

Design of Rooftop Rainwater Harvesting System for Dr. Babasaheb Ambedkar Marathwada University (Dr. BAMU) Sub-Campus, Osmanabad

Nitin P. Patil

Associate Professor and Head,
Water & Land Management Department,
Dr. Babasaheb Ambedkar Marathwada University,
Sub Campus, Osmanabad

Abstract

Rainwater harvesting is one of the most commonly used methods to save water. It refers to storing of rainwater for various uses. The notion behind rainwater harvesting is to not waste the rainwater and prevent it from running off. This method is very useful considering the water scarcity that is happening in India. As we know that surface water is not enough to meet the demands of the people, we can get additional help from rainwater. Also, most people now depend on groundwater for their uses. Many houses and even flats have submersible pumps in their place. The groundwater is decreasing day by day because of excessive usage, deforestation, urbanization and more. It is therefore necessary to make decisions about conservation and allocation of water that are compatible with social objectives such as economic efficiency, sustainability and equity. When we practice rainwater harvesting, it can maintain the level of the groundwater. Moreover, rainwater harvesting prevents water from logging on roads. It also reduces the chances of soil erosion. Most importantly, rainwater harvesting improves the quality of water which we consume, as it is the purest form of water. At the rate in which India populace is expanding, India has surpassed China from its number 1 position of most thickly populated nation of the world in 2023. These will prompt high rate of utilization of most profitable regular asset; Water's subsequent in enlargement of weights on the allowed freshwater assets. Old technique for damming waterway and transporting water to urban zone has its own issues of everlasting inconveniences of social and political. The specialized parts of this paper are water harvesting collected from rooftops which is thought to be catchment territories from all lodgings and Institutes departmental working at Dr. Babasaheb Ambedkar Marathwada University, Sub Campus situated at Osmanabad. Osmanabad is one of the districts of Marathwada region in Maharashtra state which comes under the water scarcity zone. Osmanabad receives an average rainfall of 780 mm. As a matter of first importance, required information are gathered i.e. catchment zones and hydrological precipitation information. Water gathering potential for the inns and workforce flats is ascertaining, and the tank limit with appropriate plan is to consider.

Keywords—Rainwater, Indian Technique, water collection.

I. INTRODUCTION

Harvesting Rainwater for saving drinking water has gained enormous significance as modern water saving sanitary technique. This can be used for private and public buildings as well as for many industrial areas. Beyond that rainwater harvesting plays an important role for the rainwater (storm water) management of housing estates. Due to the storage (retention) and the usage of rainwater the water flowing off housing estates in both reduced and delayed.

Rainwater harvesting is a technology used to collect, convey and store rain water for later use from relatively clean surfaces such as a roof, land surface or rock catchment. RWH is the technique of collecting water from roof, Filtering and storing for further uses. Rainwater Harvesting is a simple technique of catching and holding rainwater where its falls. Either, we can store it in tanks for further use or we can use it to recharge groundwater depending upon the situation. RWH system provides sources of soft, high quality water reduces dependence on well and other sources and in many contexts are cost effective. RWH system is economically cheaper in construction compared to other sources, i.e. well, canal, dam, diversion, etc.

WHAT IS RAINWATER HARVESTING AND WHY IS IT IMPORTANT?

Water is our most precious natural resource and something that most of us take for granted. We are now increasingly becoming aware of the importance of water to our survival and its limited supply, especially in the water scarce zone of Marathwada region. Due to the increasing scarcity of good quality water of sufficient quantity and water related problems during rainy season & ground water depletion in summer season, the word 'WATER' takes the number one priority. It is therefore necessary to make decisions about conservation and allocation of water that are compatible with social objectives such as economic efficiency, sustainability and equity. Rain Water Harvesting fulfills all the criteria to be economically efficient, sustainable and equitable source of safe water. The harvesting of rainwater simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use. Normally water is collected from the roofs of buildings which is either stored in rainwater tanks or recharged to the groundwater. Water can also be collected in dams from rain falling on the ground and its subsequent producing runoff. But due to lack of knowledge and proper design guidelines and awareness the RWH system has not been popularized as it should have been. Rain water harvesting is a technique of collection and storage of rainwater into natural reservoirs or tanks, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff).

- To reduce the run-off that chokes the drains.
- To avoid the flooding of roads.
- To raise the underground water table.
- To reduce soils erosion.
- Supplement domestic water needs.
- Enhancing the quality of environment.
- To reduce groundwater pollution.
- To meet the increasing demand of water.

This paper is written with the intention of promoting the Rain Water Harvesting System and it also includes the rain water harvesting potential in an educational institute and a complete design for the system.

