Jurnal Presipitasi
Media Komunikasi dan Pengembangan Teknik Lingkungan
e-ISSN: 2550-0023

Vol 19, No 3, 2022, **477-486**
Article available at [homepage presipitasi]

Regional Case Study

Study of Rainwater Potential as Raw Water Source for Campus Mosque at Engineering Faculty of Tanjungpura University

Ulli Kadaria[1*]

[1] Department of Environmental Engineering, Universitas Tanjungpura, Jalan Prof. Dr. H. Hadari Nawawi, Pontianak, Kalimantan Barat, Indonesia 78124
*Corresponding Author, email: ulli.kadaria@teknik.untan.ac.id

Abstract

Mosques need water in sufficient quantities for ablution, usually the mosques use surface water from PDAM services and well water. Surface water and ground water have decreased in quantity and quality, so it is necessary to find alternative sources of water to meet the clean water demand. On the other hand, the potential for rainwater is neglected, rainwater that falls is left to flow. Pontianak is one of the cities crossed by the equator which has high rainfall, the method of harvesting rainwater is appropriate in the tropics. This research was located on campus mosque at Engineering Faculty of Tanjungpura University. The purpose of this study was to determine the water demand in mosque and identify the potential for rainwater to meet the clean water demand in mosque. The method used in this research is field survey to calculate the water demand and interview with the mosque management to obtain supporting data. Based on the calculation, the total of water demand in mosque is 60 m^3/month or 2 m^3/day, while the volume of rainwater in campus mosque at Engineering Faculty of Tanjungpura University is 61.258 m^3/day, and the potential volume of rainwater each month can meet the clean water demand.

Keywords: Clean water; rainwater; water harvesting

1. Introduction

The mosque is one of the public facilities that require large amounts of water. Most of the mosques use clean water from PDAM and some use well water which is then processed and stored in a reservoir. These water sources use surface water and ground water whose quantity and quality are decreasing, so alternative sources of other raw water are needed in the context of saving and conserving water resources, but water demands are still being met. On the other hand, rainwater has a large potential to be developed into a source of clean water because it is more economial and the quality is good.

The drinking water used must meet the quality standars of the Regulation of the Minister of Health of the Republic of Indonesia No.492 of 2010 and Regulation of the Minister of Health of the Republic of Indonesia No. 32 of 2017 for clean water. Water quality that does not meet quality standards can cause various kinds of diseases such as itching, and cause corrosion of utilities or equipment made of metal such as water faucets. In terms of quantity, continuous groundwater extraction can result in land subsidence, seawater intrusion and reduced groundwater reserves.

Rainwater is one of the water resources that has not been used optimally. Rainwater is only allowed to flow into drainage channels leading to rivers and eventually flows into the sea, even though if managed properly, rainwater has many benefits for human survival. Rainwater is used for agriculture due to the use of river water and groundwater resources are reaching unsustainable levels (Piemontese et al., 2020). Rainwater also can be used to meet various human needs, including for bathing, washing and even drinking water.

Rainwater is an abundant source of water, especially during the rainy season, but the utilization of rainwater as a source of raw water is still not optimal. Rainwater is allowed to flow so that if not managed it can cause flooding. The potential for rainwater, easy access and affordability to get it, as well as good quality compared to other raw water sources, make it necessary to consider the use of rainwater as a water source. Based on research by Rahim et al. (2019), the water demand on campus can fullfill from rainwater that falls on the roof area of the building. About 25% of the total rain potential can be stored in reservoir or into the ground, and it can save water cost up to 50%.

According to the regulation of the State Minister of Environment No.12 of 2009 states that : "Utilization of rainwater is a series of activites to collect, use, and/or absorb rainwater into the ground". Rain harvesting is the process of optimally utilizing rainwater for various purposes that can be used directly or stored in advance. This research was located on the campus mosque at Engineering Faculty of Tanjungpura University. Based on a field survey, the clean water demand comes from PDAM and every month they have to pay the clean water bill. With this research, it is hoped that mosque can use rainwater to meet the clean water demand so that it is more cost-effective and supports eco-campus and eco-masjid programs to support sustainable development.

