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Micro-Component Review of Domestic Water Consumption in Selected Households of Coimbatore City

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ABSTRACT

Water is considered as one of the important components for the existence of life on earth. Conflicts for water are being engaged, everywhere around the globe, even in the high rainfall recorded countries. There are arguments running about taking lead to own, manage, access, profit, control, and regulate the scarce resource - WATER. The increase in population and arising of houses culminated in the demand for water every day. In spite of the reality, NGOs, environmentalists, conservationists, ecologists solicit people for conservation, efficient usage thereby reducing the level of water via hi-tech innovation; rather there is an increase in the consumption of water. It is believed that a major portion of water can be saved when water-based household chores are being carried out following traditional methods comparatively using labor-saving devices. There is a vast disparity in the volume of water used by the homemaker themselves and by the paid worker. With this in mind, a micro-level study on the ***Micro-Component Review of Domestic Water Consumption in Selected Households of Coimbatore City*** has been initiated with the objective to study the water consumption following traditional method and by using modern hi-tech equipment as well as water utilized for household chores by the homemaker and by the paid worker. This study was decided to take place in Coimbatore city. Thirty samples of households were chosen for this experimental study by means of the convenience sampling method.

Keywords
Domestic water consumption, micro-component, traditional, hi-tech equipment, water conservation

Introduction

The meaning of water is Life. A simple and important question: Have we ever thought how much water do we have on earth? The answer to this question cannot be answered as simple. It requires thorough knowledge and the major factors that drive the availability of water. Out of the entire volume of water that is available on the planet, 96.5 per cent was predicted to be present as oceans and only a meager amount as freshwater (2.5 per cent). Nearly 70% of the

freshwater froze as soft ice sheets, glaciers, and icy mountains in areas of Antarctica, Greenland etc., while a little below 30% is piled up as underground water in the world's water sources. The entire water assets of India are anticipated at 1,897 sq km per annum. It was projected that by 2025 myriad parts of India will join nation or region to have unconditional water paucity. (https://www.jagranjosh.com/general-knowledge/water-resources-1448271235-1).
Even though our Earth is considered as ***'Blue Planet'*** because of the availability of water, it is well-known but less understood/ handled and taken for granted (Sharma, 2021).

The overall necessity of water for household usage around the globe is about 200km^3/year, which is equivalent to 0.5% of the mediocre entire runoff. With current water consumption trends, is it possible to meet the upcoming water demand with the available water on earth? Apparently, it is achievable to meet the present and forthcoming water needs in houses, since the disparity between the water demand and supply has been widening in many parts of the world because of the factors related to the time of water distribution, capacity, and affordability.

The four major uses for water: domestic (public water supplies), power generation, industrial and agricultural. With respect to the domestic sector, the extent of water usage should be analyzed and measured to reduce its consumption or wastage. Everyone should be conscious about spending the amount of water for various activities. Unless we all lay an eye on water usage patterns whether the household chores done by the homemaker themselves or taking up any paid helpers, we would face severe water deficiency for the next generations that to come. Water expenditure might escalate to a great point in the near future, due to urbanization and changes in lifestyles of people and water-use patterns (Otaki et al., 2013).

Making use of water in domestic sector is the most significant part of municipal/ corporation water use as in many countries the ministry of water activities has been the responsibility of the government. It is the lookout of the government to ensure immense water quality and dependability that direct to increased rate. The common public health is directly associated with domestic water use. The main objective and the target of various water and sanitation schemes and projects were directed towards revamping the health of the poor. For that reason, domestic water utilization is invariably the primary precedence in the public water distribution.

Thompson et al.,(2001) points out four essential categories of water usage in a family.

1. Water for consuming – cooking and drinking

2. Water for cleaning – clothes and utensil washing, bathing, toilet flushing and cleaning)

3. Water for facilities – car washing, gardening and other casual tasks

4. Water for productivity – pet care and maintenance, other construction works

Water demand patterns keeps on changing with the higher standards of living. That is indicated mostly in high water consumption in houses, especially for maintaining hygiene. Most of the houses have attached toilets with bedrooms, separate

bathroom fitted with shower fixtures and bathtubs for everyday use. Domestic water usage stands first in the total urban water consumption. For example, 30 per cent of entire water consumption of a house is used in flushing toilets and 30 per cent for personal cleaning in UK and Canada.

