M.TECH (CIVIL ENGINEERING)

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STUDY OF REDUCING WASTAGE OF WATER IN HOUSEHOLDS USING FOOT TAP

A DISSERTATION

SUBMIIED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

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CANDIDATE DECLARATION

I **DharmenderTiwari**, Roll no**2k16/HFE/08**, student of M.Tech (civil engineering), hereby declare that the project Dissertation titled "Study of Reducing wastage of water in households using Foot tap", which is submitted by me to the Department of Civil Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of master of technology is original and not copied from any source without proper citation. This work has not been previously formed the basis for the award of any degree, diploma associate-ship, fellowship or other similar title or recognition.

Place: Delhi DHARMENDER TIWARI

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CERTIFICATE

I hereby certify that the project Dissertation titled "Study of Reducing wastage of water in households using Foot tap", which is submitted by **DharmenderTiwari**, Roll no**2k16/HFE/08**, student of M.Tech (civil engineering), Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of master of technology is a record of the project of work carried out by the students under my supervision. To the best of my knowledge this work has been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place: Delhi

Date:

DR, MUNENDRA KUMAR

ASSOCIATE PROFESSOR

ABSTRACT

To develop regulating strategies for reduction in consumption of domestic water, more proactive approach is to determine behavior of domestic consumers of water. During analysis, we found that water usage in domestic households consists of water closet, kitchen, bathing, wash-basins and many other minor or major occasional usages. From experimental study we found that water is wasted during cleaning of utensils in sink, washing of hands, trimming of beard, brushing in wash-basin because of continuous running of tap water during all these actions. This wastage happens due to the fact that we perform all these actions by our hands and also operate the tap with our hands. So, if we operate these taps without using our hands we can create breaks in continuous flow of water and water can be used efficiently. By keeping all these requirements in mind, we made an apparatus to operate tap by feet instead of hand and the amount of water save is computed. Results shows that for urban households of Delhi, water can be saved up to 34.78% and sometimes even more than this.

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CHAPTER-1

INTRODUCTION

Water is a naturally formed chemical compound that occurs in liquid, solid and gaseous forms. All these forms are somehow important to fulfil our demands and some are important for proper channelization of water with in the environment. No life can exist without water. It has been estimated that two third of human body is constituted of water. Water is not only essential for human beings but it is essential for almost all biotic species but requirements may vary.

Among all the problems faced by modern societies all over the globe, water conservation has been a question for decades. Water level depletion has been a major debatable topic for countries and will be the biggest matter of concern even in the future. Although majority of our bodies and the planet is made up of water, this water is not always safe for consumption and is even more difficult to filter. Latest studies suggest that the distribution of our hydrosphere is as follows:

Oceans – 97.2%

Ice sheets and Glaciers – 2.15%

Groundwater – 0.63%

Lakes and streams – 0.018%

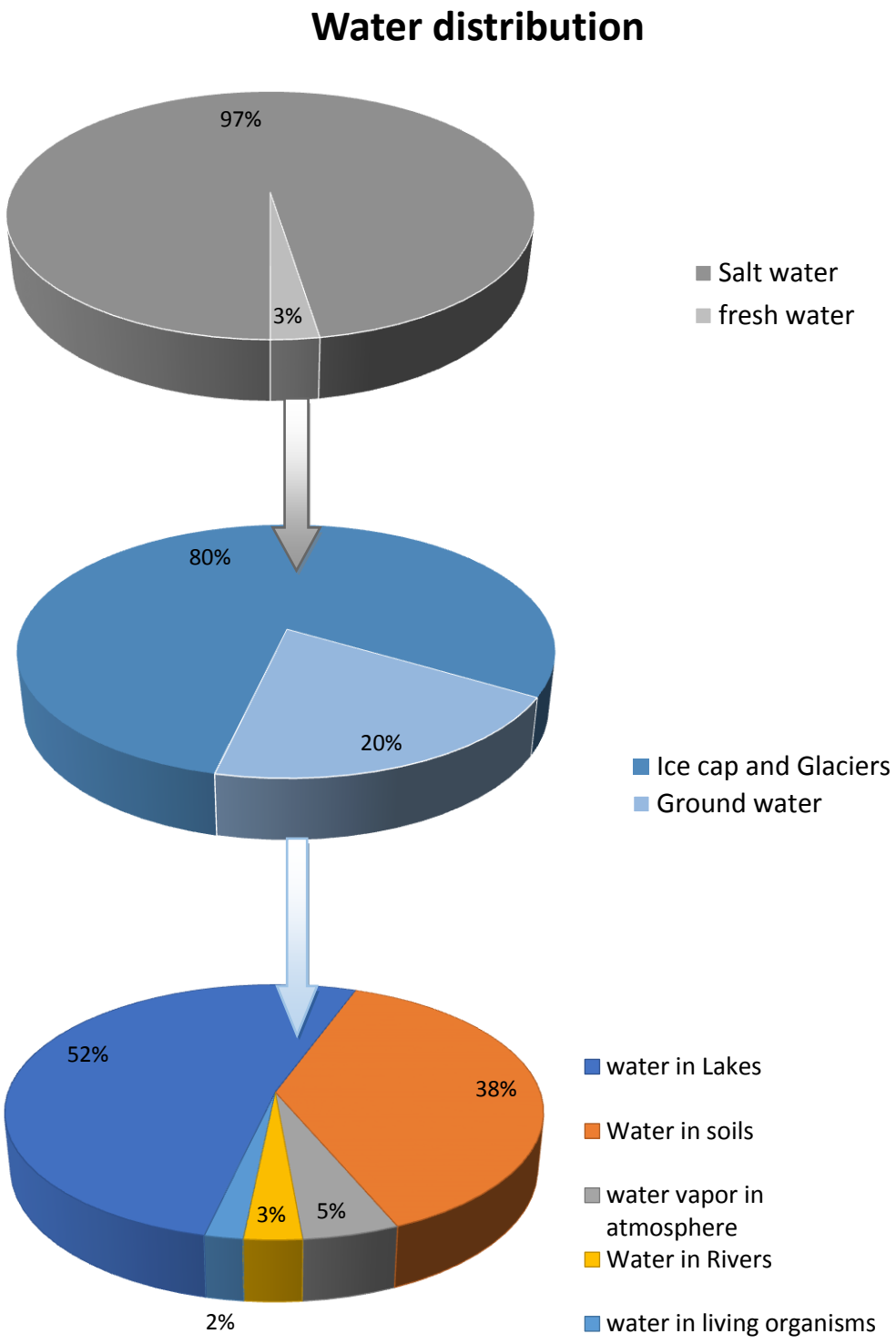
Soil water – 0.005%

Atmosphere (Moisture) – 0.001%

We are well aware of the fact that the only water mainly used to meet our daily needs comes from the Groundwater which is at a fairly low level as a whole.

The population of the world last recorded by the United Nations in the year 2011 came out at a whopping figure of **7** Billion**.** According to provisional reports released in March, 2011, the population of India was 1.21 billion with the latest reports, the

population of the world has touched a mark of 7.5 billion people, showing a phenomenal growth at an average of 7.14% per year. Whereas the population of India has crossed the mark of 1.31 billion people raising it at a rate of 8.4% in 6 years on an average.



Giving a look at these figures, and imagining the dependence of billions of people on the common groundwater source, does raise some serious questions and concerns in our minds.

In order to ensure the availability of sufficient amount of water, it becomes imperative in Morden society, to plan and built suitable water distribution techniques. A little bit advancement for planning, designing and executing any water supplying technique for efficient use of water requires a huge amount of money.

In the developing countries like India there is a problem of availability of fund, as Indian govt is spending 1-3% of total plan outlay on "water supply and sanitation sector". As a result of this India is able to cope up 80% of its urban population (which is one third of total population) with safe water supply although these are limited. Scenario of rural part still remains grim and many of our villagers are fetching water from distant places, where there is no provisions of testing and purification of water. Only 1% of total water is potable. This data means that there is an upper cap on water availability. We are required to not exploit this upper cap by wasting water during our daily routines. The various sources of water available on earth are: surface sources such as Ponds and lakes; Streams and rivers; Storage reservoirs; and oceans etc., sub-surface or underground surfaces like springs, infiltration Galleries, wells etc.