Eco-masjid is an effort to involve religious institutions, namely mosques in order to save the earth. One of the programs is to build infiltration wells as an effort to harvest rainwater so the supply of clean water is sufficient even in the dry season (Isworo, 2018). According to Prabowo (2017), mosques are very dependent on water resources for thaharah (purification) facilities, but need to pay attention to the availability of water resources that are increaingly scarce due to increaing population, reduced open areas, wasteful behaviour of water, environmental pollution. One of the focuses of the eco-masjid is access to water and sanitation which is grouped into 3 (three) activities, namely keep water, save water, and protecting water.

According to the Kementerian Negara Lingkungan Hidup and Universitas Indonesia (2012), eco-campus is one of the programs to realize the creation of a sustainable campus, namely a campus that integrates the concept of environmental insight into every component of campus life. Eco-campus becomes a place for environmental education, conservation practices and harmonious environmental maintenance.

Rainwater harvesting is a natural solution that has the potential to meet water demands such as for toilet flush. Based on the results of the study, rainwater harvesting can meet 100% of the water demands for toilet flush. Factors that influence it are the number of people in the house, the catchment area, and the volume of reservoir (McCarton et al., 2022).

Based on previous research, rainwater harvesting systems (RWHS) is one of the prominent alternative to urban water management which contributes to increased water use efficiency and conservation. The result of the research showing promising results regarding with lower impact compared to conventional centralized water distribution systems. The implementation of the hybrid systems, which is a combination of rainwater harvesting systems and greywater reuse system can save about 131 m^3/year of drinking water or 42.5% of the total drinking water consumption and reduces the flow to wastewater processing plant by 20% (Gomez-Monsalve et al., 2022).

This study aims to determine the clean water demand in mosque; and identify the potential of rainwater as a source of clean water in campus mosque at Engineering Faculty of Tanjungpura University. It is important to conduct this research as a pilot, considering the number of mosques in other universities and in the community so that the quantity of water demand is quite large and there is a lack of awareness to harvest rainwater. This rainwater potential study was conducted in order to save surface water and ground water, which are currently decreasing in quantity and quality.

2. Methods

The research is located at the Istiqomah Mosque, Faculty of Engineering, Tanjungpura University, Jl. Prof. Dr. H. Hadari Nawawi, Kel. Bansir Laut, Kec. Pontianak Tenggara, Kota Pontianak. Location coordinates 0°03'25.1"S 109°20'46.3"E.

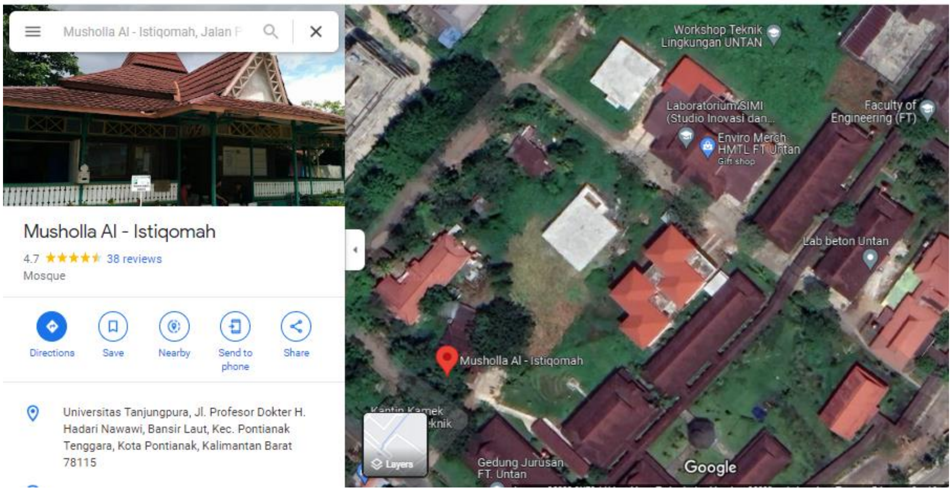

Figure 1. The Location of the Istiqomah Mosque, Faculty of Engineering, Tanjungpura University
Source : Google Maps (2022)

This research is a field study by directly calculating the water demand for mosque, measuring the area of mosque, type of roof as well as survey and interview with mosque management at Engineering Faculty of Tanjungpura University to obtain supporting data / information. The water demand is carried out by counting the number of people and their water demand in one day (5 prayer times) for 7 days. Other data needed is rain intensity that obatained from LAPAN. This research did not calculate the budget plan for the construction of reservoir, did not make detailed engineering design, did not calculate land requirements and did not analyze the rainwater quality and water treatment.

