Rainwater harvesting – A traditionally unique technique to preserve water and its usefulness

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Abstract: Water is supposed to be a perpetual, free, natural, never-ending source. The need for treated water supply is ever increasing due to unplanned population growth. Therefore, the implementation of various water conservation techniques at the individual, institutional, and community levels is essential to balance the demand. Sustainable use of potable water could balance supply and demand. Rainwater harvesting (RWH) is traditionally the most unique and simple ecological technique that can be used for both potable and domestic water purposes in residential and commercial buildings. This could naturally reduce treated water pollution and improve green living. Rainwater harvesting (RWH) systems can solve the problem of water scarcity in the non-monsoon season by storing a large amount of water per year. This technology can improve water supply for construction and gardening and also helps in artificial recharge of groundwater, thus enriching both surface and groundwater resources. The RWH system provides a tremendous amount of water and a large amount of energy savings through reduced water consumption. Moreover, considering the budget for installation and maintenance costs, the system is very effective and economical in both respects.

INTRODUCTION

The spread of human civilizations depends to a great extent on the availability of fresh water in sufficient quantity and suitable quality. All possible sources of fresh water on earth are derived from rainfall. As accumulated surface runoff, rain feeds most rivers that do not flow year-round. When surface runoff infiltrates into the subsurface, groundwater is formed. As the water table rises, it emerges as a spring. Perennial springs are the source of many surface waters such as lakes, streams, and perennial rivers.

Groundwater depletion is one of the major problems in India due to high population, rapid urbanization, irregularity of rainfall and depleting use of groundwater for agricultural purposes [1]. Groundwater depletion at regional level is mainly caused by the interaction of natural and artificial influences.

Groundwater represents a freshwater source that can be drawn from even in the dry season, as opposed to the problematic use of surface water, which may carry little or no water in lean seasons. In addition, groundwater is generally less polluted than surface water. On the other hand, groundwater is technically more challenging and more expensive to extract than surface water. However, in some regions in India, nontoxic surface water may no longer be accessible [2].

It is evident that groundwater is subject to both quantitative and qualitative pressures. Thus, many aquifers are overexploited, especially in semiarid and arid regions. Therefore, groundwater recharge is an important factor affecting groundwater extraction [3]. Groundwater recharge is related to atmospheric, surface, and subsurface components of the water balance and is sensitive to climatic and anthropogenic factors such as precipitation, land use/cover change, and urbanization [4-7].

Increasing water demand, especially in regions with limited surface water supplies, and continued deterioration of surface water quality are placing increasing pressure on groundwater resources. Water use may also increase substantially due to natural phenomena, such as novel coronavirus disease (COVID -19), which results in more frequent hand washing. This in turn raises sustainability issues related to sustainable groundwater planning and management [8]. Meanwhile, several studies have also been conducted recently to improve water consumption behaviour [9].

Recently, a driving force-pressure-state-impact-response-outlook analysis was conducted [9] to assess the general conditions of water resources in India. The study concluded that water resources management is a major challenge for the country due to (i) uneven distribution of population and economic activities, (ii) inadequate monitoring of water pollution sources, (iii) inadequate collaboration among relevant governmental and nongovernmental organizations, and (iv) insufficient guidelines and standards. The authors also showed that the greatest pressure on Iran's water resources comes from agriculture. Moreover, the socio-economic development of urban and industrial areas triggered by government policies from the mid-20th century [8] has led to increasing migration to the largest cities.

Against this background, the present work aims to investigate the feasibility of rainwater harvesting (RWH) as an alternative for some areas of water supply in India. RWH systems are designed to capture runoff water from urban/rural areas, rooftops, steep slopes, and road surfaces during high-yield rainfall periods and store it in tanks, reservoirs, sand dams, retention ponds, or underground dams for future use [10]. Some recent studies assessed RWH as one of the most promising technologies to deal water scarcity and pollution in urban areas [5,11]. A typical RWH system includes three main elements: (i) catchment, (ii) storage devices, and (iii) conveyance system [12]. Impervious urban surfaces (e.g., building roofs, parking lots, roads, sidewalks, and walkways) in cities can provide valuable catchment areas for RWH.

