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Household domestic water consumption patterns in a rural semi-arid village: A case study of Kumbha village in Hisar district, Haryana

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Abstract
The need for water in India is increasing as a result of development, both in urban and rural areas. This could exacerbate tensions and conflicts over the distribution of water sources. Understanding the specifics of actual water use on a household level is critical for water demand management. As a result, based on questionnaires and interview surveys of 105 households consisting 10 per cent of total households, this paper investigates the pattern of domestic water consumption in semi-arid Kumbha village of Hisar district in Haryana state of India, in order to better understand how local communities in the region relate to water. The study looked at household water usage on a daily and activity basis, as well as the sources, quality, duration of water supply, and awareness of water storage. According to the study's findings, the village's daily average water usage is 105 per person per capita per day. Cloth washing uses the most water utilized activity. The Calculated value of chi square test is greater than tabulated value hence null hypothesis is rejected at 5% level of significance. It is found that the people with high income utilize more water than the others. However most of residents are dissatisfied with the duration of their water supply, and 38 per cent are unaware of conservation technologies. This needs to be addressed immediately by affecting public perception through the media and conducting public awareness campaigns. It is believed that the study's findings may assist Indian policymakers and planners in optimising current water resources for rural development.

Keywords: Domestic water consumption, semi-arid, water conservation and management

Introduction
The world's and humanity's greatest pressing problem is not the threat of war, pandemic, or the breakdown of civil government, but the overwhelming problem of water scarcity (Jury and Vaux 2006) [7]. Household, particularly women and children, suffer greatly as a result of water scarcity, as they must spend many hours each day gathering water from far away sources (Gopaldas and Gujral 1995) [6]. Water is necessary for life, and it serves as a cornerstone for any country's social and economic development. It is primarily used in the residential, agricultural, and industrial sectors. Furthermore, food production is largely dependent on water availability at the agricultural production. In the twenty-first century, rising population and urbanization, combined with climate change, may diminish global water supplies (Murad *et al*. 2007; Wheida and Verhoeven 2007) [10]. Because the world's population will reach 9 billion people by the year 2050, considerably more water will be required to produce food in the future. Rural areas in developing countries are sometimes overlooked when it comes to water supply. When such facilities are available, they are rarely used to their full potential (Briscoe and DeFerranti 1988; World Health Organization 1992; Sharma *et al*. 1996) [3, 18, 15]. Due to the limited freshwater sources, water is regarded one of the most significant and sensitive issues in dry and semi-arid climates (Nyong and Kanaroglou 1999, 2001; AlKhatib *et al*. 2003) [11, 12]. Increased pressure on water resources as a result of population growth accelerates the requirement for not only good water supply management but also proper water demand management (White and Fane 2002; Mathurasa 2005) [17, 9].

The demand for water in India is increasing in both urban and rural areas as a result of population growth and economic development. The average annual fresh water availability per capita has decreased from 5,177 m3 in 1951 to 1,820 m3 in 2001, and it is expected to decrease further to 1,341 m3 in 2025 and 1,140 m3 in 2050. (Kumar *et al*. 2005).

Increased pressure on water resources as a result of population growth accelerates the requirement for not only good water supply management but also proper water demand management (White and Fane 2002; Mathurasa 2005) [17, 9]. Reduced availability may exacerbate tensions and disputes over water resource sharing (Rao 1975; Shaban and Sharma 2007) [13, 14]. A large segment of the population in the weaker parts of society (both in rural and urban regions) wastes time collecting water for their daily requirements. As a result, knowledge about a population's water consumption pattern (village) is critical for estimating the best use of available water resources. Such investigations are critical in the development of a comprehensive water policy for rural areas that will meet the growing demands of the villagers. Furthermore, the current study's results and findings with respect to Kumbha village in Hisar district will be practical, valuable, and significant, and will serve as a model for rural sector water resource management in Haryana.