After all the data are complete, the data are processed and analyzed, namely the analysis of water demand, analysis of the existing condition, water balance analysis, and rainwater discharge analysis.

Based on Ningsih (2013), the roof area is calculated using the formula :

$$Ls = y \frac{x}{\cos \alpha} \quad (1)$$

Description:

Ls = surface area of the hypotenuse (m^2)

y = length (m)

x = width (m)

α = roof slope angle

The quantity of rainwater is obtained from the calculation of the roof area and the intensity of rain based on the Ministry of Public Works, Directorate General of Human Settlements (Syawalia, 2018). The rainwater storage volume is calculated by the equation :

$$V = C.\beta.I.A.T \quad (2)$$

Description:

V = rainwater storage volume (m^3)

C = runoff coefficient

β = rainfall distribution coefficient (1)

I = rain intensity (m/hour)

A = catchment area (m^2)

T = rain duration (hour)

Water that descends from the atmosphere that is not captured by vegetation and artificial surfaces such as building roofs or waterproofing layers, then the water will fall to the surface and some will evaporate, infiltrate or be stored in basins (Isramaulana, 2014). In this research, the calculation is the rainwater discharge that can flow through the roof using the rational formula :

$$Q = 0.278.C.I.A.10^{-6} \quad (3)$$

Description :
Q = overflowing water discharge (m^3/second)
C = flow coefficient
I = rain intensity (mm/hour)
A = area of drainage (m^2)
Dimensions of the reservoir with the following volume formula :

$$V = l.w.h \quad (4)$$

Description:
V = rainwater storage volume (m^3)
l = length (m)
w = width (m)
h = height (m)

3. Result and Discussion

3.1. Water Demand Analysis

Sampling of water demand per person for one ablution was carried out at the Istiqomah Mosque, Faculty of Engineering, Tanjungpura University. The calculation is done by storing ablution water in a bucket that has been given a size. Based on the sampling results, it is known that 1 person needs approximately 3 liters of water for one ablution, so in 1 day a person needs 15 liters of water for ablution, this result is same with Wardhana (1999). The calculation of this water demand is close to the research of Natsir, et.al. (2020) which is an average of 3.9 liters/person for one ablution, and Isramaulana (2014) with the water demand for ablution is 4 liters/person, while the standard of non-domestic water demand for mosques is 20 – 40 liters/person/day (Lestari & Pamuji, 2017). The water demand is calculated by multiplying the water demand per person by the number of congregations who pray in the mosque.

Table 1. Calculation of Wudhu Water Demand at Istiqomah Mosque

Days	**Number of congregations**					**Total number of congregations (person/day)**	**Wudhu water demand (liter/day)**
	Shubuh	**Dzuhur**	**Ashar**	**Maghrib**	**Isya'**		
1	8	36	31	24	11	110	330
2	8	33	35	24	11	111	333
3	8	25	34	26	10	103	309
4	8	53	44	17	10	132	396
5	8	9	45	36	7	105	315
6	10	48	58	46	11	173	519
7	8	21	17	17	17	80	240
Average	**8**	**32**	**38**	**27**	**11**	**116**	**348.86**

Table 1 is the data ablution water demand in the Istiqomah Mosque which was taken for 7 consecutive days. The reason for collecting data for 7 days is because of the difference in the number of congregations on active days and holidays. Due to the number of congregations that vary every day and every prayer time, calculations are carried out using the average water demand. Based on the calculation, it is found that the average water demand for ablution for 1 day is 348.86 liters/day, then the water demand for ablution for 1 month is 10,466 liters/month or equivalent to 10.466 m^3/month. Besides for ablution, water is also needed for toilet activities (bathrooms, cleanliness of the mosque, etc.), and for the mosque administrators who live in the mosque.