Most of earth's water sources get their water supplies from precipitation, which may fall in various forms, such as snow, hail, rain etc. This water is needed to be conserved using some mechanism so that this can be used for various daily routine tasks. This would cause in less usage of potable water which in turn lead to abundant water availability.

In rural areas irrigation requires a lot of water supply but for this purpose farmers use ground water which is not potable. So, the real issue with potable water is not very big in rural areas as there ground water is enough for various daily routines. In urban areas, we use potable water for daily routines, which causes wastage of potable water. This in turn causes water scarcity. Also, in rural areas the extraction of ground water is almost same to the recharging of it while in urban area extraction exceeds recharging due to cemented roads.

A general household uses around 150l water per head per day for daily usage like flush, bathing, drinking, washing of clothes etc. Water scarcity doesn't allow people to use such amount of water for usage. This is due to the fact that we are wasting a lot of water on these daily activities. This wastage, if stopped, may help us to conserve water for using the next day and so on. This in turn will result water saving encouragement.

Some of the other methods of controlling water wastage and loss are:

- Water tight joints- These ensure low wastage due to leaking of water because of bad plumbing.
- Pressure in the distributed systems- High pressure leads to high wastage, so the pressure should be optimum.
- Metering- When the water supplying authority uses metering system, the loss of water is reduced to a considerable amount.

Rapid population growth, urbanization, water pollution and climate change increases water scarcity not only in India but also in whole world.From statistical data, it is observed that one fifth of world population lives in areas with water scarcity which means that water is not sufficient to meet the basic demands and one third of world population doesn't have clean drinking water. So, it is our key requirement to make policies, different strategies and activities to sustain-ably use natural resources of water, to fulfil the current and future demands.

In this paper, we conducted an activity by using an experimental setup (Tap operated by using feet). Firstly, we determined the activities where water is wasted within the domestic households. The result obtained showed that water is wasted during cleaning of utensils in sink, washing of hands, trimming of beard, brushing in wash-basin because of continuous running of tap water during all these actions.

So,an alternative approach is thought and analyzed by conducting experiments. This is done by making set up which controls all taps by using foot instead of hand. This allows doing the work with hand while operating the tap by foot. So, if we operate these taps without using our hands we can create breaks in continuous flow of water and water can be used efficiently.

1.1 OBJECTIVES OF PRESENT STUDY

This study focuses on an efficient, effective and cost effective method to reduce water wastage due to daily routine tasks such as bathing, brushing, using flushing, cleaning utensils etc. we have used data gathered from various sources such as surveys, brain storming seasons, interviews, social media etc.

Some of the objectives of our study are: -

1. To conduct surveys to gather data about usages of water in households for daily routine tasks and then using this data to create a chart depicting this data in graphical form.
2. To analyze this data to collect information about amount of water wasted due to these daily tasks and then using this analysis to draw a comparison between various water conserving methods and our method.
3. To provide an alternate but cost effective apparatus to the households so that they can contribute in water saving initiatives.
4. To encourage people through social media, awareness campaigns, advertisements etc.
5. To devise a long-term plan for comparing water supplied to the households before using this apparatus on a large scale and after using it. This comparison will give an estimate about how much water has been conserved by using this apparatus.
6. To encourage some non-profitable organization to take the responsibility of manufacturing, distributing, and maintaining this apparatus because this kind of initiatives requires capital, manpower, time and a strong will.

CHAPTER-2

LITERATURE REVIEW

Wagh Arjun in his paper titled “Modern Methods of Water Conservation in India”, suggested methods for conserving water in India. He has given many processes for water conservation including: protection of water from pollution, redistribution of water (using canal), rational use of groundwater (proper management of crops within the regions), population control, renovation of traditional water sources, use of modern irrigation techniques, increasing density of cover, crop rotation techniques, management of flood (out of total 32.8 crore hectare 4 crore hectare land is flood effected), limited use of water within the industries, reuse of urban waste water.

In this paper the focus is on implementing some water conservation mechanism so that the growth of current water supply system and technologies involved in waste water treatment can be curtailed. The author has proposed two modes of water conservation. One is short tern which is termed as emergency conservation and the other is long term which requires proper planning. These modes are depended on mood of water conserving personnel. Following types of economic benefits are estimated:

Reduction in operating cost through reduction of load on pumps and reduction in amount of chemical used and Reducing the additional load of water supplying system caused by regular increase in demand. Schedule of water conservation is analyzed in different situations such as without capacity constraints, during instantaneous shortage of water supply, with anticipation of capacity shortage in near future.

Ramakrishnaiah C.R. in his paper titled “Urban water management”, showed that better policies, reallocation, automatic and semiautomatic valves, reuse of rinsing water, and low grade water, can save water efficiently. He discussed about the condition of Bangalore city which is situated at high elevation and is far away from perennial source of water. So to meet the demand of water supply a high head pump is required along with several hundred kilometer long pipelines because water is fetched from Krishna rao sagar dam, because of this huge effort to supply water, a heavy tax is levied on water supply. Despite of these efforts consumers are wasting approximately 800 mld out of 1000mld supplied water. Only 25% of this wasted water is captured by waste water treatment plants. The remaining wasted water is allowed to mix into streams. Therefore it is strongly recommended to stop water wastage and start conserving water supplied as well as received through rain. The author of this paper has proposed certain mechanism to achieves water conservation such as public awareness, developing water conservation systems, reforms in water charge policies and proposing adaptive water allocation techniques. For this purpose he did case study of countries including Indonesia, Melbourne (Australia), and Israel.

Gary A. Gagnon (1984) in his article“The role of water audits in water conservation”, shows that water can be conserved by controlling leakage form water distribution system by executing proper water audits. Water audits can be accomplished in three phases including meter testing, leakage detection, and quantification, and system inventory. This results in saving of water to a factor of approximately 12% to 70%

Shan Yixing et al.. (2015), in their article “Household water consumption: insight from a survey in Greece and Poland”, surveyed major elements to know the behavior of domestic water consumers. These elements include: end user behaviors, socio-demographic and property characteristics, psychosocial conditions i.e., attitudes and beliefs.

Randolph Bill and Troy Patrick (2008) in their paper “Aattitude to conservation and water consumption”, conducted a survey to know the attitude of households in various types of housing using telephonic interview and making

focus groups form the same areas. In this paper, shaping in demand of water was analyzed in relation to socio-demographic composition in different households in different dwelling conditions, cultural, behavioral and institutional aspects. In this paper controlled experiments were conducted within a particular area including following strategies: installment of weather sensitive irrigating controlling switches with in households, and technological strategies to improve soil moisture retention(zeolite and nutrients retaining additive). Data was collected during the installation of device and also after simulation period ended.

Jan Lundqvist in his paper titled " Saving water: from field to fork" report and the Side Event at CSD 16, May 5–16, 2008, "Water – More Nutrition per Drop" (2004*) and "Let it Reign: The New Water Paradigm for Global Food Security" (2005**). The topics addressed in the previous reports, and also in this report, are the links between water, food and development, which are high on the agenda for Swedish international development collaboration. This report highlights the magnitude of losses and wastage in the food chain, i.e. from field to fork. It is shown that a reduction of losses and wastage would save water and facilitate the achievement of multiple development objectives.

Maher F.Abu- Taleb and Maher M .Murad in his paper titled", Use of focus groups and surveys to evaluate water conservation campaign", a campaign was launched to encourage people develop interest in water conservation almost 45000 individuals took part in this campaign they were made aware about the need of water its efficient usage.

The campaign included data gathering through questionnaire, one to one interview, brain storming and written surveys. The question that were asked were simple, straight forward, knowledge productive and in reproducible manner. Question included current water situations, attitudes towards water conservation, ideas to conserve water and questions in chronological order of activities that use water.

By reading all listed papers, we concluded that along with these traditional water conservation techniques we should develop something that can be really helpful same as automatic and semiautomatic valves as mentioned by "C.R. Ramakrishnaiah" in his paper. So, we made a temporary apparatus for experimental

purpose to know how much water can be saved by using foot tap in place of traditional tap in households.

