

Water Management for a Mega City: A Comparative Study of Selected Localities of Lahore

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Abstract: Pakistan falls in the category of water scarce countries. Lahore a major city of Pakistan, with a population of 12 million is likely to face serious water shortage in near future. The actual amount of water required for each domestic activity was pertinent in order to find the total consumption of water locality wise. One hundred families each from five selected localities were chosen for this survey. The Model town was selected as a model locality so that its findings and calculations can be generalized on other localities for comparison. It was found that for all daily indoor activities, 160.2 million liters (42 gallons) is the total quantity required. For all daily outdoor domestic activities, 487.92 million liters (128.9 million gallons) of water is to be made available. Results were examined and compared with other mega-cities, to learn from their experiences and plans to cope with the challenges in large cities.

Keywords: Individual water consumption, domestic use, urban localities, Lahore.

Introduction

From the dawn of history, as the human population has continuously increased, so have the water and wastewater disposal requirements. Water management was not a serious problem as long as the population numbers were low and concentrations of the people were not high (Lundqvist et al., 2005). According to UN, more than half of the world's population resides in urban areas, and this figure is projected to increase to 66% by 2050. Man uses water for a variety of different purposes. The most fundamental use of all may be the community water supply for the vital needs i.e to drink, to wash, to cook and to sanitize (Biswas, 1981). No two individuals or families have similar behavior patterns (Charness et al., 2007). In 1967, Lahore Water and Sanitation Authority was the main supplier, supplying water at the rate of 180 lpcd, but in 2013 it increased to 274 lpcd (Qureshi and Sayed, 2014). According to (Bureau of Indian Standards at least 200 lpcd is required for domestic usage in cities having flush systems. But as per Delhi Development Authority 225 lpcd is required for domestic consumption (Shaban and Sharma, 2007). In another estimate (Gliet, 1996) 50 lpcd of water is required for all basic human utilities including drinking, hygiene and preparing food. According to Corbella and Pujol (2009) in Barcelona, in some municipalities water consumption up to 500 lpcd is required. An average American used about 98 gallons or 371 lpcd of in 2005 (Kenny et al., 2009). Family's domestic water consumption has a positive correlation with the family income (Agthe and Billings, 1987; Arbues and Villanua, 2006; Hoffmann et al 2006).

The aim of this study is to find the level of awareness, habits and practices, identifying barriers and city-to-city learning opportunities to improve water management and resilience of the selected localities. Regarding the

scale of Lahore, and given that scale matters for tackling water management challenges, we compare the results with other megacities that were examined in earlier studies. This comparative study will help to learn from other well-managed cities and improve on weaknesses that were identified through this assessment.

Materials and Methods

Five localities were chosen for this study, 100 respondents from each locality comprised of 500. Questionnaire survey circulated sends very clear instructions to the respondents of what methodology for quantification is required. For this survey, a comprehensive set of instructions given in the questionnaire, suggested an alternate method of water utilization to be adopted for the data collection. It involved some working, calculations and recordings based on daily routine activities.

The survey therefore, proved to be very useful in terms of exposing the actual water requirement per activity which would help later on in assessing the total difference between the water demand and water supply. A standard bucket of 20 liters was chosen as a unit of measure for this study.

Results and Discussion

Locality wise percentage distribution household Activities and Water Usage Gulberg, Lahore Cantonment Board (LCB), Model Town Society (MTS), Walton Cantonment Board (WCB) and Defense Housing Authority (DHA).

Teeth and Face Washing

Four groups of consumers from 5, 10, 15 and 20 liters were formed respectively. Majority of the consumers were for the 10 to 15 liters category which is quite high.

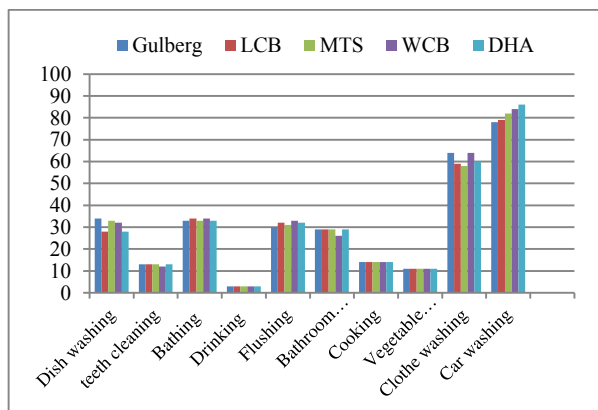


Fig. 1

In the survey Model town findings and calculations have been generalized on other localities for further understanding the pattern of domestic water consumption.

- WCB with a population of 4 million has 62 tube wells operating at the moment, drawing water at the rate of 124 cusecs/day.
- That means 151688505.6 liters of water being drawn/day.
- 151688505.6 when divided by the ratio of 14.7:57.8:19.6 and 7.8 comes to 58800, 231200, 78400 and 31200 persons.
- When this total population is multiplied by the total quantity of water used in their respective categories, it come to 294000 liters, 2312000 liters, 1176000 liters and 624000 liters.
- The total comes to 4406000 liters used in for teeth and face washing/ day.
- Of the total water available in WCB, the average consumption comes to 11.015 liters or 6.68%.

