Water Poverty in Urban India: A Study of Major Cities

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I. Introduction

In years to come, water, the need of life, is possibly to pose greatest challenge on account of its increased demand with population rise, economic development, and shrinking supplies due to over exploitation and pollution. In India, with development, the demand of water is increasing both in urban and rural areas. This may create increased tension and dispute between these areas for sharing and command of water resources. The emerging scarcity of water has also raised a host of issues related to sustainability of present kind of economic development, sustanious water supply, equity and social justice, water financing, pricing, governance and management. The present paper explores the quantity of water used in domestic households vis-à-vis the recommended quantity of water consumption in seven major Indian cities, namely, Delhi, Kanpur, Kolkata, Ahmedabad, Mumbai, Hyderabad and Madurai. The paper also attempts to find out equity in consumption of water across various socio-economic groups, sources of water supply, perception of households about quality of municipal water, and duration of municipal water supply. The organization of the rest of the study is as follows. Section II deals with methods used for data collection and analysis, while Section III discusses the recommendations of various agencies about the per capita need of water in urban areas. Results and discussions are presented in Section IV, and the last Section presents summary and conclusions of the study.

II. Materials and Methods

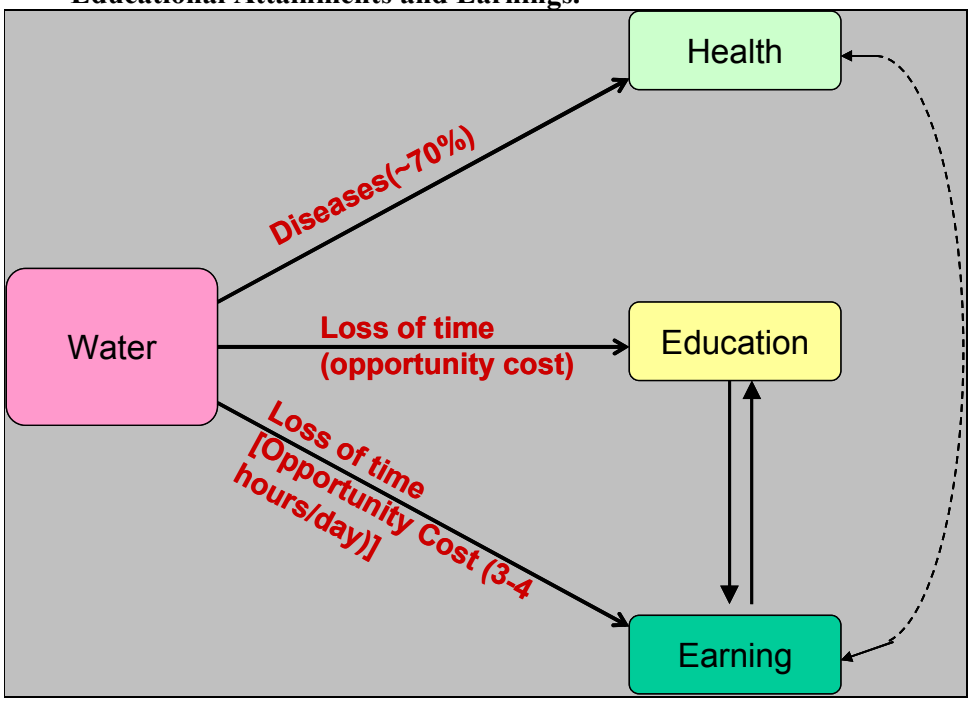
The household survey, to find out the consumption, availability, access and methods adopted for conservation of water in domestic households in seven major Indian cities, Delhi, Gr. Mumbai, Kolkata, Hyderabad, Kanpur, Ahmedabad and Madurai, was conducted in March 2005. As per the Census of India 2001, these cities, except Madurai (Municipal Corporation) are among 27 municipal corporations with million plus population, and their respective populations are 9.8, 11.9, 4.6, 3.5, 2.5, 3.5 and 0.92 millions, respectively. The number of sample households selected from each of these cities

was 507 in Delhi, 500 in Mumbai, 400 in Kolkata, 398 in Hyderabad, 303 in Kanpur, 361 in Ahmedabad, and 265 in Madurai. Thus, total 2,734 households were interviewed in these seven cities. Each of these cities were categorized in five different areas, (i) high income group (HIG) areas with well planned buildings, (ii) middle income group (MIG) areas with well planned buildings, (iii) low income group (LIG) areas with well planned buildings, (iv) slum areas, and (v) the mixed areas. Within these identified clusters, random sampling of households from electoral role was done. In each of these cities, several clusters of the same kinds of areas can be found, and therefore, from each cluster at least 8 interviews were conducted. The data was collected through a structured schedule and target respondents were the housewives. The volume of vessels in which households used to store water was measured and the number of vessels of water used in different activities was ascertained. Where running tap or piped water was used in some activities, the duration for which the tap remained open was arrived at and the quantity of water per minute coming out from the tap was measured. By multiplying the time with the quantity of water per minute, the amount of water used through running taps was arrived at. The amount of water used in toilet was assessed by volume of bucket used, and flush tank capacity. The assessment of quantity of water used in various activities was a difficult task, but all the efforts were put in to assure the accuracy of data.

