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Analyzing Domestic Water Consumption in Wana, South Waziristan, Khyber Pakhtunkhwa Province- Pakistan

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Abstract

This article is an attempt to analyze the domestic water consumption in Wana, South Waziristan in the Khyber Pakhtunkhwa province, Pakistan. In this regard, a detailed questionnaire based survey was conducted using simple random techniques. Global Position System was also used to acquire location of sampling units. Area having high-income groups and family size consume high amount of water. People having monthly income of less than 25000 PKR, consume 347 l/day and people having monthly income of 25,000-50,000 PKR consume 538 l/day. Similarly, people having monthly income of more than 50,000 PKR consume 749 l/day. The per capita consumption for small, medium and high-income group is 10, 22 and 48 l/day respectively. The total water consumption of small family, medium and large families' sizes is 423,642 and 831 l/day and the per capita consumption for these families are 6.4, 11 and 20 l/day. This study highlights the consumption of water by the family size and the income groups in Wana, South Waziristan. People are consuming more water as a result, the groundwater is depleting rapidly.

1. Introduction

Water is absolutely an essential element for survival of life on the earth (Lyu, 2019; Chen, 2018). Earth is the only planet where there is abundant water available but among these, only 2.5 percent of the Earth's total water is fresh water (Lewandowski et al., 2020; Hao et al., 2010). Only one-third of this fresh water is available for human use and more than half of this already being consumed by the growing human population (Lashari, 2007; Rahman & Parvin, 2009). It is estimated that about 99 percent of all liquid fresh water is in underground aquifers and about quarter of the world's population extract water from this underground aquifer (Gabriel & khan, 2009). Ground water is being used in all the types of activities. It contributes about 22% of the total fresh water resources of the globe (Norman, 1995; Foster, 2014; King, 2008). About 46% of its share is in performing the domestic activities and for the commercial uses (Kahlown, 2003; Limouzin, 2009). In industrial activities, this resource of natural water contributes about 24% and in agricultural activities, about 34% of the irrigation requirements are fulfilled by utilizing this water resource (Weigman, 2003; Villholth, 2006; Wada et al., 2014). Its purity and safety from the direct contamination make it more significant for human needs (Mackee, 2001; Todd and Mays, 2005). Its presence in abundance and its flexibility to extract attract the human beings towards its use (Bell, 1996; Laluraj, 2006).

This study is carry out to identify the amount of domestic water consumption in Wana, South Waziristan. Residents of Wana are facing problems due to shortages of water for domestic as well as for agricultural purposes. There is no proper mechanism for water usages. People use water irresponsibly and due to which the groundwater level has been decreasing. Ground water is safe to use because it is not expose to the human environment. It has been preferred in last millennia due to its good quality (Sravanthik, 1998; Clarke, 1991). Unfortunately, since last few decades' pressure has increased on this natural resource due to the

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contamination of surface water resources. It used for domestic, agricultural and industrial purposes (Mishra, 2003; Chowdhury et al., 2003).

In Pakistan, about 80 % of the diseases are due to the drinking of poor quality of water. In Pakistan, about 250,000 children die every year due to water born diseases and about 1/3rd of deaths are also happened due to the water related diseases (PCRWR, 2010). In Pakistan, only 25.6 % of her population has access to the pure water while remaining population drink contaminated water. This situation is more worsen in the rural areas due to their limited resources and the lack of awareness (Anwar, 2011).

2. Material and Methods

2.1. Study Area

South Waziristan shares about 70 km border with Afghanistan's Province Paktia. South Waziristan borders with North Waziristan in the north, Bannu and Lakki Marwat districts in the northeast, Tank and Dera Ismail Khan Districts in the east and Zhob District of Baluchistan in the south. The total area of South Waziristan is 6,231 km^2. Wana Plain is a large open valley about 12 miles long and 8 miles broad situated to the west of the Mehsud Highlands. The weather system of South Waziristan is with moderate hot summers and extreme cold winters. The winter season begins almost in November and remains until up to March. In winter, sometime the temperature falls below the freezing point. Similarly, summer season starts in May and continue until September. Most part of South Waziristan receives little rainfall as the area is out of the Monsoon region but areas of high latitude receives fair amount of rainfall. South Waziristan is mostly consists of rugged and rocky terrains. Hills appear to zigzag in every direction and there are no regular mountain alignments. Land for agriculture purpose is very limited. The chief plains of South Waziristan are the Wana Plain, the Zarmilan, the Bermal and and the Spain plain. The main reason behind the low percentage of agriculture land is the shortage of ground water and unavailability of rivers and streams. In most parts of the region, ground water is the main source of irrigation.

