

Utilization of Rainwater as Consumable Water with Rainwater Harvesting Methods: A Literature Review

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ABSTRACT

Background: Water demand is expected to increase in all sectors. Rainwater can be a solution to the lack of the clean water crisis. The quality of rainwater harvested is highly dependent on the rainwater harvesting system. **Methods:** This literature review is a narrative review using sources from the Scopus and Pubmed databases. The keywords used were utilization, rainwater, and rainwater harvesting methods. Of the 30 references identified in the search phase, ten were eligible for inclusion in this review. **Results:** Harvested rainwater can be used for multiple purposes such as watering plants, washing, bathing, and even cooking if the water quality meets health standards. There are three fundamental components that should be present within the rainwater harvesting system: 1) a rainwater pipe that traps water, e.g., utilizing the shape of the roof surface, 2) a water distribution system, i.e., a system that transports water from the roof to the superficies through a gutter, and 3) a reservoir that stores rainwater such as barrels, tubs, or ponds. **Conclusions:** Water conservation efforts are needed to meet the demand for water in the face of increasingly limited supply. Harvesting rainwater is one of the methods of water conservation that can be carried out by each household of the community to collect raw rainwater for consumption and use. If rainwater harvesting is practiced in a sustainable manner, it will help maintain water and environmental sustainability, thus supporting the livelihood of present and future generations.

Key words: Utilization, Rainwater, Consumable, Harvesting, Water Quality.

INTRODUCTION

A basic human necessity is water. Nearly every activity, from industrial manufacturing to daily tasks, need access to water. Since water makes up the bodies of all living things, everyone is concerned about its supply. The government and the community continue to strive for clean water. One common goal is the conservation of water resources. Conservation of water resources refers to saving and reusing water.¹ This is important because there are several problems related to water availability, including the decline in groundwater level, drought, and the impact of climate change. Limited water availability, also known as water scarcity, is caused by the increasing use of water from agriculture, industry, housing, and global climate change. One way to overcome water scarcity is to effectively utilize rainwater.²

Communities may find that rainwater is a good source of drinking water, particularly in tropical regions where it serves as the primary source. Rainwater collection enables homes to be self-sufficient and offer clean, fresh water. The following are some benefits of making rainwater the primary water source for communities: (a). Independence: Rainwater harvesting can provide a reliable source of water for communities, especially in rural and remote areas where access to water is limited. Building large-scale water supply systems can be too expensive for these communities, but rainwater harvesting systems are relatively simple to construct and maintain, making them a more affordable option. b) **Mitigating drought:** Rainwater harvesting allows communities to collect and store water during periods of heavy rainfall, which can

then be used during times of drought. By collecting and storing rainwater, communities can help to recharge aquifers, ensuring that they will have a reliable source of water during future droughts. c). **Reducing stormwater runoff:** Rainwater harvesting can help to reduce the amount of stormwater runoff, which can be a problem in drought-prone areas.

Communities can lessen the quantity of stormwater flow and avert issues like flooding, erosion, and water contamination by collecting and storing rainwater. However, there are also some challenges to using rainwater as the main source of water for communities, such as air contamination that can cause rainwater to become acidic. Additionally, the feasibility of rainwater harvesting depends on factors such as current water supplies, climate, available resources, cultural preferences, gender roles, community dynamics, supply and demand. Overall, rainwater can be a valuable source of water for communities, especially in areas where access to water is limited.

A method of gathering or storing rainwater for later use during periods of low rainfall is referred to as rainwater harvesting techniques. Judging from the scope of implementation, harvesting techniques are classified into two categories, namely¹ rooftop rainwater harvesting techniques and² surface runoff rainwater harvesting techniques using infrastructure such as ditches, reservoirs, ponds, etc. Rainwater harvesting can be developed in Indonesia, especially in the archipelago and wetlands without clean freshwater. Rainwater harvesting is also suitable for urban areas.³ In addition to clean water supplied by local water company, so-called "PDAM", some

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Table 1. Research results related to the use of rainwater using rain harvesting methods.