Data collection was carried out during the COVID-19 pandemic, so learning activities were still conducted online and the number of educators (administration, etc.) did not all enter at the same time (still implementing a shift system and work from home). The restrictions on activities and the number of people at the same time indirectly also affects the number of congregations praying in the mosque between before and after the COVID-19 pandemic. Based on the interviews with the Istiqomah mosque management, the number of congregations who prayed in the mosque before the COVID-19 pandemic was estimated to be 2-3 times the current number of congregations. This shows that the water demand before the COVID-19 pandemic or when learning activities have been carried out offline (face to face), the water demand will also increase. The cost of water during the COVID-19 pandemic ranged from Rp. 100,000 – Rp. 200,000 per month, whereas before the pandemic the cost of water can reach more than Rp. 300,000 per month.

The study was conducted during a pandemic, so the data on the number of congregations obtained was less than before pandemic. The number of congregations affects the calculation of water demands, if the number of congregations is small, the total water demands are also less than before pandemic. In this study,interviews were conducted with the management to determine the water demans before pandemic. This is intended to determine the potential of rainwater that is accomodated whether it is sufficient for water demands during pandemic conditions and before pandemic conditions or in normal conditions.

3.2. Analysis of the Existing Condition of Clean Water Facilities and Infrastructure

The existing condition of clean water facilities and infrastructure was obtained from observations, measurements, and direct interviews with the mosque's administrators with an instrument in the form of a questionnaire. The questions contained in the questionnaire are the identity of the mosque, the source of clean water in the mosque, the potential for rainwater, measurement of building dimensions, data on the number of congregations, as well as clean water facilities and infrastructure. The Istiqomah Mosque has 3 reservoirs, namely 1 fiber tub with a capacity of 3,000 liters and 2 polyethylene (PE) plastic tubs with a capacity of 1,000 liters each, and a tub capacity in the bathroom of 280 liters. So, the total capacity of reservoir is 5,280 liters.

3.3. Water Balance Analysis

The water balance analysis in this study is a comparison between the potential volume of rainwater compared to the water demand in the mosque. To obtain the volume of rainwater runoff that falls on the roof, it is necessary to collect rain intensity data obtained from the LAPAN of Pontianak City. Table 2 is the average rainfall intensity for 1 year, namely in 2020.

Table 2. Average rain intensity

No	Month	Rain Intensity (mm/hour)
1	January	162.6
2	February	447.8
3	March	178.9
4	April	203.3
5	May	215.1
6	June	410.4
7	July	242.0
8	August	171.3
9	September	387.9
10	October	201.2

No	Month	Rain Intensity (mm/hour)
11	November	385.7
12	December	130.6
Total		3136.8
Average		261.4
Maximum		447.8
Minimum		130.6

Based on the calculation, it is known that the average rainfall intensity is 261.4 mm/hour, the maximum intensity is 447.8 mm/hour, and the minimum intensity is 130.6 mm/hour.

The rainwater potential depends on intensity of rain, the type of roof, the shape of the roof, the slope of the roof, and the surface area of the roof. Zinc and onduline roofs require slope angle of at least 15^{o}, while tile roofs and metal roofs require a roof slope angle of at least 30^{o} to drain rainwater (Rahmansah & Rauf, 2014).

Based on the observations, the Istiqomah Mosque has a roof made of tile, the shape of a combined joglo and cross roof with a slope of 30^{o}. The dimensions of the length and width of the roof are obtained by measuring the length and width of the mosque, this approach is carried out assuming the area of the mosque is the same as the roof area. The flat roof area is calculated by multiplying the length and width of the roof, while the sloping roof area is calculated using equation (1). From the results of measurements and calculations, it is known that the roof length is 13.6 meters, the roof width is 13.3 meters, the flat roof area is 180.88 m^2, and the sloping roof area is 1172.63 m^2.

