International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Rainwater Harvesting an Alternative Water Supply in the Future

Renu Dey[1], Anupam kumar Gautam[2]

[1,2]Department of Environmental Engineering Maharishi Institute of Information Technology, Lucknow, India

Abstract

Rainwater harvesting (RWH) is a sustainable water management practice that involves the collection, storage, and utilization of rainwater for various purposes. This method has gained significant attention due to increasing water scarcity, urbanization, and climate change impacts. The process typically involves capturing rainwater from rooftops, surfaces, or catchment areas, directing it into storage systems such as tanks or underground reservoirs, and subsequently using it for irrigation, domestic consumption, or groundwater recharge.

The benefits of rainwater harvesting are multifaceted. It reduces dependency on conventional water sources, mitigates flooding and erosion, and enhances groundwater levels. Additionally, RWH systems can be designed to filter and purify collected water, making it suitable for potable use. The implementation of rainwater harvesting can lead to significant cost savings in water bills and contribute to environmental sustainability by promoting water conservation practices. Rainwater harvesting (RWH) is the most traditional and sustainable method, which could be easily used for potable and nonportable purposes both in residential and commercial buildings. This could reduce the pressure on processed supply water which enhances the green living. This paper ensures the sustainability of this system through assessing several water-quality parameters of collected rainwater with respect to allowable limits. A number of parameters were included in the analysis: pH, faecal coliform, total coliform, total dissolved solids, turbidity, NH_3–N, lead, BOD_5, and so forth.

Despite its advantages, the adoption of rainwater harvesting faces challenges, including initial setup costs, maintenance requirements, and regulatory barriers. Public awareness and education are crucial for overcoming these obstacles and promoting widespread implementation. Overall, rainwater harvesting presents a viable solution to address water scarcity and promote sustainable water resource management in both urban and rural settings.

Keywords: Rainwater harvesting; Conservation; Method; Drought; catchment area; conveyance system; filtration; and distribution system; Soil etc

INTRODUCTION

Rainwater harvesting is a water conservation technique that involves collecting and storing rainwater for later use, typically from rooftops or other impervious surfaces, offering a sustainable and cost-effective water source.

Rainwater harvesting is a water conservation technique that involves collecting and storing rainwater for later use, rather than allowing it to run off, and can be implemented at various scales, from individual

households to entire communities. Rainwater harvesting is collecting the run-off from a structure or other impervious surface in order to store it for later use. Traditionally, this involves harvesting the rain from a roof. The rain will collect in gutters that channel the water into downspouts and then into some sort of storage vessel.

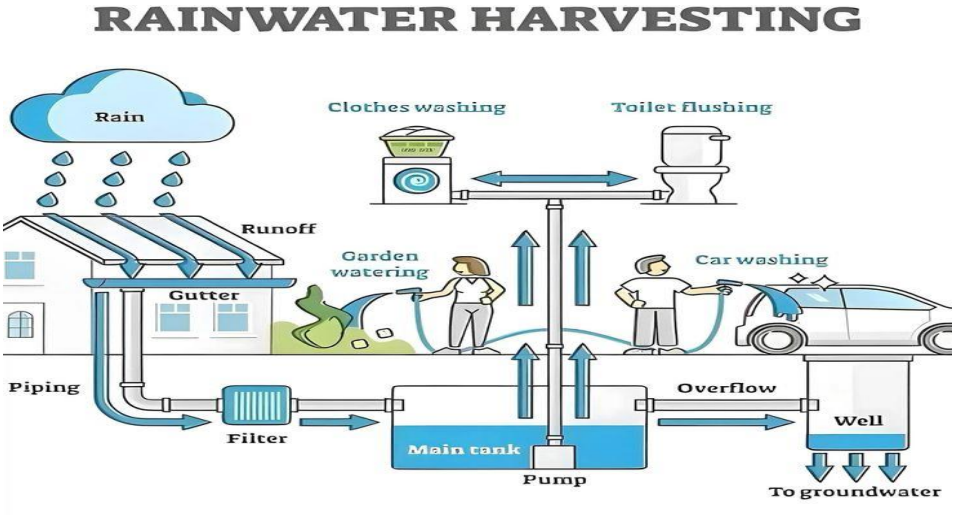
The two major types of rainwater harvesting include roof based and land-based rainwater harvesting. Rain harvested water can be used for watering livestock, laundry, flushing toilets, etc.

