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A Review of Rainwater Harvesting in Malaysia: Prospects and Challenges

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ABSTRACT: A significant issue that contributes to worldwide water shortage is a mismatch between freshwater demand and supply. Exploration and use of rainwater seem to be feasible solutions for reducing the above-mentioned problem. The potential and difficulties of Malaysia's rainwater harvesting system (RWHS) are discussed in this paper. Malaysia may be classified as a nation with a lot of yearly rainfall and a lot of household water use. Malaysia is therefore in a good position to collect rainwater for both potable and non-potable purposes. Despite the fact that the RWH guidelines were published in Malaysia in 1999, the use of RWHS as an alternative water resource is still restricted owing to its lengthy payback period and low public acceptability. The cost of implementation, the wide application of commercial buildings, a cost-effective treatment system, and effective policy implementation, the use of green materials, public perception improvement, and reliable first flush technology are all major future challenges for RWHS implementation in Malaysia. Some suggestions, such as providing enough subsidies and restricting the use of piped water, are required for RWHS to be implemented at a larger scale.

KEYWORDS: Harvesting, Flood, Pollution, Rainwater, RWHS.

1. INTRODUCTION

Freshwater shortage has become a key problem in sustainable development in the new global development. This problem is clearly becoming a danger, as well as the most significant global risk in terms of potential effect. The growing worldwide population, improved living standards, changing consumption patterns, and the development of irrigated agriculture are the major driving factors behind the rising global demand for freshwater. Furthermore, global water shortage is defined by a mismatch between freshwater demand and supply. As a result, a number of studies have been conducted to evaluate global water shortage from the physical, social, and economic perspectives [1], [2].

Rainwater harvesting has been generally recognized as a viable option for reducing and minimizing the effects of water shortage [3]–[5]. In recent years, research on rainwater harvesting systems (RWHS), especially methods and treatment systems, has expanded considerably. Rainwater harvesting and storage (RWHS) is described as the gathering and storage of rainwater for use rather than waste as runoff [6].

RWHS methods are generally divided into two categories: surface runoff and roof top RWHS. The benefits of RWHS include the conservation of potable water, the decrease of nutrient loads in rivers, and the mitigation of floods in urban catchments. RWHS also offers additional benefits, such as a reduced carbon footprint compared to conventional water delivery systems and more efficient energy usage due to less pumping from source to consumer. Furthermore,

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RWHS has the ability to simultaneously solve the issue of water shortage while reducing reliance on household water supplies.

RWHS was also anticipated to be more cost-effective with a higher water tariff. In terms of environmental advantages, a South Korean research showed that RWHS might decrease floods by up to 10%.

This is in accordance with the findings of another research, which found that RWHS is less cost-effective for water delivery alone unless it is also used for flood control. Because RWHS may decrease household water consumption, it has the potential to postpone the construction of additional storage infrastructure. RWHS serves as an alternative water supply and lowers water-related health hazards for both technological and societal reasons.

RWHS has been shown to be capable of lowering peak water demands on the urban water supply. Even in regions with little rainfall, the adoption of RWHS in many parts of New South Wales, Australia, has resulted in significant water savings from the main supply. Reduced volume and peak demand advantages may be translated into smaller infrastructure sizes and lower operation and maintenance costs. For example, in a Melbourne neighbourhood, rainwater tanks may decrease network pipe diameters and operating expenses by up to 18 percent and 53 percent, respectively. Furthermore, adopting RWHS may result in significant savings in operational costs and greenhouse gas emissions for regional water delivery systems.

Because RWHS has the potential to decrease reliance on household water supplies, it has been applied in a variety of settings, including agricultural, residential, and commercial. RWHS can reach high percentage dependability over 95 percent for residential structures in many countries, including Australia, the United States, and Iran. RWHS may achieve up to 37 percent dependability when used on big roofs with significant water use, such as commercial buildings. In agricultural areas, the use of innovative techniques that incorporate rainwater may increase yields when compared to traditional methods.

RWHS has also been optimized using a variety of techniques. Hudzori used daily rainfall data in Nusajaya, Johor Bahru to develop a mathematical model for improving water storage tank and water utility supply for RWHS. Optimal tank size and energy consumption, according to Chiu, are indications of system dependability and become economically viable when both energy and water reductions are addressed simultaneously. In addition, RWHS were designed in Italy under various environmental conditions. According to their findings, demand fraction and modified storage fraction may be used to assess RWHS performance [3].

Various studies, such as technical framework and socio-technical practices, have been undertaken with the goal of implementing RWHS in the UK. As a result, many RWHS inventions based on gravity or non-gravity have been developed in the United Kingdom. Several nations have passed laws to promote the adoption of RWHS. For example, the Japanese government provides subsidies and low-interest loans to facilities that install RWHS. Rebates and tax exemptions, on the other hand, are available to promote the adoption of RWHS. The Spanish and Belgian governments for new buildings with a specified roof area have required RWHS. The data above show that the nations have paid close attention to water management methods and have made significant efforts to locate an alternate water source. With an average

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annual rainfall of 2400 mm, Malaysia is a tropical nation with abundant water resources. Despite the fact that Malaysia has never had a severe water crisis in recent decades, the uneven distribution of rainfall across distance and time has resulted in some regions experiencing dry periods and others experiencing catastrophic floods. According to the aforementioned facts, the use of rainwater for alternative water supplies and flash flood mitigation is critical and has a great deal of potential[7].