The rainwater supply that can be collected by the roof is calculated using the equation approach to the volume of rainwater storage, namely equation (2). The runoff coefficient (C) of the roof is in the range 0.75 – 0.95 (Agustianto, 2014), the calculation uses a C value of 0.8. The rain distribution coefficient (β) is 1. The rain intensity used in the calculation is the average rain intensity, which is 261.4 mm/hour or 0.2614 m/hour. The catchment area (A) is the roof area of the sloping plane that has been calculated previously. It is assumed that in 1 day there is one rain for 1 hour. The calculation results obtained rainwater supply of 245.22 m^3/day.

3.4. Rainwater Discharge Analysis

The potential volume of rainwater that can be collected in the mosque is calculated by considering the number of dry and wet days in 1 month. The rainfall intensity used in the calculation is the minimum rainfall intensity of 130.6 mm/hour. Calculation of the roof area using equation (1), but in the calculation of the roof area using half the width of the side projection (x/2) because in design the gutters are installed only on part of the width of the roof, then rainwater is collected in rainwater reservoirs (PAH). The result of the calculation of the roof area is 586.32 m^2.

Rainwater discharge that can flow through the roof is calculated using the rational formula, namely equation (3), the rainwater discharge runoff is 0.017 m^3/s. The discharge calculation is used in design the dimensions of the gutters that will drain water from the roof to the PAH. It is recommended that the gutters used are made of Polyvinyl Chloride (PVC) because they are cheap, easy to obtain, and resistant to rust. This explanation is reinforced by the research of M.Viter & Jauhari (2017), that PVC pipes are commonly used as drains because they are hard, light, strong, easy to install, resistant to alkali or toxic substances.

The volume of rainwater is calculated using equation (2) with a runoff coefficient of 0.8, the result of calculation is 61.258 m^3/day. The potential volume of rainwater is calculated by multiplying the volume of rainwater by the number of wet days in each month, while the water supply is the result of reducing the potential volume of rainwater with water demand.

Table 3. Potential rainwater volume at Al-Istiqomah Mosque

Month	Number of days	Dry day	Wet day	Potential volume of rainwater (m^3/month)	Water Demand (m^3/month)		Water Supply (m^3/month)	
					before the COVID-19 pandemic	during the COVID-19 pandemic	before the COVID-19 pandemic	during the COVID-19 pandemic
January	31	11	20	1225.16	60	10.466	1165.16	1214.70
February	29	8	21	1286.42	60	10.466	1226.42	1275.96
March	31	12	19	1163.91	60	10.466	1103.91	1153.44
April	30	11	19	1163.91	60	10.466	1103.91	1153.44
May	31	7	24	1470.20	60	10.466	1410.20	1459.73
June	30	6	24	1470.20	60	10.466	1410.20	1459.73
July	31	5	26	1592.71	60	10.466	1532.71	1582.25
August	31	8	23	1408.94	60	10.466	1348.94	1398.47
September	30	2	28	1715.23	60	10.466	1655.23	1704.76
October	31	9	22	1347.68	60	10.466	1287.68	1337.22
November	30	5	25	1531.46	60	10.466	1471.46	1520.99
December	31	8	23	1408.94	60	10.466	1348.94	1398.47

In Table 3 the calculation uses two conditions of the water demand, before the COVID-19 pandemic of 60 m^3/month is obtained from the results of interviews with the mosque manager, and based on calculation water demand during the COVID-19 pandemic of 10.466 m^3/month. This aims to compare the water supply in two conditions.