Rain water harvesting is one of the most effective methods of water management and water conservation. It involves collection and storage of rain water at surface or in sub-surface aquifer, before it is lost as surface run off.

Rainwater harvesting helps manage storm water runoff to prevent erosion, flooding, and poor water quality in our lakes and streams. Rainwater systems counteract storm water run-off and thereby reduce flooding, erosion, and ground water contamination. Rainwater harvesting is a sustainable practice that involves collecting and storing rainwater for various uses, such as irrigation, drinking, and household purposes. This system captures rainwater from surfaces like rooftops, pavements, and other impermeable areas, directing it into storage tanks or reservoirs.

Key Components of a Rainwater Harvesting System:

1. Catchment Area: The surface from which rainwater is collected, typically rooftops or paved areas.
2. Gutters and Downspouts: Channels that direct the collected rainwater from the catchment area to the storage system.
3. Storage Tanks: Containers where the harvested rainwater is stored. These can be above-ground or underground tanks, made from various materials like plastic, concrete, or metal.
4. Filtration System: A mechanism to filter out debris and contaminants from the rainwater before it enters the storage tank, ensuring the water is clean and safe for use. The filter is used to remove suspended pollutants from rainwater collected from the roof. A filter unit is a chamber filled with filtering media such as fibre, coarse sand, and gravel layers to remove debris and dirt from the water before it enters the storage tank or recharge's structure.
5. Distribution System: Pipes and pumps that transport the stored rainwater to where it is needed, whether for irrigation, flushing toilets, or other uses.



Benefits of Rainwater Harvesting:

1. Water Conservation: Reduces reliance on municipal water supply and groundwater, helping to conserve these vital resources.
2. Cost Savings: Lowers water bills and can reduce the need for expensive infrastructure for water supply.
3. Flood Mitigation: Helps manage stormwater runoff, reducing the risk of flooding and erosion.
4. Environmental Impact: Promotes sustainable water management practices and can improve local ecosystems.
5. Drought Resilience: Provides an alternative water source during dry periods, enhancing community resilience to climate variability.

Applications:

Rainwater harvesting systems can be implemented in various settings, including residential homes, commercial buildings, agricultural fields, and urban areas. The scale of the system can vary from small, individual setups to large, community-based systems.

Rainwater harvesting is an effective and eco-friendly solution to address water scarcity, promote sustainability, and enhance water management practices.

POTENTIAL AREAS

1. Where ground water levels are declining on regular basis.
2. Where substantial amount of aquifer has been de-saturated.
3. Where availability of ground water is inadequate in lean months.
4. Where due to rapid urbanization, infiltration of rain water into subsoil has decreased drastically and recharging of ground water has diminished

The aim of rainwater harvesting

The aim of rainwater harvesting is to capture, store, and utilize rainwater as a sustainable and alternative water source to supplement or replace conventional water supplies. This helps to conserve water resources, reduce reliance on centralized systems, and mitigate the impacts of water scarcity and drought. Rainwater harvesting might be the collection of rainwater from a surface that allows for the rainwater to be stored and used at a later time. In a typical rainwater harvesting situation, rainwater is collected from an impervious surface such as the roof of a building and then stored inside of a tank or cistern. Rainwater can be collected from other surfaces as well. Other surfaces include parking lots, roadways, driveways, and even land surfaces (once surface runoff from the land surface begins). Rainwater can be harvested and stored for many uses including landscape irrigation, potable and no potable indoor use, and storm water management. Harvested rainwater can be particularly useful when no other source of water supply is available, or if the available supply is inadequate or of poor quality. Rainwater harvesting has benefits for both urban (where municipal water is available) and rural properties (where a water well is employed). The practice of rainwater harvesting ranges from simple ideas such as a rain barrel set up underneath a gutter downspout to complex systems such as for commercial buildings or systems that supply the portable water for a house.

The objectives of rainwater harvesting

Water Resource Management:

- To augment and conserve existing water resources: By utilizing rainwater, the demand on groundwater, surface water, and municipal water supplies is reduced, contributing to overall water conservation.
- To recharge groundwater aquifers: Collected rainwater can be directed to recharge pits, wells, or other infiltration systems, helping to raise the water table and improve groundwater availability.
- To reduce surface runoff: Harvesting rainwater minimizes the amount of water flowing over the land surface, thereby reducing soil erosion, and the transport of pollutants into water bodies.
- To mitigate urban flooding: By capturing rainwater at the source, the volume of stormwater entering drainage systems is decreased, reducing the risk of localized flooding and waterlogging.
- To improve water quality: Rainwater is naturally soft and low in minerals. When properly collected and stored, it can provide a high-quality water source for various uses, and can also help to dilute pollutants in groundwater.
- To address water scarcity: In regions facing water shortages or drought conditions, rainwater harvesting provides a reliable and independent source of water for essential needs.

