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THE POTENTIAL OF RAINWATER HARVESTING AS AN ALTERNATIVE SOURCE OF CLEAN WATER AT THE FACULTY OF SCIENCE AND TECHNOLOGY UIN WALISONGO SEMARANG

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ABSTRACT

The Potential of Rainwater Harvesting as an Alternative Source of Clean Water at the Faculty of Science and Technology UIN Walisongo Semarang. Rainwater harvesting (RWH) is the process of directly preventing rainwater runoff and introducing rainwater into a reservoir for daily use. RWH can also be an alternative for providing clean water in the UIN Walisongo campus area. With the construction of new buildings and the addition of the number of students each year, the need for clean water is also increasing. This study aims to determine the quality of rainwater in the FST Building and to analyse the potential of rainwater harvesting as an alternative source of clean water in the FST Building of UIN Walisongo Semarang. This study examined rainwater quality as a clean water alternative in the Faculty of Science and Technology building. The location for taking rainwater samples was carried out at the FST Campus 3 Building. Laboratory tests for rainwater quality were carried out at the Centre for Standardisation and Industrial Pollution Prevention Services (BBSPJPPI) in Semarang. The rainwater samples analyzed met the clean water quality standards based on Ministry of Health Regulation No. 32 of 2017 concerning Environmental Health Quality Standards and Water Health Requirements for Sanitary Hygiene, Swimming Pools, Solus Per Aqua, and Public Baths, except for the organic matter parameter (KMnO4), according to laboratory tests.

INTRODUCTION

Rapid population growth, accompanied by development activities, has caused changes in land use. The land, which was originally green open land, rice fields, and parks, was transformed into residential and industrial areas, as well as new road access and new toll road access. According to hydrological analysis, the impact of this land use change is an increase in direct surface flow and a decrease in the amount of water infiltration into the soil. This impact further led to an increasingly unequal distribution of water between the rainy and dry seasons, resulting in disasters. In the rainy season, flooding increases, while in the dry season, the threat of drought becomes more real. Floods and droughts cause not only loss of property but also loss of life.

In addition to their positive effects, development activities in Indonesia also have negative consequences. Land clearing and land conversion cause a reduction in water absorption areas. In areas that are still natural, 90% of rainwater returns to the natural cycle, namely the hydrological cycle, while 10% of rainwater becomes surface runoff. Meanwhile, in areas that have 10–50% built-up land (rural–suburban), the run-off value reaches 20–30%, while in areas that have 75–100% impervious area (urban), the run-off value increases by 55% [1].

In a big city like Semarang City, the rapid development, apart from increasing surface water runoff, is also accompanied by an increase in clean water sources, which are increasingly scarce. As of January 2021, 60% of Semarang City PDAM service was available, with a total of 186,726 customers. [2]. According to this data, as many as 40% of the people in Semarang City are not served by PDAM and instead use other water sources. Meanwhile, Analisar's research [3] shows that groundwater utilization accounts for around 80% of Semarang's clean water needs. In the article written by Megarani [4], it was stated that according to the results of research by the Amrta Institute for Water Literacy and the IHE Delft Institute for Water Education in 2022, as many as 79.7% of Semarang residents use groundwater to meet their daily needs, with 48.6% using deep groundwater and 31.1% using shallow groundwater. Apart from that, it was also stated that the water sources used by PDAM Semarang City are artesian water (deep groundwater wells), springs, and surface water from the Jatibarang Reservoir.

Exploitation of groundwater, which is used as a source of clean water to meet daily needs, can result in land subsidence if it is not balanced with groundwater recharge. This is especially true in areas where the soil is not solid and heavy buildings stand on top of it. To reduce the potential and as an anticipatory step, rainwater harvesting (PAH) applications can be implemented. PAH is the process of preventing direct rainwater runoff and putting rainwater into reservoirs for use. According to the Minister of Public Works Regulation No.11/PRT/M/2014 concerning Rainwater Management, there are three types of rainwater management: maximizing the use of rainwater in buildings and plots, maximizing rainwater infiltration, and temporarily retaining rainwater to reduce rainwater runoff. The first priority in rainwater management is to maximize the use of rainwater in buildings and plots, particularly in areas with limited water availability. This approach aims to maximize the use of rainwater for daily activities.

PAH can also serve as an alternative to providing clean water in the UIN Walisongo campus area. With the construction of new buildings and the increase in the number of students every year, the need for clean water also increases. The Faculty of Science and Technology Building is no exception; currently, there are 10 study programs that conduct full face-to-face lectures. The presence of almost all lecturers, students, and education staff every day in the FST Building causes the need for clean water to automatically increase. Therefore, research regarding the potential for rainwater harvesting as an alternative source of clean water based on the quality of rainwater in the FST Building needs to be carried out.