In order to realize the water consumption patterns and the consumer behaviour more deeply, it is necessary to understand the individual uses of water within the house (micro components) whether for personal cleanliness (e.g. water use in washbasins, WCs, shower and bath or communal use (e.g. water use in washing machines, dishwashers, garden, and car washing)

In Finland, bathing/ showering and laundry are listed as the activities that consume more water in households. But in Portugal, washing machines and dishwashers consume about 14% of total household water. Thompson et al.,(2001) specify that one of the cause leading to unusual water usage is the existence of water based appliances in piped households (e.g., flush toilet, baths, and showers) that has contributed to an extensive measure of water use. In the study, 64 per cent of piped households have flush toilets using an average of 19.2 liters of water per capita per day.

A study by Butler and Memon (2006), showed that water expenditure was reported to be highest in flushing toilets (27.6%), followed by washing clothes (21.7%), using showers (16.8%), faucet (13.7%), bathing (1.7%), washing dishes (1.4%) and further domestic uses (2.2%). In Netherlands, the highest consumption is for toilets (37%), followed by bathrooms (26%), kitchen use (16%) and clothes washing (16%), wherein Sweden, the major consumption is in bathrooms (32%) followed by kitchen use (23%), toilets (18%), and clothes washing (13%)

3	Hand wash	2	1.2
4	Show	63	38

Bheemkumar and Mathews (2015), suggests that water consumption varies based on various factors of the washing machine. The water used for washing varies from brand to brand of the washing machine with respect to its design and capacity. It was also predicted that front loading washing machines use less water and less energy. Most of the front loading washing machines are designed to use less water most compared to hand washing. According to Sturman et al. 2004, the indicative rates of water consumption by appliances are given below:

Table:1 Indicative water usage rates of old and water-efficient appliances

S. No	Appliance	Water consumed per use (L)	Water consumed per use with water-efficient appliances (L)
1	Toilet	(Old single flush) 11	(Dual flush 9/4.5L) 7
			(Dual flush 6/3L) 4.5
2	Urinal	12	3

	er		
5	Washing machine	120	78
6	Laundry	10	6
7	Kitchen Sink	9	5.5

Everywhere saying goes and understood that the maximum amount of water is being used when the water-based household chores are carried out by the paid workers.

Source: Water Auditing and Water Conservation, 2004

This study imparts description of domestic water consumption for various activities, factors driving change in consumption trends, water consumption differences adopting traditional (manual) method and using labor-saving devices and analyzes the volume of water used for household chores by the homemaker and the paid assistant. To achieve the aim of the study, the following objectives have been developed.

Objectives of the study:

1. To study the (micro-component) individual uses of water for various domestic activities at selected households
2. To identify the water consumption for selected activities following traditional (manual) method and using labor saving devices
3. To analyze the volume of water used for household chores by the homemaker and the paid assistant

Hypothesis of the study:

- There is no significant difference between the water consumption for selected activities following traditional (manual) method and using labor-saving devices.
- There is no significant difference between the quantity of water used for household chores by the homemaker and the paid assistant

1. Research Design

Coimbatore is likely to be one of the swiftly expanding metropolitan in South India and was characterised by scarcity in water supply, where people's needs were fulfilled by various alternative methods to access water. Focusing the areas of western part of the city where the water supply is limited with intermittent distribution of drinking water through the regions ranges from 8-10 days during non-summer and 15-20 days during the summer season. This experimental study was conducted among 30 houses from a ward. By the convenience sampling method, two lanes of houses were selected and the sample who has expressed their willingness to take part in the conduct of research was chosen. This study brings together data on the following:

- consumption of water by micro-component for various domestic activities,
- information on the use of water for selected activities following traditional (manual) method and using equipment to accomplish the task and

- facts on the difference in the actual quantity of water used by the homemaker and by the paid assistance for selected household chores of water usage in the selected area.

