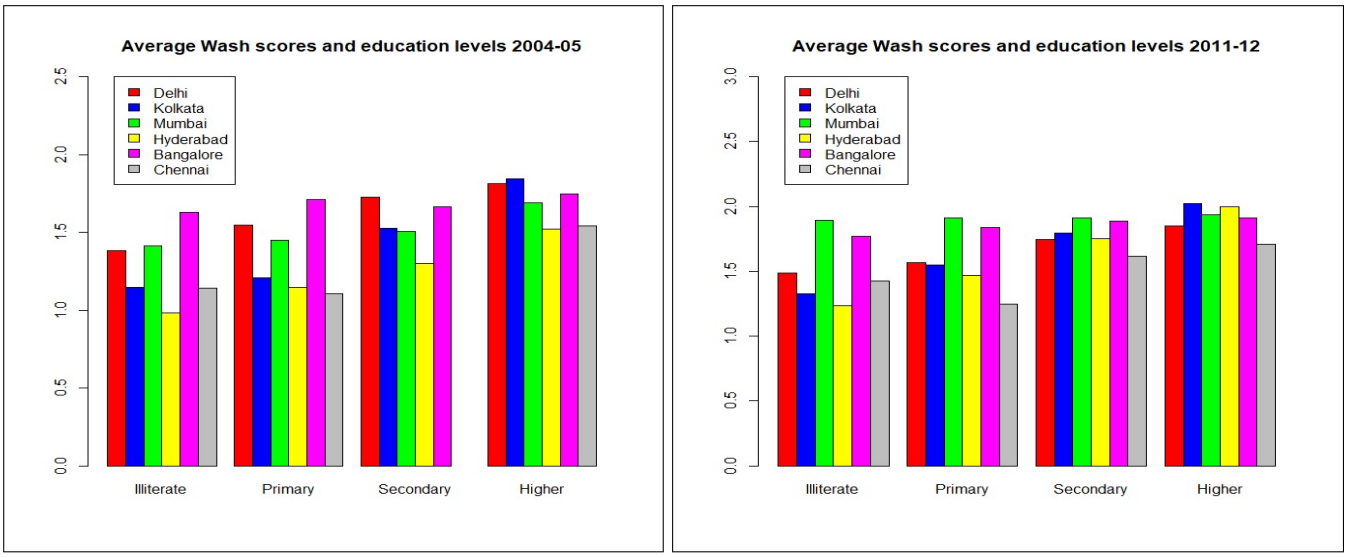
City Name	GINI Index		THEIL Index		Atkinson Index	
	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12
Delhi	0.1728038	0.160881	0.063028994	0.041469	0.035887681	0.040846
Kolkata	0.226575567	0.171076	0.091232147	0.050261	0.051466031	0.027015
Mumbai	0.15030253	0.068929	0.037767317	0.009308	0.019833899	0.004983
Hyderabad	0.265434273	0.248996	0.120435323	0.106265	0.067335004	0.060294
Bangalore	0.069037097	0.110065	0.012180335	0.024712	0.006991142	0.0135
Chennai	0.231124288	0.154101	0.103171304	0.043803	0.060272107	0.023666
Total	0.200993335	0.162619	0.076428458	0.047654	0.043500543	0.032403

Above Table presents the average results for intra-city and inter-city inequality in WASH performance during 2004-05 and 2011-12. The overall inequality has decreased from 2004-05 (Gini = 0.201) to 2011-12 (Gini = 0.162) in the entire sample of the selected cities. In both survey years, the intra-city inequalities among the metros were much higher than the inter-city inequalities. The inequality between the cities has slightly decreased from 2004-05 (Theil = 0.076; Atkinson = 0.047) to 2011-12 (Theil = 0.043; Atkinson = 0.032).

Interestingly, (from Figure 8) the absolute inequality measure suggests that it has decreased from 2004-05 to 2011-12, but it is still high in Hydrabad. Cities like Bangalore and Delhi showed a relatively low level of inequality in the 2011-12. Mumbai is the only city where inequality was found to be reduced considerably, primarily due to it's in slum development initiatives by government and NGO's.