II. HISTORY OF RAIN WATER HARVESTING

The capturing and storing of rainwater goes back thousands of years to when we first started to farm the land and needed to find new ways of irrigating crops. In hotter climates, catching that intermittent rainfall often meant the difference between life and death for communities. Whilst the need to conserve water fell away with greater urbanization in the last thousand years, we are once again returning to this ancient and vital part of greener living.

- Talibs: Medium to large sized reservoirs that provide irrigation for plants as well as drinking.
- Johads:Dams that are used to capture and keep rainwater.
- Baoris: Wells dug into the grounds that are often still used for drinking.
- Jhalaras: Specially constructed tanks that are used for the local community and religious purposes

III. RAINWATER HARVESTING AT DR. BAMU, SUB CAMPUS

Dr. BAMU, Sub campus is a wide spread educational campus with a vast area of around 60 acres. There are around 500 students studying in the sub campus, whose daily requirement has to be served. Due to this fact, there can be a possible water shortage in the future. The nearby water-tables are being exploited daily at a fast pace. And there are fields in the nearby area which require this water. So this create a situation here of the usage of the rainwater. This huge area can be utilized for the purpose of Rainwater Harvesting. With the annual rainfall of around 750 mm and an intensity of 25 mm per hour in this area provides good opportunities to harvest the rainwater. The main campus consists of five buildings namely

1. Administrative Building
2. Science Building
3. Hostel No.-01(Girls' hostel)
4. Guest House
5. University Canteen

The orientation of each building is such that it maximizes the chances of collection of water. The submerged area of Earthen Nala Bund will serve as the location for the storage of rainwater that is received in the sub campus area.

IV. STUDIES CARRIED OUT IN SUB CAMPUS

Osmanabad city is situated at an altitude of 643m from mean sea level and on the divide line of Godavari and Krishna river basins. The sub campus is situated at the area of semi Arid zone of Osmanabad city. The study area is surrounded by Industrial & Agricultural area. The total strength of campus including students and staff peoples is more 700+. Thus, with this present strength and also with the expansion, campus should also increase its facilities and maintenance requirements. Thus water is most natural resource being always in high demands by human beings and is indispensable part of the life. Hence, keeping in view all the above problems and status of campus Dr. BAMU, Sub Campus. Administrative body should focus on water scarcity problem. Therefore, in this situation, rain water harvesting system can be considered as a best solution for fighting against water scarcity in campus area.

The campus of Dr. Babasaheb Ambedkar Marathwada University, Sub Campus (Dr. BAMU) is situated at latitude 17.35 to 18.40⁰ North, and longitude 75.16 to 76.40⁰ East. Upale (M.), Osmanabad, (Maharashtra State) - 413501. The figure shown by using Geographic Information System (GIS).

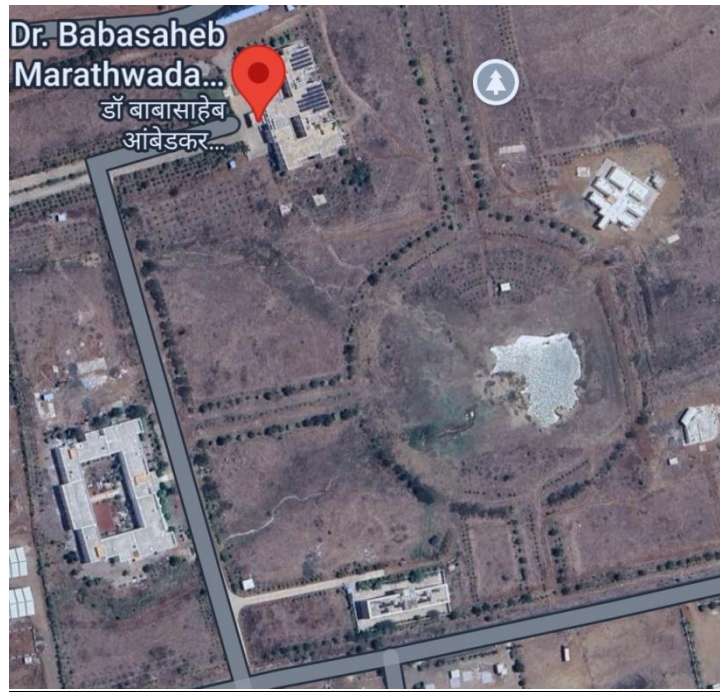


Figure 1: Satellite Image of Dr. BAM University, Sub Campus, Osmanabad

OBJECTIVES OF RAINWATER HARVESTING:

The main objectives of rainwater harvesting are:

- To meet the increasing demand of water.
- To reduce the run-off which chokes the drains
- To avoid the flooding of roads.
- To raise the underground water table.
- To reduce groundwater pollution.
- To reduce soils erosion.
- Supplement domestic water needs
- Lessens urban flooding.
- Straightforwardness in building framework in less time.
- Monetarily less expensive in development contrasted with different sources, i.e. dams, redirection, and so on.
- Water collecting is the perfect circumstance for those regions where there is lacking groundwater supply or surface assets.
- Aides in using the essential wellspring of water and keep the overflow from going into sewer or tempest channels, accordingly lessening the heap on treatment plants.
- Reviving water into the aquifers which help in enhancing the nature of existing groundwater through weakening.

