

# RAINWATER HARVESTING FOR SUSTAINABLE WATER MANAGEMENT

## Abstract

The increasing demand for water to feed the ever-expanding population and the higher standard of living have led to a global problem of water scarcity. Groundwater is the main source of freshwater for the expanding domestic, agricultural, and industrial sectors of the country. As it becomes more necessary to battle climate change, conserving water has a definite impact on a sustainable environment. Rainwater harvesting is simple technique with relatively low storage and maintenance costs. This can significantly help to mitigate the negative effects of increasing water scarcity caused by declining groundwater levels, lessen urban flooding, and preserve water supply in water-scarce places. Rainwater harvesting is the process of collecting and storing rainwater before it disperses as surface runoff. A rainwater harvesting system typically collects and stores water that runs off a roof surface. Rainwater can be collected and stored on surface tanks, or it may be conveyed underground to recharge groundwater. Surface runoff harvesting is most suitable in hilly and urban areas. Groundwater recharge is favorable, if there are sufficient favorable strata available to hold water. It is the most effective and sustainable method of managing water and it also opens up a wide range of other economic opportunities that empower people at the grassroots level. Rainwater harvesting is crucial for global water management in the 21st century.

**Key words:** aquifer; groundwater; recharge; rainwater harvesting; water management

## Authors

**Marykutty Abraham**  
Sathyabama Institute of Science and  
Technology  
Chennai-600119  
Tamil Nadu, India.  
marykuttyabraham06@gmail.com

**B. Priyadarshini**  
Sathyabama Institute of Science and  
Technology  
Chennai-600119  
Tamil Nadu, India.

## I. INTRODUCTION

Due to India's monsoonal climate, half of the annual precipitation falls within a 15-day window, and four monsoon months account for more than 90% of the country's annual river run-off.

Options that combine surface water augmentation with groundwater management can ensure sufficient water availability on a sustainable basis. As per the estimates of the Central Water Commission (CWC), Government of India, the utilizable surface water resource in India is about 690 BCM while the replenishable groundwater resource is 433 BCM (Suhag, 2016). Though large quantity of surface water is available, topographic and hydrogeologic factors do not allow effective use of most of it. About one-third of the country is now at risk of experiencing drought because of the severely constrained quantity, poor quality, and wide variations in water supply.

Tamil Nadu state has become deficient in both surface and groundwater resources. Water has become a scarce commodity in many watersheds in Tamil Nadu and, therefore, timely action is imperative for water conservation, management and augmentation to make the natural resource sustainable. The problem is getting worse, and there is a huge increase in demand for water as a result of repeated monsoon failure, unplanned urbanisation, rising population, overexploitation, and poor water management. Tamil Nadu is a state, where groundwater is the main water source for domestic, agricultural and industrial purposes (CGWB, 2011). Surface water availability is decreasing due to frequent monsoon failure and land use changes. Tamil Nadu state has to depend on groundwater to meet its water demands. Out of 384 blocks of the state, 142 blocks have been declared as over exploited blocks where the annual draft of groundwater exceeds 100% of annual groundwater recharge (CGWB, 2019). Out of the annual average rainfall of 975 mm, 48% is received during the north-east monsoon, 32% is received from the south-west monsoon while the remaining 20% falls during the transitional period (summer and winter).

Seventy-three percent of the area of Tamil Nadu is under hard crystalline formations; the remaining area is composed of unconsolidated sedimentary formations. Almost 14% of the total geographical area of the state is occupied by wasteland which acute faces challenges of water scarcity (NRSC, 2011). For sustaining the present level of irrigation and converting wasteland into productive land, it is essential to improve groundwater availability through artificial recharging.

## II. MOTIVATION FOR THE STUDY

Due to population expansion and a greater level of life, there is a rise in the amount of water that needs to be pumped from aquifers. Uncontrolled aquifer extraction can result in land subsidence, saline water intrusion in coastal aquifers, and a decrease in the physical and chemical quality of water. Sometimes, these environmental effects will be minor and first difficult to notice. The management of the groundwater system must be done correctly in order to maintain the aquifer's hydrological equilibrium.

Even though the coastal Tamil Nadu/ Chennai receives annual average rainfall of 1200 mm, as the total rain is received in around 30-40 rainy days of the year and, there is need to harvest rainwater to meet future demands. Groundwater recharge is decreasing in Chennai due

to degradation of existing tanks by siltation & encroachments, unplanned urbanization which damages drainage channels & potential recharge areas etc. Consequently, there is need to either harvest and store rainwater in tanks or to enhance groundwater recharge to meet future water demands. To enhance groundwater potential, recharge arrangements need to be carried out. There is enormous scope to drain the excess rainwater to the underground formation by groundwater recharge. This will help in improving the groundwater availability and quality in the nearby areas.

### **III. NEED FOR RECHARGE**

The country's primary source of groundwater recharge is rainfall. A portion of the precipitation that falls on the earth seeps into the soil. The infiltrating water is used in part to make up the soil moisture deficit, and some of it percolates down and reaches the water table, a process known as natural recharge. Rainfall recharge is influenced by a variety of hydro-meteorological parameters, topographic factors, soil characteristics, and water table depth. For effective groundwater management, the rate of natural groundwater recharge must be quantified. In India, the peninsular hard rock regions produce 5–10% of rainfall as recharge, whereas the alluvial regions supply 15–20% of rainfall (Athavale et al., 1992; Mohan & Abraham, 2010; Abraham et al., 2021).