Asset score has been used to classify households in various economic classes, such as the 'very poor', 'poor', 'lower', 'middle' and 'upper' classes. We assigned certain weights to the assets possessed by households, and by summing up the scores for each asset, 'asset score' for a household was arrived at. The assets for which data were collected and weights assigned to them, are as follows: four-wheeler/car (weight 5.0), refrigerator (2.0), washing machine (2.0), microwave oven (2.0) three/two-wheeler (1.5), colour-television (1.5), computer/laptop (1.0), music devices like cd/dvd/vcd/MP3 player (0.5), internet connection (0.5), black and white television (0.5), mobile phone (0.5), cable for television (0.25), and radio/tape recorder (0.25). The following ranges of asset scores were used to classify the households in the above mentioned economic /asset classes: (a) Very poor class: asset score 0.00 (has no assets on which data is collected); (b) Poor class: asset score between 0.01 to 0.99 (at least has radio/tape recorder and/or black and white television); (c) Lower class: asset score between 1.00 to 4.99 (at least has black & white television, radio/tape recorder, cable, mobile phone, or some of them with other assets); (d) Middle

class: asset score between 5.00 to 9.99 (at least has colour-television, refrigerator, washing machine or some of them with other assets); (e) Upper class: asset score 10.00 and above (at least has four-wheeler, refrigerator, washing machine and colour television, or some of them with other assets). Annual income data of households were also collected. The Pearson correlation coefficient between the household asset score and the income was found to be 0.722 (p-value 0.0001). However, we have used household assets score rather than monthly income for classifying households in various economic categories, as there is a greater possibility of under or over reporting of income. Besides categorizing households on the basis of asset score, we have also classified the households in five socio-economic classes (SEC) based on education and occupation of the main wage earner of the household. These five SEC classes are SEC-A, SEC-B, SEC-C, SEC-D and SEC-E (Shaban and Sharma, 2007).

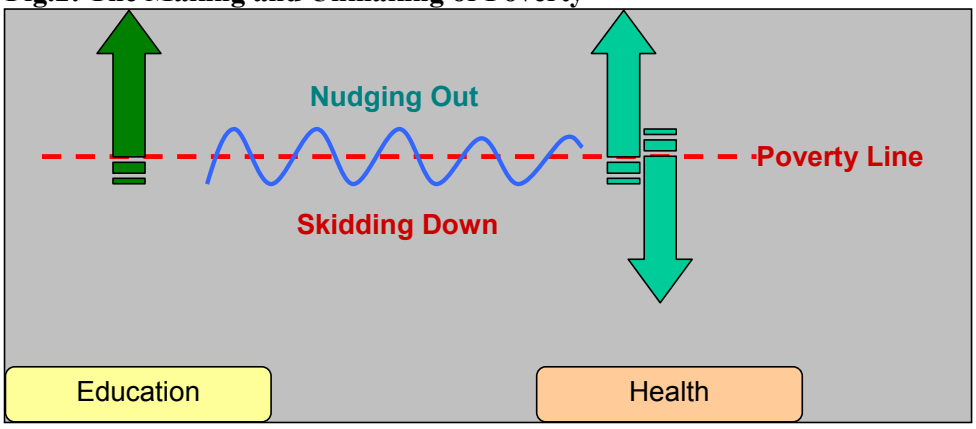
Fig.2: A Deterministic Relationship between Water Availability, Health, Educational Attainments and Earnings.



The importance of supply/availability of clean water in economic and health spheres has been the main motivating factor for the present study. It is estimates that about 70% of diseases in human being are due to consumption of uncleaned water. The access to water also has huge cost on educational attainments and incomes of individuals/households. A

large share of population from the poorer section of the society (both in rural and urban areas) loses their precious time collecting water for their daily needs. This deprives them from daily wages crucial for their economic sustenance (see Fig.1). Further, recurring health expenditures due to consumption of uncleaned water and low wages due to lower skills keep them in vicious circle of poverty. While education helps to improve their earnings, the health expenditures and loss of time/wages due to illness keep them in poverty and penury (see Fig.2). Clean, adequate and regular water supply, therefore, are extremely important in countries like South Asia, more so in India where a large section of population lives in poverty and consumes uncleaned water, to help sizeable proportion of the population move above poverty line.

Fig.2: The Making and Unmaking of Poverty



III. Quantity of Water Required for Different Activities

A number of factors like climate, culture, food habits, work and working conditions, level and type of development, and physiology determine the requirement of water. As per the Bureau of Indian Standards, IS:1172-1993, minimum water supply of 200 litres per capita per day (lpcd) should be provided for domestic consumption in cities with full flushing systems. IS:1172-1993 also mentions that the amount of water supply may be reduced to 135 lpcd for the LIG and the economically weaker sections (EWS) of the society and in small towns (Modi, 1998).

Besides domestic requirement, water is also demanded for commercial, industrial, and civic or public use. The IS:1172-1993 gives the total requirement of water in industrial and commercial towns with full-flushing system as 280 lpcd. The Ninth Plan (1997-2002) had advocated the requirements of water in urban areas as 125 lpcd in cities with the

planned sewerage systems; 70 lpcd in cities without planned sewerage system; and 40 lpcd for those collecting water from public stand-posts. However, in the Tenth Plan (2002-07), the cities with planned sewerage system are classified into two groups based on population, i.e., metropolitan or megacities and non-metropolitan cities. In the former, the recommended minimum water supply level is 150 lpcd and in the latter 135 lpcd. (Govt. of India, 1997, 2002). The National Commission on Urbanisation (1988) recommended that a per capita water supply of 90-100 litres per day is needed to lead a hygienic existence, and emphasised that this level of water supply must be ensured to all citizens (quoted in Ramachandraiah, 2001)

The World Health Organization (WHO) classifies the supply and access to water in four service categories. These categories are, (1) no access (water available below 5 lpcd), (2) basic access (average approximately 20 lpcd), (3) inter-mediate access (average approximately 50 lpcd), and (4) optimal access (average of 100-200 lpcd) (WHO, 2003; see also Bartram, 2003). Considering the fact that various agencies recommend different quantities of requirement of water for domestic use, we have taken 100 lpcd consumption (an indication of availability, as consumption is determined by the availability) of water as benchmark for finding out water deficient households. It must be noted here that there is no strong basis for this 100 litres bench mark but it is some kind of average requirement one must get in order to live with minimum health and hygiene.