Materials and Methods

The current study was conducted at the micro-level in Haryana's semi-arid zone, in Kumbha village of Hisar district. The village is a part of Ghaggar-Yamuna alluvial plain. In Hansi tehsil of Hisar district, this village is situated between 29°7'51"N Latitude and 76°4'26"E longitude at international map. It covers an area of about 1932 hectares. The village is almost flat, with sandy and sandy loam soils of medium texture. Organic matter and nutrients are poor in soils. The village's main crops are wheat, cotton, and rice, while minor crops include bajra, jowar, mustard, and vegetables. These crops are grown using a combination of semi-automated and traditional labour. The Bhakra canal system provides agricultural feed to the village, and agricultural fields are generally irrigated by lined canals. The village's livestock includes buffaloes, cows, sheep, and goats. The majority of the village's households are belongs to small and medium-size farmers who engage in intensive farming. Agriculture and livestock are the pillars of the village economy.

Data collection on consumption pattern of Domestic Water

On a household level, knowing the details of real water use and its end use, such as drinking, washing utensils, toilet flushing, bathing, and clothes washing, is critical for water demand management. However, in most underdeveloped nations, including India, obtaining such information is extremely difficult. As a result, the majority of the data for this study derived from primary sources. Water scarcity is a visible occurrence in the semi-arid Kumbha village of Hisar district, and extensive research at the household level pertaining to domestic water consumption patterns at the micro-level as a specific case have yet to be done in the state and country. As a result, the entire research methodology used in this work is interdisciplinary and descriptive. The household survey included questions regarding daily and activity-specific consumption, water supply sources, quality, duration and frequency, distance among sources, and awareness of rainwater harvesting technologies in the village. Housewives were the target demographic.

Estimation of water consumption

The volume of the vessels used to keep household water was measured, as well as the number of vessels used for various tasks. When using running tap water, the quantity of water per minute that came out of the tap was measured as well as the duration for which the tap was used. The volume of water utilised through a running tap was calculated by multiplying the duration by the quantity of water per minute. The amount of water used in a toilet was calculated based on the volume of buckets used and the capacity of the flush tank. The evaluation of the quantity of data and water utilised in various activities was a tough undertaking, but every effort was taken to ensure that the data was accurate.

Classification of socio-economic categories

Based on the annual income of the households in Kumbha village, the self-collected data of households was categorised into four socio-economic classes. These four classes are Sec-A (<25000), Sec-B (25000-49999), Sec-C (50000-100000) and Sec-D (>100000). In general, a household assets score rather than annual income is recommended for dividing households into distinct socioeconomic categories. In addition, the major wage earner's education, occupation, and land holdings can be used to classify socio-economic classes. The selection of household annual income as the primary indicator for categorising various socioeconomic categories in the current study was justified on the grounds that it is simple to use and understanding. Under this indicator, however, there is a greater risk of respondent households under report and over report of data related to annual income.

The following statistics were employed in this study: frequency, percentage, means, and standard deviation were all of which were calculated using a Microsoft Excel spreadsheet. Chi-Squre test also employed to know about the association with economic status and domestic water consumption on the people of Kumbha village.

Results and discussion

Daily domestic consumption of water

It has been calculated that the residents of Kumbha village use 49150 of domestic water each day (Table 1). Sec-B households used the most domestic water in the village, followed by Sec-D households. More than 65 percent of the village's total household water use was accounted for by these two socioeconomic classes. The Sec-C and Sec-A group families used the minimum amount of domestic water, which was 7.9 and 27.46 percent of the village's overall usage.

Table 1: The number of households and their water consumption in Kumbha village by socioeconomic group.

Socio-economic Classes	No. Households	Total Consumption	Percent
Sec-A	28	13500	27.46
Sec-B	41	18250	37.13
Sec-C	10	3500	7.92
Sec-D	26	13900	27.49
Total	105	49150	100

Source: Calculated and Based on Primary Data Collected from Field, May, 2021.

Table 2 presents the daily water use in Kumbha village by household and by per capita. The data clearly shows that the village's per capita water availability is below the prescribed criteria of 150 l/day, which are the minimal amounts of water required by rural households and recommended by the World Health Organization (WHO) (Dieterich and Henderson 1963: Gleick 1996) [4, 5]. The WHO also divided the availability and access to water into four categories. (WHO 1997, 2003; Bartram 2003) [19]. These categories are: (1) no access (water availability below 5 LPCD), (2) basic access (average of 20–50 LPCD), (3) intermediate access (average of 50–100 LPCD), and (4) optimal access (average of 100–200 LPCD).