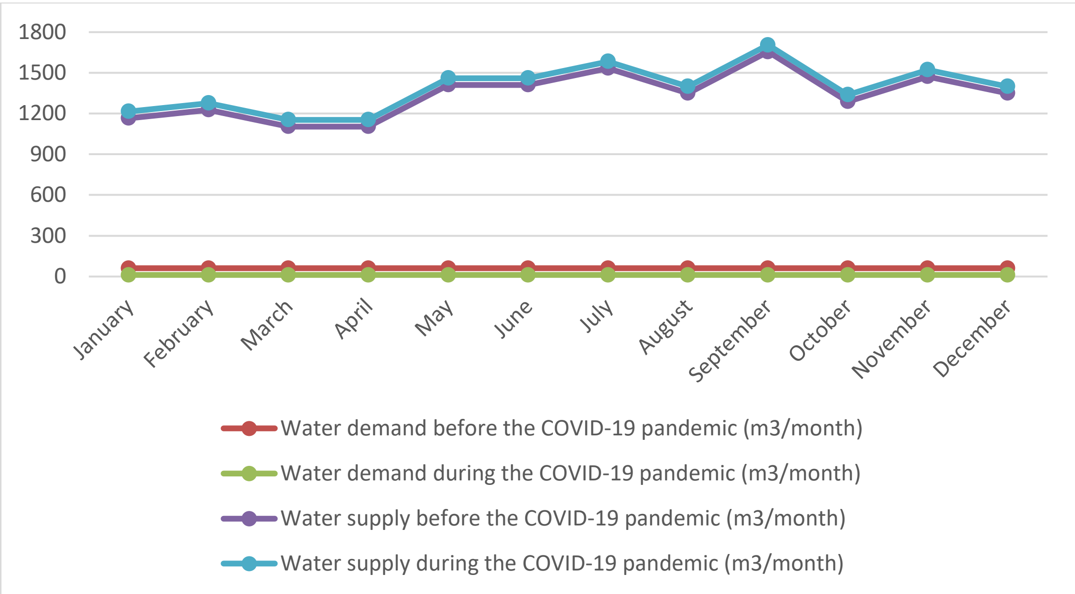

Figure 2. Comparison of water demand before covid-19 pandemic, during covid-19 pandemic and potential rainwater volume at Al-Istiqomah Mosque

Based on the Table 3 and Figure 2, it can be seen that there is still quite a lot of water remaining every month before and during COVID-19 pandemic, this means that rainwater has great potential as a source of clean water to meet water demand in the mosque.

The potential of rainwater is also supported by Lestari & Pamuji (2017) who researched rainwater as a source of clean water in the Agung Mosque of Banjarbaru South Kalimantan. From the result of calculations the volume of rainfall that can be obtained through the roof of the building indicates that the volume of water produced by rain is 1,785.60 m^3, while the water demand is 1,350 m^3/month. So, volume rainwater supply is greater than the volume of water demand. It can be concluded that rainwater is considered to be able to meet the demand of clean water in the mosque.

3.5. Tank Design Analysis

The design analysis is preceded by an analysis of the adequacy of the reservoir to meet daily water demand. The storage capacity period is the length of time to hold water that calculated by comparing the storage capacity and the total daily water demand. Based on the interview with mosque administrators, the total water demand in the Istiqomah Mosque is 60 m^3/month or 2 m^3/day for ablution, toilets, etc., while the calculation results show that the potential for rain water is 61.258 m^3/day. The water storage capacity is the sum of the reservoir and the tub in the bathroom, which is 5.28 m^3. So the water storage capacity in the form of PAH is 55.978 m^3.

According to the regulation of State Minister of Environment No.12 of 2009 states that : "Rainwater collection ponds are ponds or tank used to collect rainwater that falls on the roof of buidings which are channeled through gutters. PAH can be made of ferrous cement, brick, and fibreglass reinforced plastic (FRP) (Setyawaty & Anggraini, 2014). Besides that PAH can be in the form of polyethylene (PE) tanks which are easily found on the market, have various types of brands and shapes, capacities ranging from 250 – 5,200 liters, and are easy to move. The required PE tank is calculated by dividing the volume of water to be collected by the capacity of the PE tank to be purchased. However, if the PAH is made of concrete, the building is permanent and the dimensions are calculated using the volume formula in equation (4). The planned PAH height is 3 m, the ratio of length and width = 2:1, then the calculation is:

$$V = l.w.h$$
$$= 2w.w.3$$
$$= 6w^2$$
$$w = (\frac{V}{6})^{0,5}$$
$$= (\frac{55,978}{6})^{0,5}$$
$$= 3.054 \text{ m}$$
$$l = 2w$$
$$= 6.109 \text{ m}$$

