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Determination of peak hour and maximum daily factors on domestic usage patterns in the Special Region of Yogyakarta

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Abstract. Water use during peak hours and daily maximum are two interrelated terms in water usage patterns. Fluctuations in water use can be determined by planning standards, namely, estimates of peak hour and daily factors, so as to optimize air production and improve services. This study aims to calculate the maximum peak hour and daily factors. This research was carried out in the Special Region of Yogyakarta with a sampling technique carried out using a stratified proportional random sampling as many as 200 respondents. The results showed that the use of water at peak hours was 266.73 liters / day, which was in the morning between 06.00 and 08.00 am, while the maximum daily use of water is 774.09 litres/day which is on Sunday. The peak hour factor in the Special Region of Yogyakarta is 1.30 and the maximum daily factor is 1.26, when compared to the standard established by the Directorate General of Human Settlements, Ministry of Public Works, the peak hour factor is 1.5 while the daily maximum is 1.1. This means that the peak hour and maximum daily factors cannot be generalized in the Special Region of Yogyakarta.

1. Introduction

Fluctuations in water demand in a place are strongly influenced by population conditions, and in general, it is shown that the denser the population, the lower the peak load. Settlements in sub-urban areas (periphery) will provide a greater peak hour load than settlements in big cities. Fluctuations in water demand in an area are determined by the number of people who use water, the local environment, and the conditions of the water supply itself.

In fluctuations in water use, they cannot be separated from the so-called peak hours and daily maximum. The peak hour in water usage is the most water usage at certain hours during one day (24 hours), to determine the amount of water usage in one day, the peak hour factor is needed. While the maximum daily use is the most water usage on certain days of the week, to determine the amount of water use in one week, the maximum daily factor is needed. [1].

Taking into account the current conditions, the problem of water usage patterns always fluctuates, because people have different habits of using water [2]. The research, which was conducted in the Yogyakarta Special Region, was conducted to determine the pattern of water use in the area, which is used as an effort to expand the water distribution network.

This research generally aims to find the peak hour factor and maximum daily factor that can be used to determine the amount of water use at certain hours and the amount of water use on certain days, in addition to that it can also be used to predict community water needs, both now and in the future, and can also be used to calculate reservoir dimensions.



2. Methodology

In this study, the sample taken was 200 respondents. The sampling method was carried out using stratified proportional random sampling. Stratified proportional random sampling is used to accurately describe the characteristics of a heterogeneous population, the population concerned must be divided into uniform layers (strata) and each layer will be taken randomly. The stratified sample is the type of work of the head of the family, the level of family income and the education level of the head of the family. Data analyses were using Equation (1), (2), and (3).

$$Q_{ri} = \frac{Q_h}{7} \tag{1}$$

where:

Q_{ri} : is the daily average discharge in a week (m^3/day)

Q_h : is the flow rate every hour (m^3/day)

7 is the number of days in a week

$$f(\text{peak hour}) = \frac{Q_{hm}}{Q_{ri}} \tag{2}$$

where:

F (peak hour): is the peak hour factor

Q_{hm} : is the peak hour discharge in one day (m^3/day)

Q_{ri} : is the daily average discharge in a week (m^3/day)

$$f(\text{max. day}) = \frac{Q_{dm}}{Q_{ri}} \tag{3}$$

where:

$f(\text{max.day})$: is the maximum daily factor

Q_{dm} : is the maximum debit day in one week (m^3/day)

Q_{ri} : is the daily average discharge in a week (m^3/day)

The category of city and domestic water use is often used as a standard in planning water distribution networks, this standard is set by the Ministry of Public Works, domestic water use determined by the Ministry of Public Works divides based on the number of residents as shown in Table 1.

Table 1. Water use by city category [4]

Categories	Total population	City category	Domestic water use (LPCD*)
I	> 1000000	Metropolitan	190
II	500000 - 1000000	Big	170
III	100000 - 500000	Currently	150
IV	20000 - 100000	Small	130
V	3000 - 20000	Sub-district capital	100
VI	< 3000	Village	60

*LPCD = liters per capita per day.

The domestic water use determined by the Ministry of Public Works in Table 1 is the result of an empirical approach, namely by comparing domestic water use in various regions with a certain population. However, the use of domestic water as determined by the Director General of Human Settlements of the Ministry of Public Works does not consider socio-economic aspects and household habits in using water, so that the use of domestic water will certainly differ from one area to another, including research conducted in the Special Region of Yogyakarta different from other regions, although the categories of cities in the two regions are the same.

As a comparison, the use of water by type of activity can be seen in table 2, this type of activity is found in areas that have 4 seasons.