Table 2: Domestic water consumption per household and per capita per day in Kumbha Village by socioeconomic group.

Socio-economic Classes	Per Household (Litre) Mean	Std. deviation	Per Capita (Litre) Mean	Std. deviation
Sec-A	482	321.02	62.21	24.19
Sec-B	445	285.67	68.78	19.64
Sec-C	350	240.41	145.5	99.66
Sec-D	534	359.21	75.5	35.00

Source: Calculated and Based on Primary Data Collected from Field, May, 2021.

In the village, the average daily domestic water use per household is 468 liter, while the daily domestic water use per capita is around 105 liter.

Source of water for domestic and drinking uses

The majority of household in Kumbha village depend on the govt water supply for their domestic requirements. But in context to drinking water, majority of household depend on hand pump. Up to 81 per cent household from Sec-C category depend on hand pump followed by 80 per cent household from Sec-A category, 75 per cent from Sec-B category for their drinking water purposes. Majority of households form Sec-D category depend on paid supply, followed by Sec-B category for their drinking water needs.

Table 3: Water supply sources in households from various socioeconomic groups in Kumbha village.

Source of Drinking Water	Sec-A	Sec-B	Sec-C	Sec-D
Government Supply	20	5	4	6
Hand pump	80	75	81	60
Paid Supply	0	20	15	34

Source: Calculated and Based on Primary Data Collected from Field, May, 2021.

Table 3 shows that the residents of Kumbha village depend on Hand pump followed by Paid supply and very few residents use Government water supply for their drinking water needs because the quality of government supply was not fit for the health.

The field survey revealed that the water supply is subject to significant seasonal variations in the villages as well. During the summer, the village's water supply crisis gets even worse. Respondents were asked to list the activities they would be willing to give up in the face of water scarcity in order to get information about how people manage their water use during these periods. Few households in the village claimed that they would go to long lengths to obtain water in order to continue their water use habits rather than forego any of their household tasks. The majority of households said that they would be willing to give up household cleaning and limit water use for toilet flushing and clothes washing in order to deal with the summer time water shortage. Additionally, households use the village's water tanker facility on a paid basis to solve the issue of water supply during the summer. An additional investigation showed that affluent households utilized tanker services more frequently than poorer ones.

Perception of water quality

For rural communities in developing nations, no agreement has been reached on acceptable drinking water quality criteria. Due to the technical nature of the issue, many studies believe that creating water quality standards is the sole responsibility of specialists or planners. Sheat (1992) [16] has emphasised, however, that planners must take into account how water consumers perceive the quality of the water. He argues that, particularly when it comes to drinking water quality, perception may very well override reality. This perception among the locals is founded on their indigenous knowledge and needs to be treated seriously.

According to the field observation in Kumbha village, it is found that the quality of water is not fit for drinking as well as domestic use. Many residents claimed that the quality of water supplied to them is not of good quality, so the people of village cover long distance for their drinking purposes.

Quantity of water consumption for different domestic activities

The amount of domestic water that a household needs depends on a number of variables, including the environment, culture, eating habits, degree and kind of development, and physiology. In Kumbha village, washing clothing uses the most water per household, accounting for roughly 21 percent of total usage. This is followed by consumption for bathing (16.5 Per cent), domesticating livestock (13.6), housecleaning (14.3 per cent) and washing of utensils (11.9 per cent). A household uses less than 10 per cent of its total water usage for drinking and cooking, on average.

Table 4: Distribution of water consumption by activity (LPCD) across various socioeconomic groups in Kumbha village.

Activity	Sec-A	Sec-B	Sec-C	Sec-D	Daily Water Consumption
Bathing	15.6	17.2	14.62	16.1	16.5
Flushing	6.3	6.1	6.33	7.12	7.2
Washing of Clothes	22.12	20.2	19.5	20.32	21.1
Drinking	6.2	7.95	7.98	8.2	8.1
Cooking	4.98	5.99	6.93	7.92	6.2
Washing of utensils	14.12	11.35	12.43	11.24	11.9
Cleaning of house	8.52	9.68	10.45	10.22	14.3
Domestication of livestock	16.82	15.54	13.43	9.98	13.6
Any other Use	5.34	6.98	8.33	8.90	6.1

Source: Calculated and Based on Primary Data Collected from Field, May, 2021.

