A review on Rainwater Harvesting and its importance

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Abstract

Water is an essential substance that is used for daily activities in households. However, many households lack access to water. This is caused by depleting natural water resources as a result of increased pressure on available water resources. Some factors contributing to this situation include: massive population expansion, rapid urbanization, inadequate rainfall, climate change, poor management of available water resources and lack of policies that encourage water conservation. Flooding on the other hand is a situation resulting from excessive surface runoff not being collected properly. Flooding can be classified as a natural disaster. However, rainwater harvesting is a technique that tries to collect surface runoff in order to reduce water scarcity. Rainwater harvesting can be said to be a technique that provides solution to the challenges associated with water scarcity and also provides a solution to flooding, when proper rainwater harvesting systems are put in place

Keyword: Rainfall, harvesting, potable water

Introduction

Rainwater harvesting can be referred to as the deliberate and planned collection of rainwater instead of allowing it to flow as runoff. Rainwater harvesting is essentially important because it can help in reducing water scarcity. According to Bashar et al (2018), rainwater harvesting has been employed in various cities of Bangladesh as a means to tackle issues relating to water scarcity. Rainwater has also been used as a means to argument water supply. Almazrouri et al (2017), opined that groundwater are important water reservoirs that are maintained by rainwater; consequently, deliberate and conscious effort should be made to channel rainwater appropriately. Rainwater harvesting can be used as a means to reduce to reduce the impact of flooding while serving as an alternative water source (Kucukkaya et al 2020). Halder et al (2019), opined that the application of rainwater harvesting in urban areas for flood management may be difficult due to a number of factors; some of these factors include: hydraulic capacity of drainage infrastructure, efficiency of rainwater harvesting methods employed, flood frequencies etc. Roof –harvested rainwater has been observed to play a crucial and important role in providing water used for drinking and other domestic uses in island communities (Kirs et al, 2016).

Although the popularity of rainwater harvesting has risen recently, the major problem associated with it is the unavailability of a detailed and suitable rainfall data; this challenge is experienced more in developing countries (Nguyen & Han, 2017). Jing et al (2018), opined that rainwater harvesting has been widely used to reduce urban water scarcity and flooding challenges. Ayob & Rahmat (2017), opined that the pressure exerted on water sources can be attributed to socio-economic growth; consequently, there is need to manage potentially available natural resources (rainwater) for drier periods when demand will be high and supply low.

Even though having a structure for rainwater harvesting is considered a wonderful solution for the conservation of water in arid regions; determinants such as hydrology, environment, topography and socio-economy affects the selection of rainwater harvesting location (Sayl et al, 2017). In another study by Sayl et al (2020), it was opined that although rainwater harvesting is said to be a means to guarantee the availability of water for domestic & other uses; the major problem facing the improvement and development of rainwater harvesting in arid areas is the scarce and intermittent rainfall. There is need to know the amount of water that can be harvested at a particular location considering the catchment size; in addition, the quality of the harvested rainwater, cost of rainwater and the prevailing government laws (Rahman, 2017). Roman et al (2017), opined that a continuous monitoring and adaptive control (CMAC) approach can be applied to a conventional rainwater harvesting system so that there can be a reduction in the discharge to the combined sewers a rainfall event reduced the water demand for irrigation and improve overall health of vegetation.

Even though rainwater harvesting systems could play an important mark up role in potable water supply and can be used in the monitored delivery of water to urban streams. However, the performance of this rainwater harvesting system can be improved using real time control technology (Xu et al,2018). Braga et al (2018), observed that combined sewer overflows have continually posed a problem for regions that manage storm water using sewer systems; however, advanced rainwater harvesting is an innovative approach for the proper management of storm water, increased water conservation and minimized sewer outflows. The use of rainwater for different domestic chores in the household has been seen to reduce the overall running cost of the home. This is in agreement with the findings of the study carried out by Stec & Zelenakova (2019), from the

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results of this study, it was ahown that the use of rainwater for toilet flushing could achieve water savings between 18% and 29%

Increasingly, many people having known the current dilapidating state of the environment, have decided to mitigate environment footprint by using rainwater harvesting; this approach improves the protection against damage caused by an increase in precipitation frequency and intensity (Hoffman-Caris et al 2019). There are many pressures on available water resources due to factors such as demographic, economic, social causes, environmental degradation, climate change and technological changes; however, a simple yet effective method has the ability to augment surface and ground water sources in areas lacking water (Yannapoulos et al 2019). In an effort to assess the reliability of the use of rainwater to cover the water demands of a logistics company in Mexico, results showed that the water demands of the logistics company can be met using rainwater alone (Zavala et al, 2018). In Guatemala, rainwater harvesting has served as a means to respond to the prevailing water scarcity in the region; this scarcity can be attributed to high vulnerability to climate change, traditional agricultural practices etc (Wu et al, 2018).