RWHS from a Global Perspective RWHS is defined as the direct collection of rainfall from roofs and other purpose-built catchments, as well as sheet runoff from manufactured ground or natural surface catchments and rock catchments for potable and non-potable purposes. RWHS has been the subject of much research because it offers many environmental and societal benefits. The number of studies linked to RWHS has grown dramatically over the last four decades, as shown in Figure 3 based on a keyword search in the Scopus database for the term "RWHS." The total number of publications found using the keywords "rainwater harvesting" was 2000 at the time of this study. RWHS offers high-quality water, decreases dependence on piped water, and is cost-effective in general. The RWHS may be small or big, depending on the size of the system. A method of collecting RWHS from a building's roof allows for the practical and efficient use of rainfall. RWHS may be used in both small and big buildings; however, certain requirements must be met before the system can be implemented [8], [9].

1.1 Malaysian RWHS:

1.1.1 Policy:

The Malaysian government was prompted to implement RWHS during a severe drought in 1998, particularly in the Klang Valley. The Ministry of Housing and Local Government has encouraged people to build rainwater collectors because of the water shortage. As a result, in 1999, the government published a guideline on how to construct a rainwater collecting and usage system. Following this, different authorities have developed policies and guidelines in the form of initiatives. This is to make RWHS easier to deploy in residential and government buildings.

The Malaysian government has undertaken a number of initiatives to assist the program. The aboveground tanks in most RWHS projects in Malaysia are made of high-density polyethylene (HDPE). RWHS installation prices vary from RM 20,000 to RM 350,000, depending on the size and kind of structure. RWHS is being studied by the Malaysian government as a potential alternative resource for reducing reliance on river and other surface waters.

1.1.2 RWHS Benefits:

RWHS benefits may be classified into two categories in general: environmental and economic. It may be utilized as an alternate water source to augment piped water for environmental reasons. RWHS may assist to decrease flash floods in metropolitan areas, limit soil erosion, and prevent pollution from entering water bodies when utilized on a wide scale. Several scholars have looked into the economic benefits of RWHS. RWHS has the potential to lower bills because it is very useful for non-potable water use. The RWHS was evaluated for single-family and multi-family structures in terms of financial viability. According to their research,

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the RWHS investment has a payback time of 33 to 43 years for single-family homes and 61 years for multi-family buildings for a 20m^3 tank.

Rashidi Mehrabadi has discovered that conserving rainwater from greater roof surfaces in Iran may provide approximately 75% of non-potable water demand. Because the RWHS benefit is highly reliant on water use, system design, rainfall, and other unknown factors, a long-term assessment is required to better understand the impacts of each variable on its benefits. This is a great starting point for building the future RWHS.

1.1.3 RWHS Type:

Various kinds of RWHS have been installed in Malaysia, including backyard systems, frontage systems, and subterranean systems. Because they lack a distribution system, backyard and frontage systems are also designated as "collection systems alone." The most common system is the backyard system, which is inexpensive and simple to set up compared to other systems that need a plumbing infrastructure. There are two ways to place the storage tank in this system: on the ground or raised. Ground tanks are extensively used for RWHS development in nations like Brazil, Australia, and Portugal, as well as continents like Africa, while raised tanks typically have three levels, namely top, middle, and bottom. Figure 1 shows the Typical RWHS designs of (a) backyard system, (b) frontage system, and (c) underground system implemented in Malaysia.