CHAPTER-3

3.1 METHODOLOGY AND APPARATUS USED

- Four inches broad wooden plank,
- Gate valve,
- Nails of different varieties according to requirement,
- Modded iron strip (modded similar to gear of bike andused in place of valve operating handle),
- ½ inches elbow 90^0,
- 2 inches and 6 inches nipples,
- male adaptor brass threaded,
- 2 feet PVC pipe,
- brass elbow, tap, spring, two clamps,
- threefeet plastic pipe, one adhesive tube.

3.2 EXPERIMENTAL SET UP

1. Cut 4 inches broad plank in 12 inches, 7 inches and 8 inches long pieces.
2. Attach 12 inches and 7 inches planks perpendicularly with 8 inches plank with the help of 4 small nails: two on each plank (Figure 1). This serves as foundation for our apparatus.

Figure 1. Arrangement of planks for test appratus

3. With the help of iron strip make assembly analogous to gear of bike which serves the purpose of handle of gate valve operated with the help of feet(Figure 2)
4. Remaining assembly is divided in two parts, bottom part (below gate valve) and top part (above gate valve).
5. Top part: - This part is formed by assembling “male adaptor brass threaded” followed by 2 feet PVC pipe which is further followed by brass elbow and then tap is installed.
6. Bottom part: - This part consists of two inches nipple attached to elbow followed by six inches nipple and then plastic pipe is attached to it(Figure 3).

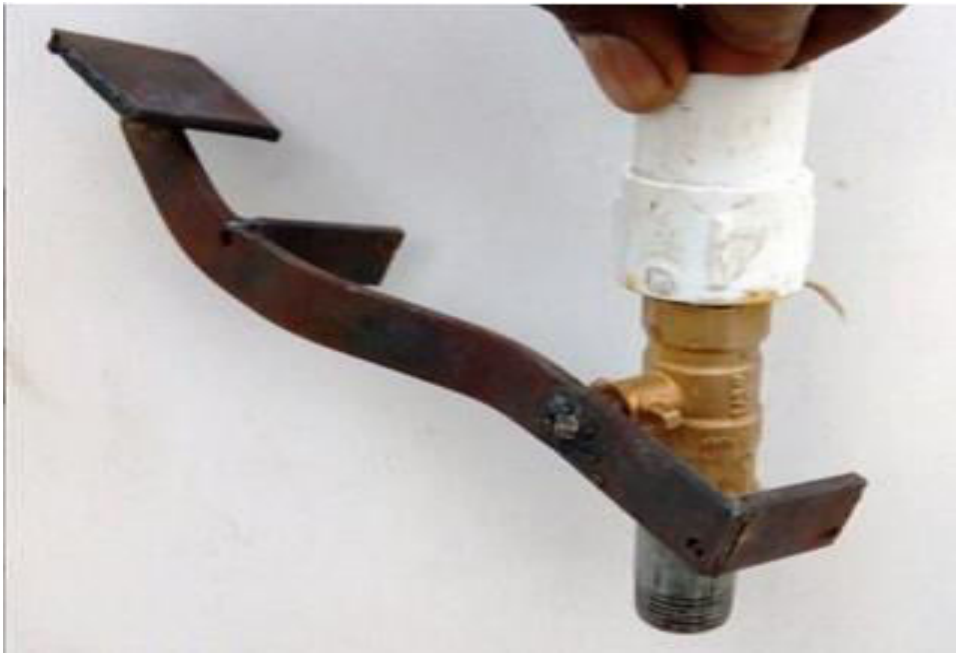


Figure 2. Arrangement of foot operating lever

Figure 3. Lower half portion test apparatus

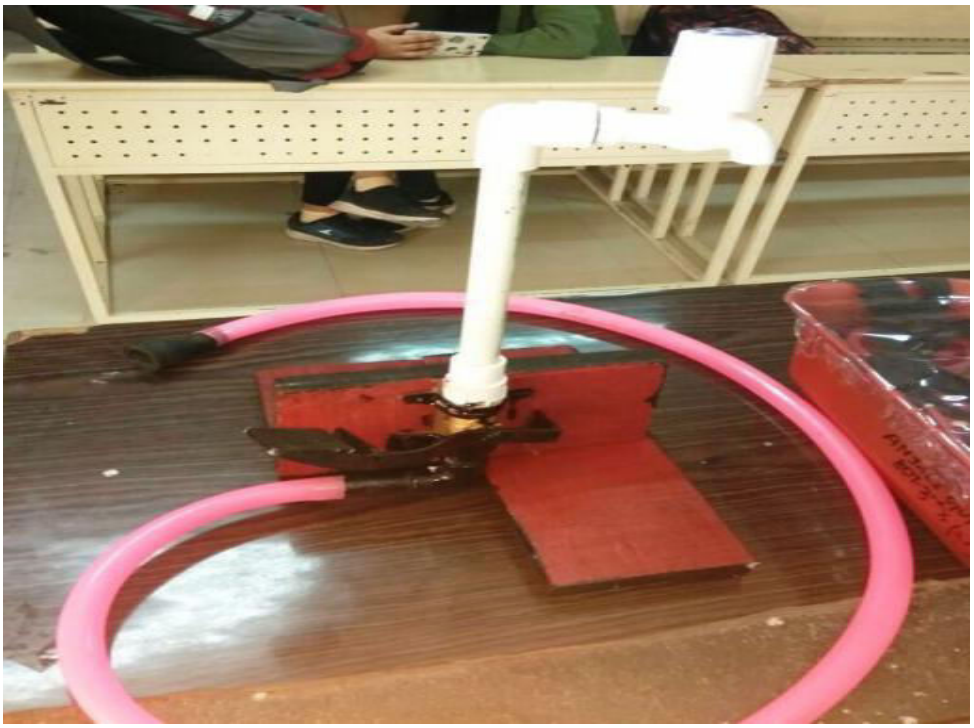


Figure 4. Complete test apparatus

7. Both the parts are assembled at top and bottom of gate valve. Then, whole product is attached with wooden planks with the help of clamps and nails. Spring is attached by using nail and hole in the modded iron strip handle (Figure 4).
8. Now this assembly is used in kitchen sink, washbasins to know the water used by this apparatus.

CHAPTER-4

PROCEDURE AND OBSERVATIONS

Now use this apparatus on different area where water curtailment can be done, as wash basins, kitchen sink etc. Data is collected by both current and feet tap system, then, save in water is estimated by comparative study between data of both systems. The wash-basins, kitchen sink are mainly found in urban part of Delhi. So, we used data only for urban part of Delhi for experimental purpose.

4.1 DATA COLLECTION FOR CONVENTIONAL TAP SYSTEM

The data is collected once by using current conventional tap system fitted in the kitchen and washbasins as:

1. Record the time period for running water from tap during activities like washing of hands, beard trimming, cleaning mouth in washbasins and washing of utensils in kitchen sink.
2. Along with time period the running tap water, we should collect the running water in measuring jar to note down the volume of water used for different activities.

This whole data collected is represented within the table. Then, graphs are plotted which demonstrate the save in water using foot tap instead of conventional tap system.

Estimated number of households in Delhi	= 36.26 Lakh
Urban household	=34.6 Lakh
Average household sizes in Urban	= 4.51

Table.1 Data for conventional tap system in morning

Activities	**Average time taken(sec)**	**Water used (L) per day**
Rinsing mouth and cleaning tongue(while Brushing)	60	2.2
Washing Hands	30	1.2
Shaving	80	0.915
Washing Utensils in sink	80	3.4

Water used:

Amount of water used by Delhi (Urban) households on daily basis
= Number of urban households x size of households x volume of water used for particular activities of a particular day.

1. Rinsing mouth and cleaning tongue(while Brushing)
   $=34.6 \times 10^5 \times 4.51 \times 2.2 = 34.33$ ML
2. Washing Hands
   $=34.6 \times 10^5 \times 4.51 \times 1.2 = 18.7$ ML
3. Shaving (considering one member per family)
   $=34.6 \times 10^5 \times 6.4/7 = 3.16$ ML
4. Washing Utensils in sink
   $=34.6 \times 10^5 \times 6.4 = 11.75$ ML

Total usage of water in Delhi households per day = 67.94 ML

If, we require comparing the different practices used for water conservation with this foot tap system. The comparison should be done on annual basis. So, amount of water used annually by conventional tap system
= 67.94 x365 = 24,798 ML

Table.2 Data for conventional tap system in evening

Activities	**Average time taken(sec)**	**Water used (L) per day**
Rinsing mouth and cleaning tongue(while Brushing)	60	2.2
Washing Hands	30	1.5
Washing Utensils in sink	80	3.6

Water used:

Amount of water used by Delhi (Urban) households on daily basis
= Number of urban households x size of households x volume of water used for particular activities of a particular day.