Bathing

Out of the categories of 20, 30 and 40 liters, only 18.6 % of the total population consumes 20 liters of water daily for bathing.

Table 1. Water Consumed for Bathing (All Localities)

Bathing	Gulberg		LCB		M T S		WCB		DHA		Total	
	f	%	f	%	f	%	f	%	F	%		
20 liters	21	19.8	21	20.2	18	18.0	14	13.7	22	21.0	96	18.6
30 liters	47	44.3	34	32.7	48	48.0	39	38.2	41	39.0	209	40.4
40 liters	38	35.8	49	47.1	34	34.0	49	48.0	42	40.0	212	41.0

Water consumption for bathing by WCB: -
 20 liter = 54800 persons x 20 liters = 1096000 liters.
 30 liters = 152800 persons x 30 liters = 4584000 liters.
 40 liters = 192000 persons x 40 liters = 7680000 liters.
 Total = 13360000 liters.

The average water consumption comes to 33.4 liters per capita.

According to Qureshi and Sayed.,2014, water used for bathing in WASA (Water &Sanitation Agency, 2013) supplied areas of Lahore, comes to 73.60 liters or 42.3%. For Delhi it is 31.7% (Shaban, 2008). According to Jiang 2004, Beijing consumes around 40.82%. In East Africa (Thompson, 2001) the figure is 38%. Mayer et al, (1999) concluded that an average American consumes 16.8% of their total water supply for bathing.

Drinking

Results show that middle category of 2.5 liters tops in all localities followed by lower category of 1.5 liters. Water consumption for drinking in the WCB:

1.5 Liters = 90,000 persons x 1.5 liters = 135000 liters.
 2.5 liters = 235200 persons x 2.5 liters = 588000 liters.
 3.5 liters = 74400 persons x 3.5 liters = 260400 liters.
 Total = 983400 liters.
 Average consumption is 2.45 liters per capita.

In Delhi 5% consumption for drinking is recorded per household (Shaban and Sharma, 2007). Beijing is 2.16% (Jiang, 2004). In UK it is 4% (Water wise, 2007).

Toilet Flushing

It is estimated that a single flush takes about 20 liters of water. 46.7 % and 53.1 % is the overall result. WCB figures would be:

20 liters (39.2 %) = 156800 persons x 20 liters = 3136000 liters.
 40 liters (60.8 %) = 243200 persons x 40 liters = 9728000 liters.
 Total = 12864000 liters.

Average water consumption comes to 32.16 liters.

JICA report (2010) = 14.8 liters. 16.5% of the total available water is used for flushing in Delhi (Shaban and Sharma, 2007). In UK, it is 30% (Water wise, 2007). For Finland and Portugal, the figures are 14% and 21% (Lallana et al., 1999; Vieira et al, 2007). In USA 26.7% of water is used for flushing (Mayer et al., 1999).

Bathroom Washing

The majority i.e. 46.1% belong to the 40 liters, followed by 44 % in 30 liters. Only 9.7 % represent 20 liters category. WCB figures are:

20 liters = 19600 persons x 20 liters = 392000 liters.
 30 liters = 160800 persons x 30 liters = 4824000 liters.
 40 liters = 219600 persons x 40 liters = 8784000 liters
 Total = 14000000 liters.

Average water consumption comes to 35 liters per capita. JICA report (2010) =30.25 liters.

Cooking

LCB and MTS with 51% are the leading consumers. A relatively large number of 28.7 % fall in the 20 liters category. About 23.1 % of the respondents belong to 10 liter category.

Table 2. Water consumed for cooking (all localities)

Cooking	Gulberg		LCB		M TS		WCB		DHA		Total	
	f	%	f	%	f	%	f	%	f	%	f	%
10 liters	27	25.5	26	25.0	20	20.2	23	22.5	23	21.9	119	23.1
15 liters	51	48.1	53	51.0	51	51.5	46	45.1	48	45.7	249	48.3
20 liters	28	26.4	25	24.0	28	28.3	33	32.4	34	32.4	148	28.7

WCB figures would be as follows: -

10 liters = 90000persons x 10 liters = 900000 liters.
 15 liters = 180400 persons x 15 liters = 2706000 liters.
 20 liters = 129600 persons x 20 liters = 2592000 liters.
 Total = 6198000 liters.

Average water consumption comes to 15.49 liters.

Average per capita = 2.81 liters

JICA (2010) = 4.3 liters 3.7% of water consumption for Delhi per family (Shaban and Sharma, 2007). In Beijing per family uses 5.21% of water is used for cooking (Jiang, 2004).

Vegetable or Fruit Washing

Results show that almost half of the population was consuming 15 liters of water for washing vegetables or fruits whereas 36.6 % uses 10 liters. WCB consumes: -

5 liters = 31200 persons x 5 liters = 156000 liters.