IV. Results and Discussion

IV.1. Domestic Consumption of Water

It is important to note here, and this will be amply clear later, that the quantity of water consumed in most of the Indian cities is not determined by the demand but the supply. People attempt to adjust to the quantity (as well as quality) of water supplied. The 54th round National Sample Survey Organisation (NSSO) data reveal that 80% of the households in urban India, across different segments, consider that they have sufficient water supply (Bajpai and Bhandari, 2001), while the present study finds that about 71% of the households in these seven cities consider water supply as adequate. The share of households considering water supply adequate to their need is 73% in Delhi, 77% each in Mumbai and Kolkata, 49% in Hyderabad, 75% in Kanpur, 63% in Ahmedabad and 82% in Madurai. In fact, this shows nothing but adjustment of people to the supply so much that

they do not feel that more water is required. This in turn creates hygiene and sanitation problems resulting in several health consequences.

Table 1: Domestic Water Consumption per Household and per capita per day (in litres).

Cities	Per Household		Per Capita	
	Mean	Std. Deviation	Mean	Std. Deviation
Delhi	377.7	256.8	78.0	49.9
Mumbai	406.8	158.6	90.4	32.6
Kolkata	443.2	233.6	115.6	64.9
Hyderabad	391.8	172.0	96.2	43.8
Kanpur	383.7	286.2	77.1	58.2
Ahmedabad	410.9	224.1	95.0	54.6
Madurai	363.1	182.1	88.2	44.4
Total	398.3	220.20	91.56	51.51

Source: Calculated using data from 'field survey'.

Table 1 shows per household as well as per capita consumption of water in seven major cities in the country. It is very obvious from the Table that in all the cities, the consumption (indication of availability) of water per capita is much lower than what is recommended by the Bureau of Indian Standard, IS:1722-1993, and the Tenth Five Year Plan. Moreover, it is even lower than the recommended level for LIG colonies and weaker section households. The data is also an indication for the lower public hygiene and sanitation conditions in Indian cities. The average per capita water consumption in domestic households for all the seven cities is about 92 lpcd. The highest consumption is in Kolkata (116 lpcd), followed by Hyderabad (96 lpcd), Ahmedabad (95 lpcd), Mumbai (90 lpcd), Madurai (88 lpcd), Delhi (78 lpcd), and Kanpur (77 lpcd). It is surprising to find that in Delhi water consumption is so low when Delhi Jal Board claims supplying, on an average, 211 lpcd per household. Similarly, the Brihan-Mumbai Municipal Corporation (BMC) claims of supplying 198 lpcd (total water supply to the city 2950 million litres per day - less 20% lossess), but the consumption in Mumbai, as mentioned above, is only about 92 lpcd. In terms of international comparison, the Indian cities have far less consumption of water. For example, domestic water consumption in Munich is 130 lpcd, and in Amsterdam it is 156 lpcd. In Singapore, Hong Kong, Sydney and Tokyo, the consumptions are 162 lpcd, 203 lpcd, 254 lpcd, and 268 lpcd, respectively (Down to Earth, 2005). Overall, in terms of per capita consumption of water, the condition in two North Indian cities, Delhi and Kanpur, seems to be worse. The dispersion statistics (standard deviation) shows that wide variations in per capita consumption of water also exist in North Indian cities. Besides, having the highest level of water consumption, Kolkata also has wide variation in consumption of water per capita. In terms of the variation, Kanpur,

Ahmedabad and Delhi follow Kolkata. In these seven cities, a very small proportion of population consumes water above 100 lpcd. As shown in Table 2, only about 35 percent of the total population in the cities consumes water above 100 lpcd. There also exist wide variations in proportion of household in different cities consuming water above 100 lpcd. For example, in Kolkata 52.9% of the households consume water above 100 lpcd, but in Kanpur only 24.7% consume water above 100 lpcd. Likewise, Ahmedabad (37.9% of the households), Hyderabad (37%), Mumbai (31%), and Madurai (30.7%) follow Kolkata in terms of the consumption of water above 100 lpcd.

Table 2: Water Consumption Category-wise Distribution of Households (%).

Litres /capita/day	All 7 Cities	Cities						
		Delhi	Mumbai	Kolkata	Hyderabad	Kanpur	Ahmedabad	Madurai
Below 50	17.5	29.8	5.4	11.8	9.0	33.7	19.4	17.0
50 to 75	22.6	22.1	29.4	13.5	21.6	24.4	20.8	26.4
75 to 100	25.3	20.7	34.2	22.0	32.4	17.2	21.9	26.0
100 to 135	20.2	17.2	23.6	24.3	23.4	14.2	18.8	17.4
135 to 175	8.7	5.3	5.0	15.0	8.3	6.9	12.7	10.2
175 to 200	2.2	2.2	1.4	4.8	2.3	1.3	2.2	.8
Above 200	3.4	2.8	1.0	8.8	3.0	2.3	4.2	2.3
Total	100	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: As for Table 1.

Kanpur has a dubious distinction among the cities under focus. In this city, more than one-third of population uses water below 50 lpcd. And in this respect, Kanpur is followed by Ahmedabad (19.4% of population consuming water below 50 lpcd), Madurai (17.0%), Kolkata (11.8%), Hyderabad (9.0%), and Mumbai (5.4%). The water consumption among different areas in a city is not vary different from each other, except that the model class of consumption for HIG, MIG and LIG areas is formed by the consumption class of 75-100 lpcd, and in the case of slums and mixed areas, it is 50-75 lpcd (Table 3). However, where 23.4% of the population in HIG areas uses water above 135 lpcd, in slum areas only 9.6% of population uses water above 135 lpcd. The consumption of water by various socio-economic classes shows that although a sizeable proportion of households in all the classes consume water below 50 lpcd, it is in the case of SEC-E where the consumption is very low. More than one-quarter of households in this class consumes water below 50 lpcd (Table 4). Also, as compared to 23.3% of the SEC-A consuming above 135 lpcd, it is only 8.1% of the population in SEC-E which consumes water above this limit. The consumptions by socio-economic classes do largely correspond with the consumptions based on the asset classes. Whereas 25.7% of the population in SEC-E has the

consumption below 50 lpcd, 28.1% of the population in 'very poor' category consumes water below this limit (Table 5). Similar to HIG, MIG and the LIG areas, the model class of consumption for 'Upper', 'Middle' and 'Lower' categories of households, based on the asset score, is also 75-100 litres per capita per day.