The result of the study indicate thaat rainwater has great potential as a source of water to meet the mosque's water demand. This is in line with the eco-masjid and eco-campus programs. Based on Prabowo (2017), eco-masjid provides various advantages for mosques in terms of the following operations anf maintenance :

1) Increase water and energy security as resources needed by mosques and their congregations.
2) Improving the efficiency of the implementation of mosque operational activities and the use of various resources
3) Savings in operating and maintenance costs through reducing the consumption of various resources.
4) Avoid various risks of environmental impacts by increasing activities that have added value for the mosque
5) Become a place of learning for the younger generation about the values of good and ringht environmental care and management.
6) Eco-masjid is not only oriented to get wordly benefits but also as a practice of worship and alms.

Universities that have environmental insight integrate environmental science into policies, plans, programs and activities of the Tridharma Perguruan Tinggi implemented by the entire academic community. This is intended to create a green campus that is environmentally cultured in order to realize sustainable development as part of achieving the Sustainable Development Goals (SDGs). The main focus of the eco-campus is on efficient use of energy and water, minimizing waste and pollution manageent, reducing emissions and greenhouse gases, and economic efficiency.

4. Conclusions

Based on the calculation, the total of water demand in mosque is 60 m^3/month or 2 m^3/day, while the potential for rainwater in campus mosque at Engineering Faculty of Tanjungpura University is 61.258 m^3/day, and the potential volume of rainwater each month can meet the clean water demand. The great potential of rainwater as a source of clean water in mosque can save water resources which are currently limited in quantity and take advantage of the potential of rainwater which is often neglected, also supports the existence of eco-campus and eco-masjid programs because research is carried out in the campus environment as a pilot. The results of the study can also be applied in the community because the number of mosques are quite large and requires a lot of clean water.

Acknowledgement

I would like thank to Engineering Faculty of Tanjungpura University for funding this research, surveyors, and all parties who have helped this research.

References

Agustianto, D.A. 2014. Model Hubungan Hujan dan Runoff (Studi Lapangan). Jurnal Teknik Sipil dan Lingkungan 2 (2), 215 – 224.

Anuar, K., Adrianto, A. & Sukendi. 2015. Analisis Kualitas Air Hujan sebagai Sumber Air Minum terhadap Kesehatan Masyarakat (Studi Kasus di Kecamatan Bangko Bagansiapi api). Jurnal Dinamika Lingkungan Indonesia 2 (1), 32 – 39.

Asnaning, A.R., Surya & Saputra, A.E. 2018. Uji Kualitas Air Hujan Hasil Filtrasi untuk Penyediaan Air Bersih. Prosiding Seminar Nasional Pengembangan Teknologi Pertanian Politeknik Negeri Lampung, Lampung : 8 October 2018. pp.288 – 293.

Gomez-Monsalve, M., Dominguez, I.C., Yan, X., Ward, S. & Oviedo-Ocana, E.R. 2022. Environmental Performance of A Hybrid Rainwater Harvesting and Greywater Reuse System : A Case Study on A High Water Consumption Household in Colombia. Journal of Cleaner Production 345 (131125), 1 – 14.

Google Maps. 2022. The location of the Istiqomah Mosque, Faculty of Engineering, Tanjungpura University. Link : https://www.google.com/maps/place/Musholla+Al+-+Istiqomah/@-0.05708,109.3439663,17z/data=!3m1!4b1!4m5!3m4!1s0x2e1d5996d3ac93f7:0x79d7284707ae635a!8m2!3d-0.0571481!4d109.3461268?hl=en

Isramaulana, A. 2014. Rencana Anggaran Biaya untuk Sumur Resapan Masjid Besar Kota Banjarbaru. Jurnal Info Teknik 15 (2), 239 – 254.

Isworo, A. 2018. Profil GSG Kampung Brajan : Menggerakkan Jama'ah Dakwah Melalui Gerakan Shadaqah Sampah Berbasis Eco Masjid. Jakarta : Direktorat Pengelolaan Sampah, Direktorat Jenderal Pengelolaan Sampah, Limbah dan Bahan Beracun Berbahaya Kementerian Lingkungan Hidup dan Kehutanan.

