



Non-Volumetric Pricing is a Threat to Water Reserves

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Abstract

Pakistan is a country having the world largest irrigation system but despite that, it is facing several droughts and floods. The storage capacity of the country is only 30 days whereas the required standard capacity is 120 days. The major source of water for the country is surface water and in many areas, groundwater is also used in a large quantity for domestic as well as agricultural use. Pakistan has large water reservoirs but still, it is facing serious challenges in providing safe drinking water due to the mismanagement of natural water resources. The major cause behind the depletion of water resources of the country is over-use of water. The main objective of this study is to find the behavior of people by comparing volumetric and nonvolumetric water use and the price they pay for both. There is a need to compare volumetric and nonvolumetric water pricing scenarios and its impact on water conservation for the district of Hyderabad. The study was conducted through questionnaire surveys, from three administrative units of the Hyderabad namely Qasimabad, Latifabad, and City. Three types of water utilities, namely Tapped water (water supplied by WASA), groundwater and tankered water were found as major sources for domestic use. The domestic use of groundwater is found to be mostly unpaid, while people having lined water services pay an average of Rs 300 (USD 2.2) but the percentage of these people is only 60%. On the other hand, people who consume tankered water (volumetric based charging) are paying on average Rs 5000 (USD 35.7) per month. The main finding of this study is that the households which were using tanker water were more careful in optimizing the use of water as compared to those who were using tapped water. Therefore, considering the economic worth of water, if it is charged on a volumetric basis then the misuse of water can be reduced noticeably.

Keywords: Basic Needs; Drinking-Water; Drinking-Water Management; Water Affordability.

1. Introduction

In most of the countries, especially in developing, the use of water and its valuation is the major issue and Pakistan is one of them which face serious challenges in water management and the revenue generated from the usage of water. The discrepancies in the system, ineffective policies and other external factors are responsible for the unproductive use of water and insufficient retrieval of finances occurred on supplying the utility. Some people have the opinion that the state or a government should provide safe water at free of cost as it is the responsibility of the state to provide basics needs to its citizens [1]. Placing some charges on the usage of water is as pricing other economic goods, which is an important factor for infrastructural development and demand management policies, which controls misuse of good and helps in conservation of natural resources [2].

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The approaches to controlling water use and designing efficient water policies for revenue collection significantly depends upon the population density of an area. Especially scarcity of water and its mismanagement are the major issues of urban areas of Pakistan. The country is facing rapid urbanization and it is estimated that by 2025, 50% of the population will be living in urban areas [3]. The migration from rural areas to urban areas, on a large scale, poses several challenges and mounts severe pressure on the economy of the country. The urbanization also affects the basic facilities, including water. This situation becomes more complicated with the unplanned settlements and underserved and poorly planned utility services. This menace has always been a challenge and of main concern for policymakers [4].

For a sustainable and long-lasting policy, it is always intended to consider the opinion of all stakeholders. Since consumers are the major stakeholders for sustainable water supply and distribution system, therefore, they are encouraged to participate in setting out a water tariff. Various approaches have been identified by researchers to analyze water tariff structure and determining an acceptable water tariff. Different factors such as Household's water demand, income, education, preference, satisfaction, and available resources should be considered while designing a reasonable water tariff [5].

Water tariff design is not a current emerging issue but different researches have been conducted since the 1970s in the developed countries. In the United States of America, the residential water demand or domestic water demand was analyzed in the 1970s [6-8]. Economic analysis and econometrics application studies had been carried out in the 1980s highlighting several economic methods to find out an appropriate water tariff [9-12]. In 1990s, new insights were emphasized, which include low flow equipment and welfare consequences of price regulation [13-17].

In Pakistan, the pipeline network for domestic water supply and drainage lines runs in parallel, which sometimes causes leakages and intermixing, resulted in deterioration of water quality [18]. In most of the cities of Pakistan, the main source of water use is from groundwater, which contains various pathogens including many viral, bacterial, and protozoan agents causing 2.5 million deaths from the endemic diarrheal disease each year [19].

Geographically Pakistan lies in southern Asia, bordering India in the east, Afghanistan, and Iran in the west, and China in the north. In the east of Pakistan, there exist mountains of Himalaya and Karakorum. In the north, Hindu Kush ranges exist, and hill regions (up to 4700 m) in the northwest and in the upland Baluchistan plateau exist. The climatic conditions are mostly arid to semiarid with varying levels of average rainfalls in different areas of Pakistan [20-21]. Indus is the major river of Pakistan, generating from Lake Masroora in Tibet and runs throughout the length of the country and finally falls into the Arabian Sea. The Indus River is the major source of water supply to the settlements along its terrain.