Table 3: Area and Consumption Category-wise Distribution of Household (%).

Litres /capita/day	Area				
	High income group area with well planned building	Middle income group area with well planned building	Low income group area with well planned building	Slum area	Others (a mixed area)
Below 50	19.8	17.7	13.2	21.3	15.5
50 to 75	16.3	20.5	23.4	27.0	26.2
75 to 100	21.2	26.4	31.0	24.2	23.8
100 to 135	19.2	20.0	21.4	17.9	22.5
135 to 175	12.9	8.4	7.6	6.2	8.5
175 to 200	3.8	2.1	1.4	2.3	1.3
Above 200	6.7	4.9	2.0	1.1	2.3
Total	100.0	100.0	100.0	100.0	100.0

Source: As for Table 1.

Table 4: Socio-economic and Consumption Category-wise Distribution of Household (%).

Litres/ capita/day	Socio-economic Category				
	SEC-A	SEC-B	SEC-C	SEC-D	SEC-E
Below 50	18.0	17.7	14.1	15.2	25.7
50 to 75	17.7	19.3	25.5	27.5	26.6
75 to 100	22.2	24.9	27.8	29.1	22.7
100 to 135	18.8	21.9	21.6	20.0	16.9
135 to 175	13.1	9.6	7.6	5.4	5.1
175 to 200	2.8	3.4	1.1	1.1	2.1
Above 200	7.4	3.2	2.3	1.7	.9
Total	100.0	100.0	100.0	100.0	100.0

Source: As for Table 1.

Table 5: Asset and Consumption Category-wise Distribution of Household (%).

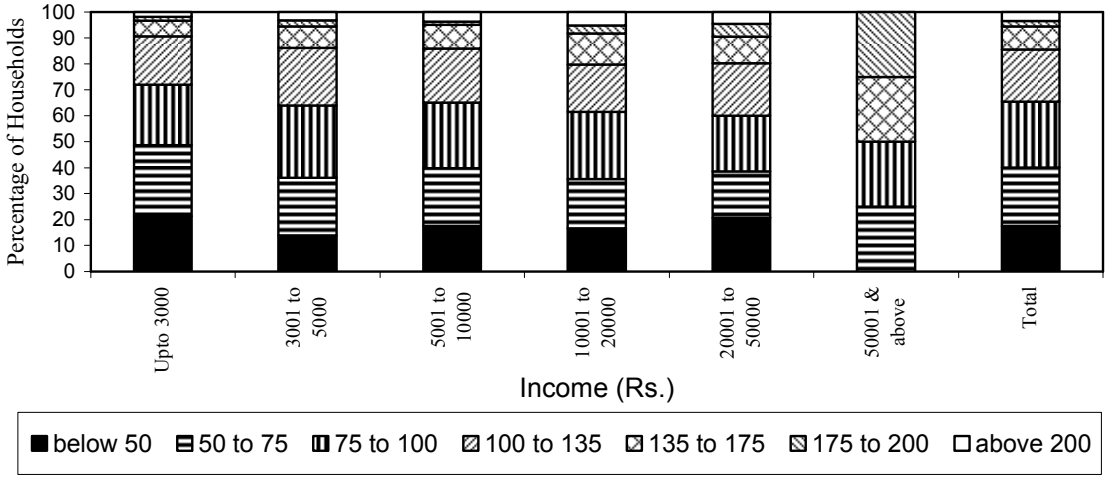
Litres /capita/day	Asset Class				
	Very Poor	Poor	Lower	Middle	Upper
Below 50	28.1	16.7	13.1	21.5	21.7
50 to 75	23.1	25.9	25.3	18.8	15.8
75 to 100	24.0	28.4	25.9	24.1	22.2
100 to 135	15.7	19.5	22.6	18.8	16.3
135 to 175	5.0	6.2	8.6	9.5	13.1
175 to 200	1.7	1.7	1.9	2.6	3.6
Above 200	2.5	1.5	2.6	4.8	7.2
Total	100.0	100.0	100.0	100.0	100.0

Source: As for Table 1.

Inadequate water supply in Indian cities seems to be a rule rather than an exception. Even if we take 100 litres per capita per day as the criterion for defining water deficient and sufficient households, 65% of the sample households remain water deficient. The

proportion of deficient households is the highest in Kanpur (75.2%), followed by Delhi (72.6%). In fact, except Kolkata, in all the other cities, the water deficient households are above 60%. Analysis shows that households with monthly income up to Rs.3000 suffer the most as about 72% of such households are found to be water deficient (Fig.3). Area-wise classification of water deficient households (Table 6) shows that, as expected, these are slum areas which have maximum percentage of water deficient households in all the cities. In Ahmedabad and Kanpur, the percentages of water deficient slum households are as high as 86.1%, and 82.1%, respectively, while it ranges between 70% to 75% in case of Delhi, Mumbai, and Hyderabad. Among the cities, the least percentage of water deficient households are found in Kolkata (47.3%). Per capita water consumption in different areas, asset-classes and SECs of households are highly correlated with each other, as they have very similar percentages of water deficient/sufficient households (see Tables 3, 4, and 5).

Fig. 3: Monthly Incomewise Distribution of Households in Various Water Consumption Categories in Seven Major Cities in India.



Source: As for Table 1.

Table 6: Percentage of Water Deficient Households in Different Areas (consuming below 100 lpcd).