V. METHODS OF RAINWATER HARVESTING:

Broadly there are two ways of harvesting rainwater.

1. Surface runoff harvesting:

2. Roof Top rainwater harvesting:

Various methods of rainwater harvesting are described in this ~~section~~

3. Surface runoff harvesting:

In urban area rainwater flows away as surface runoff. This runoff could be caught and used for recharging aquifers by adopting appropriate methods.

4. Roof Top rainwater harvesting:

It is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building. It can either be stored in a storage tank or diverted to artificial recharge system like farm pond or percolation tank. This method is less expensive and very effective and if implemented properly helps in augmenting the ground water level of the area.

VI. COMPONENTS OF THE ROOF TOP RAINWATER HARVESTING :

The illustrative design of the basic components of roof top rainwater harvesting system is given in the typical schematic diagram.

The system mainly constitutes of following sub components:

- Catchment • Transportation • First flush • Filter

IX. RAINFALL DETAILING:

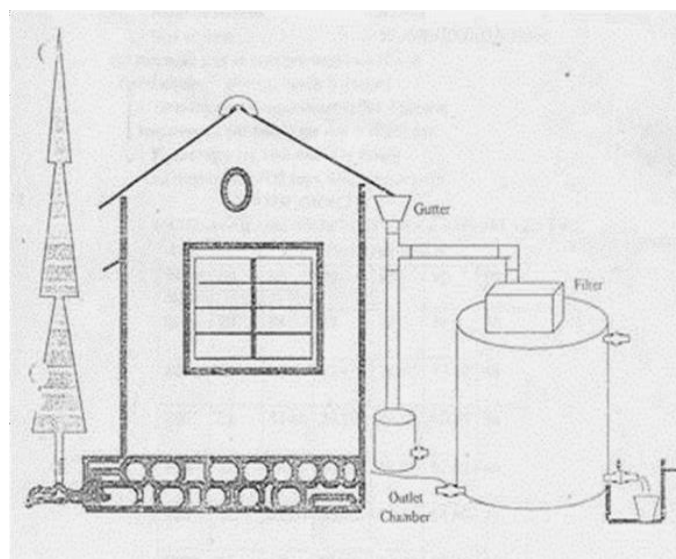


Figure 2: Showing the conveyance of Rainwater from Roof to Storage tank

Year	2015	2016	2017	2018	2019	2020	2021	2022
Ave. Rainfall (mm)	476.6	898.3	960.3	572.1	773.5	744.3	1099.6	771
Average Annual Rainfall						786.96 mm		

Runoff Coefficients of Different Surfaces:-

DIFFERENT SURFACES	RUNOFF COEFFICIENT (C)
Roof Conventional	0.7-0.8
Roof Inclined	0.85-0.95
Concrete /Kota paving	0.6-0.7
Gravel	0.5-0.7
Brick Paving	0.7

ANNUAL RAINWATER HARVESTING POTENTIAL

Annual rainwater harvesting potential is given by:-

$$V = C \times I \times A$$

Where,

V=Volume of water that can be harvested annually in m³,

C = Runoff coefficient

I = Annual rainfall in (mm)

A = Catchment area in (mm)

In Osmanabad, the rainy season starts from Mid June to Mid October. An Average maximum rainfall in Osmanabad is 1099.6 mm in 2021. According to Indian Meteorological Department, Pune the yearly Rainfall in Osmanabad region from 2015 – 2022

CATCHMENT AREA & VOLUME OF RAINFALL

Location	Admin. Building	Science Building	Girls Hostel	Guest House	Canteen
Area (M ²)	2000	2400	600	600	300
Volume (M ³)	1259.14	1510.96	377.74	377.74	188.87

Calculation of volume by obtained rainfall by average rainfall in jodhpur. (333mm)

volume = area x average rainfall – 20%(transpiration)Water Collection Potential

Total Rain water collection – 37,14,450 liters

Capacity of single tank - 10 x 10 x 6 Cu. m

Number of Tanks - 7 (As per suitable Location)

Runoff coefficient with respect to types of surface areas:-

TYPE OF AREA	RUNOFF COEFFICIENT (C)
Residential	0.3-0.5
Forests	0.5-0.2
Commercial & industrial	0.9
Parks & Farms	0.05-0.3
Asphalt or Concrete Paving	0.85

VII. ADVANTAGES OF RAINWATER HARVESTING

The rainwater harvesting system is one of the best methods practiced and followed to support the conservation of water. Today, scarcity of good quality water has become a significant cause of concern. However, rainwater, which is pure and of good quality, can be used for irrigation, washing, cleaning, bathing, cooking and also for other livestock requirements.