One of the primary aims of the study is to find out the domestic water usage, per capita per day water consumption. The controlling factors such as economic level of the family, daily usage pattern, climate, available water and appliance that use water make the difference in its consumption.

Otaki et al., (2013), points that one accurate approach to appraise the fundamental element is to split up the per capita water consumption to a micro-component level. Unless we know the consumption of water by micro-component values, we would not be able to be aware of water utilization in the toilet, kitchen, laundry, bath, and so on. With the gathered data it happen to possible to calculate the volume of used water.

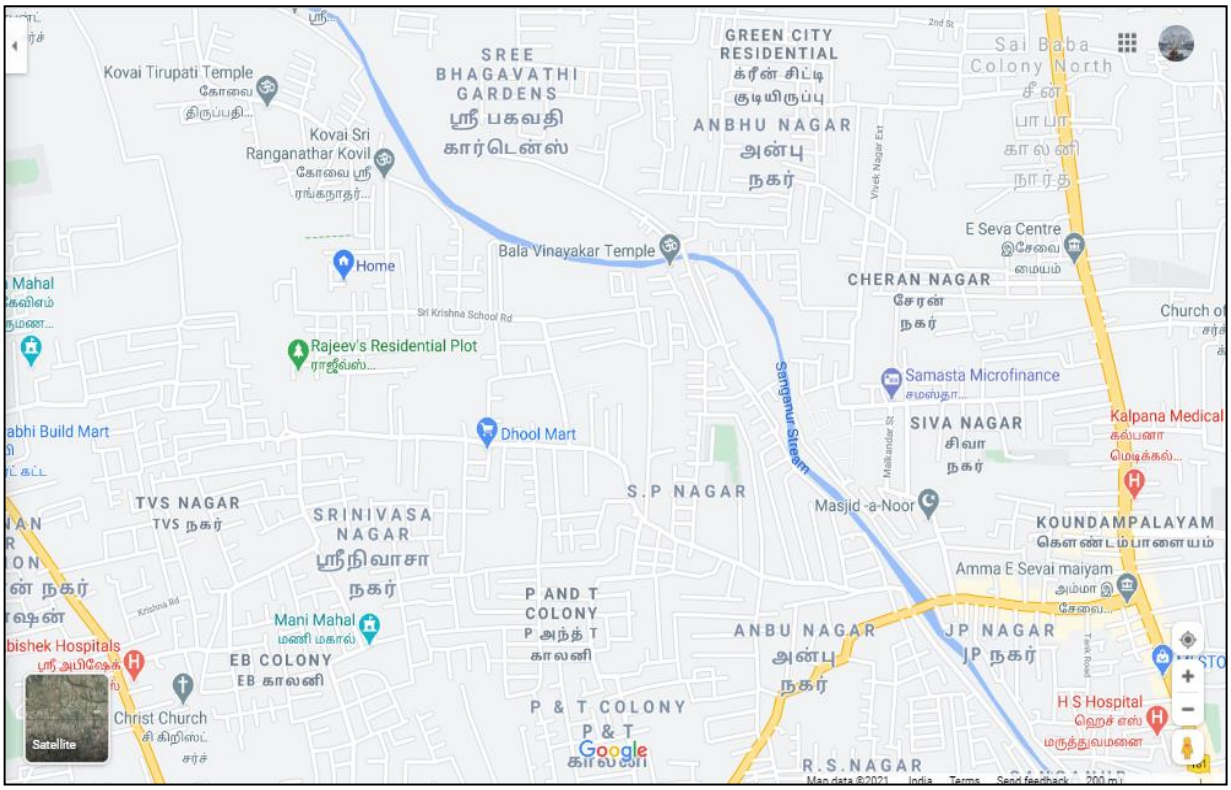
Devasenadhipathi et al., (2016), found out that the water supply in the city is often limited, and the Coimbatore City Municipal Corporation (CCMC) uses a combination of imported surface water, "sweet water", and local groundwater, "salt water", to meet the water needs of the city. Since the west zone of the selected city face acute water demand, need arise to find the study objectives of the area among the households.