Hyderabad is located on East bank of river Indus and it is the 2nd largest city, by population, in Sindh while 8th largest city in Pakistan [22]. It serves as an industrial hub and marketing zone for interior Sindh and plays an important role in the growth of the national economy. Like other major cities of Pakistan, water is provided by various suppliers including public and private sectors and Different pricing mechanism is adopted by different suppliers.

The public utility provider WASA charges water on area-wise bases, which is a non-volumetric approach. On the other hand, some private vendors provide volumetric water but they charge very high prices. The comparison of both systems shows that the price charged by WASA is negligible. Private vendors fetch water illegally and sell at very high prices which are a burden on the national economy and water reserves. Our overburdened economy is further hampered by low-cost recovery and water stealing through the water supply system.

There is a strong need to redefine and redesign our domestic water policies and collection methods and modes to relieve this burden. For that, volumetric water pricing is a simple solution and it is practically implicated in numerous European countries and contributes significantly towards their economies. Although these countries are also facing certain types of losses but they are negligible as compared to the case in Hyderabad, where a low recovery is accompanied by high water losses.

By implementing volumetric water charging, 92% of European countries have attained 100% cost recovery. Portugal and Greece have certain obligations regarding the implementation of volumetric pricing. As a result, their recovery rate is not up to the extent of other European countries [23]. While later in 2016, Greece has adopted the Water Framework Directive (WFD) pricing system and adopted a 100% cost recovery [24].

1.1. Study Area

Hyderabad, which is the 4th largest city of Pakistan and 2nd largest city of Sindh. It is located at South East of the country. Geographic coordinates for this city are 25.367 °N latitude and 68.367 °E longitude with an elevation of 13 meters (43 ft). It is located on the east bank of the river Indus. It has a population of more than three million. The population has tremendously increased in the last few decades, not only with the population growth rates but migration from rural areas and in most of the cases Hyderabad is the first choice for the people of rural Sindh to settle for various purposes including education, health, and attraction of city light (Figure 1.).

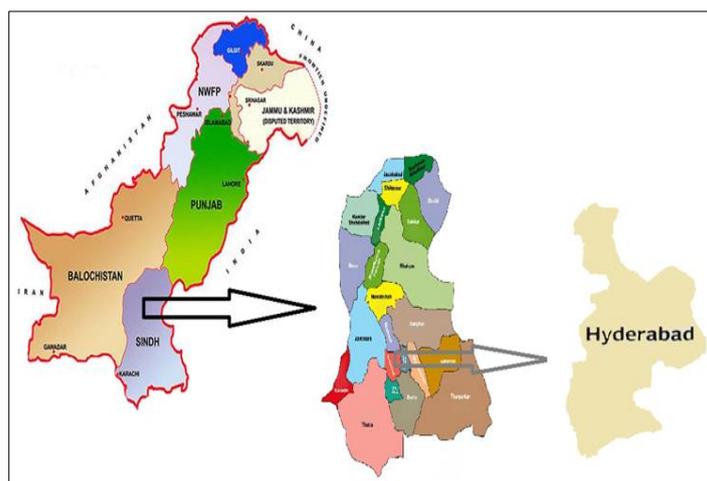


Figure 1. Study area

2. Research Methodology

The methodology of this study is based on a detailed survey which was designed to achieve the objectives, answer the research questions and to test the hypotheses. The questionnaire was divided into four major parts.

The first part included basic information such as the number of persons living in a home, income, education, area of the house, the location of the house and so on. The second part focusses on the health issues of the respondent faced and the amount expended on treatment. The third part included water supply information such as the source of water, amount consumed, the cost incurred on water, the treatment made and so on. Last part of the questionnaire was about future pricing. Five attributes were presented in different combinations and presented as choice sets to be selected by consumers to capture the willingness to pay as per discrete choice experiment method. Informed consent statement was presented to the respondents so that they respond voluntarily and know the purpose of the data collection. A clear written statement on the questionnaire as well as verbal consent was presented to respondents. Verbal consent was necessary because of the low education level of the area and less understanding of the English language. The consent statement clearly contains the confidentiality issue and survey was taken with the agreement of the respondent.