Areas	All 7 Cities	Delhi	Mumbai	Kolkata	Hyderabad	Kanpur	Ahmedabad	Madurai
HIG Areas	57.3	68.4	48.8	39.8	64.6	75.0	42.5	66.7
MIG Areas	64.6	78.1	69.2	42.1	61.7	66.1	56.3	76.8
LIG Areas	67.4	71.7	76.2	55.7	61.7	70.2	69.2	66.7
Slum Areas	72.5	72.4	74.1	58.1	65.4	82.1	86.1	70.0
Mixed Areas	65.5	72.0	73.1	40.5	62.0	82.8	57.8	67.3
Total	65.4	72.6	69.0	47.3	63.1	75.2	62.0	69.4

Source: As for Table 1.

IV.2. Activity-wise Consumption of Water

At household level, bathing consumes highest amount of water. Together, in all the seven cities, it consumes about 28% of the total water at household level (Table 7). Consumption in toilets (20.0%), washing clothes (18.6%) and washing utensils (16.3%) follow the consumption in bathing. On an average, less than 10% of the total water in a household is used for drinking and cooking.

Table 7: Activity-wise Distribution of Water Consumption in Cities (% of total consumption by households / day).

Activity	All 7 cities	Delhi	Mumbai	Kolkata	Hyderabad	Kanpur	Ahmedabad	Madurai
Bathing	28.2	31.7	23.7	37.1	25.6	29.1	22.8	26.6
Washing clothes	18.6	14.2	24.3	14.0	20.9	16.3	21.4	18.9
Drinking	4.2	5.0	4.2	2.6	4.3	3.8	4.9	4.9
Cooking	3.0	3.7	1.7	2.3	3.1	3.2	3.3	4.2
Toilets	20.0	16.5	21.6	15.9	24.1	20.1	19.1	25.7
Cleaning house	7.3	7.0	6.6	11.7	3.5	5.7	12.4	1.9
Washing utensils	16.3	16.5	17.4	16.1	16.5	15.4	15.2	16.1
Others	2.4	5.6	0.5	0.3	2.0	6.3	0.9	1.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: As for Table 1.

Among the cities, households (37.1%) in Kolkata consume highest proportion of total water in bathing. Delhi (31.7%) Kanpur (29.1%), Madurai (26.6%) and Hyderabad (25.6%) follow Kolkata in this regard. Toilet consumes 15-26% of the water at household level in these cities, the highest being in Madurai (25.7%) and the least in Kolkata (15.9%). Washing clothes also accounts for about 14-22% of the total water consumption at household level, and it is the highest in Mumbai (24.3%), followed by Hyderabad (20.9), and Ahmedabad (21.4%). Interestingly, North Indian cities Delhi, Kanpur and even Kolkata use less proportion of water in washing clothes than other cities.

IV.3 Sources and Perception about Safety of Water

A majority of households in major cities in India depend on the municipal water supply for their daily needs. The 54th round NSSO data show that 70.1% of the households in urban India depend on tap water (municipal supply), 21.4% on tube wells, 6.7% on wells/open wells, and the rest on other sources (Bajpai and Bhandari, 2001). However, the present study shows that as high as 92% of the households in the seven major Indian cities under focus are using municipal water supply (tap water). Of this 92% of the population, 9.5% are dependent on community taps and the rest (90.5%) on their own private taps provided by municipalities (Table 8). The proportion of households using community tap water is lower than the 54th round figures of NSSO mainly because the it covered all the urban areas in the country, while the present study covers only seven major cities having relatively developed water-infrastructures. The Table 8 also shows that some households are not using water from only one source but from multiple sources. It is noteworthy that, although, as mentioned above, about 92% of the households use municipal tap water supply, the proportion of the households dependent only on this source is significantly lower in all the cities, except in Mumbai. The gap between the share of households using municipal tap water and the share of households dependent only on this source is very high in Madurai, Hyderabad, Kanpur, Ahmedabad, and Kolkata. This indicates the lack of reliability, regularity, and sufficiency of water supply through municipal taps. Mumbai seems to be the only exception among the seven cities, as in this city only about 5.6% of the total households are dependent on sources other than municipal tap water supply. In comparison to Mumbai, the dependence of households on sources other than municipal tap water supply in other cities is significantly high. It is as high as 84.5% in Kanpur, 82.3% in Madurai, 60.3% in Hyderabad, 31.5 % Kolkata and 28.6% in Delhi. Thus, except Mumbai, in other cities a sizeable proportion of households use water from other sources (non-municipal tap). In Delhi, 24.5% of the households use tube wells, 0.2% wells/open well, 2% tankers, 2.2% packaged/mineral water, and 0.2% other sources. Overall, 7.5% of the households in Delhi depend only on groundwater. In Kanpur, tube well serves almost 80% of the households, and the share of the households dependent only on groundwater in the city is about 41%. In Ahmedabad and Hyderabad, the proportion of households utilizing the tube well water is 38.5% and 48.5%, respectively, while 5% and 0.3% of the households in these two cities, respectively, depend only on groundwater. Overall, in all these seven cities about two-fifth of the households is using groundwater, and about 7%

are solely dependent on this source. Thus, the second largest source of water for a majority of households in major cities in the country is groundwater. The rapid increase of population in these cities is making people more dependent on it leading to rapid decline in groundwater table. Delhi, Hyderabad, Kanpur are suitable examples in this regard (see also Soni, 2003).

Table 8: Dependence of Household (%) on Various Sources of Water (multi-source possible).

Source	All 7 cities	Delhi	Mumbai	Kolkata	Hydera -bad	Kanpur	Ahmed- abad	Madu -rai
1.Municipal Tap Water	92.0	91.9	98.6	98.8	99.7	54.1	94.2	98.5
-- of which community tap	9.5	8.1	1.5	1.9	0.3	45.9	20.0	1.5
Depend only on Municipal Tap water	57.6	71.4	94.4	68.5	39.7	15.5	59.6	17.7
2.Groundwater								
a. Tube well/hand-pumps	38.1	24.5	3.6	27.8	48.5	79.2	38.5	81.1
--of which private tube-well /hand-pumps	24.0	6.3	3.6	1.0	41.8	36.4	37.2	76.7
b. Well/Open Well	1.0	0.2	0.6	2.8	3.3			
Depend only on Groundwater	6.9	7.5		1.3	0.3	40.6	5.0	1.5
3. Tanker	2.1	2.0		0.5	10.6			1.1
--of which municipal tankers	59.3	60.0		100.0	54.5			100.0
4. River/Canal /Tank	0.4			2.8				
5. Packaged/Mineral Water	0.8	2.2	1.0		0.5	0.3	0.2	1.5
6. Others (Railways supply, broken pipes, mill compounds, etc.)	1.1	0.2	0.6			5.3	2.5	

Source: As for Table 1.