Environmental Sustainability:

- To promote sustainable water management practices: Rainwater harvesting encourages a more environmentally conscious approach to water usage.
- To reduce energy consumption: By lessening the reliance on centralized water treatment and distribution systems, the energy required for pumping and treating water can be reduced, lowering carbon emissions.
- To minimize the environmental impact of development: Implementing rainwater harvesting in urban areas can help manage stormwater sustainably and reduce the strain on natural water systems.

Socio-Economic Benefits:

- To provide an independent and reliable water source: This is particularly beneficial for households, communities, and businesses in areas with unreliable or expensive water supplies.
- To reduce water bills: By utilizing harvested rainwater, the consumption of paid water from municipal sources decreases, leading to cost savings.
- To support agriculture and food security: Harvested rainwater can be used for irrigation, especially in dryland areas, contributing to increased agricultural productivity.
- To empower communities: Implementing and managing rainwater harvesting systems at a local level can foster community participation and ownership of water resources.

Methodology

Methods Of Harvesting Water

- Capturing run-off from rooftops, roads.
- Capturing run-off from local catchments
- Capturing seasonal flood water from local streams
- Conserving water through watershed management. It involves utilization of rain water for domestic or agricultural purpose.

SURFACE RUNOFF HARVESTING:

It is a method in which rainwater flowing as surface runoff is caught and used for recharging aquifers by adopting appropriate methods.

ROOF TOP RAINWATER HARVESTING (RTRWH):

In rooftop harvesting, the roof becomes the catchment, and the rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to artificial recharge system.

Techniques of Rain Water Harvesting Storage of rainwater on surface for future use: The storage of rain water on surface is a traditional techniques and structures used were underground tanks, ponds, check dams, weirs etc. Recharge to ground water: The collected rainwater is transferred to the ground through suitable means for recharging the depleting aquifers.

The process of a rainwater harvesting system generally involves the following key stages:

1. **Catchment:**

- This is the surface where rainwater falls and is collected. The most common catchment is a **rooftop**, but it can also include paved areas, open grounds, or even specialized membranes.
- The size and material of the catchment area influence the amount and quality of water collected. Smooth, non-toxic surfaces are ideal.

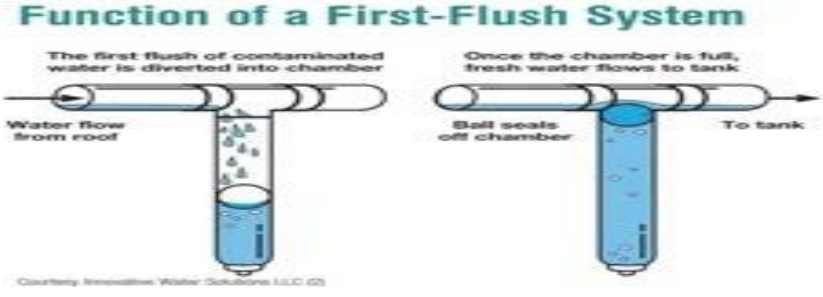
2. **Conveyance:**

- Rainwater from the catchment area is transported to the storage or recharge system through a conveyance system.
- This typically consists of gutters (channels along the roof edges) and downspouts (vertical pipes that carry water downwards).
- The conveyance system should be properly designed with adequate slopes to ensure efficient flow and prevent stagnation.
- Leaf screens or gutter guards can be installed to prevent leaves, debris, and other large particles from entering the system.

3. **First Flush Diversion**

The first spell of rain washes away dust, pollutants, bird droppings, and other contaminants accumulated on the catchment surface and in the conveyance system during dry periods.