1. Rinsing mouth and cleaning tongue(while Brushing)
   $=34.6 \times 10^5 \times 4.51 \times 4.4 = 34.33$ ML
2. Washing Hands
   $=34.6 \times 10^5 \times 4.51 \times 1.2 = 18.7$ ML
3. Washing Utensils in sink
   $=34.6 \times 10^5 \times 3.6 = 12.44$ ML

Total usage of water in Delhi households per day = 64.47 ML

If, we require comparing the different practices used for water conservation with this foot tap system. The comparison should be done on annual basis. So, amount of water used annually by conventional tap system
= 64.47 x365 = 23,531.55 ML

Total amount of water used annually by conventional tap system
24,798 + 23,531.55 = 48,329 ML

4.2 DATA COLLECTION FOR FOOT TAP SYSTEM

The data is collected by installing foot tap system fitted in the kitchen and washbasins as:

1. Record the time period for running water from tap during activities like washing of hands, beard trimming, cleaning mouth in washbasins and washing of utensils in kitchen sink.
2. Along with time period the running tap water, we should collect the running water in measuring jar to note down the volume of water used for different activities.

This whole data collected is represented within the table. Then, graphs are plotted which demonstrate the save in water using foot tap instead of conventional tap system.

Table.3 Data for Foot Tap System in morning

Activities	**Average time taken(sec)**	**Water used (L) per day**
Rinsing mouth and cleaning tongue(while Brushing)	40	1.5
Washing Hands	18	0.8
Shaving	40	0.428
Washing Utensils in sink	50	2.2

Water used:

Amount of water used by Delhi (Urban) households on daily basis
= Number of urban households x size of households x volume of water used for particular activities of a particular day.

1. Rinsing mouth and cleaning tongue(while Brushing)
   $=34.6 \times 10^5 \times 4.51 \times 3 = 23.4$ ML
2. Washing Hands
   $=34.6 \times 10^5 \times 4.51 \times 0.8 = 12.46$ ML
3. Shaving (considering one member per family)
   $=34.6 \times 10^5 \times 3/7 = 1.48$ ML
4. Washing Utensils in sink
   $=34.6 \times 10^5 \times 2.2 = 7.63$ ML

Total usage of water in Delhi household per day
= 44.97 ML

If, we require comparing the different practices used for water conservation with this foot tap system. The comparison should be done on annual basis. So, amount of water used annually by foot tap system

= 44.97 x 365 = 16,414 ML

Table.4 Data for Foot Tap System in Evening

Activities	**Average time taken(sec)**	**Water used (L) per day**
Rinsing mouth and cleaning tongue(while Brushing)	40	1.5
Washing Hands	18	1
Washing Utensils in sink	50	4

Water used:

Amount of water used by Delhi (Urban) households on daily basis

= Number of urban households x size of households x volume of water used for particular activities of a particular day.

1. Rinsing mouth and cleaning tongue(while Brushing)
   $=34.6 \times 10^5 \times 4.51 \times 3 = 23.4$ ML
2. Washing Hands
   $=34.6 \times 10^5 \times 4.51 \times 1 = 15.58$ ML
3. Washing Utensils in sink
   $=34.6 \times 10^5 \times 2.2 = 7.6$ ML

Total usage of water in Delhi household per day

= 46.58 ML

If, we require comparing the different practices used for water conservation with this foot tap system. The comparison should be done on annual basis. So, amount of water used annually by foot tap system

= 46.58 x 365 = 17,002 ML

Total amount of water used annually by conventional tap system

16,414 + 17,002 = 33,416 ML

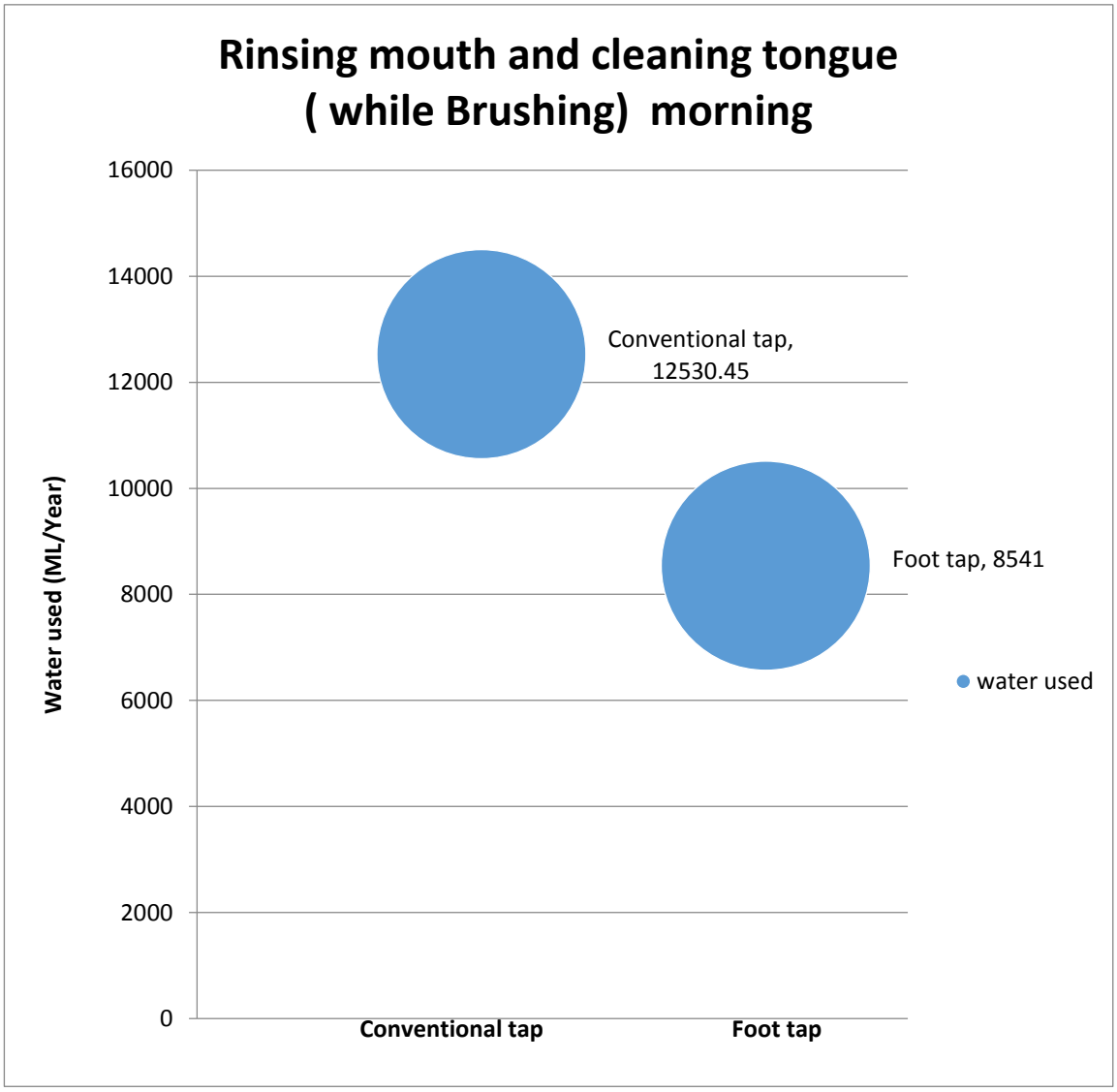


Figure. 5 Graphical representation of water used in rinsing mouth and cleaning tongue in morning