Respondents were asked about water use and also they were asked about water source for domestic and drinking purpose separately. If the source was other than tap water, then they were asked about the quantity of water they used for the last month. It approximated the average water use of a household. They were asked about water quantity in terms of tankers if they used tanker, and if they used plastic cans for fetching water, they were asked about the number of jerry cans. The number of tankers and jerry cans were then converted into liters to have a better comparison. They were also asked for the cost of each unit so that their total monthly expense on the water can be calculated and also questions were asked about the treatment of water.

As the data intended to collect was discrete in nature, so sample size is determined using $(z^2 \times p(1-P))/e^2$. Where z is z-score, which can be found from tables, the z-score value is 1.96 for a confidence level of 95%, which is the assumed confidence level in this study, p is percent response obtained, which in this case is 50% e is the margin of error which is 5% in this case. From this formula, it was determined that 384 samples were required to complete this study. For a margin of safety, it was decided to complete 400 samples.

Before starting a formal survey, the questionnaire was pre-tested for reliability, using a pilot testing technique, in which the twenty questionnaires having the same attributes and the same format was completed by the twenty different respondents. The queries and suggestions from the respondents were noted and changes were made in the questionnaire accordingly. Results of pilot testing were separately analyzed and problems and suggestions from the respondents and reviewers were incorporated into the main survey.

The Hyderabad city is constituted by five administrative units i.e. Latifabad, Qasimabad, Cantonment, Rural, and Main City area. From these 5 units, only 3 were selected for data collection as they receive water from WASA. Cantonment and rural units were not considered because of difference in water supply systems. In Cantonment, water is being provided by a cantonment board and is associated with all other facilities provided to the cantonment residents. This service is not separately charged and is merged with the package of services offered to the residents of the cantonment. Due to the lack of water structures or very fewer water utilities, the water services in the region of Hyderabad rural (bharari) are quite different. Besides this, there is no proper water supply system in the rural areas, the major source is groundwater, for that, people have to arrange or manage water by themselves. Since these two units have different water systems, therefore, they were not considered in the survey.

Equal population distribution among these three subdivisions is assumed in this study. The total sample size is divided into three equal parts to comprehend the overall situation of the city. Each subdivision is further categorized based on ostensive income class division and all the areas in each income class is listed for all three subdivisions. Two small areas from each sub-division were randomly selected and clustered sampling was done within each selected area. Thus 18 sections of the city were surveyed with a sample size of 400, among which 369 successful surveys have been conducted.

These sections included 6 sections from each subdivision. Gharibabad, Liaquat Colony, Hala Road, Paretabad, Halanaka, Heerabad, and Market were surveyed from city subdivision, unit number 2,6,9,11,12 and Kohsar areas were surveyed from the subdivision Latifabad, while Ali Nagar, Faraz Vilas, Prince Town, Anwar Vilas, Citizen Colony, and GMB Colony were surveyed from subdivision Qasimabad. These areas were selected randomly among all areas/ small units of the subdivision.

The collected data is digitized to make it compatible for analysis. For digitizing data, each question has been assigned all possible responses and then responses are entered against each question for each questionnaire. Then similar types of responses are grouped together to make the analysis. Different categories are made for some of the attributes to capture the actual scenario.

Based on frequency analysis, collection and billing rate is specified. Water use information provided the mean to analyses and grab information about water sources and the water used by consumers. Billing amount and collection rate is specified by the response of people which is compared then for different sources. In this Study, the comparison for lined water supply (nonvolumetric) and tankered water supply (volumetric) is compared.

A separate interview instrument was set up for WASA officials. Seven Interviews were also conducted from officers of various ranks including higher authorities. Demand, supply, treatment, fetching, distribution, and the charging mechanism was obtained and verified from officials. Loopholes in systems and other barriers in the system were also discussed. Mechanism of Tariff design, tariff revision, a billing mechanism, collection methods, and collection rate are also obtained through interviews.

3. Results and Discussion

Major sources of water for domestic use are lined water (tap water), groundwater and in some cases where both of these services are unavailable, people purchase water through tanker services. Among 386 of total respondents, 338 users have lined water, 8 of them have groundwater as a primary source, while some people fetch water in cans from nearby water sources. This distribution and adaptation of primary water source vary as per location and quality of water being provided by the source, Distribution network, water availability, and supply timings. Another important aspect is that whether the source is sufficient to fulfill consumer's water demand or not? Answer of this question is of primary concern for source selection. Results of usage and average price for each source in each area is encapsulated in Table 1.