- A **first flush diverter** is a mechanism that automatically discards this initial dirty water, ensuring that cleaner water is collected for storage or recharge. A first flush device is a valve that ensures that runoff from the first spell of rain is flushed out and does not enter the system. This needs to be done since the first spell of rain carries a relatively larger number of pollutants from the air and catchment surface



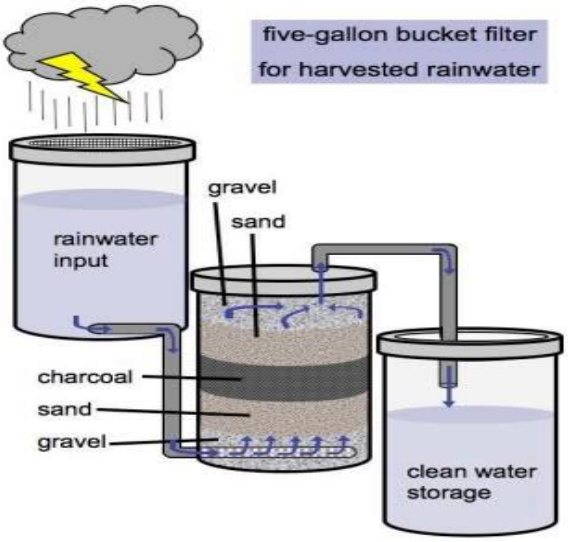
4. Filtration:

The filter is used to remove suspended pollutants from rainwater collected from the roof. A filter unit is a chamber filled with filtering media such as fibre, coarse sand, and gravel layers to remove debris and dirt from the water before it enters the storage tank or recharge's structure.

Different types of filters can be used depending on the intended use of the harvested water and the level of purity required. Common filtration methods include:

To further improve water quality, the collected rainwater usually passes through a **filtration system** before storage or recharge.

- **Screen filters:** To remove larger debris like leaves and twigs.
- **Sand and gravel filters:** To remove finer suspended particles.
- **Charcoal filters:** To absorb odors and some chemical contaminants.
- **Cartridge filters:** For finer filtration down to specific micron sizes.
- **UV disinfection:** To kill bacteria and viruses (especially if the water is intended for potable uses after further treatment).



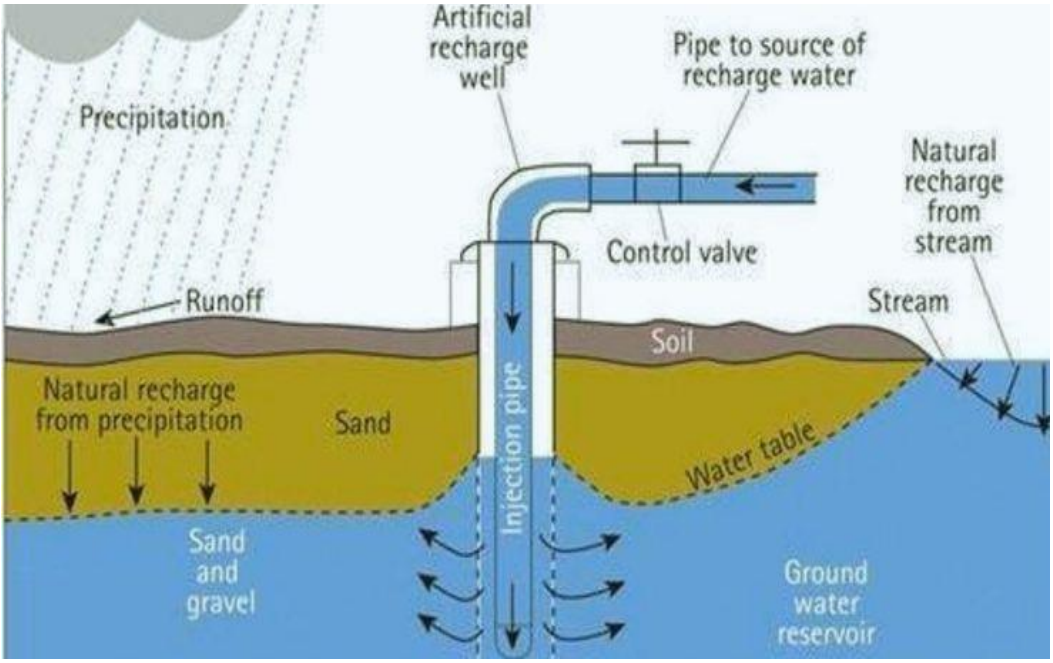
5. Storage (for Direct Use):

- If the harvested rainwater is to be used directly, it is stored in a **storage tank** or **cistern**.
- The size of the storage tank depends on factors like rainfall patterns, catchment area, water demand, and the desired period of self-sufficiency.
- Storage tanks can be made of various materials like plastic, concrete, fiberglass, or metal. They can be installed above ground or underground.
- Properly sealed tanks prevent contamination, evaporation, and mosquito breeding.
- An **overflow pipe** is essential to allow excess water to escape when the tank is full. This overflow can be directed to a recharge system or a safe discharge point.

