

Rooftop Rainwater Harvesting (RRWH) for Schools: Scenario Water Resources Development in Yuniior High School

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ABSTRACT

Rooftop Rainwater Harvesting (RRWH) is the most popular alternative water source in many urban, suburban, and rural areas. It has received renewed attention as a source of abundant water, water-saving and conservation, and sustainable development. The city of Biak Numfor-Papua Numfor – Papua is facing the problem of water scarcity due to the natural conditions of corals and rocks. The supply of clean water is not able to meet the demand. However, the weather conditions in Biak Numfor-Papua are unpredictable, with high rainfall being a potential for water conservation. This study proposes RRWH as a rainwater harvesting system for non-potable water consumption developed in the Junior High School (SMP) Building. The urgency of placing RRWH in schools is to fulfill the need for clean water and develop water conservation habits for teachers and students. This study describes the perceptions of teachers and students on the implementation of RRWH in schools. The distribution of questionnaires to 30 junior high school teachers and 60 junior high school students to find out their perceptions about the limitations of clean water, the potential for implementing RRWH, and the involvement of teachers and students in RRWH management. The analysis results show that most teachers and students reveal that water availability in schools is very minimal. Furthermore, the potential for implementing the RRWH system is highly rated—likewise, respondents' perceptions of the possibility of involving students in the management of RRWH. The results of this study indicate that the RRWH model can be applied to Junior High School in Biak Numfor-Papua.

Keywords: *Water Conservation, Management, and Perception*

1. INTRODUCTION

In general, the amount of water on earth is enormous, but the amount of clean water available is insufficient, so many people experience water shortages [1]. Water shortages are triggered by increasing demand, increasing population, uneven water distribution, increasing water pollution, and inefficient water use. Several studies have identified that water shortages are exacerbated by water leakage due to equipment damage that is not repaired immediately and bad behavior in water use. In addition, there are still potential sources of clean water that have not been used, such as rainwater as an alternative water source. One way to conserve water in schools is to harvest rainwater to collect, collect, and store rainwater. Rainwater is one of the natural resources that has not been utilized optimally and is only allowed to flow into drainage channels to rivers which eventually empties into the sea [2]. Rainwater can be stored and managed correctly. In this case, rainwater will have many benefits for human survival, especially for the sustainability of providing clean water in the

community. Rainwater itself can be used to meet various human needs, including bathing, washing, and even drinking water.

Rainwater harvesting is a method or technology used to collect rainwater from building roofs, ground surfaces, roads, or rock hills and is used as a source of clean water supply [3]. Rainwater harvesting is an alternative water source practiced for centuries in countries that often experience water shortages [4]. Rainwater quality generally allows it to be used as a source of clean water because of its low contaminant content. However, when rainwater interacts with natural conditions, the water will carry contaminants both physically, chemically, and microbiologically.

Several works of literature show different conclusions regarding the quality of rainwater harvesting (RRWH) from the rooftop of buildings [5]. The quality of RRWH is highly dependent on regional characteristics such as topography, weather conditions, type of rainwater catchment area, level of air pollution, type of storage tank, and rainwater management.

Generally, the collected rainwater is very clean in suburban or rural areas. However, in urban areas where there are many industrial areas and dense transportation flows, the quality of rainwater is so affected that it contains heavy metals and organic matter from exhaust gas emissions. In addition to industry and transportation, the surface of the rainwater-catching material also affects the water quality [6].

The city of Biak Numfor-Papua is also experiencing the problem of water scarcity. The land covered by coral and rocks hinders the springs' achievement, likewise with the low water absorption level. This complicates efforts to conserve clean water. On the other hand, the potential for rainwater is quite large, indicated by the high intensity of rain.

The concept of rainwater harvesting can be applied to buildings with a large roof area. In addition, the use of clean water is also simultaneous, or water storage does not last long. For this reason, the authors offer the construction of RRWH in one of the junior high schools (SMP) in Biak Numfor-Papua. Teachers and students can manage rainwater harvesting systems for non-potable water consumption as a solution to the problem of water scarcity. With this application, teachers can develop students' environmental knowledge and attitudes in water conservation efforts.

This study describes the concept of Roof Rain Water Harvesting (RRWH) and the perceptions of teachers and students about the application of the concept as a conservation lesson in SMP on Biak Numfor-Papua.

2. METHODS

This study uses a quantitative method to review the perceptions of teachers and students about the conservation learning method through the application of RRWH in the junior high school building. The research sample consisted of 30 teachers and 60 students from three public junior high schools in Biak Numfor-Papua. Perceptions were assessed on three aspects: the availability of clean water in junior high schools, the potential for implementing the system in schools, and students' involvement in system management. Before distributing the questionnaire, the researchers present the WWRH system to the teacher and student. Data analysis used descriptive quantitative methods to answer respondents' perceptions of RRWH placement in schools.