No	Author	Results
1	Adinugraha F, dkk ⁽⁵⁾	The reservoir is used as a place to collect filtered rainwater. The water in the reservoir can be used as a reserve for clean water needs.
2	Malik, Yogi Septian ⁽¹⁾	Rainfall parameters are very sensitive to quantitative hydrology of individual scale rainwater harvesting to meet water needs in Bengkalis District, Bengkalis Regency.
3	Tanti Untari, Joni Kusnadi ⁽⁶⁾	The results of this study are known physical, chemical, and biological characteristics of rainwater in Malang City as follows.
4	Hari Dwi Wahyudi, Syarifah Aini ⁽⁷⁾	The results of the filtered rainwater quality test show a value below the maximum threshold according to Regulation No. 32 of the Ministry of Health of the Republic of Indonesia of 2017 concerning Environmental Health Quality Standards and Water Health Requirements for Sanitation, Swimming Pools, Solus Per Aqua, and Public Baths.
5	Fayez A. Abdulla, A.W. Al-Shareef ⁽⁸⁾	Rainwater harvesting is a technology that exists in most of Jordan but is not widespread. Samples from a roof system show that the water can be used for drinking purposes.
6	Dr. N. Balasubramanya ⁽⁹⁾	Rainwater collection is easy and economical in both rural and urban areas. All of the proposed treatments are very effective in reducing microbial contamination and are feasible at both rural and urban levels. Stormwater harvesting and disposal are affordable for individuals and are very useful in drought-prone areas.
7	A. K. Daoud, K. M. Swaileh, R. M. Ussein, M. Matani ⁽¹⁰⁾	The physicochemical quality of rainwater on the roof of the Palestinian Territory is generally sufficient for use as potable water. However, microbial analysis of saved stormwater samples showed significant microbial defilement by TC, FC, HPC, and several other microorganisms. The presence of these pathogens/potential pathogens clearly shows that the water is not appropriate for direct intake without treatment.
8	Che-Ani A.I, Shaari N, A. Sairi, M.F.M. Zain and M.M. Tahir ⁽¹¹⁾	Demand for water sources is increasing every day due to population growth and expansion in urbanization, industrialization, and irrigated agriculture. Adopting the idea of sustainability and retaining water sources will assist in addressing global water scarcity. The rainwater harvesting system is one of the ideas that may be utilized to solve the problem of water scarcity. The amount and quality of rainwater accumulated depends on the location's weather, geographic features, community activities, and storage tanks. In addition, since rainwater has high water quality, it has great potential as a future alternative water resource. The quality of rainwater always exceeds surface water and is comparable to groundwater. It can dissolve salts and minerals that are harmful to drinking and non-drinking water without touching the ground or rocks. The Sandakan City Council has proven that the rainwater harvesting system improves the quality of life of the people of Sandakan. The successful introduction of the stormwater harvesting system in Sandakan has contributed significantly to the future development and quality of life of its people. Government agencies play an important role in promoting this practice; for example, providing incentives by having relevant agencies provide funding.
9	Abdul Roviq, Hartuti Purnaweni, Suharyanto ⁽¹²⁾	Rainwater provided to refugees should be filtered again because it is suspected that it is unfit for consumption due to the presence of E. coli bacteria. Water that is to be consumed for drinking water must first be boiled.
10	L.R. Prihadi, Anie Yulistiyorini & Mujiyono ⁽¹³⁾	Rainwater harvesting systems in areas experiencing water shortages are an alternative to meet the needs of clean water in the community. This system can be applied to every house to provide clean water during the dry season. According to Jasa Tirta 1 laboratory results, the quality of rainwater after using the rainwater harvesting system is pH (6.5), Turbidity (4.2 NTU), Chloride (85.4 mg/L), Nitrate (<0.123 mg/L), Sulfate (<0.230 mg/L), Magnesium (3 mg/L), Total Hardness (12 mg/L), Ammonia (0.077 mg/L), and Iron (Ttd). With these parameters, the water produced by the rainwater harvesting system in the Mulyosari hamlet area meets the requirements for drinking water in accordance with the drinking water quality standards in PERMENKES & PER/IV/ number 492/MENKES/2010.

communities also use groundwater. However, overuse of groundwater, use of catchment areas for settlements, and designation as commercial areas cause groundwater shortages. When the water supply is unpredictable or limited, rainfall might be used as a backup to handle this problem. Stormwater can be utilized for flushing, cleaning, and sometimes even drinking.⁴ Rainwater harvesting technology, also known as rainwater harvesting technology or rainwater harvesting, is defined as a method of collecting or storing rainwater for further use during periods of low rainfall. Judging from the scope of its implementation, harvesting techniques can be divided into two categories:¹ covering rainwater harvesting technology (rainwater harvesting via a roof) and² rainwater harvesting (and runoff) technology with reservoir structures such as ditches, ponds, and reservoirs.³

Stormwater is a high-quality water source that can be used during the rainy season and has the capability to reduce pressure on the usage of clean water sources (freshwater sources). Stormwater harvesting from the roof of a house is usually the cleanest alternative for use as a source of clean water and only requires simple processing before water is used. Accordingly, rainwater harvesting appears to be a good alternative for areas experiencing groundwater quality problems.⁵

MATERIALS AND METHODS

This study is a literature review that tries to analyze rainwater harvesting for the provision of drinking water suitable for consumption. A

systematic search of available databases was conducted to acquire appropriate sources, i.e., reputable international and national journals, totaling 30 studies. Of the 30 studies found, ten were found to be relevant to the topic of this literature review. The bibliography of this article was written using the Mendeley application with the Vancouver writing style.

RESULTS

Table 1 shows the results of relevant studies related to research on the use of rainwater as drinking water using rainwater harvesting methods.