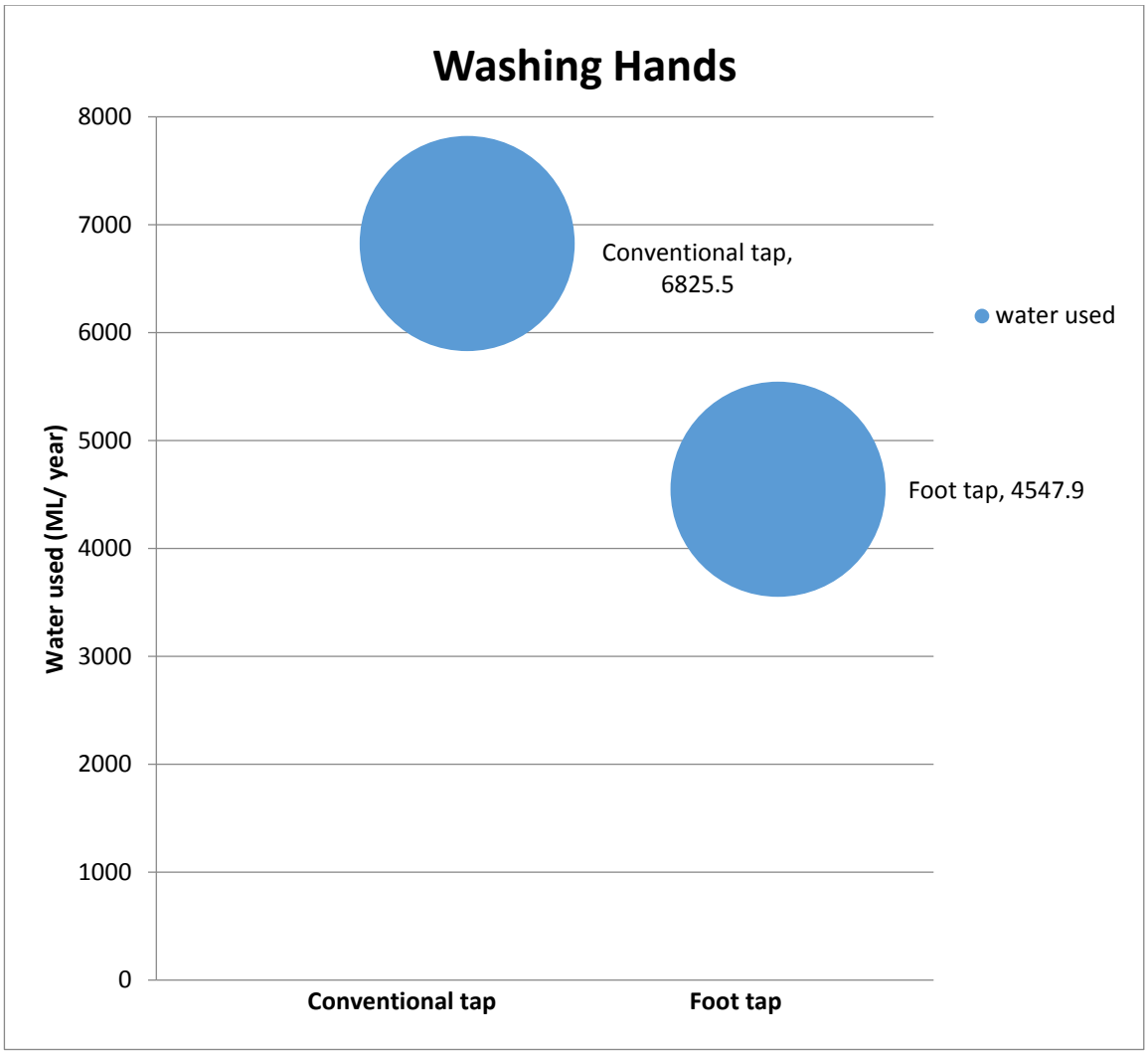


Figure. 6 Graphical representation of water used in washing hands in morning

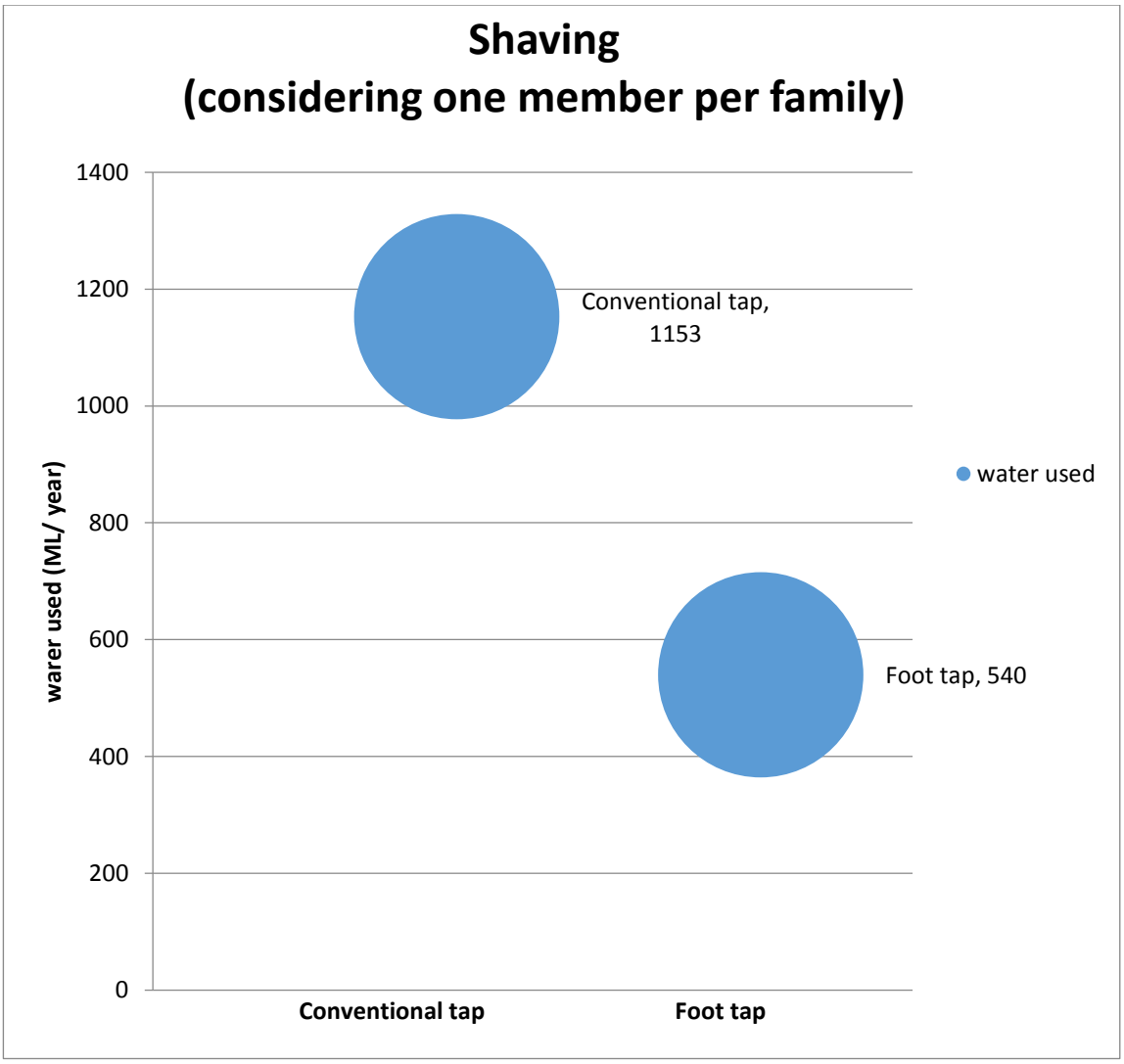


Figure. 7 Graphical representation of water used in Shaving

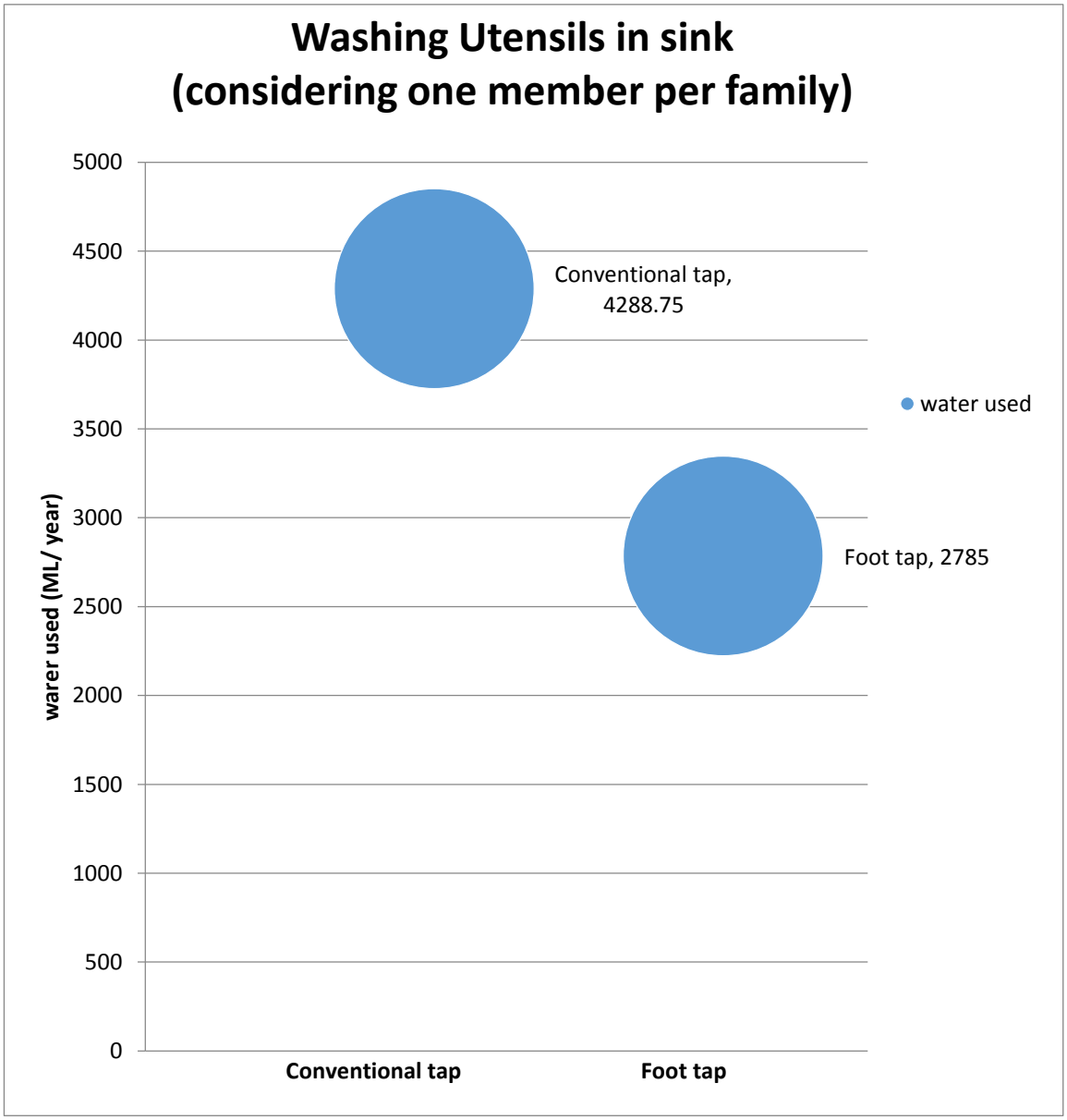