Figure 1. Location of Study Area

2.2. Data Collection and Analysis

This study has been conducted in Wana tehsil South Waziristan in KP Province. Primary data were collected from field survey and Global Positioning System (GPS). Secondary data were collected from concerned government departments. The methodology adopted for the achievement of desire objectives as suggested by Mahmood et al., (2020).

A semi-structured questionnaire of was designed. During questionnaire survey 170 household were interviewed. The respondents were asked regarding socio-economic characteristics of the households concerning respondent's occupation, monthly income in PKR, family members, sources of water and daily water consumption in liters. GPS was also used during the field survey to acquire the exact location of sample sites. These coordinates were used in GIS environment to develop sample sites map Fig. 2. The satellite image of Landsat 8 having 30m resolution was downloaded from United States Geological Survey (USGS) open source geo-database.

The monthly household income was classified in three classes. The first category consists of low income which has monthly income of <25,000 PKR (170 PKR= 1US$, 2021). Second category includes HH having monthly income of 25,000-50,000 PKR; and the third group consists of high income which has monthly income of >50,000 PKR. These income classes were used to identify the variation in water consumption among various segments of the community.

Similarly, family size was classified into three groups, which are small, medium and large family. Families that have less than 10 members were categorized as small family. Similarly, family that consists of 10 to 15 members was categorized as medium and above 20 members was categorized as large families.

The daily water consumption was also categorized into three groups, namely low, medium and high consumption. The low consumption consume <50 liter per day, medium consumption is 50-100 liter per day and high consumption is >100 per day.

Frequency distribution was performed to make monthly income and family size classes of the surveyed households. The average domestic water consumption per day for each income and family size class was calculated using the following formula:

$$C=\sum N/n \qquad (1)$$

Where "C" is the average water consumption per household per day, "N" is the numerical value of each observation and "n" is the number of observations. Average water consumption per person per day "c" was calculated using the following formula:

$$C= C/Fs \qquad (2)$$

Where "c" is the per capita water consumption, and Fs is the average family size. The total consumption was calculated by using the following formula:

$$T= (p) \times (c) \qquad (3)$$

Where "T" is the total consumption in liter per day and "p" is the total population.