Importance of rainwater harvesting

The process of rainwater harvesting dates back many centuries. Many clans have adopted rainwater harvesting in order to solve various problems in the environment. In some populated countries like Bangladesh, there is a rising need for clean water; rainwater harvesting has been observed to be one of the most promising methods of making up the gap in clean water supply (Bashar et al, 2018). Tan et al (2018), opined that in Malaysia, rainwater harvesting has been known as a very important means for generating water for domestic use especially during drought or dry periods. In order to address the rising pressure on water resources in Kuching Sarawak, the Malaysia government has used many proactive approaches; some of them include recycling, reuse and rainwater harvesting (Kuok & Chiu, 2020). The principle of water conservation can be applied using various methods. Susilo & Jafri, (2019), opined that rainwater harvesting is an important means for water resources conservation as it can be used as a method for recharging ground water. In Saudi Arabia, groundwater recharge cannot be accurately measured due to irregular rainfall events as a result of climate change; sometimes flood or large surface runoff maybe generated as a result of these irregular rainfall events; simple but effective water storage methods such as rainfall harvesting can be employed in order to recharge ground water sources and reduce flooding (Almazouri et al, 2017)

The issues surrounding water scarcity has led to the renewed interest in rainwater harvesting. Bashar et al (2018), carried out a study on the feasibility of rainwater harvesting in cities in Bangladesh. From this study, it was observed that rainwater harvesting has potential to save about 500-800m^3 of water each year. This is significant because water logging and flooding will be reduced to a very large extent. Rainwater harvesting has also been shown as a viable means for augmenting water supply in regions experiencing water scarcity (Tan et al, 2917). Domestic chores such as cleaning, gardening, laundry irrigation and car wash services consume about 50% of water supply in some parts of Malaysia. However, rainwater has proved to be a suitable replacement or alternative due to the fact that these chores or activities do not need treated water or energy for pumping or distribution.

Gato & Muhammad (2019), opined that rainwater harvesting is employed in some countries as a means of maintaining and preserving groundwater; this is done by channeling the rainwater into wells that can be used to recharge groundwater. This agrees with the findings of Almzroui et al (2017), that opined that rainwater harvesting is a simple but effective water augmentation method that reduces the pressure on groundwater sources and also ensures sustainability of water supply & its sources. In a quest to seek alternative sources of water supply, as a result of the realization that alternative ways for the collection of water should be set up, rainwater harvesting has begun to be looked upon as a viable way for the mitigation of problems relating to water scarcity in buildings (Aslan &Selcuk, 2020). Radonic (2019), opined that rainwater harvesting is clearly different from other management technologies that operate on the principle of demand; this is because the relationship between rainwater and urban hydro-social systems is very different due to the fact that in redirecting and storing rainwater urban flows , ecosystems are altered; thereby highlighting the potentials of rainwater harvesting to provide beyond reduction in water use.

Kirs et al (2017), opined that roof harvested rainwater is a crucial and viable source of water that can be

employed or used by many island communities for drinking and other domestic purposes in situations where other water sources is limited or not available. Rainwater harvesting has been opined as a crucial tool for the conservation of water. It can also provide safe accessible and cost effective water supply for various needs (Sayl et al, 2016). In order to overcome dry spell in Ethiopia, rainwater management and harvesting are fundamental techniques for land and water development; this is due to the fact that they allow the management, storage and use of scattered /intensive rainfall for more productive use (Castelli et al, 2017). Even though the selection of appropriate sites for rainwater harvesting presents a huge challenge, rainwater harvesting is still very beneficial in the semi-urban geographical regions of the world (Gaikwad & Pawar, 2018). Although rainwater has generally opined as a method of diminishing water scarcity challenges in arid and semi-arid regions of the world, the effectiveness of rainwater harvesting can be improved by locating appropriate sites for rainwater harvesting structures (Khudhair et al, 2020).

According to Tiwan et al (2018), rainwater harvesting has shown promise as a solution to problems associated with the continuous depletion of the water resources across the world. The increase in population has led to increase in demand for quality drinking water, however, the available ground and surface water are being used up very fast. This situation has led to the revitalization of old practices that can serve as a viable decentralized water source (Patel et al, 2020). According to Susilo et al (2017), the advantages of using rainwater harvesting include provision of clean water that is cheap, decentralized and uncomplicated; reduction of power cost for water pumping, quality alternative water source for coastal and petland flooding. Although rainwater is perceived as a good water source alternative typically combined with other systems to argument tap water, there is need to understand the factors affecting the hydraulic performance as well as the cost effectiveness of the rainwater harvesting system (Stys & Stec, 2020). According to Lani et al (2018), rainwater harvesting has received a lot of attention in recent times due its ability to reduce and minimize water scarcity. Al-Batsh et al (2019), carried out an assessment of rainwater harvesting systems in Yatta area of Palestine; from this study, it was opined that rainwater harvesting is of great socio-economic relevance in cities where water sources are limited or unclean.