Table 2. Types of water use activities [5]

No.	Types of activities	Water usage (%)
1.	Flushing the toilet	41
2.	Shower and wash	37
3.	Activities in the kitchen	6
4.	Drinking water	5
5.	Washing clothes	4
6.	House cleaning	3
7.	Watering plants	3
8.	Cleaning family furniture	1

The amount of water use is inseparable from the activities carried out daily, causing different patterns of water use at each time of the day. Based on the results of research conducted by Leaden et al. (1990) in the United States, there are variations in water use at certain times of the day (Table 3).

Table 3. Variations in water usage for one day [6]

No.	Descriptions	Water usage hours
1	Lowest water usage rate	11.00 pm - 5.00 am
2	Highest water usage rate	5.00 am - 12.00 am (peak usage at 07.00 am - 08.00 am)
3	Medium water usage rate	12.00 am - 05.00 pm (calm water usage around 3.00 pm)
4	Increased night use	05.00 pm - 11.00 pm (peak at 06.00 pm - 08.00 pm)

Table 3 above describes water use activities that are closely related to water use at peak hours and daily maximums; water use is certainly closely related to the routine activities of each household. The use of water in the Special Region of Yogyakarta is certainly very different as stated by Leiden et al. (1990) in the United States.

3. Results and discussion

3.1. Domestic water usage by type of activity

The use of domestic water based on this type of activity is a human activity in utilizing daily water which is carried out routinely, where the activity is carried out in the household, so that the use of domestic water carried out outside the household is not included in this study, even though the type of activity is the same as at home.

Household water use in the Special Region of Yogyakarta consists of types of activities that contribute to the amount of domestic water use, several types of activities that contribute to this are:

- a. bath
- b. washing clothes
- c. cooking/drinking
- d. wash kitchen utensils
- e. wash the floor
- f. ablution
- g. washing the vehicle
- h. watering plants
- i. other water usage

The use of domestic water in each type of activity can be seen implicitly in Figure 1.

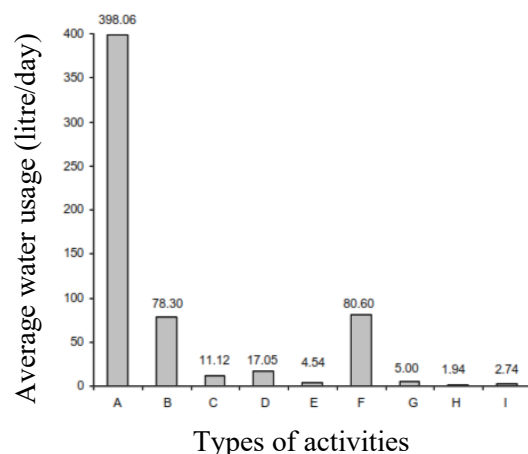


Figure 1. Domestic water usage by type of activity

3.1.1. Bath. The use of domestic water in each type of activity is dominated by the type of bathing activity, which is 39.06 litres/day, from the average number of family members as many as 5 people there are as many as 60.57% or as many as 3 people who carry out routine activities every day, such as going to work, going to school, or other activities that are carried out every day, this contributes greatly to the use of water in this type of bathing activity, because every morning activity it is always preceded by a shower. In addition to routine activities that contribute to the large use of domestic water for bathing activities, it was also found that the use of domestic water for this type of bathing activity is strongly influenced by a habit of the community in utilizing water, namely the habit of using water for bathing is influenced by the presence of a place for bathing. Water reservoirs (water containers), the use of water in the type of bathing activity in the household using a bath is relatively larger when compared to using a bucket, this is evident from the 200 respondents studied, there are 152 households that use the bath, and 48 households which uses a bucket as a shelter for bathing. The use in the type of bathing activity using a bathtub has an average water use of 413.37 liters/day, while using a bucket has an average water use of 349.58 liters/day. From the description above, it can be concluded that the use of water in the type of bathing activity using a bathtub tends to use more water compared to using a bucket [7].

3.1.2. Washing clothes. The average use of water to wash clothes is 78.30 liters/day. There are 96.5% or as many as 193 households doing laundry activities at home, while the remaining 3.5% or as many as 7 households do not do laundry activities at home, however, households that do not wash clothes are included as dividers in calculate the average use of water. This situation contributes to the small use of water for this type of work [8].

3.1.3. Cooking/drinking. The use of water for cooking/drinking activities is 11.12 liters/day. This activity ranks fifth in the most water use in the Special Region of Yogyakarta, the size of the use of water in this type of activity is strongly influenced by the number of family members and the daily mobility of family members. From as many as 200 respondents, it turns out that the average number of family members is 5 people and those who carry out routine activities are 3 people per household, but from the average number of family members who carry out routine activities, there are 60 households that have both parents. The number of working parents contributing to the use of water in the type of cooking/drinking activities is small, this is because often lunch or drinking activities are carried out outside the home [9].