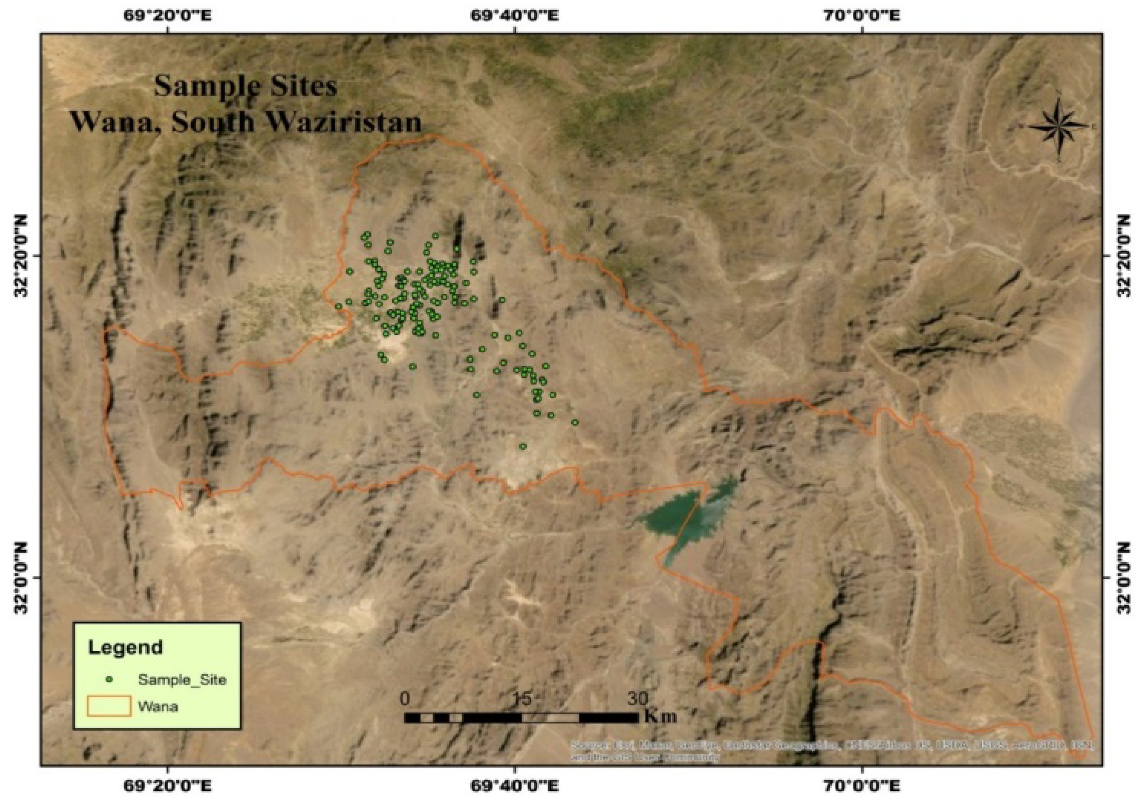

Figure 2. Sample sites map

3. Results and Discussion

3.1. Socio-Economic Characteristics of Studied Population

The age of respondents is ranging from 22 years to 73 years old (Table 1). The maximum percentage lies between the age limit of 10 to 35 years. This comprises of the 52%. The second major share is the age limit of 35-40 years and this makes the 41%. In this survey, only 6% respondents have the age limit more than 50 years. The frequency is also mentioned which shows the responses taken in the questionnaire survey.

Table 1. Age of Respondents in Wana

Serial No.	Years	Frequency	Percentage
1	<35 Years	89	52.35
2	35-50 Years	70	41.17
3	>50 years	11	6.47
	Total	**170**	**100**

*(Field survey, 2021)

The family sizes in the study area were categorized in three classes, small, medium and large family. Families, which have less than 10 members, were categorized as small family (Table 2). Similarly, family, which consists of 10 to 15 members, was categorized as medium and above 20 members was categorized as large families. As far as the family size is concerned, about half the population, which becomes 49% was a middle family. The other large percentage of the family size was of those people who were living in the large family structure (about 31%). In addition, the people living in the nuclear family were only 18%.

Table 2. Family size of the Respondents

Serial No.	Families Size	Frequency	Percentage
1	Small Family	32	18.82
2	Medium Family	84	49.41
3	Large Family	54	31.76
	Total	**170**	**100**

*(Field survey, 2021)

Monthly income of the respondents ranges from less than 25000 to more than 5000 PKR (Table 3). According to that survey and (with the frequency of 77), 45% people had the monthly income of less than 25000. The other group of population belonged to 40.58% and they had the income, which lied between 25,000 and 50,000, and only 14% percentage was having the monthly income more than 50 thousand.

This important data is about the daily water consumptions in the study area (Table 4). It is evident that about half of the population of the respondents had the daily domestic usage of 47.6%. The other percentage was 31% of the people who use the average water less than 50 liters. Moreover, the percentage of the people, which lies in between 50 to 100 liters, was 20%.

It is evident in the tabular data that majority of the pumps was electric pumps which makes the 60% of the data (Table 5). The other major use is of solar pumps. Solar pumps make the 26% of the total pumps in the region and 10% are the tube well. The data also reveals that hand pumps were only 4% and these hand pumps are mainly use for domestic purposes only.

The diameter of the pipeline of the water pumps and the capacity of these water pumps were classified in five groups that is from 1 inch to 4 inch (Table 6). 44% pumps had the capacity of the 3 inches. 16% were having the 4 inches diameter of the pipe. 22% pumps were those, which had the capacity of the only 2 inches. 9 % of the water pumps have the capacity of 2.5 inches and 7 % have 1 inches capacity which mostly falls in hand pumps category.

