DETERMINATION OF DAILY WATER CONSUMPTION PATTERN
(A CASE STUDY OF KHYBER PUKHTOONKHWA, PAKISTAN)

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Abstract

Water is not only necessary for life but it plays vital role in the social accompanied with economic growth of that specific country especially developing countries. Increasing population and rapid urbanization accompanied with climate change may reduce the supply of fresh water globally in twenty-first century. This study aims to understand current household water use and water use pattern in different five houses of different five places of KPK Pakistan for five months, to improve the efficiency of house hold water use, to encourage sustainable use and conservation of water resources. For the provision of new fresh water facilities. It’s necessary for water supply system planners to comprehend current water consumption behaviors of inhabitant, and how they use water of the new facility in future. The water consumption pattern is differs for the nations and societies and dependent on factors which may vary consumption on daily, weekly, monthly and yearly basis. These factors are availability of water source, economic, cultural, seasonal, climatic, and approachability to these water sources.

Daily water consumption pattern for five different houses in different areas of KPK for five months were found by carefully examining the time taken by pump to fill the Household overhead tanks. But in order to increase reliability of the acquired data the pumps were allowed to fill the tank till water flow for one minute at overflow pipe of the water tank was not recorded. During the period of research (March 2018 to July 2018) it was concluded that the average consumption in Charsadda (urban), Charsadda (rural), Mardan (urban), Mardan (rural) and Kohat (urban) was 102.84, 61.81, 105.99, 66.44 and 100 litres per capita per day (LPCD) respectively.

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Interestingly it was also observed that the trends of water consumption were almost the same in urban and rural areas of different districts of KPK.

Keywords: Daily water Consumption Pattern, Peak factors, LPCD, Overflow pipe, Flow rate

I. Introduction

Fresh water sources are not abundant in nature. Although over 2/3 part of our planet consists of water but the quantity of fresh water sources availability on the earth is not in abundance for use. Out of which only three percent is potable, two percent is frozen in glaciers and polar ice caps, which leaves only 1 percent as useable water and the rest 97 percent is saltish water [I].

Now a day freshwater shortage is not only a global challenge for sustainable development but it also affects human intervention, inadequate freshwater supply, and inappropriate management which causes a rapid deterioration of existing fresh water sources [IX]. There is a vast competition for the use of fresh water consumption due to agricultural crops, industries and urbanization. By the end of year 2050, more water in future required to produce foodin demand of the Earth’s population as demand increased to 9 billion [X]. Thus, reuse of municipality wastewater is now becoming a critical issue because of increasing water demand for human and agricultural sector consumption [IX]. Pakistan, which is previously a country of water-surplus quantity, currently considered as a country approaching towards water deficiency [VII]. The gross demand of water in Pakistan for the purpose of non-irrigation estimated in 2007 approximately 8.5 billion m³, expected to increase about 11.2 billion cubic meter by the year of 2025, following an increasing rate 1.5 percent due to rapid urbanization and industrialization [XI]. The intensity of rainfall is currently in-adequate to encounter the rapid increasing requirement of water consumption. In addition, it is currently expected that these constant incremental increase in the consumption of water will reaches to severe condition promoting scarcity in the quantity of fresh water sources in future [II].

Per person water availability in Pakistan per year reduced from 5,000 cubic meters in 1951 to 1038 cubic meter per year by 2010 which was somewhat above is the internationally recognized water scarcity level of 1000 cubic meter [IV].

Moreover, as per the water stress index, if the fresh water availability in a country drops below 1000 m³ per person per year, it is considered as a water-scarcie country and if it decreases from 500 m³ then country is in absolute water scarcity [III].

It is estimated that 67% of the global population will face moderate to high water stress and half of the population will suffers limitations in t supply of fresh water by 2025 [VII].

Supply of fresh water sources to the entire population of world from now to 2030 as absolutely the finite supply is recognized as a clearly mentioned and significant challenge due to the fact that the quantity of fresh and drinking water sources are only one percent of the world’s total water which is managed in a poorand haphazard manner. Population growth is one of the key factor affecting water scarcity, besides
this improving the level of living standards, urbanization and variability in supplies at consumer end due to climate change will also add unbearable pressure on fresh water sources which leads insufficiency in numerous parts of the world [VI].