In a first phase, the efficiency of a RWH project is directly related to the probability of occurrence (and intensity) of rain events [13]. In addition, the local circumstances of a RWH project, including (i) the intended use of the collected water, (ii) civil engineering concerns, (iii) economic budget, and (iv) socio-political conditions, should be considered [14].

A starting point for designing a domestic RWH system is to decide the intended supply/consumption purpose (e.g., drinking, agricultural, or industrial) of the collected water [15], and water quality plays a major role in this decision [16]. Naus et al [17] analyzed the potential of some alternative options (including RWH) to replace unsafe drinking water options in Bangladesh and argued that global adoption of safe drinking water options varies by user community and is not necessarily guaranteed. The likely contamination of collected rainwater with physicochemical/microbiological contaminants during the runoff and/or storage phases of RWH is a serious issue that can jeopardize the success of a RWH project in an urban area. Therefore, the quality of the collected stormwater should be properly evaluated. The author suggests more public awareness, involvement, and support to avoid hazards from the consumption of collected storm water.

WHAT IS RAINWATER HARVESTING?

Although our planet is nearly three-quarters water, not all of it is suitable for use. The water in the oceans and seas cannot be used for drinking, and little of it can be used for other purposes. Therefore, there is a constant stockpiling of water that is suitable either for drinking or for domestic and industrial use. Areas on Earth that have long faced water storage have been able to combat this problem by capturing what little rainwater they received, which slowly spread to areas that received a lot of rain. As a result, the modern system of rainwater harvesting was introduced.

Rainwater harvesting is a traditionally unique technology for collecting and storing rainwater from roofs, land surfaces, or rocks, using both simple methods such as jugs and pots and more complex techniques such as underground retention ponds. The techniques, which are widespread in Asia and Africa, date back to the practices of ancient civilizations in those regions and still serve as an important source of drinking water in rural areas.

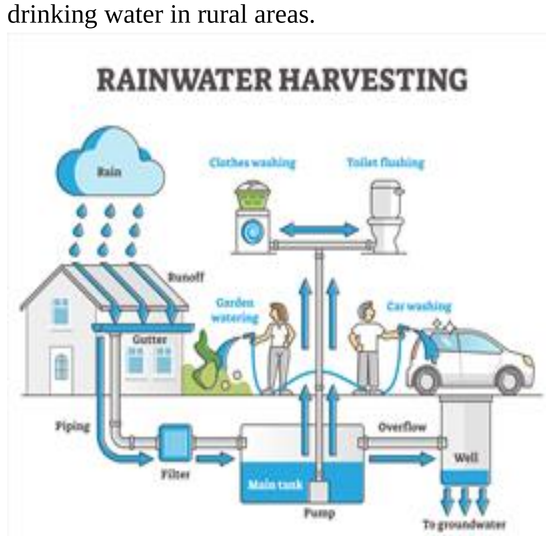

Figure: 1. Rainwater harvesting system

BENEFITS OF RAIN WATER HARVESTING SYSTEM

- Rainwater is a comparatively clean and completely free source of water.
- Rainwater is more suitable for landscape plants and gardens because it is not chlorinated.
- It can amplify other sources of water supply such as groundwater or municipal water connections.
- It lowers the cost of water supply.
- It can provide an excellent backup water source for emergencies.
- It is socially acceptable and environmentally sound.
- It uses simple technologies that are inexpensive and easy to maintain.
- Less flooding and less loss of topsoil.
- It is free; the only costs are for collection and use.
- It reduces surface water pollution from sediment, fertilizers, and pesticides from storm water runoff, resulting in cleaner lakes, rivers, oceans, and other storm water receptors.
- It is used in areas with insufficient water resources.
- It is good for laundry because rainwater is soft and requires less detergent.
- It can be used to replenish groundwater.
- It minimizes the runoff that clogs the storm drains.