Households in these cities also face wide seasonal fluctuations in municipal tap water supply. More than 85% of the households in these cities say that shortage in water supply becomes acute during summer. The seasonal variations in municipal tap water supply leads to use of ground water by households as it is seen as the easiest, fastest and to an extent durable 'solution' to the water crisis. And, as mentioned above, this is resulting in groundwater depletion in and around the cities. The overuse of groundwater resources has lead to increase in arsenic concentration in many wards in Kolkata, and similarly fluoride concentration in majority of cities and towns in Rajasthan and Gujarat.

About 11% of the households in Hyderabad are dependent on tanker water supply. Out of this, 46% are dependent on private tankers. This indicates that private vendors have their hey-day in the city. About 2% of the households in Delhi and 1.1% in Madurai are also using tanker water supply. The packaged/mineral water, particularly for drinking purpose, is also making inroad to urban households. This is supported by the fact that 2.2% of the households in Delhi, 1.0% in Mumbai and 1.5% in Madurai use packaged water. Kolkata

seems to be an exception as none of the surveyed households in the city has reported using packaged water for drinking purpose. It is interesting to note that although about 10% of the households in Kolkata say that water is 'not so safe' and 'not safe at all', and further about 26% express their inability to say anything about the quality of tap water supplied by municipal corporation, still none of these households report using packaged/mineral water (Table 9). Ideological orientation of the population, largely supporting communist ideology and having reservations about multinationals and private companies, may be playing a big role in this regard. Table 9 also shows that only about 40% of the households in Kolkata view municipal water "quite safe" or "very safe". In Madurai, Mumbai and Delhi, about 74%, 65% and 52% of the households, respectively, view municipal water supply "quite safe" and "very safe", but in the case of Kanpur, only about 11% say so. Thus, one finds that a sizeable share of households do not consider the municipal tap water as 'safe' or 'very safe' for drinking.

Table 9: Perception of Households (%) about the Quality of Water from Municipal Taps.

Safety Level	All 7 Cities	Delhi	Mumbai	Kolkata	Hyderabad	Kanpur	Ahmedabad	Madurai
Not safe at all	2.9	2.96	.20	3.25	2.76	9.90	1.11	1.89
Not so safe	5.0	6.71	2.40	6.50	3.02	12.54	2.49	1.89
Somewhat safe	21.5	30.97	28.40	24.25	12.06	20.46	7.20	21.13
Quite safe	28.6	30.97	31.80	15.50	22.36	10.23	43.49	47.55
Very safe	25.6	20.51	33.60	24.25	57.04	.99	9.14	26.04
Cannot say	16.8	7.89	3.60	26.25	2.76	45.87	36.57	1.51
Total	100.0	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: As for Table 1.

Contamination of municipal tap water has been a common problem, particularly in slums, in Indian cities. The data from Municipal Corporation of Greater Mumbai (MCGM) shows that 8-10% of the samples taken at consumer taps in 1997 and 1998 were contaminated by coliform bacteria and unfit for consumption (MCGM, 1999). However, the present study reveals that about 46% of the households in slums "feel" that municipal tap water supply is 'somewhat safe'. In comparison to Mumbai, about 37% in Delhi, and only 10% in Kolkata considered that piped water is "somewhat safe". As opposed to Mumbai, where none of the households living in slum areas state that the Municipal tap water is "unsafe", 2% slum households in Delhi and 2.7% in Kolkata consider the water "not safe at all". In Kolkata, about 49% of the slum households were unable to say anything about the quality of the municipal water, while in Delhi and Mumbai, the percentages of slum households expressing the similar views were 26% and 8%, respectively. A study by Karn, et.al.

(2003) in some selected slums in Mumbai shows that the percentage of households boiling water before consumption varies from slum to slum: highest being 14%, and the lowest 5%. However, the present study shows that about 12% of the slum households boil water before consumption, and 80% filter it by cloth, and remaining 8% do not use any purification method before consumption. In Delhi's slums, about 9% of the households filter the water before its consumption, 6% boil it, and 85% use no purification methods. In Kolkata, about 78% of the slum households use no purification method. In Kanpur, none of the households in slum areas reported using any water purification methods.

IV.4 Duration of Water Supply and Distance of Source of Water

Cleanliness of municipal water in Indian cities is not the only issue, the supply is also very erratic and for a very limited duration. A basic need and service like water on tap for 24 hours a day has been unheard of for decades in most Indian towns (ADB, 1993). As the supply is highly erratic and for a very limited duration, the households and housing societies store water in their tanks and drums. In the seven cities, about 18% of the households, who reported using municipal tap water supply, stated that the water supply on tap was available for 24 hours, while about 25% and 27% claimed that it was available for a few hours (less than 4 hours) twice a day, and once in a day, respectively (Table 10). About 21% of the households in these cities report that water on tap comes for a few hours in two days. Among the seven cities, only in the case of Ahmedabad and Kolkata, about a half of the total households report that the water on tap is available for 24 hours. But in case of Mumbai, Delhi Kanpur and Madurai, only 5%, 14%, 6% and 3%, respectively, of the total households report so. In Hyderabad, hardly any household reports the supply of water for 24 hours. More than 80% of the total households in Mumbai get water on tap for a few hours once in a day, while about two-thirds of the Delhi residents report that they get the supply twice a day for a few hours. Hyderabad, has dubious distinction among the cities as about 90% of households in the city state that the water on tap is supplied only for a few hours once in two days. In Kanpur, the situation is more pathetic, where more than two-fifths of the households inform that the supply of municipal tap water is not predictable at all.