The mid-eastern region is known as a dry zone; there has been many episodes of drought in the past years due to many factors and worsened by climate change leading to a huge water crisis; rainwater harvesting is widely accepted as a possible means of relieving water crisis (Ibrahim et al, 2019). In an analysis on the dynamics of global research irrigation, it has been opined that in order to meet the needs for agricultural purposes, various issues influencing the possibility of acceptance by farmers such as economic and financial feasibility should be studied intensively (Valasco et al, 2019). Freni &Liuzzo carried out a study with the intention of measuring and evaluating the effectiveness of rainwater harvesting in the mitigation of the consequences of flooding in residential areas of Palermo (Southern Italy). From this study, it was observed that rainwater harvesting has a crucial role to play in the reduction of flood volumes in order to provide solutions that can be used to prevent drainage systems failure during a storm event. There are many advantages associated with the adoption of rainwater harvesting systems; they include economic advantage, provision of alternative water source and consequent reduction of pressure placed on water sources and the use of unambiguous /cheap techniques that can be easily installed, maintained and expanded to meet the water needs of various households (Yannopoulous et al, 2019). In an attempt to describe rainwater harvesting as a means of addressing water challenges as a result of rapid urbanization, population expansion and climate change, Zabidi et al (2020), categorized rooftop harvesting and pond harvesting systems as part of sustainable urban drainage systems with the capacity of addressing problems associated with water scarcity.

Abadallah and Antary (2021), opined that due to the growing need for water in hotels as a result of the boast in the tourism industry in Jordan, there was need to for a conservative approach aimed at reducing the quantity of water used in hotels in the region. From the study, it was observed that although rainwater harvesting was an excellent approach towards the conservation of water; however, paucity of funds will impede the efforts of hoteliers to put in place and activate water conservation mechanisms. Creative and innovative approaches to rainwater harvesting has been opined as a viable methods for storing water inorder to meet up with increasing demand; this can be successful when there is a realization of the possibility of collecting, storing and reusing rainwater in buildings designed putting into

consideration biometric approaches (Aslan &Selcuk, 2020). Radonic (2019), opined that although there are existing limitations imposed by water utilities, emphasis on water consumption, promotion of rainwater harvesting and materials that improve awareness of the operations of rainwater harvesting systems and subsequently a reduction in overall water demand. The availability of water in arid regions directly affect the rate of civilization or development of these regions, it is therefore important that an innovative and cost-effective approach such as rainwater harvesting should be introduced in these regions (Sayl 2017).

Methods of rainwater harvesting

The methods that can be employed in harvesting rainwater are numerous. The choice of these methods are influenced by socio-economic or cultural beliefs/inclinations. Gu et al (2017), investigated the use of ridge-furrow rainwater harvesting for supplementary irrigation; from the results of this study, it was observed that ridge-furrow rainwater harvesting improved nitrogen nutrition index (NNI), radiation use efficiency, water use efficiency, seed yield and oil content. In order to mitigate the effect of climate change and increase farmers income and secure food products in Sub-saharan Africa. Tan et al (2017), opined that rainwater harvesting should be done in-situ. The method of rainwater harvesting may affect the quality of harvested water and limit its usage. Adeyeye et al (2018), carried out a study on the physiochemical characteristics of harvested rainwater from different rooftops in Ikote L.G.A Ekiti State Nigeria; from this study, it was observed from water quality index, that harvested rainwater was suitable for domestic use with minimal treatment to enhance quality.

In a study exploring the key issues associated with the application of rainwater harvesting systems within the Amazon region, it was opined that the contemporary methods for rainwater harvesting utilizes rooftops as the main technique; however, there are differences in set-up and usage management (Cardoso et al, 2018). Kumar & Jhariya (2016), opined that rainwater harvesting aimed at marking up water resources can be done using structures like check dams, percolation ponds and gully check dams; however, their appropriateness as water harvesting structures are dependent on some factors such as slope, infiltration, runoff, land use/cover, soil texture, micro-water shed area etc. Rainwater harvesting has been considered as a viable alternative for water supply and can be achieved from sites such as ponds and rooftops (Oviedo-Ocana et al, 2017). Marwa et al (2018), opined that although rainwater harvesting is mostly developed and adopted in semi-arid areas and characterized by the ratio between the collection and receiving areas, it is carried out in 7 different forms: rooftop water harvesting, water harvesting for human consumption, water harvesting for animal consumption, inter-row water harvesting for animal consumption, micro catchment water harvesting, medium sized catchment water harvesting and large catchment water harvesting.

The hoops method of rainwater harvesting are used due to the fact that it is suitable for the production of pastures especially in dry areas; these are comprised of earthen structures constructed as semi-circles on a land with gentle slopes (Al-Tawaha et al, 2018). Ojwang et al (2017), observed that water scarcity is very severe in Mombasa; consequently, implementing rooftop harvesting strategies into water supply and demand model was necessary for developing a sustainable remedy to the water scarcity in Mombasa. The methods of collection employed in rainwater harvesting may impart positively or negatively on the quality of water collected (Rahman 2017).

Conclusion

The review paper above shows the importance of using rainwater harvesting as a tool for sustainable provision of potable water. It can also be seen that rainwater harvesting is an essential tool for groundwater recharge, provision of water for various needs and also flood control. This review also highlights the some methods used for rainwater harvesting. From this review, it can be understood that rainwater harvesting methods employed can affect the quality of the water collected. Overall, rainwater harvesting is a viable means to argument available water resources. The Government and other concerned organizations should make policies that encourage rainwater harvesting

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