Table 1. Category Rating Indicator

Category	Rate
Very High	3.26 – 4.00
High	2.51 – 3.25
Low	1.76 – 2.50
Very Low	1.00 – 1.75

The results of the perception analysis are divided into four categories (Table 1)

3. RESULTS AND DISCUSSION

3.1. Rooftop Rainwater Harvesting System with the Storage Tank

Rooftop Rainwater Harvesting (RRWH) is a technique for collecting and storing rainwater into tanks or reservoirs [7]. The RRWH works because rainwater stored on the roof of the house/building is channeled through a ditch or pipe to the RRWH building, divided into several bulkheads containing various media to filter rainwater from various impurities. Objects that can be used as screens for filtering media are sequential fibers, sand, gravel, charcoal, red coal, gravel mixed with limestone and sand. After passing through the last partition, the water will be accommodated in the reservoir. Then the water will be poured into a water reservoir. This tub has holes for air circulation so that water can be pumped out of the tub. The provisions for making RRWH are that the well must be on flat ground/land, not on marble, steep, or unstable soil; wells and landfills and septic tanks are at least five meters measured from the edge of the tank.

The method of making a rainwater harvesting system is as follows:

1. Excavation of soil to make wells. The depth of excavation does not exceed the groundwater level;
2. Reinforcing the good walls with concrete and installing bricks and ceramics.
3. Filling the wellbore with coral, palm fiber, crushed stone, and charcoal;
4. Installation of pipes by connecting roof gutters to wells as rainwater reservoirs;
5. Construction drainage channels from infiltration wells to ditches to anticipate excess water.

The RRWH system requires healthy management, namely continuous water filling and cleaning once a year. This is because rainwater which contains much dirt, first enters the water intake tub [8]. Rooftop Rainwater Harvesting (RRWH) is one of the simple solutions offered to overcome a clean water crisis threat. Especially in climate change. The utilization of Rooftop Rainwater Harvesting (RRWH) is very wise because Rooftop Rainwater Harvesting (RRWH) optimizes the utilization of wasted rainwater. Moreover, this technology is relatively cheap compared to other technologies, such as seawater desalination technology.

Calculation of rainwater harvesting is needed to determine the volume of rainwater that can be accommodated through the roof of the building by using a simple calculation method to determine the volume of rainwater that can be accommodated or consumed for

domestic needs. Based on the estimation of water users in schools, as many as 800 people/day with a volume of 5 liters/person. As well as rainfall estimates based on rain data for ten years, it is concluded that the amount of water utilized in a year is 774 m³. Figure 1 describes the RRWH system in a school building.



Figure 1. Rooftop Rainwater Harvesting

3.2. Teacher and Student Perceptions about the Implementation of RRWH

The implementation of RRWH requires the support of teachers and students. Water tank maintenance activities that are carried out regularly can be carried out with the involvement of teachers and students. The involvement of teachers and students is part of the introduction of water conservation culture. The results of the analysis of teacher and student perceptions of the RRWH system are divided into four categories (Table 2)

Table 2. Indicators of Teacher and Student Perceptions.

Indicator	Perception of Teacher	Perception of Student
Availability of Clean Water	2.33	2.08
System Deployment Potential	3.37	3.37
Involvement of students in the management of RRWH	3.49	3.52

The results of the analysis above indicate that respondents consider that the availability of clean water in schools is very minimal. The perception of teachers and students regarding the availability of water is 2.33 or indicates a low category. Furthermore, respondents' approval of the potential of conservation system is the high category. The result means that the respondents assess that the RRWH system can be installed in school buildings. Teachers and students also have a high desire to be involved in the management of RRWH.

From these considerations, schools will store enough water to meet their needs for flushing toilets, washing hands, and watering plants. The school environment

sanitation program will be realized well thanks to the adequacy of clean water.

The description of the study results shows that educational facilities make it possible to apply the rainwater conservation model. The provision of water with a 1m³ capacity tank is adequate to meet the clean water needs of teachers and students. Clean water is the main requirement in maintaining environmental sanitation [9]. The priority of providing integrated infiltration wells in the use of rainwater is also an effort to balance the local water balance in Biak Numfor-Papua.

The construction of an integrated Roof Rainwater Harvesting (RRWH) facility is an effort to raise the environmental awareness of teachers and students. Student participation in water conservation activities is part of environmental education. In addition, the school will become a medium for developing a culture of water conservation and providing a learning experience for students in solving environmental problems.

An experiential learning method is practical and permanent cognitive development [10]. In addition, this model also makes it easier for teachers to transfer knowledge to students [11].

4. CONCLUSION

RRWH is a water conservation system for the limited clean water in Biak Numfor-Papua. Implementation of the system requires the support of teachers and students in its maintenance. Teachers and students generally have a good perception of installing the RRWH system in schools. With this system, teachers and students can create a clean school environment.

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