Rainwater Harvesting:
Grab hold of Water Where it Falls!

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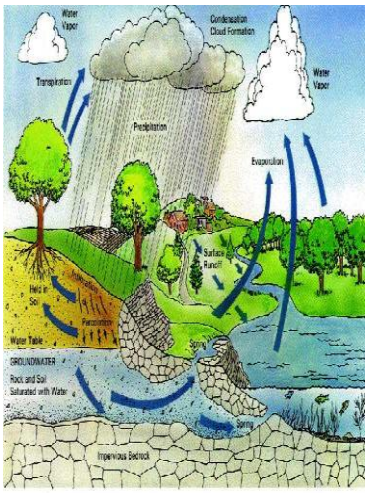
Abstract

Till about thirty years back, the areas around our homes and offices used to be unpaved and the rain falling on these areas would percolate into the soil and remain there for being drawn through shallow open wells. With the proliferation of flat complexes, not only have these areas been paved and percolation of rainwater into the soil almost totally stopped, the quantity of water drawn from the soil below has increased manifold. Consequently open wells and not - so - deep bore wells started drying up. The reason is that no sincere attempt is made to replenish the ground water table with rainwater during the monsoon. The Rainwater harvesting is the simple collection or storing of water through scientific techniques from the areas where the rain falls. It involves utilization of rain water for the domestic or the agricultural purpose. The method of rain water harvesting has been into practice since ancient times. It is as far the best possible way to conserve water and awaken the society towards the importance of water. The method is simple and cost effective too. It is especially beneficial in the areas, which faces the scarcity of water.

People usually make complaints about the lack of water. During the monsoons lots of water goes waste into the gutters. And this is when Rain water Harvesting proves to be the most effective way to conserve water. We can collect the rain water into the tanks and prevent it from flowing into drains and being wasted. It is practiced on the large scale in the metropolitan cities. Rain water harvesting comprises of storage of water and water recharging through the technical process

Introduction

It was very difficult to imagine few decades before that you will require to buy drinking. The use value of water was never undermined, but its about time that even its exchange value is given due importance. Fresh water today is a scarce resource, and it is being felt the world over. More than 2000 million people would live under conditions of high water stress by the year 2050, according to the UNEP (United Nations Environment Programme), which warns water could prove to be a limiting factor for development in a number of regions in the world. About one-fifth of the world's population lacks access to safe drinking water and with the present consumption patterns; two out of every three persons on the earth would live in water-stressed conditions by 2025. Around one-third of the world population now lives in countries with moderate to high water stress—where water consumption is more than 10% of the renewable fresh water supply, said the GEO (Global Environment Outlook) 2000, the UNEP's millennium report. Pollution and scarcity of water resources and climate change would be the major emerging issues in the next century, said the report. These issues would be followed by problems of desertification and deforestation, poor governance at the national and global levels, the loss of biodiversity, and population growth, said the report - The Observer of Business and Politics, 12 October 1999.



The reality of water crisis cannot be ignored. India has been notorious of being poor in its management of water resources. The demand for water is already outstripping the supply. Majority of the population in the cities today are groundwater dependent. In spite of the municipal water supply, it is not surprising to find people using private tube wells to supplement their daily water needs. As a result, the groundwater table is falling at an alarming rate.

Extraction of groundwater is being done unplanned and uncontrolled thus this has resulted in:

Hydrological imbalance

Deterioration in water quality

Rise in energy requirements for pumping

Rain Water Harvesting, is an age-old system of collection of rainwater for future use. But systematic collection and recharging of ground water, is a recent development and is gaining importance as one of the most feasible and easy to implement remedy to restore the hydrological imbalance and prevent a crisis.

Technically speaking, water harvesting means A system that collects rainwater from where it falls rather than allowing it to drain away. It includes water that is collected within the boundaries of a property, from roofs and surrounding surfaces. Experts suggest various ways of harvesting water:

- Capturing run-off from rooftops
- Capturing run-off from local catchments
- Capturing seasonal flood water from local streams
- Conserving water through watershed management

Local water harvesting systems developed by local communities and households can reduce the pressure on the state to provide all the financial resources needed for water supply. In addition, involving people will give them a sense of ownership and reduce the burden on government funds.

Need for Water Harvesting

The scarcity of water is a well-known fact. In spite of higher average annual rainfall in India (1,170 mm, 46 inches) as compared to the global average (800 mm, 32 inches) it does not have sufficient water. Most of the rain falling on the surface tends to flow away rapidly, leaving very little for the recharge of groundwater. As a result, most parts of India experience lack of water even for domestic uses.