A onetime experimental research has been formulated and conducted in the houses of thirty samples of households. Kothari (2004), states that experimental research is necessary to get at facts firsthand, at their source, and actively to go about doing certain things to stimulate the production of desired information. In such a research, the researcher must first

Source: (https://www.google.com/maps/place/Coimbatore+Corporation+West+Zone) provide himself with a working hypothesis or guess as to the probable results then works to get enough facts (data) to prove or disprove his hypothesis. Evidence gathered through experiments or empirical studies is today considered to be the most powerful support possible for a given hypothesis.

The samples were chosen for this experimental study by means of the convenience sampling method. The methods for measuring water consumption for selected activities are obtained through experiments. Each micro component was determined by gathering information on ownership of appliances, its age, frequency of use and, the volume of water used per use.

To estimate the flow rate of the used water, it was decided to install a water meter to the water outlet connected to the bathing outlet, toilet flush, hand wash, clothes washing outlet, sink outlet, common use outlet, with the consent of the homemaker. This system cannot be applied as a number of selected households expressed their unwillingness in the installation of those devices in their wastewater system. The manual method of measuring the wastewater was then adopted where the wastewater from the ***sink, hand wash, and washing machines or by manual washing*** was collected in large measurable containers. To measure the used water the required tools (i.e) a measuring cup (1 liter of water), measuring container (15 – 20 liters of water) were primarily used.



With the measuring tools, a quantity of 10 liters of water was measured and kept aside the before day of the experiment for the purpose of cooking and the households were instructed to use the water for their next day's cooking. The same procedure was followed for drinking purposes too. At the end of the day, water consumed for ***cooking and drinking*** was calculated by measuring the remaining water.

Figure 1: Measuring used water

Accessing the volume of water used for *flushing toilets*, three variant in the operation ie manual method – used for traditional type of toilets, single flush - the full capacity of the cistern water tank would be emptied, and the dual flush – where 30% and 70% of the full capacity of the cistern water tank would be discharged according to the selection of the flush where a considerable amount of water could be conserved.

For ***manual way*** of flushing toilets, a preoccupied measurable water container with water was kept in the toilets for the usage of the household members and the used water was computed with the remaining water left at the end of the day, an additional volume of water was also added and noted for its consumption.

In ***single flush operation,*** the full capacity of the cistern water tank was accessed by the content of water it holds. ***Dual flush system*** was measured as, once the cistern water tank is full, the water inlet to the tank was shut off, and after the partial flush the remaining water was measured to estimate the flushed volume of water. Water consumed for toilet flushing was estimated by the number of flushes done per day either full flush, 30%, and 70% flush.

In evaluating the water used for ***bathing, pet care, and gardening and for other purposes*** like washing their portico, front yard, moping the house, the households were asked to fill water in the measurable containers before usage and the further usage was also recorded. In houses those use overhead shower for bathing, the used water was accessed with the duration of bath taken and the flow of water per minute.

Normally water was made to flow through a hose to clean the household's vehicles such as cars, motorcycles, and bicycles. The time taken to wash the vehicles was noted with the aid of stopwatch and the flow of water from the hose where the discharge was calculated at the rate of liter per minute.

2. Result and Interpretation

The results of descriptive analysis (Table 2) show that of the total water usage, 66.69% (483.57 ± 236.83L) was used for activities like washing of clothes, bathing, and flushing of the toilet. About 19.33% (151.98±98.27L) of the water was used for cooking and washing utensils. A mere 2.90% (19.82±8.96L) of the water was used for other basic activities like drinking and brushing. The rest of the water (10.94%) was spent for external household activities like gardening, vehicle washing, and other purposes.

The findings show that the highest quantity of water was consumed in bathrooms and toilets. It was evident that higher consumption of water for bathing indicates that the households used overhead showers in a majority of the houses. Leakages in pipelines or in showers can result in wastage of water. Hence, people using overhead showers must adopt a cautious attitude. The pipelines must be inspected regularly for leakage to avoid water wastage. Similarly, toilets consume a high quantity of water. Leakages in flush tanks often contribute to the wastage of a large quantity of water. Therefore, water-efficient devices and fittings, are recommended.