Kementerian Lingkungan Hidup & UI. 2012. Pedoman Green Campus pada Perguruan Tinggi. Jakarta.

LAPAN Kota Pontianak. 2021. Data Intensitas Hujan. Pontianak

Lestari, E. & Pamuji, B. 2017. Perencanaan Teknologi Pemanenan Air Hujan sebagai Sumber Air Bersih pada Masjid Agung Banjarbaru Kalimantan Selatan. Jurnal Muara Sains, Teknologi, Kedokteran, dan Ilmu Kesehatan 1 (2), 1 – 12.

M. Viter, J. & Jauhari L.P.B. 2017. Perancangan Kap Lampu yang Memiliki Nilai Budaya Tangerang Selatan dengan Menggunakan Material Pipa PVC. Jurnal Inosains 12 (1), 11 – 15.

McCarton, L., O' Hogain, S & Nasr, A. 2022. Special Issue : NBS for Resilient Cities and Communities The Circular Economy of Water – Investigaring The Spatial Variation of Rainwater Harvesting Systems in Ireland. Journal Nature-Based Solutions 2 (100018), 1 – 25.

Natsir, M.F., Agus, M.A.A., Rachmadani, S.A., Mushbir, A.L., Fasha, A.D., & Fachry, A. 2020. Analisis Kuantitas Air Bekas Wudhu pada Masjid Kota Makassar 2020. Jurnal Nasional Ilmu Kesehatan 2 (3), 44 – 50.

Ningsih, F. 2013. Pemanfaatan Air Hujan untuk Kebutuhan Air Minum (Studi Kasus Desa Limbung Kecamatan Sungai Raya Kabupaten Kubu Raya). Skripsi, Universitas Tanjungpura.

Peraturan Menteri Kesehatan Republik Indonesia Nomor 492 Tahun 2010 tentang Persyaratan Kualitas Air.

Peraturan Menteri Kesehatan Republik Indonesia Nomor Nomor 32 Tahun 2017 tentang Standar Baku Mutu Kesehatan Lingkungan dan Persyaratan Kesehatan Air untuk Keperluan Higiene Sanitasi, Kolam Renang, Solus per aqua, dan Pemandian Umum.

Peraturan Menteri Negara Lingkungan Hidup No. 12 tahun 2009 tentang Pemanfaatan Air Hujan.

Piemontese, L., Castelli, G., Fetzer, I., Barron, J., & Liniger, H. 2020. Estimating The Global Potential of Water Harvesting from Successful Case Studies. Global Environmental Change 63 (102121), 1 – 13.

Prabowo, H. 2017. Ecomasjid : Dari Masjid Makmurkan Bumi, Jakarta : Lembaga Pemuliaan Lingkungan Hidup dan Sumber Daya Alam. Majelis Ulama Indonesia.

Rahim, S.E., Damiri, N., Zaman, C., Husin., Anggraini, D.E., Harokan, A., & Muntaha, A. 2019. Perencanaan Panen Air Hujan sebagai Sumber Air Bersih Alternatif di Kampus STIK Bina Husada Palembang. Prosiding Seminar Nasional Hari Air Dunia 2019, Palembang : 21 March 2019. pp.133 – 144.

Rahmansah & Rauf, B. 2014. Arsitektur Tradisional Bugis Makassar. Jurnal Forum Bangunan 12 (2), 56 – 63.

Setyawaty, L.M. & Anggraini, F. 2014. Modul Sosialisasi dan Diseminasi Standar Pedoman dan Manual, Penampungan Air Hujan. Pusat Penelitian dan Pengembangan Permukiman Balitbang Kementerian Pekerjaan Umum.

Syawalia, S. 2018. Perencanaan Sistem Penyediaan Air Bersih dari Sumber Air Hujan pada Kawasan Permukiman Kumuh Kelurahan Tambelan Sampit Kecamatan Pontianak Timur. Skripsi, Universitas Tanjungpura.

Wardhana, W.A. 1999. Dampak Pencemaran Lingkungan. Yogyakarta : Andi Offset.