6. Recharge (for Groundwater Replenishment):

- In some rainwater harvesting systems, the primary goal is to replenish groundwater aquifers.
- Collected and sometimes filtered rainwater is directed into **recharge structures** such as:
- **Recharge pits:** Small excavated pits filled with porous materials like gravel and sand.

- **Recharge wells or shafts:** Boreholes or deeper excavations that allow water to reach deeper permeable layers.
- **Percolation tanks:** Small surface water bodies designed to allow water to slowly seep into the ground.
- **Check dams:** Small barriers built across streams to slow down water flow and increase infiltration.



7. Distribution (for Direct Use):

- If the stored rainwater is to be used within a building or for irrigation, a **distribution system** is required.
- This typically involves a **pump** to draw water from the storage tank and a network of **pipes** to deliver it to the point of use (e.g., taps, toilets, washing machines, irrigation sprinklers).
- A **flow meter** can be installed to monitor water usage.
- For indoor use, especially for non-potable applications, proper labeling of pipes is crucial to avoid cross-contamination with the potable water supply.
- A **backflow prevention device** is necessary to prevent harvested water from flowing back into the public water supply.

8. Treatment (for Potable Use - Optional and Requires Specific Systems):

- If the harvested rainwater is intended for drinking water, it requires more advanced **treatment processes** beyond basic filtration.
- This can include fine filtration, disinfection (e.g., UV, chlorination, ozonation), and sometimes even reverse osmosis depending on the water quality and local regulations.
- Potable water treatment systems should be carefully designed and maintained according to health guidelines.

The specific components and complexity of a rainwater harvesting system can vary greatly depending on the scale, intended use, and local conditions. Simple systems might involve just a water barrel under a

downspout, while large-scale commercial or community systems can be highly engineered with multiple stages of filtration, storage, and distribution.

CONCLUSION

Rainwater harvesting is a vital and sustainable practice that offers numerous environmental, economic, and social benefits. It stands as an effective method for conserving precious freshwater resources by capturing rainfall where it lands, thereby reducing reliance on increasingly stressed sources like groundwater and municipal supplies. The water harvesting technique increases farmer's income and it is very popular. Wider hydrological research is necessary to see how resilient the ground water system is. The technology is well known by the local population but training is necessary for the younger generations to make them aware of the wider setting. Rainwater harvesting is a viable option to supplement city water for non-potable human uses, such as irrigation. The overall efficiency of a rainwater harvesting system to supplement city water increases as area increases. The system would be highly effective in high commercial regions where there are warehouses and large buildings. Rainwater harvesting is crucial for ensuring water security, promoting environmental sustainability, and building more resilient societies.

REFERENCES

1. Rural Water Supply Network. "Rural Water Supply Network Self-supply site". www.rural-water-supply.net/en/selfsupply. Retrieved
2. Behzadian, k; Kapelan, Z (2015). "Advantages of integrated and sustainability based assessment for metabolism based strategic planning of urban water systems". Science of The Total Environment. Elsevier. 527-528: 220–231.
3. Zhu, Qiang; et al. (2015). Rainwater Harvesting for Agriculture and Water Supply. Beijing: Springer. p. 20. ISBN 978- 981-287-964-6.
4. http://www.mid-day.com/articles/bmc-to-make-rainwater-harvesting-mandatory-for-large-societies/17110192
5. Everson C, Everson TM, Modi AT, Csiwila D, Fanadzo M, Naiken V, Auerbach RM, Moodley M, Mtshali SM, Dladla R (2011). Sustainable techniques and practices for water harvesting and conservation and their effective application in resource-poor agricultural production through participatory adaptive research : report to the Water Research Commission
6. GSS 2020 Demography: Population Projection. Ghana Statistical Service. nationalaccount_macros.php?Stats=MTA1NTY1 NjgxLjUwNg=¼/webstats/s679n2sn87 (accessed 22 April 2020).
7. Khayan, K., Heru Husodo, A., Astuti, I., Sudarmadji, S. & Sugandawaty Djohan, T. 2019 Rainwater as a source of drinking water: health impacts and rainwater treatment. Journal of Environmental and Public Health 2019. https:// doi.org/10.1155/2019/1760950.