Malfunctioning of water level controllers and manual clothes washing result in high consumption of water. The study shows that a

considerable quantity of water was used for cleansing the clothes manually and it is necessary to buy water-efficient washing machines. Based on the results, it is suggested that people must be made aware of using water-efficient appliances. The public must be educated about water conservation methods, such as shortening the shower time, reducing the amount of water spent on gardening and car washing, and making provisions for rainwater harvesting.

Table 2. *Descriptive analysis of water usage*

Activities	Minimum	Maximum	Mean	Std. Deviation
Cook (L)	6.00	36.00	17.70	9.19
Drink (L)	4.00	30.00	14.36	6.79
Bath (L)	58.00	355.40	153.48	69.14
Brush (L)	2.00	9.50	5.46	2.17
Flush (L)	47.50	316.00	161.83	76.87
Wash Clothes (L)	33.00	380.00	168.26	90.82
Wash Utensils (L)	16.50	286.00	134.28	89.08
Garden (L)	0.00	200.00	38.36	54.88
Wash Vehicles (L)	0	50.00	8.90	14.25
Pets (L)	0.00	6.00	1.08	2.01
Others (L)	1.00	90.00	29.99	20.00
Cook (%)	1.11	4.60	2.41	0.91
Drink (%)	0.69	4.55	2.12	1.10
Bath (%)	11.55	31.55	21.10	5.55
Brush (%)	0.34	1.49	0.78	0.27
Flush (%)	7.82	35.35	22.43	6.89
Wash Clothes (%)	5.48	41.27	23.16	8.79
Wash Utensils (%)	3.28	33.65	16.92	8.00
Garden (%)	0.00	39.82	5.48	8.15
Wash Vehicles (%)	0.00	6.33	1.24	1.92
Pets (%)	0.00	1.06	0.15	0.30
Others (%)	0.20	13.02	4.22	2.74
Water spent	65.92	378.00	191.07	55.23

Activities	Minimum	Maximum	Mean	Std. Deviation
Total	329.60	1329.20	733.71	282.06
Water per head	***65.92***	***378.00***	***191.07***	***55.23***

The findings of ANOVA (Table 3) illustrate that there exists a significant difference between the consumption of water using traditional methods and labor-saving devices ($p<0.05$). The result demonstrates that traditional hand washing consumed more water (M= 204.8±88.98 L) when compared to semi-automatic (M=195.077±74.43L) and fully automatic (M=66.271±31.57L) devices and the difference is significant ($F=8.972$, $p<0.05$). This indicates the need for efficient and fully automatic washing machines to reduce water wastage during cloth washing. It was observed that conventional flushing significantly reduced water consumption in toilets when compared to water consumed in western flush systems ($F=-3.301$, $p<0.05$). Significant difference was also observed in the consumption of water using manual cleaning, using single flush for cleaning, and using dual flush for cleaning ($F=3.59$,$p<0.05$). It was found that the consumption of water was the least in the manual method and the most in the dual flush method. This result reaffirms the higher consumption of water in western flush systems as the need arises to flush twice or thrice to flush out the solid waste.

Based on these results, it can be inferred that manual flushing consumed lesser quantity of water per head when compared to single flush and dual flush ($p<0.05$), and fully automatic washing machines consumed lesser quantity of water when compared to manual and semi-automatic machines (Table 3). Based on these findings, ***Hypothesis 1: There is no significant difference between the water consumption for selected activities using traditional (manual) method and labor-saving devices,*** **is rejected.**

Table 3. *Difference in water consumption between traditional method and using labor-saving devices for performing selected activities*

Activities		**N**	**Mean±Std**	**F**	**p**
Washing machine (L)	Hand	10	204.8±88.98	8.972	0.001
	Semi-automatic	13	195.077±74.43		
	Fully automatic	7	66.271±31.57		
Washing machine (%)	Hand	10	25.602±5.09	25.567	0.000
	Semi-automatic	13	28.025±5.58		
	Fully automatic	7	10.636±5.27		
Flush (L)	Traditional	8	104.563±49.22	-3.301	0.004
	Western	22	182.648±75.16		