Table 3. Monthly Income of the Studied Population

Serial No.	Monthly Income (PKR)	Frequency	Percentage
1	<25000	77	45.29
2	25000-50000	69	40.58
3	>50000	24	14.11
	Total	**170**	**100**

*(Field survey, 2021)

Table 4. Domestic Water Consumption

Serial No.	Water Consumption Per day (Liter)	Frequency	Percentage
1	< 50	54	31.76
2	50-100	35	20.58
3	> 100	81	47.64
	Total	**170**	**100**

*(Field survey, 2021)

Table 5. Groundwater pumping in the study area

Serial No.	Groundwater Pumping	Frequency	Percentage
1	Electric Motor	102	60
2	Solar Pump	43	25.29
3	Tube well	17	10
4	Hand Pump	8	4.17
	Total	**170**	**100**

*(Field survey, 2021)

Table 6. Capacity of water Pump in Wana

Serial No.	Water Pump Capacity (Inches)	Frequency	Percentage
1	1	12	7.05
2	2	36	21.17
3	2.5	16	9.41
4	3	76	44.7
5	4	27	15.88
	Total	**170**	**100**

*(Field survey, 2021)

Spatial variation has been noted in water consumption. In the areas, where the families' sizes are large, consumption of water is also larger. Similarly, the areas that has high-income group consume maximum water. The water consumption increases with the increase in monthly income and size of the family. The Cross tabulation shows that in low-income group 6 and 16 HH were consuming water less than 50 l/day and 50 to 100 l/day respectively. In middle-income group 13 HH was consuming water from 50 to 100 l/day, while most of the high-income group were consuming more than 100 l/day (Table 7). Similarly, analysis further reveals that small families consuming less than 100 l/day. In medium size families, most of the HH are consuming water from 50 to 100 l/day while large families consume water more than 100 l/day (Table 9). Moreover, the water consumption increases as HH family size and monthly income increases. People having monthly income of less than 25000 PKR, consume 347 l/day and people having monthly income of 25,000-50,000 PKR consume 538 l/day. Similarly, people having monthly income of more than 50,000 PKR consume 749 l/day (Table 8). The per capita consumption for small, medium and high-income group is 10, 22 and 48 l/day respectively. The total water consumption of small family, medium and large families' sizes are 423,642 and 831 l/day and the per capita consumption for these families are 6.4, 11 and 20 l/day (Table 10).

Table 7. Family income level and water consumption cross tabulation

Income Level	Water Consumption			Total
	< 50	50-100	>100	
< 25,000	6	16	13	35
25,000-50,000	4	13	2	19
> 50,000	0	17	24	41
Total	10	46	39	95

Table 8. Per Capita Consumption by different income groups.

Monthly Income	Per Capita Consumption (l/day)	Total Consumption l/day
< 25,000	10	347
25,000-50,000	22	538
> 50,000	48	749

Table 9. Family size and water consumption cross tabulation.

Family	Water Consumption			Total
	< 50	50-100	>100	
Small Family	9	8	7	24
Medium Family	7	30	22	59
Large Family	5	8	10	23
Total	21	46	39	106

Table 10. Per Capita consumption by the Family size.

Family	Per Capita Consumption (l/day)	Total Consumption in l/day
Small Family	6.4	423
Medium Family	11	642
Large Family	20	831

4. Conclusion

The study concludes that the residents in the study are using ground water for domestic and agricultural purposes. Population is also increasing rapidly and this put immense pressure on ground water. The consumption of water is different among the different income groups and family sizes. Monthly income group and family size have direct connection with water consumption. Larger families consume more water as compared to smaller families. Spatial variation has been noted in water consumption. In the areas, where the family sizes are large, consumption of water is also larger. Similarly, the areas that has high-income group consume maximum water. The water consumption increases with the increase in monthly income and size of the family. Moreover, the water consumption increases as HH family size and monthly income increases. People having more monthly income consume large water as compared to people who have less monthly income.

5. Way Forward

The small and medium reservoirs under the present conditions are the only possible way to meet the impeding water crisis. As these small dams would be mostly in areas of water scarcity, hence the dam's effect on raising aquifer would be most significant, in supplementing the irrigation resources and extending cultivation. Large dams, no doubt will affect the recharging and raising of aquifer more, but that would be localized and in the same vicinity, whereas these small dams would do so in different localities and their impact will be more widely felt.

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Author contributions

Saddam Hussain and Shakeel Mahmood contributed eaqually in data analysis and writing of the manuscript. Shakeel Mahmmod reviewed and updated the final version of the manuscript.

Conflicts of interest

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

Research and publication ethics were complied with in the study.

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