Figure. 8 Graphical representation of water used in washing utensils in sink in morning

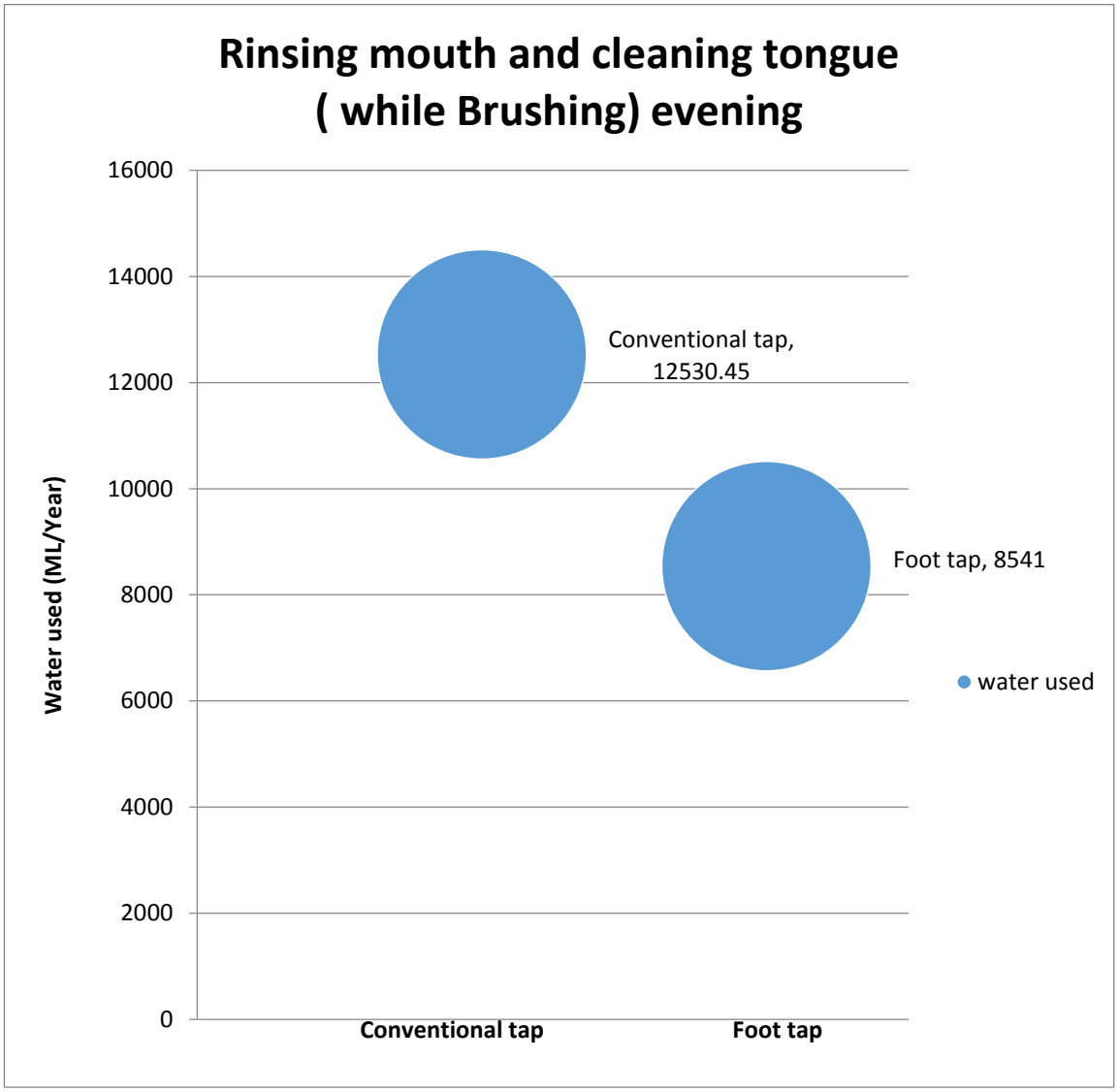


Figure. 9 Graphical representation of water used in rinsing mouth and cleaning tongue in evening