MATERIALS AND RESEARCH METHODS

This research is laboratory research. In this study, an analysis of the quality of rainwater as an alternative source of clean water was carried out in the Faculty of Science and Technology Building at UIN Walisongo Semarang. Rainwater sampling was carried out at the Faculty of Science and Technology Building, UIN Walisongo Semarang, located on Jl. Prof. Hamka Campus 3, Ngaliyan, Semarang. Rainwater quality laboratory tests are carried out at the Centre for Standardisation and Industrial Pollution Prevention Services (BBSPJPPI), located on Jl. Kimangunsarkoro No. 6, Semarang.

Rainwater samples were taken from the FST Building and tested at the Semarang Centre for Standardisation and Industrial Pollution Prevention Services (BBSPJPPI) to determine the quality of rainwater. The results of testing parameters in rainwater are then compared with quality standards based on Minister of Health Regulation No. 32 of 2017 concerning Environmental Health Quality Standards and Water Health Requirements for Sanitation Hygiene, Swimming Pools, Solus Per Aqua, and Public Baths.

RESEARCH RESULTS AND DISCUSSION

Rainwater samples that fell in the area of the Faculty of Science and Technology Building were taken and their quality tested at the laboratory of the Centre for Standardisation and Industrial Pollution Prevention Services (BBSPJPPI) in Semarang on October 10 and 24, 2022. Each 5-liter sample of rainwater was analyzed. Before being sent to BBSPJPPI in a container, rainwater pH and temperature are measured. This is because pH and temperature are values that change easily over time. The results of the rainwater quality testing are then compared with quality standards based on Minister of Health Regulation No. 32 of 2017 for sanitation hygiene purposes, and the results are shown in Table 2 below.

Table 2. Rainwater Quality Test Results Based on Minister of Health Regulation No. 32 of 2017

No.	Parameter	Unit	Analysis Results		Quality standards
			October 10, 2022	October 24, 2022	
A	Physical Parameters				
1	Turbidity	NTU	1.75	1.22	25
2	Color	TCU	12.87	6,235	50
3	Dissolved solids (Total Dissolved Solids)	mg/l	50	54	1000
4	Temperature	°C	26.0	25.5	± 3°C air temperature
5	Flavor	-	Tasteless	Tasteless	Tasteless
6	Smell	-	No smell	No smell	No smell
B	Biological Parameters				
1	Total coliforms	CFU/100 ml	40	11	50
2	E. coli	CFU/100 ml	0	0	0
C	Chemical Parameters				
1	pH	-	7.68	8.02	6.5-8.5
2	Iron	mg/l	0.037	0.030	1.0
3	Fluoride	mg/l	0.037	0.026	1.5
4	Hardness (CaCO3)	mg/l	24.43	18.53	500
5	Manganese	mg/l	< 0.010	< 0.010	0.5
6	Nitrate as N	mg/l	0.552	0.083	10
7	Nitrite as N	mg/l	0.035	0.006	1.0
8	Cyanide	mg/l	0.002	0.006	0.1
9	Detergent	mg/l	< 0.010	< 0.010	0.05
10	Total pesticide	mg/l	-	-	0.1
11	Mercury	mg/l	< 0.001	< 0.001	0.001
12	Arsen	mg/l	< 0.003	< 0.003	0.05
13	Cadmium	mg/l	< 0.001	< 0.001	0.005
14	Chromium (valency 6)	mg/l	< 0.001	< 0.001	0.05
15	Selenium	mg/l	< 0.002	< 0.002	0.01
16	Zinc	mg/l	< 0.009	< 0.009	15
17	Sulfate	mg/l	3,791	3,122	400
18	Lead	mg/l	< 0.030	< 0.030	0.05
19	Benzene	mg/l	-	-	0.01
20	Organic substances (KMnO4)	mg/l	12.32	7,785	10

Based on the results of laboratory analysis of the quality of rainwater taken at the Faculty of Science and Technology Building, it is known that the quality of rainwater in 2 samples meets almost all the quality standards in Minister of Health Regulation No. 32 of 2017, so it can be said that the rainwater that falls from the FST Building is suitable to be used as a source of clean water. Physical parameters such as turbidity, colour, dissolved solids (TDS), temperature, taste, and odour meet quality standards. Similarly, biological parameters such as total coliforms and E. coli meet quality standards. Meanwhile, for chemical parameters, there is 1 parameter out of 18 tested on October 10, 2022, that does not meet the quality standards, namely organic substances ($KMnO_4$). The total pesticide and benzene parameters were not tested.

When precipitation or rain occurs, rainwater itself is clean water. However, this rainwater can become polluted when it is in the atmosphere due to the presence of dust particles, microorganisms, and gases such as carbon dioxide, nitrogen, and ammonia. The quality of harvested rainwater can vary depending on pollution in the atmosphere, harvesting methods, and storage, but overall it is almost the same as a supply of clean, processed water. [5].