Surface water sources fail to meet the rising demands of water supply in urban areas, groundwater reserves are being tapped and over-exploited resulting into decline in groundwater levels and deterioration of groundwater quality. This precarious situation needs to be rectified by immediately recharging the depleted aquifers.

Hence, the need for implementation of measures to ensure that rain falling over a region is tapped as fully as possible through water harvesting, either by recharging it into the groundwater aquifers or storing it for direct use.

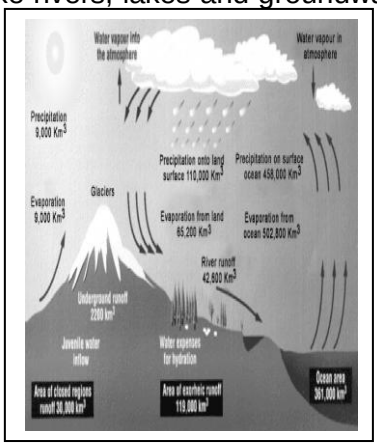
Science of Water Harvesting

In scientific terms, water harvesting refers to collection and storage of rainwater and also other activities aimed at harvesting surface and groundwater, prevention of losses through evaporation and seepage and all other hydrological studies and engineering inventions, aimed at conservation and efficient utilization of the limited water endowment of physiographic unit such as a watershed.

Rain is a primary source of water for all of us. There are two main techniques of rainwater harvesting:
Storage of rainwater on surface for future use.

- Recharge to groundwater.
- Directly collected rainwater can be stored for direct use or can be recharged into the groundwater.

All the secondary sources of water like rivers, lakes and groundwater are entirely dependent on rain as a primary source.



HYDROLOGICAL CYCLE

The term water harvesting is understood to encompass a wide range of concerns, including rainwater collection with both rooftop and surface runoff catchment, rainwater storage in small tanks and large-scale artificial reservoirs, groundwater recharge, and also protection of water sources against pollution.
The objective of water harvesting in India differs between urban and rural areas. In urban areas, emphasis is put on increasing groundwater recharge and managing storm water. On the other hand, in rural areas securing water is more crucial. There the aim is to provide water for drinking and farming, especially for life-saving irrigation, and to increase groundwater recharge.

Rooftop / Runoff Rainwater Harvesting for Artificial Recharge to Ground Water

Water harvesting is the deliberate collection and storage of rainwater that runs off on natural or manmade catchment areas. Catchment includes rooftops, compounds, rocky surface or hill slopes or artificially prepared impervious/ semi-pervious land surface. The amount of water harvested depends on the frequency and intensity of rainfall, catchment characteristics, water demands and how much runoff occurs and how quickly or how easy it is for the water to infiltrate through the subsoil and percolate down to recharge the aquifers. Moreover, in urban areas, adequate space for surface storage is not available, water levels are deep enough to accommodate additional rainwater to recharge the aquifers, rooftop and runoff rainwater harvesting is ideal solution to solve the water supply problems.

ADVANTAGES OF RAINWATER HARVESTING

1. To meet the ever increasing demand for water. Water harvesting to recharge the groundwater enhances the availability of groundwater at specific place and time and thus assures a continuous and reliable access to groundwater.
2. To reduce the runoff which chokes storm drains and to avoid flooding of roads.
3. To reduce groundwater pollution and to improve the quality of groundwater through dilution when recharged to groundwater thereby providing high quality water, soft and low in minerals.
4. Provides self-sufficiency to your water supply and to supplement domestic water requirement during

summer and drought conditions.

5. It reduces the rate of power consumption for pumping of groundwater. For every 1 m rise in water level, there is a saving of 0.4 KWH of electricity.
6. Reduces soil erosion in urban areas
7. The rooftop rainwater harvesting is less expensive, easy to construct, operate and maintain.
8. In saline or coastal areas, rainwater provides good quality water and when recharged to ground water, it reduces salinity and helps in maintaining balance between the fresh-saline water interfaces.
9. In Islands, due to limited extent of fresh water aquifers, rainwater harvesting is the most preferred source of water for domestic use.
10. In desert, where rainfall is low, rainwater harvesting has been providing relief to people.

Design Considerations

Three most important components, which need to be evaluated for designing the rainwater harvesting structure, are:

1. Hydrogeology of the area including nature and extent of aquifer, soil cover, topography, depth to water levels and chemical quality of ground water
2. Area contributing for runoff i.e. how much area and land use pattern, whether industrial, residential or green belts and general built up pattern of the area
3. Hydro-meteorological characters like rainfall duration, general pattern and intensity of rainfall.