1. Easy to Maintain:

Utilizing the rooftop rainwater harvesting system provides certain advantages to the society. First of all, harvesting rainwater allows us to better utilize an energy resource. It is important to do so, since drinking water is not easily renewable and it helps in reducing wastage. Systems for the collection of rainwater are based on simple technology. The overall cost of their installation and operation is much lesser than that of water purifying systems. Maintenance requires very little time and energy. The result is the collection of water that can be used in substantial ways even without purification.

2. Reducing Water Bills:

For many families and small businesses, rainwater harvesting leads to a large reduction in their utilities bill. On an industrial scale, harvesting rainwater can provide the needed amounts of water for many operations to take place smoothly. It also lessens the burden of soil erosion in a number of areas, allowing the land to thrive once again. In fact, it can also be stored in cisterns for use during times when water supplies are at an all time low in summer.

3. Suitable for Irrigation and watering gardens:

As such, there is little requirement for building new infrastructure for the rainwater harvesting system. Most rooftops act as a workable catchments area, which can be linked to the harvesting system. This also lessens the impact on the environment by reducing use of fuel based machines. Rainwater is free from many chemicals found in ground water, making it suitable for irrigation and watering gardens. In fact, storing large reservoirs of harvested water is a great idea for areas where forest fires and bush fires are common during summer months.

4. Reduces Pressure on Ground Water:

With increase in population, the demand for water is also continuously increasing. The end result is that many residential colonies and industries are extracting ground water to fulfill their daily demands. This has led to depletion of ground water which has gone to significant low level in some areas where there is huge water scarcity.

5. Reduces Floods and Soil Erosion:

During rainy season, rainwater is collected in large storage tanks which also help in reducing floods in some low lying areas. Apart from this, it also helps in reducing soil erosion and contamination of surface water with pesticides and fertilizers from rainwater run-off which results in cleaner lakes and ponds.

6. Can be Used for Several Non-drinking Purposes:

Water collected in the rainwater harvesting system can be put to use for several non-drinking functions as well. Rainwater when collected can be used for several non-drinking functions including flushing toilets, washing clothes, watering the garden, washing cars etc. It is unnecessary to use pure drinking water if all we need to use it for some other purpose rather than drinking.

VIII. DISADVANTAGES OF RAINWATER HARVESTING

1. Unpredictable Rainfall:

Rainfall is very difficult to predict and sometimes little or no rainfall can limit the supply of rainwater. It is not advisable to depend on rainwater alone for all your water needs in areas where there is limited rainfall. Rainwater harvesting is suitable in those areas that receive plenty of rainfall.

2. Initial High Cost:

Depending on the system's size and technology level, a rainwater harvesting system may cost anywhere between \$200 to \$2000 and benefit from it cannot be derived until it is ready for use. Like solar panels, the cost can be recovered in 10-15 years which again depends on the amount of rainfall and sophistication of the system.

3. Regular Maintenance:

Rainwater harvesting systems require regular maintenance as they may get prone to rodents, mosquitoes, dust and other foreign material on the roof top, algae growth, insects and lizards. They can become as breeding grounds for many animals if they are not properly maintained.

4. Storage Limits:

The collection and storage facilities may also impose some kind of restrictions as to how much rainwater you can use. During the heavy downpour, the collection systems may not be able to hold all rainwater which ends in going to drains and rivers. Rainwater harvesting is a system that is gaining speed over time. Areas that experience high amounts of rainfall will benefit the most from the system and will be able to distribute water to dry lands with ease. However, the beneficial environmental impact of the system is what drives it further as of now.

CONCLUSION

Recharge of ground water and the consequently the rise in water table is a gradual process and we cannot suddenly increase the ground water table after constructing recharge structures, by constructing any type of recharge structure, and we can give our contribution in aquifer recharge. This will help to rejuvenate the depleting ground water resources. Also help to save the little amount of rain water which was used to drain away from many years. Thus it is concluded that implementation of RWH system of Dr. Babasaheb Ambedkar Marathwada University Sub Campus, Osmanabad would result in the form of the best approach to deal with present scenario of water scarcity and storing huge quantity of 37,14,450 liters in a year in the university sub campus. The harvested rainwater can be utilized to satisfy the daily needs of drinking water for the students and staff members.

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