Table 1. The frequency of use for each Source

Source of Water	Latifabad		Qasimabad		Hyd. City	
	Frequency	Avg. payment (USD)	Frequency	Avg. payment (USD)	Frequency	Avg. payment (USD)
Tap	99	1.85	110	1.64	129	1.35
Ground Water	1	0	2	0	5	0
Tanker Water	16	40	11	28.57	1	32.14
Total	124		123		135	

Latifabad subdivision has the largest number of tankered water users. The reason for preferring this source is low reliance on public water utility and non-access to the public water lines. Poor water quality, and insufficient supply through water lines are among the main reasons for which people are extremely unsatisfied regarding public water utility. Color, taste, and odor of water in many localities is reported under-standard. It is reposted that 25% occupants rely on and buy tankered water due to inappropriate water quality and inadequate water quantity. Despite having more than 300% in price difference, people are forced to use this utility because of no other option. It is also noticed that people using tankered water in this region have a significantly high conservation rate and less water usage as compared to consumers having lined water supply. Approximately people having tankered water consumes 40% less water than people having lined supply.

In Qasimabad Subdivision, a better situation has been observed. In this subdivision, 90% of people have a reliance on lined water services as their primary source. The second most popular source in this region is tanker water. Total 11 households use tankers as their primary source of water. The supply timing and quality of water are better as compared to Latifabad based on the opinion of people. The Satisfactory level in terms of quality and quantity is better than the

residents of Latifabad. Groundwater is also used as a primary source in this region, but the percentage is quite low, indicating low reliance on groundwater. Though groundwater is a most popular secondary source of water followed by tankered water. Similar results have been captured in this subdivision too with about 35% water conservation by tankered water usage.

In city subdivision, more than 95% of consumers have a reliance on lined water. 129 out of 135 responded are using lined water with the highest satisfaction level in the district. Data depicts that there are certain areas in the city subdivision, where water is being supplied for 24 hours. None of the respondent from Latifabad or Qasimabad responded to have supply for more than 10 hours. The tanker water supply in this region is minimum with only 1 respondent from this area is using tanker water as a primary source. Since a number of tankered water consumer is only one, so conservation practice and water use variance could not be calculated appropriately.

Though numbers of consumers in all three regions using tanker water are fewer in number the fact to be noticed is the difference in price range and the amount of water they consume. Tanker water is a volumetric source, and a calculated amount is provided in a tanker. The average price of each tanker is Rs. 1500 (\$ 10.71) per 10000L capacity tanker. While the average price charged on the non-volumetric source, which is lined supply is Rs. 300 (\$2.14) per month only. The average price of tanker water is observed as Rs. 5000 (\$ 35.71) per month. Average consumption of tankered water is about 50000 Litters per month per house. On the other hand, water obtained on average 10 hours daily with the discharge of 4 liters per minute through lined water supply make the average consumption of 75000 liters per month per house. This shows about 45% more consumption through the non-volumetric source. There is a huge difference between the pricing of each source and water consumption through each source.

Price of Lined water is charged on an area basis. For comparison, the area of households is divided into four categories which are less than 90 sq yards, in between 90 and 200 sq. yards, in between 200 and 500 sq. yards and houses having an area of more than 500 sq. yards. The average price of each category is mentioned for Qasimabad in Table 2, for Latifabad in table 3, and for Hyderabad City in table 4 respectively. The range of water charges varies between Rs. 120 (\$ 0.85) to Rs. 470 (\$ 3.35).

Table 2. Avg. Billing Amount in Qasimabad

Area Of House (Sq. Yards)	Frequency	Avg. Payment (USD)	No of Respondents Get Tankers.	Avg. Payment For Tankers (USD)
Less than 90	22	1.14	0	0
90-200	81	1.64	5	14.28
200-500	13	2.21	1	28.57
More than 500	7	2.57	6	42.85
Total	123			

Table 3. Avg. Billing Amount in Latifabad

Area Of House (Sq. Yards)	Frequency	Avg. Payment (USD)	No of Respondents Get Tankers.	Avg. Payment For Tankers (USD)
Less than 90	31	1.14	0	0
90-200	72	2.00	1	28.57
200-500	18	2.28	3	35.71
More than 500	3	3.57	12	42.85
Total	124			

Table 4. Avg. Billing Amount in City

Area Of House (Sq. Yards)	Frequency	Avg. Payment (USD)	No of Respondents Get Tankers.	Avg. Payment For Tankers (USD)
Less than 90	67	0.92	0	0
90-200	52	1.78	0	0
200-500	16	2.00	1	32.14
More than 500	-----	-----	-----	-----
Total	135			

Similar to billing amount the recovery rate is not the same from all three regions. Based on several issues like poor water quality, variation in water quantities, different supply timings, inconsistent water provision and uncertainty of water supply, the rate of payment is quite low. The percentages of people who pay bills are 50%, 60%, and 70% respectively from Latifabad, Qasimabad and city subdivisions. Data depicts that a huge population does not pay water bills because they do not receive water bills, 10%, 15% and 30% people from City, Qasimabad, and Latifabad do not receive bills. Figure 2 represents the collection rate.