10 liters = 138000 persons x 10 liters = 1380000 liters.
 15 liters = 192000 persons x 15 liters = 2880000 liters.
 20 liters = 39200 persons x 20 liters = 784000 liters.
 Total = 5200,000 liters.

Average per family = 13 liters
 Average per capita = 2.36 liters

Dish Washing

Majority of consumers i.e. 72 % fall in the 30- and 40-liters categories while the remaining 23.3% go for 20 liters category.

Table 3. Water consumed for dish washing (all localities)

Dish Washing	Gulberg		LCB		M TS		WCB		DHA		Total	
	F	%	f	%	f	%	f	%	f	%	f	%
10 liters	4	3.8	9	8.7	5	5.1	3	2.9	4	3.8	25	4.8
20 liters	16	15.1	32	30.8	18	18.2	26	25.5	28	26.7	120	23.3
30 liters	42	39.6	31	29.8	35	35.4	34	33.3	41	39.0	183	35.5
40 liters	44	41.5	32	30.8	41	41.4	39	38.2	32	30.5	188	36.4

WCB shows the following data:

10 liters = 11600 persons x 10 liters = 116000 liters.
 20 liters = 102000 persons x 20 liters = 2040000 liters.

30 liters = 133200 persons x 30 liters = 3996000 liters.
 40 liters = 152800 persons x 40 liters = 6112000 liters.
 Total = 12264000 liters.

Average per family = 30.66 liters.

Average per capita = 5.57 liters.

16.5% of its water/family is consumed by Delhi daily for washing dishes (Shaban and Sharma, 2007).

Washing Clothes

In DHA 30.5% consumes 80 liters for washing clothes whereas in WCB the figure is merely 12.7%. WCB uses the following quantity:

40 liters = 74400 persons x 40 liters = 2976000 liters.
 60 liters = 156800 persons x 60 liters = 9408000 liters.
 80 liters = 117600 persons x 80 liters = 9408000 liters.
 100 liters = 50800 persons x 100 liters = 5080000 liters.

Total = 26872000 liters.

Average per family = 67.18 liters.

Average per capita = 12.21 liters.

JICA report (2010) = 37 liters.

In the USA an estimated water use for washing clothes comes to 21.7% (Mayer et al, 1999). in Delhi consumes 14.2%. In Mumbai it's as high as 24% (Shaban and Sharma, 2007).

Car Washing

The leader in 60 liters category is LCB, with 26.9% compared to just 16.2% in DHA. In WCB, 49% of households fall in 80 liters slot.

Table 4. Water consumed for car washing (all localities).

Car Washing	Gulberg		LCB		M TS		WCB		DHA		Total	
	f	%	f	%	F	%	f	%	F	%	f	%
40 liters	10	9.4	10	9.6	5	5.1	5	4.9	9	8.6	39	7.6
60 liters	20	18.9	28	26.9	21	21.2	17	16.7	17	16.2	103	20.0
80 liters	49	46.2	38	36.5	45	45.5	50	49.0	45	42.9	227	44.0
More than 80 liters (100)	27	25.5	28	26.9	28	28.3	30	29.4	34	32.4	147	28.5

Willingness to install water meters and increase in water charges

In our area of study, it became pertinent to ask the respondents, if they are willing to install and pay more for the water they consume in their houses. Results obtained are appended in tables below.

Table 5. Use of meter for water billings.

Use of Meter	Gulberg		LCB		M TS		WCB		DHA		Total	
	F	%	F	%	F	%	f	%	F	%	F	%
Yes	31	29.2	35	33.7	38	38.4	29	28.4	28	26.7	161	31.2
No	75	70.8	69	66.3	61	61.6	73	71.6	77	73.3	355	68.8

Table 6. Willingness to accept increase in water charges.

Willing to increase	Gulberg		LCB		M TS		WCB		DHA		Total	
	F	%	F	%	f	%	f	%	F	%	F	%
5%	28	26.4	24	23.07	23	23.2	21	20.6	20	19.0	116	22.5
10%	5	4.7	8	7.7	14	14.1	5	4.9	6	5.7	38	7.4
20%	2	1.9	3	2.9	2	2.0	4	3.9	5	4.8	16	3.1
30%	2	1.9	1	1.0	3	3.0	1	1.0	2	1.9	9	1.7
Not Willing	69	65.1	68	65.4	57	57.6	71	69.6	72	68.6	337	65.3

Conclusion

It is concluded that for all daily indoor activities, 160.2 million liters (42 gallons) is the total quantity required. For all daily outdoor domestic activities, 487.92 million liters (128.9 million gallons) of water is to be made available. The use of modern water saving devices and gadgets like sensor-controlled faucets and shower heads will help saving the same amount of water as done by using bucket. Up to 50% of water could easily be saved by using of latest water saving devices.

Several barriers include general awareness, habits and practices, consumer willingness to pay, and financial continuation that may retard the efforts for improving and urban water management sustainability. Many cities are facing similar water-related challenges. Finding sustainable and prompt solutions can be stimulated by sharing the experiences and knowledge of multiple cities that are trying to cope with these challenges.

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