DISCUSSION

Rainwater harvesting is a method or technology used to acquire rainwater from roofs, land surfaces, streets, or rocky hills, which is then used to supply clean water. Rainwater is an extremely crucial part of the water supply, especially in regions where there is no clean water supply system, poor quality surface water, and no ground water.⁸

Rainwater is the purest form of water. Good quality rainwater may be accumulated and stored if rainwater harvesting systems are controlled and operated efficiently. This means that the roof stays clean, the first tools and filters are used, and the tank is kept closed to prevent light infiltration, which promotes algae increase and mosquito breeding.¹⁴ The physicochemical qualities of rainwater in terms of color, odor and taste, pH, total dissolved solids (TDS), and total hardness (TH),

meet the World Health Organization standards. The result from the filtered rainwater quality test shows a value below the maximum threshold, according to the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017 concerning Environmental Health Quality Standards and Water Health Requirements for Sanitary Hygiene, Swimming Pools, Solus Per Aqua, and Public Baths.⁷

There are three basic aspects that should be present in a rainwater harvesting system: 1) a rainwater pipe that traps water according to the shape of the roof superficies, 2) a water distribution system, i.e., a system that distributes rainwater from the roof to the holding container via a gutter, and 3) a stowage basin that stores rainwater, e.g., barrels, tubs, or ponds. In addition to the three fundamental components, additional equipment may be added with support components such as a water pump for pumping water from a tub or reservoir.¹⁵

Rainwater can be a good source of drinking water, but it is important to consider the benefits and safety of using it. Here are some benefits of using rainwater as a source of drinking water:

Low levels of dissolved minerals and pollutants: Rainwater contains very low levels of dissolved minerals and pollutants, making it ideal for drinking water. It is naturally filtered and mineral-enriched, which can help improve digestive processes and reduce bloating, joint pain, and inflammation.

Renewable resource: Rainwater is a renewable resource that can be collected and stored for future use. By collecting and storing rainwater, communities can become more self-sufficient and less dependent on outside sources of water.^{16,17}

Cost-effective: Rainwater harvesting systems are relatively simple to construct and maintain, making them a more affordable option for communities, especially in rural and remote areas where access to water is limited. However, it is important to note that rainwater can also contain germs and other contaminants that can make people sick. Here are some safety considerations when using rainwater as a source of drinking water:

Proper maintenance: It is important to maintain the rainwater system properly and ensure that the water quality is appropriate for the intended use. Germs and other contaminants can be found in rainwater, so it is important to ensure that the system is clean and free of debris.

Additional treatment: Rainwater might not be safe for household use without additional treatment. If you collect and store rainwater for drinking, you are responsible for ensuring that your water is safe. You should have your water and your system tested to ensure that it is safe for drinking.

Avoid using for certain purposes: For some uses, such as drinking, cooking, brushing your teeth, or washing or watering plants you expect to consume, rainwater should be avoided. If available, utilize the municipal tap water instead, or buy bottled water for these uses.¹⁸⁻²² In summary, rainwater can be a reliable source of drinking water, but it's crucial to weigh its advantages and safety concerns. It could need more treatment and proper upkeep to guarantee that the water is safe to consume due to many sources of pollutants including from air and the communities behavior relate to water source.^{22,23}

The use of rainwater for drinking water has various advantages for the environment. To name a few, these are: lessen the strain on water systems. Rainwater collection and use can lessen the strain on municipal water systems by lowering demand on them. This can be particularly significant in regions with scarce water resources or high water demand. Bring the hydrologic cycle back: Restoring the hydrologic cycle the mechanism that moves water through the earth's atmosphere, seas, and land—can be aided by rainwater harvesting. By collecting and storing rainwater, communities can help to replenish groundwater supplies and reduce the amount of stormwater runoff.

Minimize carbon footprint: By lowering the energy required to process and transport water, rainwater harvesting can assist in lowering the carbon footprint of communities.

Communities can lessen their need on energy-intensive water treatment and transportation systems by utilizing rainwater. Preserve local watersheds: By lowering the quantity of contaminants that enter nearby waterways and the amount of stormwater runoff, collecting and using rainwater can help preserve local watersheds.²³⁻²⁶ This can help to improve water quality and protect aquatic ecosystems. Maintain healthy soils: Rainwater is free of chemicals and salts that are typical of treated water, which can help to maintain healthy soils.

In addition to being essential for plant growth, healthy soils can lessen environmental issues like soil erosion. In general, there are a number of environmental advantages to using rainwater for drinking water, including as lessening the strain on water infrastructure, reestablishing the hydrologic cycle, lowering carbon emissions, safeguarding nearby watersheds, and preserving healthy soils. But it's crucial to make sure the water quality is suitable for the intended purpose and that the rainwater system is properly maintained.

CONCLUSION

To meet the demand for water whose supply is increasingly limited, water conservation efforts are needed. Harvesting rainwater is one of the methods of water conservation that can be carried out by the community at the household level via collection of raw rainwater suitable for consumption. If rainwater harvesting is practiced in a sustainable manner, it will help maintain water sustainability and environmental sustainability and support the livelihoods of present and future generations.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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