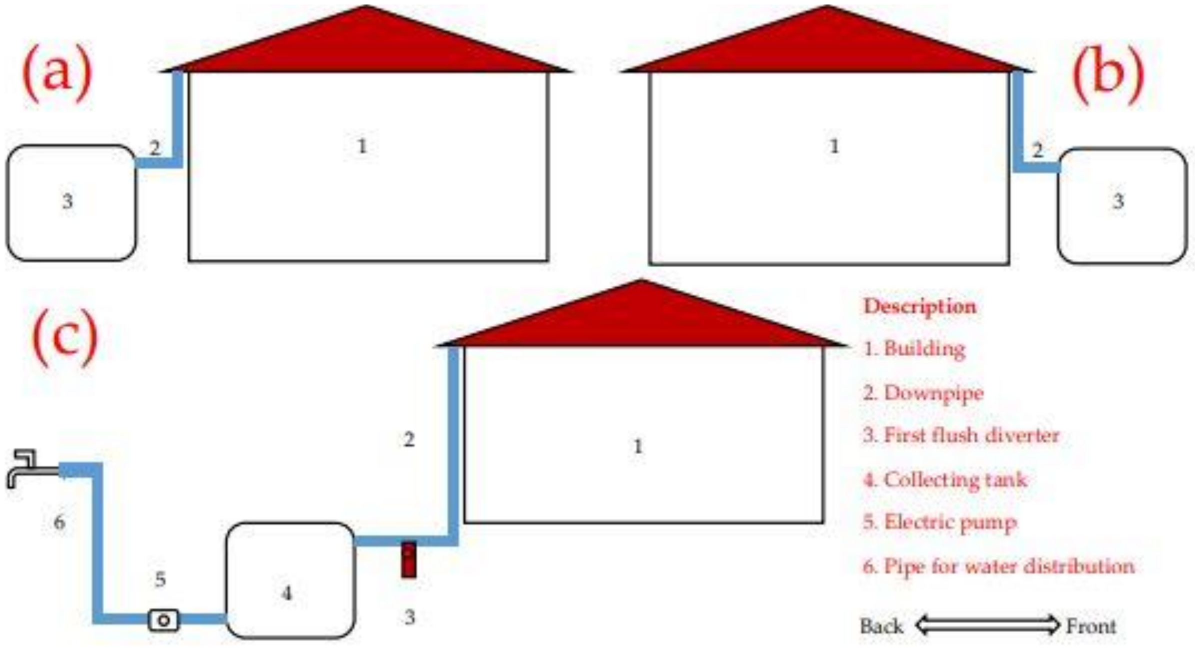

Figure 1: The above figure shows the Typical RWHS designs of (a) backyard system, (b) frontage system, and (c) underground system implemented in Malaysia.

The top-level tank is often used for water delivery, while the middle and lower-level tanks are utilized to store rainwater collected. Metal and polyethylene tanks are often utilized for raised and ground tanks in this system.

It uses the same installation idea as the backyard system for the frontage system. To make maintenance easier, a change is typically made by replacing the polyethylene tank with a reinforced concrete tank. Concrete tanks are considered more durable than polyethylene tanks, making them more cost-effective in the end. It should also be mentioned that using a concrete tank is less expensive (up to 38 percent compared to polyethylene tanks). For small scale systems like as household usage, the cost of the subterranean system, which includes a pump, was about RM1700.

1.1.4 RWHS Software is a piece of software developed by RWHS:

Because effective RWHS design requires a great deal of data and analysis, software may help speed up the process. As a result, many computer-based models have been created and deployed, including the SimTanka2, Warwick calculator, and the RWHS (JKUAT-RWH) calculator from Jomo Kenyatta University of Agriculture and Technology. SimTanka2 and the Warwick calculators were created to determine the optimum tank size for RWHS, while the JKUAT-RWH calculator is used to assess the system's dependability by running a long-term time series of daily rainfall. Yield after Spillage (YAS) program, on the other hand, was created to assess real rainfall availability and storage conditions.

2. DISCUSSION

The increasing global requirement for freshwater is being driven by a growing global population, improving standard of living, changing buying habits, and the expansion of irrigated agriculture. Furthermore, a mismatch between freshwater demand and availability characterizes the worldwide water crisis. Therefore, a variety of studies have been undertaken to assess the physical, social, and economic aspects of global water scarcity.

Rainwater collecting has long been acknowledged as a potential alternative for mitigating the impacts of water scarcity. Rainwater harvesting systems (RWHS) research, particularly techniques and treatment systems, has exploded in recent years [10]. RWHS (rainwater harvesting and storage) is the collection and storage of rainwater for use rather than waste as runoff.

Surface runoff and roof top RWHS techniques are the two most common types of RWHS. The advantages of RWHS include potable water conservation, reduced nutrient loads in rivers, and flood mitigation in urban catchments. RWHS also has other advantages, such as a lower carbon footprint than traditional water delivery systems and greater energy efficiency owing to less pumping from source to user. Furthermore, RWHS has the potential to address both the problem of water scarcity and the dependence on home water sources.

3. CONCLUSION

The development of rainwater harvesting deployment across the world was assessed in this study, with an emphasis on potential improvements in Malaysia. Because of many water problems in Malaysia, such as rising water demand, excessive rainfall, and an over-reliance on surface water, the adoption of RWHS is extremely timely. RWHS has been shown to provide a variety of socioeconomic and environmental advantages.

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Bills will be saved, flash floods will be avoided, and the need for new water delivery infrastructure will be postponed. The Malaysian government for a long time, particularly in government and public buildings, has used RWHS. Overall, however, the success remains insufficient, owing to the comparatively expensive investment, low water tariff, and lack of government incentive, limited public awareness, and weak enforcement. When compared to small-scale systems in a residential neighbourhood, RWHS is more lucrative when installed on a big scale, such as in commercial buildings. This is due to the huge roof area, which offers sufficient volume for heavy use, as well as a higher water cost than a residential tariff. To achieve broader adoption of RWHS, many policy implementation changes are required, including providing an adequate incentive and controlling the excessive use of piped water.

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