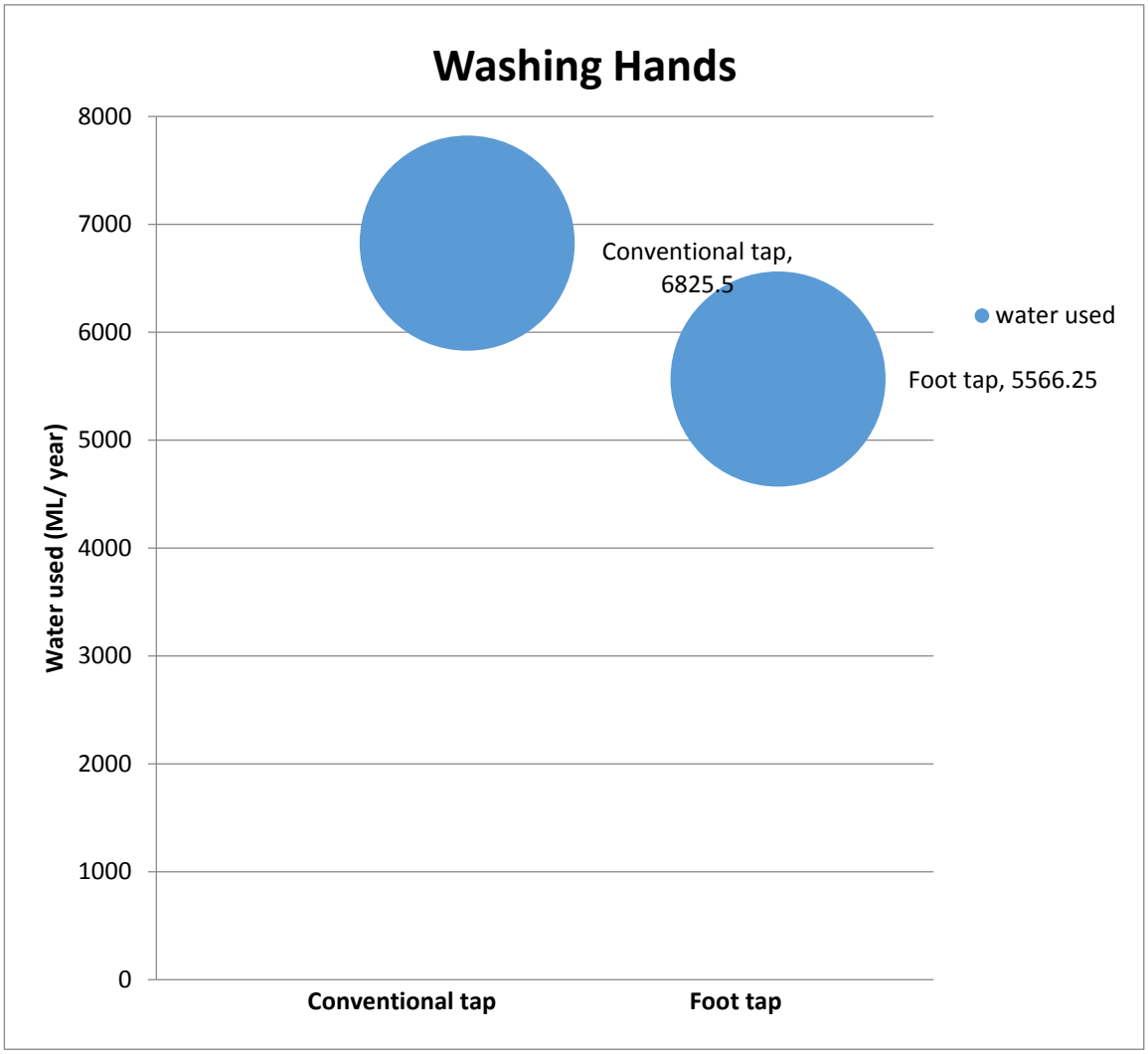


Figure. 10 Graphical representation of water used in washing hands in evening

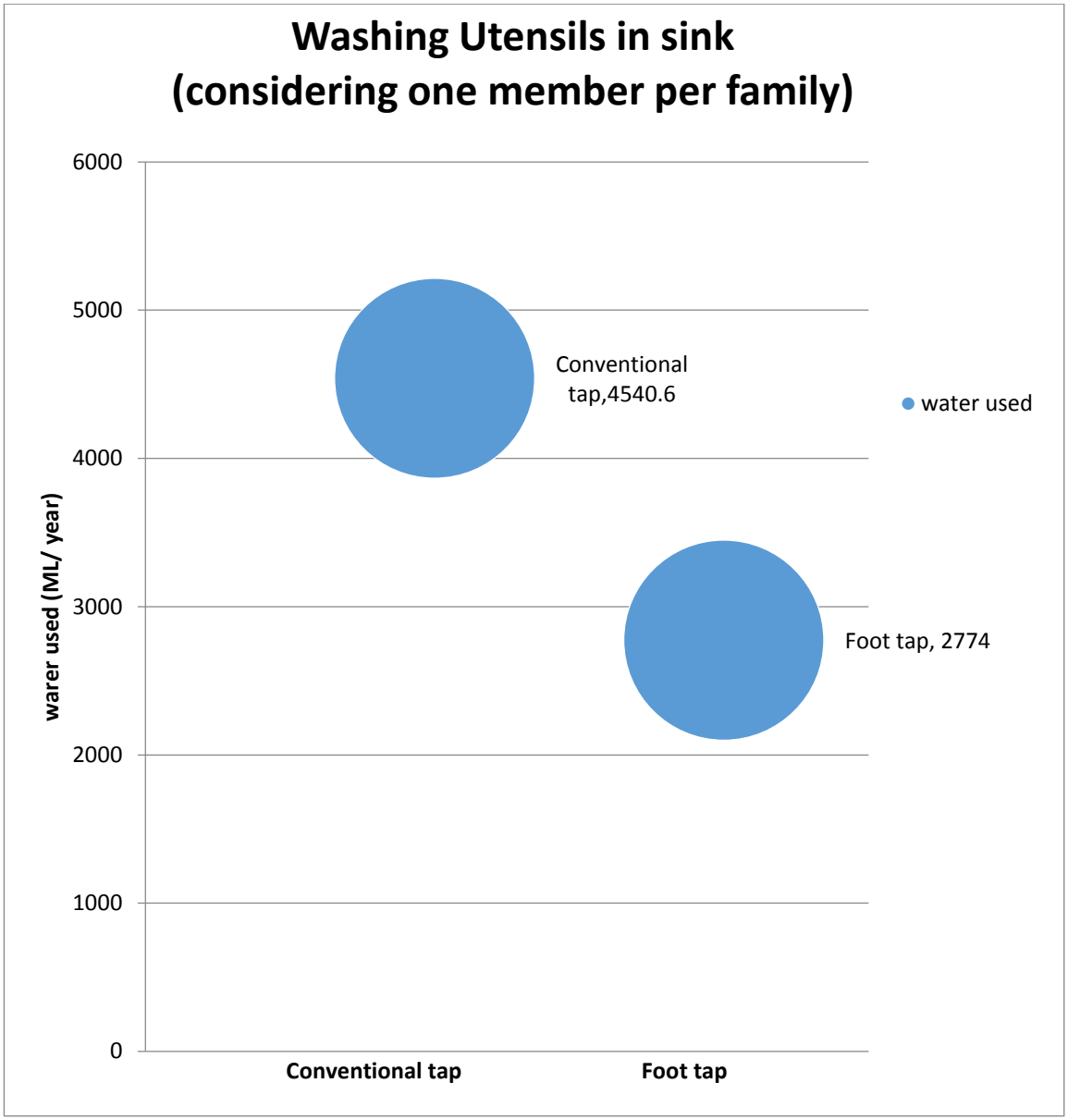


Figure. 11 Graphical representation of water used in washing utensils in sink in evening

Total amount of water save using foot tap instead of conventional tap

= (48329-33416) ML

= 14,913 ML

Percentage of water saved = 30.86%

4.3 WATER CONSERVATION THROUGH RAIN WATER HARVESTING

In capital city Delhi property rates are too high. So it is too difficult for person to willingly provide space for rain water harvesting when rain water is associated only for some months of a year.

On an average people of Delhi lives in 2 BHK or 2 BHK house whose area approximately varies from 60sq-m to 90 sq-m.

Average rainfall of Delhi is 105 mm.

Volume of tank required = 0.105 x 75 = 7.8 cu-m

So, to store rain water approximately 8 cu-mtank is required for complete one year storage. So a tank of 2 sq-m surface area is required it would be too costly for a house.

So, inspite of providing individual storage tank collaboration can be made between different community households to provide storagesufficient to store water at a particular area. Suppose four households of same area (60 sq-m) collects the rain water to a main storage tank.