Table 10: Availability of Tap Water to Households (%) in Indian Cities.

Supply	All 7 Cities	Delhi	Mumbai	Kolkata	Hyderabad	Kanpur	Ahmedabad	Madurai
24 hours / round the clock	17.9	13.6	5.0	47.3	0.3	5.6	50.1	2.6
For a few hours once in a day	27.0	15.4	84.4	2.8	7.0	7.3	38.5	14.7
For a few hours twice a day	24.9	64.3	7.4	39.3		44.2	6.4	1.5
Once in two days	20.7		0.2		88.9		2.2	77.0
Once in four days	0.0							0.4
Once in a Week	0.2							3.4
Not predictable	1.8	3.7	2.8	0.5	2.0	1.7		
Cannot say	7.3	3.0	0.2	10.3	1.8	41.3	2.8	0.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: As for Table 1.

Only about 68% of the total population in the seven cities under focus have source of water supply within their premises. The 54th round NSSO data also reveals that a total 65.7% of the households in urban India have source of water supply within their dwelling or premises (Bajpai and Bhandari, 2001). There is a wide variation among the cities in terms of location of the source of water. Where about 62% and 50% of the households have the source of water outside the dwelling and premises in Kanpur and Kolkata, respectively, in Mumbai, only about 13% of the households have the source of water outside their premises. In Ahmedabad and Delhi, about one-fifth and one-fourth, respectively, of the total households collect water from outside their house premises.

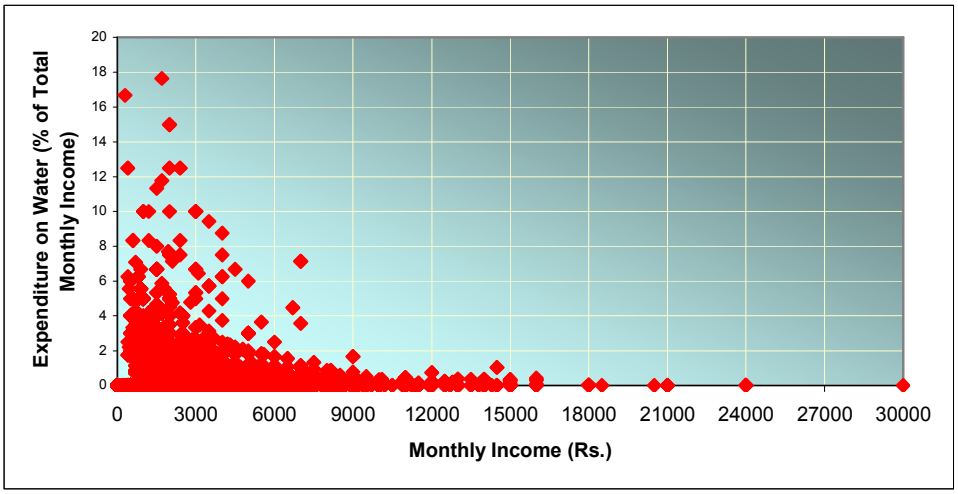
IV.5 Expenditure and Determinants of Domestic Water Consumption

Available data on slum households in Mumbai show that poorer households spend a large share of their income on water. These are households with monthly income of Rs.3000 (below poverty line) or less who suffer the most (Fig.4). Fig.5 shows that about 5% of such households spend more than 2% of their income on water. Thus, water which should have otherwise been human right, takes precious shares of income of the poor.

The analysis of determinants of water consumption has always been of special interest to academics and policy makers. Although, it is known that water consumption is supply constrained in the cities under focus, we have attempted to find out the determinants of even this limited supply/consumption of water. As shown in Table 11, there are considerable variations among the cities in terms of per capita water consumption and the greatest similarity emerges only between

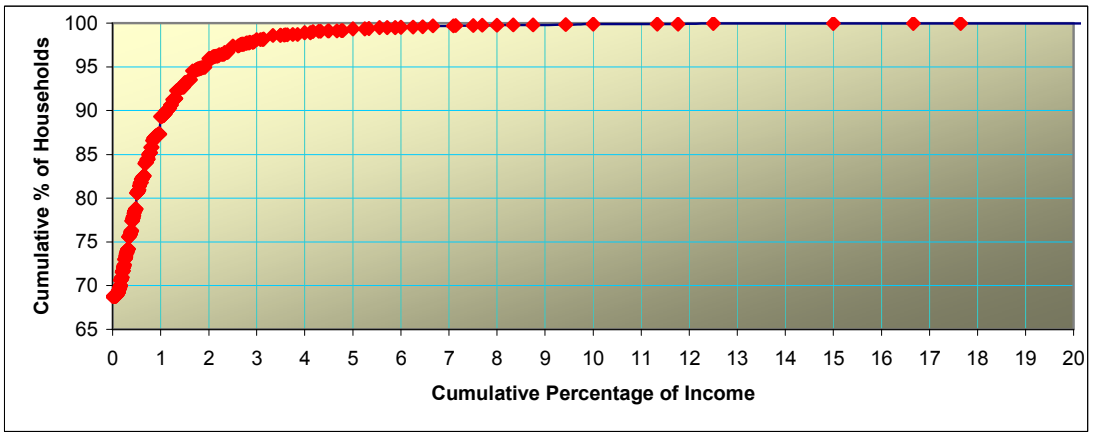
Kanpur and Delhi. As expected, with increase in family members in a household, per capita water consumption declines (more so in Kolkata). The richer households and households with higher education level have higher consumption of water. Importantly, it is found that the households which have 24 hours of water supply consume about 20 lpcd more than the households not having 24 hours water supply. This again shows that water consumption in domestic households in Indian cities is supply constrained.

Fig.4: Relationship between Household Income and Expenditure on Water of Slum Households in Mumbai.