Activities		**N**	**Mean±Std**	**F**	**p**
Flush (%)	Traditional	8	14.907±5.4	-4.657	0.001
	Western	22	25.16±5.14		
Type of Flush (L)	Manual	8	104.563±49.22	3.579	0.042
	Single flush	16	181.109±75.56		
	Dual flush	6	186.75±81.05		
Type of Flush (%)	Manual	8	14.907±5.4	14.355	0.000
	Single flush	16	23.903±4.95		
	Dual flush	6	28.51±4.36		

Table 4. *Difference in water consumption per head between traditional and labor-saving devices*

		N	**Mean±Std**	**t/F**	**p**
Toilet	Traditional	8	176.885±31.61	-1.123	0.272
	Western	22	196.227±61.44		
Flush	Manual	8	176.885±31.61	4.286	0.024
	Single flush	16	214.281±57.13		
	Dual flush	6	148.084±47.31		
Washing machine	Hand	10	223.954±59.74	4.732	0.017
	Semi-automatic	13	188.099±40.23		
	Fully automatic	7	149.608±48.23		

The findings of the t-test (Table 5) demonstrate that there was no significant difference between the homemakers and paid servants regarding the water consumed for washing clothes and utensils (P>0.05); thereby, suggesting that water consumption for household chores did not vary between homemakers and paid assistants. Hence, ***Hypothesis 2: There is no significant difference between the quantity of water used for household chores by the homemaker and paid assistant*** **is accepted**

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Table 5. *Difference of usage of water between paid assistant and homemaker*

	Paid assistant	Homemaker	t	p

	(n=16)	(n=13)		
Washing clothes	204.613±100.65	170.146±105.2	0.895	0.379
Washing utensils	199.625±65.56	153.915±81.55	1.637	0.115

3. Conclusion

Water demand in India is predicted to escalate at a rocket speed and is expecting to surpass the availability of water. Hence it is imperative to manage the available precious resource in order to make this resource available for our future generation. Good management starts at home. The domestic sector of water used at the household level should be managed in an efficient manner so that the existing and the upcoming generations would be free from the term water scarcity. An increased rate of water usage has been noticed because of people's lackadaisical water use behavior, higher living standards of the people, water leakage, hesitate to upgrade the old appliances. To manage the water use in a house it is necessary to understand the water consumption by micro-components (i.e) for individual activities which concentrate on water. The difference between the volume of water when used by the homemaker and by a paid staff should be noticed. The amount of water that was used undertaking traditional practice or with the help of any equipment involved should be assessed. Among the selected samples, 66.69% of water was used for activities like washing of clothes, bathing, and flushing of the toilet. About 19.33% of the water was used for cooking and washing utensils. A mere 2.90%of the water was used for other basic activities like drinking and brushing. The rest of the water (10.94%) was spent on external household activities like gardening, vehicle washing, and other purposes. Using overhead showers results in a higher wastage of water, using showers can be limited or restrict the use of overhead shower. Attempt can be made to recycle the water used for other purposes like toilet flushing, gardening etc.

It was clear that using traditional practices of washing clothes consume more water. And it is necessary to shift to the operating of latest technologies meant for clothes washing for efficient water management. In this study it shows that even though the latest innovation of dual flush water cistern saves water, but it requires operating multiple times to clean. It shows higher consumption of water in this dual flushing system. People should be conscious on the water wastage areas and various water conservation ideas. People's attitude towards water conservation cannot be changed in a day by felicitating only awareness and lectures unless installation of efficient water conservation tools to the fixtures must be encouraged. In a long run it was believed that this would substantially control the wastage of water. Final note to say: Our next destination for a sustainable, cost-efficient, and quality water management system can be made possible by smart water systems run by ***Artificial Intelligence*****.** Further research is required in this thrust area for a well designed and structured water schemes.

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