Significantly decreased household income levels less water will be consumed under different activities, and vice versa. Additionally, some of the water consumption rates for various activities were confirmed using on-site measurements and direct observations, and it was discovered that the amount of water reported by the households closely matched what was seen during the survey. Additionally, 1-2 times per day on average were recorded for bathing and using the toilets. Three meals are prepared each day. Further, Kumbha is a rural area where most of households wash their clothes by hand.

Duration of water supply

The quality of the water supplied to households is not the only issue; its availability is also critical. Water supply in households for 24 hours a day is unheard of in Indian villages. Because the supply is erratic and only available for a limited time, households store water in tanks and drums. In Kumbha village more than 70 per cent of households claimed that they get water for domestic uses in once in week and remaining households get water only for 2-3 days in a week. Status on duration of water supply in Kumbha village given in table 5.

Table 5: Household perceptions of the duration of water supply across various socioeconomic groups in Kumbha village.

Duration of Water supply	Sec-A	Sec-B	Sec-C	Sec-D
2 Days in a Week	21.42	17.07	30	46.15
Once in a week	78.58	82.93	70	53.85

Source: Calculated and Based on Primary Data Collected from Field, May, 2021.

Awareness about water conservation

Water conservation has the potential to play a significant role in addressing rural water supply challenges. However, awareness of rainwater harvesting is insufficient in Kumbha village, with only 40 per cent of households aware of the technology, while 38 per cent are unaware (Table 12). About 22 per cent of households did not respond to the question about their knowledge of water conservation practices.

Table 6: Household opinions toward water conservation in Kumbha village across socioeconomic groups.

Awareness of Water conservation	Sec-A	Sec-B	Sec-C	Sec-D
Yes	7.8	11.6	5.4	16.33
No	12.9	18.4	1.7	3.87
No Answer	5.96	9.4	2.4	4.56
Total	26.66	39.04	9.5	24.76

Source: Calculated and Based on Primary Data Collected from Field, May, 2021.

In all four socioeconomic classes in the village, approximately 16 percent of Sec-D households are aware of water conservation practices, followed by approximately 11 percent of Sec-B households, 7.8 per cent of Sec-A households, and 5 percent of Sec-C households. Because water conservation technology leads to adaptation, local and state governments must place special emphasis on spreading awareness about various methods of water conservation and management. Kumbha village is a semi-arid Indian village. Other villages of comparable size, physical evolution, and climatic environment in India's semi-arid region are likely to be symptomatic of the Kumbha village's domestic water consumption pattern characteristics. As a result, it is hoped that the findings of this study can be extrapolated and applied to other villages in India's semiarid region.

Association with Economic Status and Water Utilized by People of Kumbha village for Domestic Purposes

The area under study is categorized according to economic status that are Sec-A (<25000 rupees per annum), Sec-B (25000-49999 rupees per annum), Sec-C (50000-99999 rupees per annum) and Sec-D (>100000 rupees per annum). A study is conducted to test if there is any significant difference between different economic groups and quantity of water utilized for various domestic purposes.
For this the hypotheses is:

H_0: Economic status of people is independent of the quantity of water utilized for domestic purposes.

H_1: Economic status of people of Hisar district is dependent of the quantity of water utilized for domestic purposes.
The *Calculated value* of chi square is 1584.20 which greater than *tabulated value* is 128, hence H_0 is rejected at 5% level of significance. It is concluded that the economic status of people and water utilized by them for domestic use is significantly associated. It was noticed that people of high income group utilize more water than that of people with low income group.

Conclusion

Water-intensive economic activities and population growth are to blame for the world's declining per capita water availability. Increased consumption by the privileged class puts additional strain on this depleting natural resource. A systematic rise in rural water supply would check the high degree of migration from rural to urban areas in search for employment. Water consumption in Kumbha village is significantly lower than WHO standards. The erratic and limited duration of water supply in the village is a common phenomenon. This has forced the villagers to rely on

alternative water sources, such as private tube wells, hand pumps, and private vendors who deliver water via tankers. As a result, new water markets are emerging in the village, and private water vendors are in high demand during the summer season.

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