Note: No. of households = 13,148; Data relate to the MUTP affected slum households, 1996-2002.
Source: Mumbai Metropolitan Region Development Authority (MMRDA).

Fig.5: Slum Households and Their Expenditure on Water as Percentage to Total Income.



Note: No. of households = 13,148; Data relate to the MUTP affected slum households, 1996-2002.
Source: Mumbai Metropolitan Region Development Authority (MMRDA).

Table 11: Determinants of Consumption of Water in Domestic Households.

Determinants	*Regression Coefficients*	*t-values*	*P=Values*
Intercept (α_0)	93.240	15.005	0.000
Mumbai (α_1)	22.399	2.811	0.005
Kolkata (α_2)	58.971	7.319	0.000
Hyderabad (α_3)	29.043	3.685	0.000
Kanpur (α_4)	11.093	1.144	0.253
Ahmedabad (α_5)	42.674	4.575	0.000
Madurai (α_6)	34.421	3.311	0.001
No of family members (ϕ_0)	-5.343	-5.104	0.000
Family Members Mumbai (ϕ_1)	-1.721	-1.157	0.247
Family Members Kolkata (ϕ_2)	-7.171	-4.569	0.000
Family Members Hyderabad (ϕ_3)	-2.539	-1.682	0.093
Family Members Kanpur (ϕ_4)	-1.332	-.772	0.440
Family Members Ahmedabad (ϕ_5)	-7.194	-4.032	0.000
Family Members Madurai (ϕ_6)	-5.384	-2.538	0.011
Asset Score (β)	.716	3.007	0.003
Year of Schooling of Housewife (λ)	.359	1.736	0.083
24 hrs Tap Water Availability (π)	19.392	7.083	0.000
$R^2 = 0.444$			
$f = 41.750$			0.000

Note: α_1 to α_6 are slope shifters dummies while ϕ_1 to ϕ_6 are slope shifter variables.
Source: Computed using field survey data.

V. Conclusions

Although recycled by the Nature, the fresh water is a limited resource. The high water consuming economic activities and population explosion are responsible for declining per capita water availability. To consume more is emerging main goal of societies, more so of

the ‘privileged’, thus putting further pressure on this diminishing natural resource. Indian cities have been appropriating water resources traditionally meant for ‘subsistence’ in rural areas. This process stands accelerated due to high degree of migration of the rural people to large cities in search of livelihood. The urban population, though not even one-third of the total Indian population, is quite large in sheer numbers, viz. around 290 millions. This would need a systematic augmentation of water supply to urban areas, without adding pressure to the available water for rural areas. The major observations drawn from the paper are: (a) It is observed that water consumption in Indian cities (more so in large cities) is far lower than the norms laid down by Bureau of Indian Standards. Not to mention, in comparison to other major cities in the world, the consumption in Indian cities is also far deficient. The lower consumption results mainly because the water supply not keeping pace with population growth and increasing needs of users; (b) It is interesting to observe that though a majority of households consume water below the specified norms, they, by and large, show satisfaction with the available supply. This is mainly because they have delimited their aspiration and requirements of water in relation to available supply from the concerned municipalities or water authorities (c) Some household activities, like washing clothes, bathing, use in toilets, and washing dishes and utensils are the most water consuming activities in the cities under focus. It has also been found that in these cities, a majority of the households perceive the above activities as most water wasting activities. This shows that given appropriate and affordable technologies to save water in specified activities, the households would be willing to adopt them. In fact, there exists a large scope for reducing water consumption in washing clothes by adopting appropriate soap/detergent and machines; and in toilets by changing and modifying the flushing system. An awareness campaign about the best practices in these activities can play a big role in saving precious water; (d) As expected, the availability and mode of use of water varies across the socio-economic classes within the cities. But, surprisingly, the difference is not very high. On an average, about 20 litres of consumption is higher among the higher classes; (e) City-wise variations in the supply and quality of water are very much visible. Water supply in cities like Kolkata and Hyderabad is far better, while Kanpur and Delhi perform the worst. Though it is also true that water supply in Hyderabad is a mix of adequacies and inadequacies, where multiple agencies pitch in to meet the needs. The municipal corporation supplies water to majority of households once in two days. Water tankers and bore-wells compensate the deficiency of municipal water in this city; (f) Twenty four hour

water supply on municipal taps is a dream for a majority of households in the large cities in the country. The study reveals that only about 18% of the total households in these cities get 24 hours municipal water supply. The erratic and limited duration of supply of water has become a common phenomenon in these cities. This has forced the households, in majority of the cities, to depend on groundwater and other sources of water, like the private vendors who supply water through tankers and drums. These, in turn, are leading to depletion of groundwater due to over withdrawal by the burgeoning population and emerging water markets. In fact, during the summer season private water vendors have their hay-days in these cities; (g) The much talked commodification of water and water services is also making dent into the otherwise role of government departments as the key supplier of water in cities. For instance, in cities like Delhi, Mumbai, Hyderabad, Ahmedabad, and Madurai some households have started using packaged water for drinking purposes. It is also true that so far none of these cities have permanently handed over the task of supply to their citizens (NGOs) or the private sector.

To conclude, it can be stated that the supply of water in large cities of India is going to be a big challenge in future. The rapid increase in population in these cities, depleting water resources and enhanced consumer needs are going to create a difficult situation. The market oriented development is creating new needs in sectors like entertainment industry and tourism, building industry, adapted new technologies pushing up water needs, more supply in shopping malls, and so on. Simultaneously, the alarming rise in pollution levels in surface water bodies and even in groundwater is going to add to the situation. Therefore, an urgent need is felt for a comprehensive water policy for cities which is suitable and satisfactory to growing needs of citizens. The prevailing 'adhocism' in protecting, enhancing and conserving water needs to be done away with.

[Note: This paper partly draws from the paper "*Water Consumption Pattern in Domestic Households in Major Indian Cities*" by Abdul Shaban and R.N. Sharma, published in Economic and Political Weekly, June 9, 2007.]

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