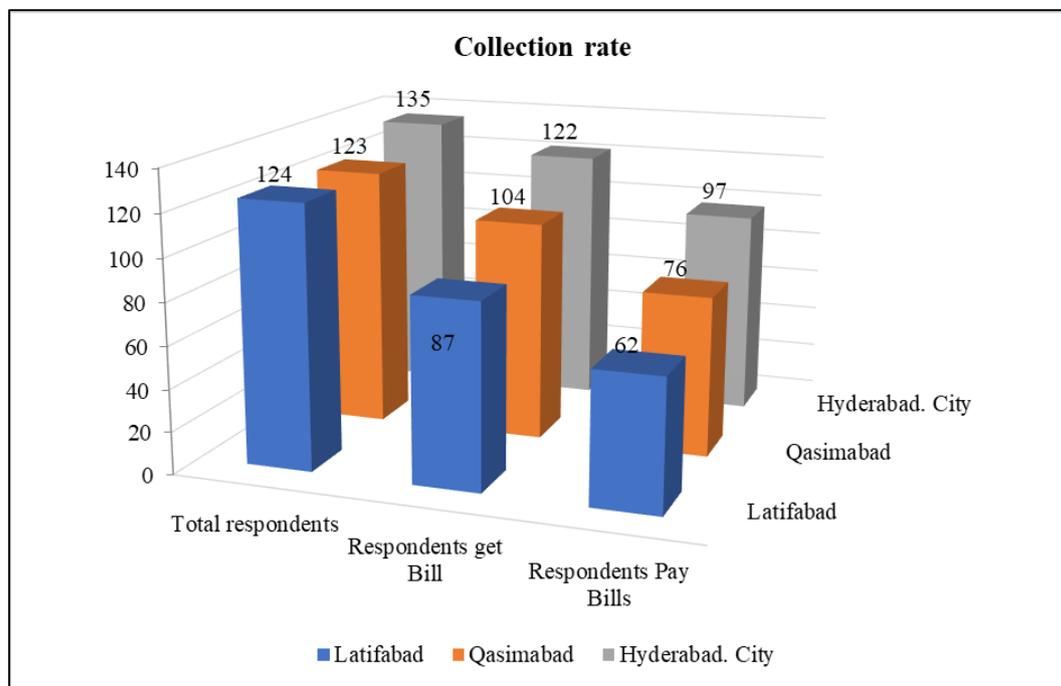


Figure 2. Collection rate in different areas of Hyderabad

Despite very minimal water prices, the collection of water charges is not more than 60% which is an alarming situation. Not only the consumers are responsible for this low recovery, but the lack of interest, poor policy implementations, and non-penalizing the defaulters are the reasons on the management side.

4. Conclusion

The study shows the usage of water in three different areas of Hyderabad, most of the people are using tapped water in City subdivision and in Qasimabad and Latifabad. Residents do not prefer tanker water as it is expensive and limited. Residents using tankers pay on average Rs. 5000 (\$35.71) per month while consumers of lined water pay Rs 300 (\$ 2.14) for unlimited use. It is also observed that the water use habits of people using tanker water are much more conservative as compared to people using lined water. Waste ratio and inefficient use of water are also found to be more in consumers having lined water supply. About 50% reduced water use by people of the same area shows a high conservation rate and low wastages like Overflows in Underground and overhead tanks which are also been witnessed by residents in the areas where people use lined water. In light of above-mentioned facts, it is concluded that volumetric pricing is a conservative approach and a lot of water is being wasted due to nonvolumetric pricing. Also, the price of water charged from consumers having lined supply is quite less as compared to the private vendors who supply water through tankers. Despite very low water prices and ambient water supply, the collection rate is less than half of the expenses incurred on water treatment and supply.

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7. Conflict of Interest

The authors declare no conflict of interest.

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