Everyone in the world, whatever their approach of development, social and economic situations, have the right to have access to potable water in adequate quality and quantity as per their basic needs. Standards for domestic water use differ with climatic conditions, life style, culture, technology and economy and people’s behaviour to treats fresh water during their diurnal activities [V].

In households’ water is used for drinking, preparation of food, bathing, flushing toilets, washing of clothes, and watering of gardens and lawns. As per the guidelines of WHO; Drinking Water Quality, Defines use of water for domestic purpose as the “the usage of water in usual for all the domestic purposes counting the drinking water consumption, for bathing and the preparation of food”[III].

The consumption of daily water consumption in Dhaka city was determined via a questionnaire and a for domestic water a unique type bucket was used for households having different activities this research study presents 200 to 300 litres per person per day consumption of potable water in the middle class families [I]. As per the recommendation of WHO50 to 100 litres of water (LCPD) is required meeting the needs of daily domestic activities i-e for personal hygiene, cleaning of floors along with washing of clothes etc. [IX].

Besides the size of household, social and economic status, seasonal variationalong with climatic changes there are some other issues associated with consumption rate such as shared overhead tanks, shared taps education and water faucets. And through a cluster of data acquired from metered data and storage container inventories based on the above-mentioned factors it was concluded that most of the houses used water below 135 LPCD except a very few houses [VI].

Household’s daily and activity wise water use is greatly affected by the availability of water source, its quality, duration of availability and frequency of water supply. A research was conducted where the size of the vessels used for the measurement were used for domestic used where stored water in vessels were measured along with observing water from running tap, the time in a specific tap was used and consumed quantity of water measured unit of flow per minute flowing out from the specific tap was measured. These results revealed the average daily water consumption was 117.0 LPCD. While in low-income family the observed consumption of water was 97 LPCD [X].

II. Method and Materials Used

Brief description of study areas

This research study was conducted out at the same time for five different households in three different districts as shown in Table 1 having different particulars
i.e rural, urban, source of fresh water, economic status, education level of family members and water source accessibility for a period of five month starting from March and ending at July.

Table 1: GPS coordinates of Households

| Study Area       | Latitude       | Longitude      |
|------------------|----------------|----------------|
| Charsadda Urban  | 34° 8'55.63"N | 71°43'48.21"E |
| Charsadda Rural  | 34° 9'36.48"N | 71°46'19.94"E |
| Mardan Urban     | 34°11'45.02"N | 72° 2'55.26"E |
| Mardan Rural     | 34°13'24.35"N | 72° 4'7.55"E  |
| Kohat Urban      | 33°35'9.65"N  | 71°26'4.89"E |

The seasonal characteristics of all the three districts are almost the same where winter starts from the mid of November to the end of March and summer months are May to September. The mean maximum temperature in summer is over 40 °C (104 °F) and is expected more than 40 °C mostly while the mean minimum temperature in summer is 25 °C (77 °F). The mean minimum temperature during winter is 4 °C (39 °F) and maximum is 18.35 °C (65.03 °F) as shown in Table 2.

Table 2: Households and water source particulars

| Study Area       | Number of persons | Water source depth (ft) |
|------------------|-------------------|------------------------|
| Charsadda Urban  | 8                 | 100                    |
| Charsadda Rural  | 14                | 73                     |
| Mardan Urban     | 10                | 103                    |
| Mardan Rural     | 5                 | 82                     |
| Kohat Urban      | 5                 | 142                    |

Estimation of daily water consumption

As all the households involved in the research had their own water sources along with their own overhead storage tank. The volume of their storage tank was found along with the determination of discharge of their pumps using container of known volume and stopwatch. The household water tank was filled and after that the time for which the supply pump delivers water to the storage tank was noted precisely till next 24 hours in order to find out the volume of consumed water within 24 hrs. The same at which it was previously filled. Furthermore, to acquire greater accuracy the pump was allowed to fill the tank till flowing water was not observed at overflow pipe of the storage tank for at least one minute.

Further analysis of the acquire data was carried out using Microsoft excel. Where daily per captia consumption, their patterns along with monthly peak factors were determined for various days of a week. In order study the variation of daily water consumption at different days of a week in a month.
III. Results and Discussion

Daily water consumption was obtained by the multiplication of water supplying pump discharge rate with the time taken by storage tank to fill till flowing water at the overflow pipe was not noticed for at least one minute.