3.1.4. Wash kitchen utensils. The type of activity to wash kitchen utensils ranks fourth most in water utilization, which is 17.05 liters/day. This type of activity is closely related to the type of

cooking/drinking activity, so the reason for the size of the use of water in this type of activity is also the same as the type of cooking/drinking activity, in addition to the same reason as the type of cooking/drinking activity, there are also other reasons that cause the size of the activity [10]. The use of water in the type of activity to wash kitchen utensils, namely the frequency of washing kitchen utensils. In the Special Region of Yogyakarta, the frequency of kitchen utensils varies, from 200 respondents studied, it turns out that there are 13% or as many as 26 households who do this type of activity washing kitchen utensils with a frequency of 3 times a day, 43.5% or as many as 87 households with a frequency of 3 times a day. 2 times a day, 43% or as many as 86 households with a frequency of 1 time a day, and 1 household does not wash kitchen utensils.

3.1.5. Wash the floor. The washing of floors is a type of activity that ranks seventh out of nine types of activities that use water, which is 4.54 liters/day. The size of the use of water in this type of activity is closely related to the number of households that carry out floor washing activities and the frequency with which they are carried out in one week. Of the 200 respondents studied in the Special Region of Yogyakarta, it turned out that there were 56.5% or as many as 113 who carried out this type of floor washing activity, while the remaining 43.5% or as many as 87 households did not do this type of floor washing activity, this was caused by the household. It does not have a tile or ceramic floor, but only a dirt floor.

There were also variations in the frequency of floor washing; from 113 households that carried out this type of floor washing activity, there were 46.02% or as many as 52 households that carried out this type of floor washing activity with a frequency of every day; 17.70% or as many as 20 households with a frequency of once every two days; 19.47% or as many as 22 households with a frequency of once every 3 days; and 16.81% or as many as 19 households with a frequency of once a week.

3.1.6. Ablution. Of the 200 respondents studied in the Special Region of Yogyakarta, there are 167 Muslim households, while the remaining 31 are Catholic, 1 Christian household, and 1 Hindu household. The use of water in the type of ablution activity does not include non-Muslim religions as a divisor in calculating the average use of water. Based on the results of the study, it is known that the average use of water for ablution every day is 80.60 liters/day. Based on field data, it was found that the average every time for ablution is 5 liters, so the average use of water for ablution is the number of family members x the average each time ablution x prays 5 times, then the result is: $5 \times 5 \times 5 = 125$ liters/day, which means that it can be concluded that $80.60 : 25 = 3.224$. This means that from the average number of family members as many as 5 people, it turns out that only 3 people pray, or in other words, the average household in the Special Region of Yogyakarta that does not pray is 2 people.

3.1.7. Washing vehicles. The type of vehicle washing activity ranks sixth in terms of water use, which is 5 liters/day. The size of the use of water in this type of activity is closely related to the number of households that carry out vehicle washing activities and the media used every time they wash their vehicles. Of the 200 respondents studied, 25% or as many as 50 households carried out this type of vehicle washing activity, while the remaining 75% or as many as 150 households did not carry out this type of vehicle washing activity with details for the following reasons: 1. As many as 23 households do not perform any type of vehicle washing activity because they do not have a vehicle, either in the form of a motorbike, car, or other form of vehicle; 2. Although up to 127 households do not carry out this type of vehicle washing activity because they always use a cloth every time they clean the vehicle, they do not need water.

Households who carry out this type of vehicle washing activity also experience variations in the media used every time they wash their vehicles, the media that are often used every time they wash their vehicles are two, namely buckets or water hoses. Of the 50 households that carried out this type of vehicle washing activity, there were 80% or as many as 40 households that carried out this type of vehicle washing activity using bucket media, while the remaining 20% or as many as 10 households

carried out this type of vehicle washing activity using a water hose. Different media resulted in different average use of water in the type of vehicle washing activity; Based on the calculation results, it was found that the average use of water using bucket media was 9 liters/day, while the average use of water using water hose media was 64 liters/day.

3.1.8. Watering plants. The activity of Watering Plants uses the smallest amount of water compared to other types of activities, which is 1.94 liters/day. Of the 200 respondents studied, 7.5% or up to 15 households that used their home yards to grow plants, while the remaining 92.5% or 185 households did not use their home gardens as a place to plant plants, but were only left as a place to grow plants for children's play. Based on the description above, it can be concluded that households in the Yogyakarta Special Region are not interested in growing plants in their yards, so the use of water for watering plants is also relatively small.

3.1.9. Other water usage. Other types of water use activities occupy the eighth highest rank in water utilization, which is 2.74 liters /day. Types of other water use activities include feeding livestock and filling fish tanks; these two types of activities include other types of water use activities and include contributing to the large use of domestic water, including these two types of activities in domestic water use. , because the water used is sourced from households. Of the 200 respondents, there were 3.5% or as many as 7 households that carried out other types of water use activities with details of 4 households carrying out livestock drinking activities with an average water use of 32.68 liters / day, and 3 households do this type of activity to fill fish tanks with an average water use of 139.27 liters / day, which means that 193 households in the Special Region of Yogyakarta do not carry out other types of water use activities, based on the results of field observations, it is known that 193 the household is not allowed to carry out other types of water use activities, due to the limited land available.