Contamination of dissolved chemicals during precipitation and leaching due to the characteristics of the rainwater system components can cause levels of organic substances ($KMnO_4$) in the analysed rainwater samples to exceed quality standards. Meanwhile, the levels of biological parameters contained in rainwater (total coliform) are caused by bird droppings or poor rainwater collection and storage design. [5]. In this study, rainwater samples flowing through gutters from the roof were collected in open buckets, so contamination of these biological parameters was very likely to occur. This is also supported by the presence of birds that live and often land on the Faculty of Science and Technology Building and its surroundings.

Based on the results of laboratory tests on the quality of rainwater, the rainwater that falls on the FST Building can be used as an alternative source of clean water in the FST Building. Certain treatments are required to eliminate $KMnO_4$ organic material content that exceeds quality standards. The presence of organic matter in water is closely related to changes in water's physical properties, namely the appearance of undesirable color, odor, taste, and turbidity. Excessive levels of organic substances like $KMnO_4$ in water not only produce an unpleasant odour, but they also pose a health risk by potentially causing stomach aches when consumed. [6].

Research by Fatian, Siswoyo, and Haribowo [7] on rainwater collected and stored for different periods of time shows that the longer the storage period, the higher the $KMnO_4$ levels and total coliforms. Treatment to reduce $KMnO_4$ and coliform content in water is through a filtration process using zeolite, activated carbon, and activated sand. These filters have several advantages, namely that they are simple and relatively easy to implement by ordinary people; there is no need to add chemicals; there are low operating and maintenance costs; and the filter material is relatively easy to maintain.

Other research on rainwater quality was carried out by Yulistyorini, Idfi, and Fahmi [8]. The collected rainwater has a $KMnO_4$ concentration that exceeds the quality standard, so further treatment is required. It is stated that the $KMnO_4$ contained in rainwater can come from household and industrial processes, as well as materials originating from agricultural and livestock activities. $KMnO_4$ levels that exceed quality standards can affect human health in the kidneys, liver, skin, and nervous system [9]. Aside from that, it also produces an unpleasant odor in the water.

The quality of the rainwater that fell on the FST UIN Walisongo Semarang Building was also compared with the mandatory parameters for drinking water quality standards in Minister of Health Regulation No. 492/Menkes/Per/IV/2010. If this rainwater is to be used as a source of drinking water, it requires prior processing because there are parameters whose values exceed quality standards. The parameter under consideration is the total coliform bacteria count. Coliforms are bacteria commonly found in the environment that are usually found in the intestines of mammals, including humans. Microbial contamination of raw water sources has the potential to spread waterborne disease. High concentrations of microbes in water cause water turbidity, but they can also cause diarrhea, fever, nausea, vomiting, and digestive disorders. [10]. In unclean environmental conditions, coliform bacteria can multiply quickly, resulting in greater contamination.

Research on rainwater treatment to eliminate coliform bacteria in water sources was carried out by Yulistyorini, Idfi, and Fahmi [8]. Rainwater is given several filtration treatments using activated carbon and zeolite. In the first treatment, the filter used only activated carbon, resulting in a 30% reduction in coliform concentration. The second treatment (using 75% active carbon and 25% zeolite) and the third treatment (using 50% active carbon and 50%

zeolite) actually increased the coliform concentration in the water after treatment. The fourth treatment, which used 25% activated carbon and 75% zeolite, resulted in a 36% reduction in coliform content. Meanwhile, the fifth treatment, using zeolite alone, resulted in a 29% reduction in coliforms. Activated carbon can lower the concentration of coliforms in water because it can bind microorganisms.

An alternative use of collected or harvested rainwater is to irrigate plants in the gardens surrounding the FST Building, following the priority scale for rainwater management as outlined in Minister of Public Works Regulation No. 11/PRT/M/2014 concerning Rainwater Management. Priority 1 is carried out to maximize utilization in daily activities, even though water availability is sufficient in the FST Building. Priority 2 is carried out to maximise rainwater infiltration, which is carried out in areas that make it possible to carry out rainwater infiltration efforts.

CONCLUSIONS AND RECOMMENDATIONS

Laboratory tests confirm that the rainwater quality in the FST UIN Walisongo Semarang Building meets the clean water quality standards outlined in Minister of Health Regulation No. 32 of 2017, which pertains to Environmental Health Quality Standards and Health Requirements for Water for Sanitation Hygiene, Swimming Pools, Solus Per Aqua, and Public Baths, with the exception of organic substance parameters ($KMnO4$). This research suggests that we need to conduct research on the potential for rainwater harvesting in all buildings at UIN Walisongo Semarang to determine the overall PAH potential of the institution. Additionally, we need to build a reservoir to collect rainwater for use as a source of clean water or for groundwater recharge.

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