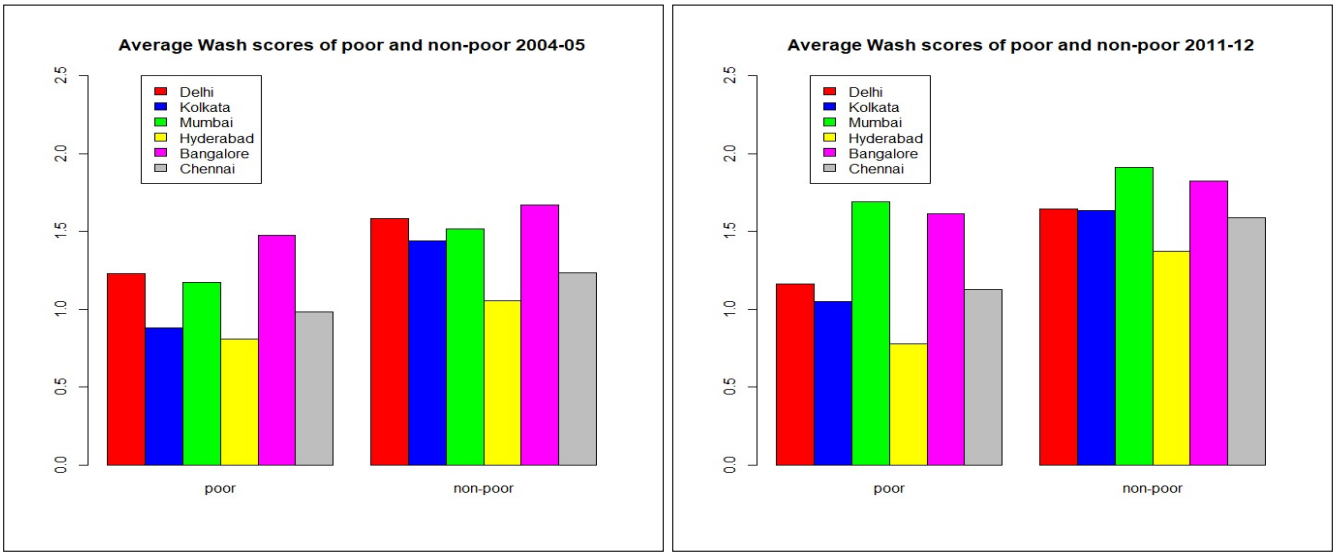
3.3 Dependence on Background variable

Fig : 6 - WASH Dependence on Education



From the Figure 6 we can see that people with primary, secondary and higher educated people have better WASH score than Illiterate people.We notice that though the inequality between WASH scores between the pairs (people with higher education, illiterate people) and (people with secondary education, illiterate people) decreased, the inequality between the people with secondary education and the illiterate people increased resulting in the total increase in the inequality between the literates and the illiterates.

Fig : 7 - WASH Dependence on Living Condition(Poor and Non-poor)



From the figure 7 we also notice the inequality between the rich and the poor. In 2004-05 we could say that the rich have better wash scores than the poor. But, in 2011-12, this value even increased more. This shows that the inequality between the rich and the poor has also increased in 7 years.

4 Conclusion

This article represents a study of WASH availability and accessibility in six major metro cities (Mumbai, Delhi, Chennai, Bangalore, Kolkata, and Hyderabad) and relative estimation of WASH inequalities and factors associated with it. The inequality in WASH is both within and between cities. The intra city inequalities are significant across the economic status, housing types, educational level, socio-religious groups, and the occupational structure regarding access, availability, and overall WASH performance. This study concludes that the intra-city inequality is a major barrier to a sustainable city and overall urban development of Indian cities.

India has been actively working with "WASH Initiative in improving water sanitation and hygiene in selected states of India "since 2011. WASH interventions in India has adopted the rights-based approach for improving water and sanitation conditions through mass mobilization and targets mainly rural and peri urban population. Although India does not have an umbrella WASH policy, several policies for improved sanitation, clean drinking water, and menstrual hygiene, each focusing on different aspects of WASH have been undertaken.

The Government of India has initiated several programs related to WASH in urban areas, such as the Jawaharlal Nehru National Urban Renewal Mission (JNNURM; launched in 2005), the North Eastern Region Urban Development Programme (NERUDP; launched in 2009), the Swachh Bharat Mission-Urban (SBM-U; launched in 2014), and the Smart Cities Mission (launched in 2015). These programs are specifically focused on providing basic facilities and services like water supply, adequate sanitation, solid waste management, integrated housing, and other basic amenities to the urban population. This policies implemented by government tend to to achieve the sustainable development in Indian cities, which mainly focus on universal access to civic amenities and slum development strategies through increased resource allocation and proper planning.

Although just 11 per cent of the policies that we had assessed have identified the barriers for the different segments. It is critical to reflect on how effective the urban development programmes are in addressing the intra-city and intercity

inequalities and how relentlessly the policies focus in the direction of improving the living conditions of marginalised urban poor residing in informal settlements. The robustness of policies can be enhanced if more and more policies can focus on identifying the barriers faced by the different segments in accessing WASH services. Needless to say, better identification of barriers would also have a positive impact on subsequent downstream components such as formulation of strategies and outcomes.

To conclude, a job well begun is half done. Policies are like the mariner's compass to the captains who are in charge of implementation of large developmental programmes. They provide direction to the steering hand and help to keep the course. A more robust policy would help in achieving better outcomes from WASH projects and programmes. Our analysis shows that WASH policies in India definitely need a robustness enhancement. Policy formulation, particularly at the State level, should be strengthened. Emergent paradigms such as LCS should be introduced in addition to the traditional GSS approaches. More importantly, barriers that come in the way of access to WASH services should be given considerable focus, and not relegated to a footnote.

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