Each type of activity provides a different contribution to the use of domestic water; the implicit contribution of each type of activity is presented in Table 4.

Table 4. Percentage of water use in each type of activity

No.	Types of activities	Water usage (%)
1	Bath	66.42
2	washing clothes	13.06
3	cooking/drinking	1.86
4	wash kitchen utensils	2.84
5	wash the floor	0.76
6	ablution	13.45
7	washing the vehicle	0.83
8	watering plants	0.32
9	Other water usage	0.46
	Total	100

3.2. Peak hours and maximum daily factors

The use of water at peak hours and daily maximum is closely related to time, since use of water at peak hours is the largest amount of water used for domestic purposes at certain hours of the day, while the maximum daily amount is the highest amount of water used for domestic purposes at certain times of the day and certain days of the week.

Peak hour and maximum daily water usage play a very important role in determining the peak hour and maximum daily factors, based on the calculation results, the following values are obtained:

- maximum daily average = 774.09 liters/day (Sunday);
- average water usage in one week = 612.91 liters/day;
- average daily peak hours = 347.92 liters/day;

- Average peak hour water usage = 266.73 liters/day (morning).

From the data above, it can be determined the peak hour and maximum daily factors by using equations (4) and (5) as follows:

$$f(\text{peak hour}) = \frac{347.92}{266.73} = 1.30 \quad (4)$$

$$f(\text{max. day}) = \frac{774.09}{612.91} = 1.26 \quad (5)$$

According to the Directorate General of Human Settlements, Ministry of Public Works (1996), the peak hour factor is 1.5, while the maximum daily factor is 1.1. The standard set by the Directorate General of Human Settlements, Ministry of Public Works (1996) is very different from the results of research conducted in the Special Region of Yogyakarta, where the peak hour factor in the area is 1.30 and the maximum daily factor is 1.26, so that if in the Special Region of Yogyakarta, water distribution network will be carried out, so the standards set by the Directorate General of Human Settlements, Ministry of Public Works (1996) are not suitable, and it is recommended to use peak hours and maximum daily factors in the results of this study. It can be concluded that the peak hour and maximum daily factors set by the Directorate General of Human Settlements; Ministry of Public Works (1996) cannot be generalized to every region.

4. Conclusion

Per capita water use in the Special Region of Yogyakarta has matched the use of water in small towns set by the Directorate General of Human Settlements, Ministry of Public Works at 130 LPCD. The amount of water use can continue to increase along with the increase in population, but not only the use of water is not only due to population growth, but also because of the advancement of human life.

The peak hour of water use is 266.73 liters / day, which is in the morning between 06.00 and 08.00 am, while the maximum daily water use is 774.09 liters / day on Sunday. The peak hour factor in the Special Region of Yogyakarta is 1.30 and the maximum daily factor is 1.26, when compared to the standard established by the Directorate General of Human Settlements, Ministry of Public Works, the peak hour factor is 1.5 while the daily maximum is 1.1. This means that the peak hour and maximum daily factors set by the Directorate General of Human Settlements, Ministry of Public Works, cannot be generalized in the Special Region of Yogyakarta.

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References

- [1] Syahputra B 2013 *Pro. Inter. Conf.on Infrastructure Develop.* p143-146
- [2] Syahputra B 2011 *Pros. Semin. Nas. Sains & Teknologi* **1** B10-B14
- [3] Syahputra B 2012 *J. Lingk. Sultan Agung* **1** 1–15
- [4] Direktorat Jendral Cipta Karya 1996. *Petunjuk Teknis Air Bersih.* Dept. P.U.
- [5] Fair GM, Geyer JC and Okun DA 1971. *Elements of Water Supply and Wastewater Disposal.* Second Edition, (New York : John Wiley & Sons) p615
- [6] Leiden VDF, Troise FL and Todd DK 1990 *The Water Encyclopedia* Second Edition, (USA : Lewis Publishers, Inc.)
- [7] Syahputra B, Kiono BFT and Sudarno 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **896** 012033
- [8] Departemen Pekerjaan Umum. 2020. *Modul Proyeksi Kebutuhan Air Dan Identifikasi Pola Fluktuasi Pemakaian Air. Perencanaan Jaringan Pipa Transmisi Dan Distribusi Air Minum.* Jakarta
- [9] Billings RB and Jones CV 2008. *Forecasting urban water demand.* (Denver: American Water Works Association)

- [10] Syahputra B and Nafiah 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **896** 012034