NEED FOR RAINWATER HARVESTING

- As water becomes increasingly scarce, achieving water self-sufficiency is the order of the day.
- The urban water supply system is under tremendous pressure to provide water for the ever-growing population.
- Groundwater is being depleted and polluted.
- Soil erosion as a result of uncontrolled runoff.
- Health risks due to consumption of polluted water.
- Halting groundwater decline and raising groundwater levels
- Improving water quality in aquifers
- Maintaining surface water runoff during the monsoon season
- Reducing soil erosion
- Create a culture of water conservation

HOW TO HARVEST RAIN WATER?

Water Harvesting refers to the collection and storage of rainwater and also to other activities such as surface water harvesting, groundwater extraction, and prevention of losses through evaporation and infiltration. Rainwater harvesting has been experienced for more than 4,000 years and is a good possibility for areas that lack fresh surface or groundwater of good quality. In this way, water harvesting ensures continuous and reliable access to water. The role of rainwater harvesting systems as supplemental, back-up, or emergency water supplies will become more important, especially as climate variability increases and droughts and floods may become more frequent in many areas.

In general, there are two types of rainwater harvesting:
1. Collecting surface runoff
2. Rainwater harvesting on the roof

SURFACE RUNOFF HARVESTING

In urban areas, rainwater runs off as surface runoff. This runoff could be captured and used to recharge aquifers by using appropriate methods.

- *Rooftops:*

If there are already buildings with impermeable roofs, the catchment area is effectively available for free and they provide a supply at the point of consumption.

- *Paved and Unpaved Areas (Surface Runoff):*

Landscapes, open fields, parks, storm drains, streets and sidewalks, and other open areas can be effectively used to collect runoff. The main advantage of using land as a collection area is that water can be collected from a larger area. This is especially beneficial in areas with low rainfall.

- *Water bodies:*

The potential of lakes, tanks and ponds to store rainwater is immense. The captured rainwater can be used not only to meet the city's water needs, but also to recharge aquifers.

- *Storm water Drain:*

Most housing developments have an adequate network of storm drains. When properly maintained, these provide an easy and inexpensive way to collect rainwater.

ROOF TOP RAINWATER HARVESTING

It is a system for collecting rainwater where it falls. In roof water harvesting, the roof becomes a catch basin, and rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to an artificial recharge system. This method is less costly and very effective and, if used properly, helps raise the water table in the area.

QUALITY OF RAINWATER

The quality of rainwater collected is an important issue, as it could be used for drinking water purposes. The quality of water collected from roofs depends on both the quality of the roof and the environmental conditions, i.e., local climate, air pollution, etc. [11]. Before using it as drinking water, tests must be performed to verify the viability and applicability of the water.

METHODOLOGY

Rainwater harvesting is a more effective technology that can easily be done with normal equipment in the event of a water crisis. A qualitative assessment is important before using the collected rainwater as drinking water.

The maximum amount of rainwater that can be collected from a roof is

$$V = A\times R\times C \text{ .... (1)}$$

where V is the harvestable water volume, A is the catchment area, R is the total precipitation volume, and C is the runoff coefficient. Equation (1) was used to calculate the amount of water harvested from each residential building.

CONCLUSION

Water scarcity is one of the critical problems in India. This problem is not new and cannot be solved overnight. Rainwater harvesting is an effective option not only to recharge the aquifers but also to shop water for future use. The system is also cost effective, saving large amounts of money per year. The energy savings and associated lower emissions are important components of this system. In addition, the growing awareness of the water crisis has led to the proposal of rainwater harvesting as a community amenity. Small and medium residential and commercial buildings can use this system as a sustainable option for water supply. It is almost the only way to improve their own water supply without waiting for a community system to develop.

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