For sustainable water management rainwater should be either drained to a nearby storage area or recharged in underground formations. Groundwater recharge is decreasing in the region due to degradation of existing tanks by siltation, encroachments and unplanned urbanization which have damaged drainage channels as well as potential recharge areas. To enhance groundwater potential, artificial recharge arrangements need to be made. To avoid adverse consequences due to large scale pumping and for sustainable management of this aquifer, artificial recharge is necessary.

#### **1. Need for Recharge is due to**

- Population growth, urbanization & higher standards of living
- Surface water resources are almost exploited
- Deterioration of quality of water
- Climate change and its adverse effects
- During rainy season lot of surface water is wasted and in summer acute water scarcity occurs
- Saline water intrusion is a major problem in our coastal aquifers

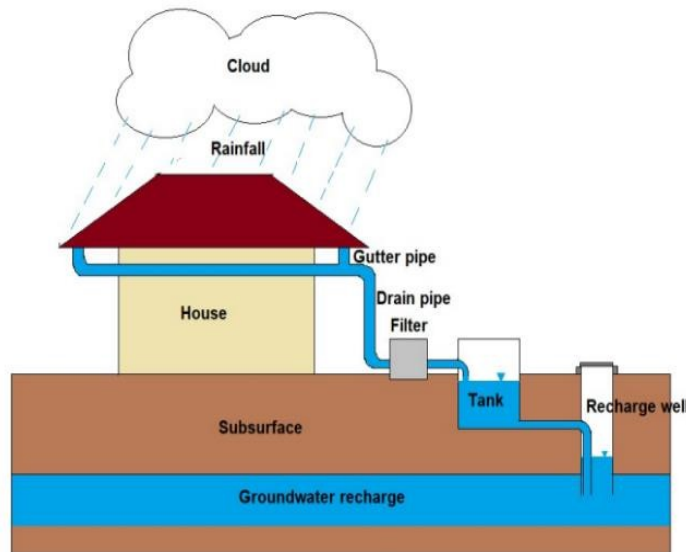
#### **2. Advantages of Rain Water Harvesting using Groundwater Recharge**

- Aquifers have vast storage capacity
- Minimum evaporation loss
- Economical
- Underground formations act like natural filters
- Control on floods and droughts
- Water is available at the point of use
- Loss of land is minimum
- Environmentally attractive

- Controls salt water ingress in coastal aquifers

#### IV. METHODS OF RAIN WATER HARVESTING

Rainwater can be harvested and stored in a surface tank or can be sent underground for groundwater recharge.



**Figure 1:** A typical rainwater harvesting system

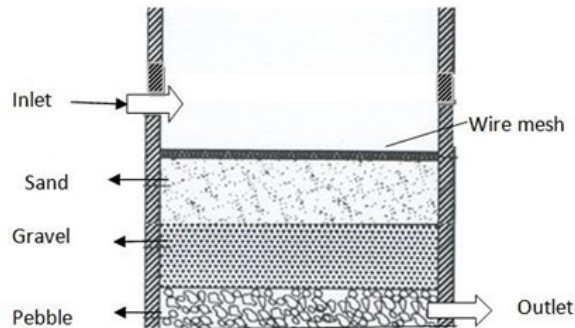
1. Method of rain water harvesting depends on the catchment area. The catchment area is the surface on which the rainwater falls. This may be a roof top or open area contributing runoff to the recharge point.
  - Roof Top Rain Water Harvesting: In rooftop harvesting, the roof becomes the catchment, and the rain water is collected from the roof of the house/building.
  - 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.
2. Rain Water Harvesting Techniques
  - Storing rain water for direct use in storage structures
  - Groundwater recharge/ Aquifer storage
3. Objectives of the Scheme
  - To increase the natural recharge of the aquifer
  - To enhance Conservation, development and sustainable management of water resources by implementing artificial recharge measures
  - To improve the quality of groundwater which is saline in nature

## V. RECHARGE STRUCTURE

Based on the lithology study suitable structures such as percolation tank, recharge pit/trench, recharge shaft, check dams, recharge well etc for an area can be selected. In rural areas gully plugs, contour bunds, ponds, abandoned wells etc are often used for groundwater recharge. There is also traditional rainwater harvesting structures prevalent in some parts of the country.

Recharge shaft (figure 1) is identified as the most suitable structure for hard rock area, provided good sandy layer prevails below. This is especially suitable for areas where the first layer is clay followed by clayey sand, sandy layer and hard rock. Recharge Shafts can be constructed upto sandy layer for water harvesting to enhance the groundwater potential of the area. In the case of Recharge Shaft, recharge is fast and there are practically no loss of water in the form of soil moisture and evaporation, which normally occur when the source water has to traverse the vadose zone.

Soil acts as a natural filter material for groundwater. A filter with sand, gravel and pebble need to be provided to enhance the quality of recharge water in case of storage tank, shaft, well etc.



**Figure 2:** Filtering Mechanism

## VI. CONCLUSIONS

The need for water is growing as a result of population expansion and rising living standards, and rainwater harvesting appears to be a good solution to somewhat offset the overexploitation. Rainwater harvesting is an important option for sustainable water management. Rainwater harvesting is a simple technology that collects, stores, and transports rainwater that runs off into any type of surface or subsurface storage. Recharge systems are typically site specific and the level of sophistication of the technology required depends largely on the hydrogeological and lithological situation of the aquifer. The study envisages improving groundwater availability through artificial recharging of groundwater by harvesting rainwater.

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