Estimated number of households in Delhi = 36.26 Lakh

Urban household =34.6 Lakh

Suppose four house make a single storage than number for storage tank required (if all the houses contributes) = 34.6/4 = 8.65 lakhs

So total amount of water saved by storage tank = $8.65 \times 8 \times 10^8$ ML

= 6920 ML

CHAPTER-5

RESULTS

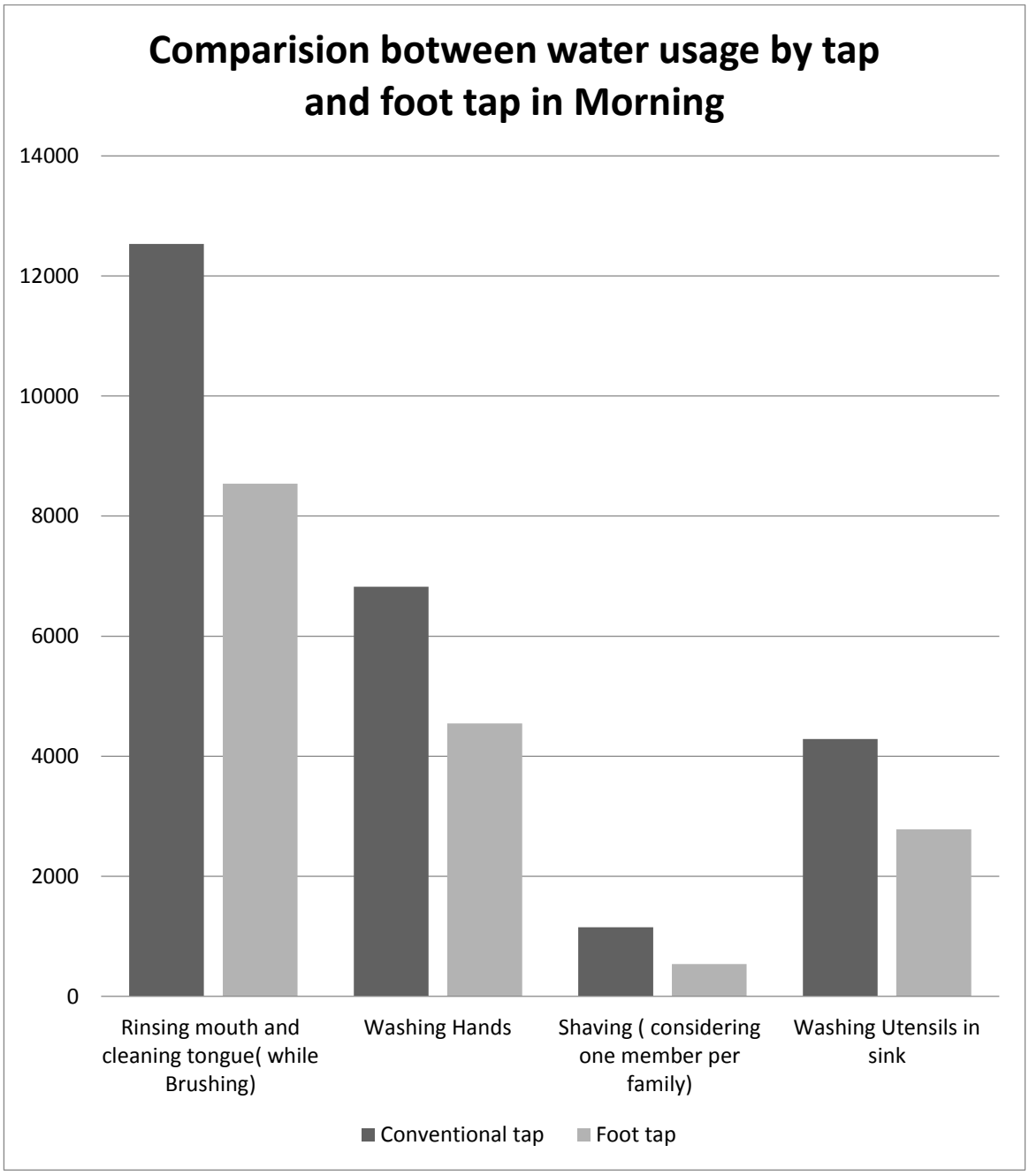


Figure 12. Comparison between water usage by tap and foot tap in morning

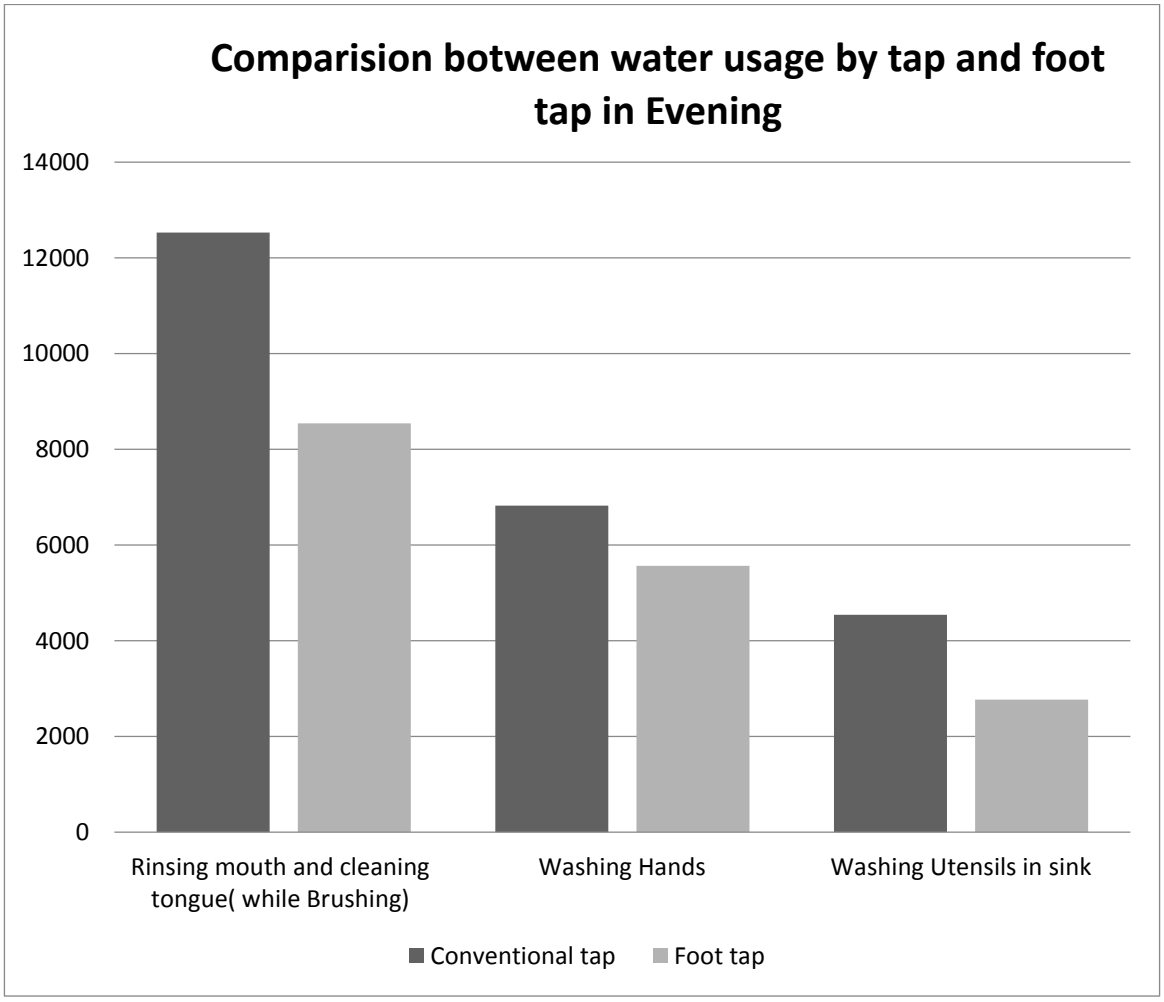


Figure 13. Comparison between water usage by tap and foot tap in evening

Total amount of water save using foot tap instead of conventional tap

= (48329-33416) ML

= 14,913 ML

Percentage of water saved = 30.86%

CONCLUSION

Scarcity of water is spread all over the world as we cannot create water we can only save it by using it efficiently. So, it is our sole responsibilities to invent something that will cut down the usage of water by meeting all the demands.To fulfill these requirements we developed an experimental setup for operating tap by using foot instead of hands.

Based on the results of this experiment we recommend that this apparatus should be used in every household, so that the water usage can be reduced to a factor of 34.78 or even more.

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