Table 3: Average Daily Water Consumption for the five months 2018

| Study Area   | March       | April     | May       | June       | July       |
|--------------|-------------|-----------|-----------|------------|------------|
|              | Average daily Consumption (LP CD) | Peak factors | Average daily Consumption (LP CD) | Peak factors | Average daily Consumption (LP CD) | Peak factors |
| Charsad da Urban | 78.98 Max: 1.21 | 99.19 Min: 0.79 | 115.5 Max: 1.21 | 117.51 Max: 1.25 | 118.83 Max: 1.24 |
| Charsad da Rural | 46.16 Max: 1.33 | 54.39 Min: 0.69 | 58.46 Max: 1.38 | 78.12 Max: 1.47 | 79.94 Max: 1.21 |
| Mardan Urban | 59.72 Max: 1.33 | 77.81 Min: 0.77 | 116.29 Max: 1.24 | 129.95 Max: 1.30 | 130.41 Max: 1.30 |
| Mardan Rural | 62.65 Max: 2.07 | 64.65 Min: 0.49 | 64.24 Max: 1.45 | 70.72 Max: 1.47 | 72.95 Max: 2.08 |
| Kohat Urban | 97.72 Max: 1.25 | 99.48 Min: 0.82 | 101.96 Max: 1.20 | 101.27 Max: 1.18 | 103.27 Max: 1.19 |

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Average daily water consumption for Charsadda urban, Charsadda rural, Mardan Urban, Mardan rural and Kohat urban were found to be 106.0, 61.8, 102.84, 66.44 and 100.74 LPCD respectively. However, Daily water consumption for each month of study period along with their maximum and minimum factors are shown in Table 3.

Estimation of daily water consumption

Daily water consumption for the representative households were observed and determined for the study period without any discontinuity. Water consumption within the month of March shown in Figure 1 representing a water consumption in rural area’s ranges between 46.16 to 62.65 LPCD while water consumption in Urban area’s ranges between 59.72 to 97.72 LPCD.

![Fig. 1: Daily Water Consumption in study Area’s for March 2018](image1)

Water consumption within the month of April shown in Figure 2 representing a water consumption in rural area’s ranges between 54.39 to 64.65 LPCD while water consumption in Urban area’s ranges between 77.81 to 99.48 LPCD. Increase in consumption was observed due to the increase in temperature as increase in temperature results an increase in the consumption of water in Households.

![Fig. 2: Daily Water Consumption in study Area’s for April 2018](image2)

Figure 3 shows water consumption within the month of May representing increase in water consumption as result of increase in temperature having a water consumption in
rural area’s ranges between 58.46 to 64.24 LPCD while water consumption in Urban area’s ranges between 101.96 to 116.29 LPCD.

Fig. 3: Daily Water Consumption in study Area’s for May 2018

Similarly Figure 4 shows water consumption within June representing same trend of increase in rural area’s ranges between 70.72 to 78.12 LPCD while in Urban area’s ranges between 101.27 to 129.95 LPCD.

Fig. 4: Daily Water Consumption in study Area’s for June 2018

Same trend of increase can be seen in Figure 5 following same trends of increase ranges from 72.95 to 79.94 LPCD for rural and 103.27 to 130.41 LPCD in Urban Area’s respectively.

Fig. 5: Daily Water Consumption in study Area’s for July 2018
An increase in water consumption were found during study period both in urban and rural areas represented by Figure 6. Besides increase in temperature water consumption in household depends upon the demographic characteristics, education, income, cost of fresh water supply, water quality, types of water supply system, infrastructure of water distribution system and metering.

**Fig. 6:** Daily Water Consumption in study Area’s for Study Period

**IV. Conclusion**

- The actual daily water consumption observed during the research period is far less than the one which water supply facilities planners were used for the design of water supply systems.
- The trends of water consumption were almost the same in the urban and rural areas of different districts.
- There is also possibility that the water consumption rate drops for the households having no individual water supply sources and storage reservoirs.
- Besides seasonal changes, huge impacts on daily water consumption were observed due to cultural and demographic variations.

**V. Recommendations**

- Water supply planners need to adopt the actual water consumption while designing fresh water facilities to reduce the depletion available fresh water sources and to promote sustainability.
- Further study is required for determining diurnal consumption pattern for design of the continuous water supply and to use water in a conservative manner.
- Water consumption patterns for a specific area is not appropriate to use every in the world due to cultural, seasonal, demographic and socio-economic variations.
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