Components Of Rain Harvesting System

A rainwater harvesting system comprises components of various stages - transporting rainwater through pipes or drains, filtration, and storage in tanks for reuse or recharge. The common components of a rainwater harvesting system involved in these stages are illustrated here.

1. Catchments

The catchment of a water harvesting system is the surface which directly receives the rainfall and provides water to the system. It can be a paved area like a terrace or courtyard of a building, or an unpaved area like a lawn or open ground. A roof made of reinforced cement concrete (RCC), galvanised iron or corrugated sheets can also be used for water harvesting.

2. COARSE MESH

At the roof to prevent the passage of debris.

3. GUTTERS

Channels all around the edge of a sloping roof to collect and transport rainwater to the storage tank. Gutters can be semi-circular or rectangular and could be made using:

- Locally available material such as plain galvanised iron sheet (20 to 22 gauge), folded to required shapes.
- Semi-circular gutters of PVC material can be readily prepared by cutting those pipes into two equal semi-circular channels.
- Bamboo or betel trunks cut vertically in half.

The size of the gutter should be according to the flow during the highest intensity rain. It is advisable to make them 10 to 15 per cent oversize.

Gutters need to be supported so they do not sag or fall off when loaded with water. The way in which gutters are fixed depends on the construction of the house; it is possible to fix iron or timber brackets into the walls, but for houses having wider eaves, some method of attachment to the rafters is necessary.

4. Conduits

Conduits are pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system. Conduits can be of any material like polyvinyl chloride (PVC) or galvanized iron (GI), materials that are commonly available.

The following table gives an idea about the diameter of pipe required for draining out rainwater based on rainfall intensity and roof area:

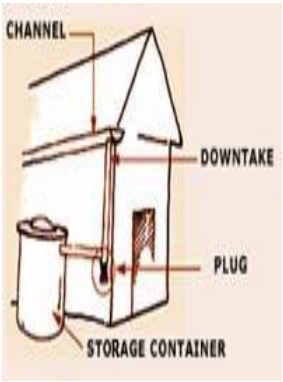
Diameter Of pipe (mm)	Average rate of rainfall in mm/h					
	50	**75**	**100**	**125**	**150**	**200**
50	13.4	8.9	6.6	5.3	4.4	3.3
65	24.1	16.0	12.0	9.6	8.0	6.0
75	40.8	27.0	20.4	16.3	13.6	10.2
100	85.4	57.0	42.7	34.2	28.5	21.3
125	-	-	80.5	64.3	53.5	40.0
150	-	-	-	-	83.6	62.7

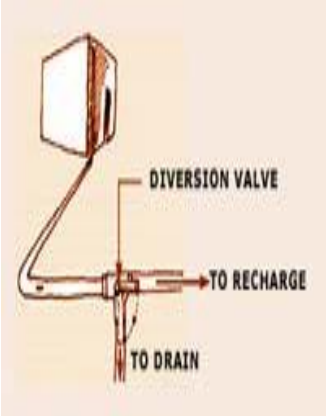
Sizing of rainwater pipe for roof drainage

mm/ h - millimeters per hour; m - meters

5. First-Flushing

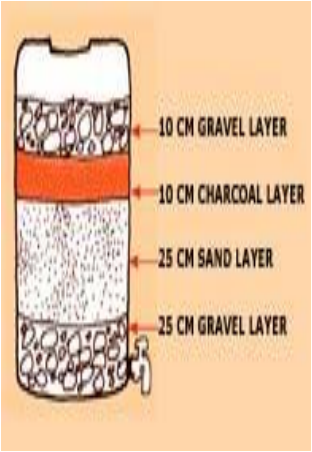
A first flush device is a valve that ensures that runoff from the first spell of rain is flushed out and does not enter the system. This needs to be done since the first spell of rain carries a relatively larger amount of pollutants from the air and catchment surface.





6. FILTER

The filter is used to remove suspended pollutants from rainwater collected over 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 water before it enters the storage tank or recharge structure. Charcoal can be added for additional filtration.



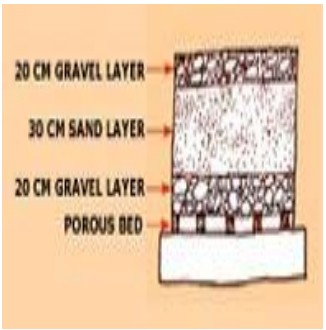
A water harvesting manual for urban areas

1. Charcoal water filter

A simple charcoal filter can be made in a drum or an earthen pot. The filter is made of gravel, sand and charcoal, all of which are easily available.

2. Sand filters

Sand filters have commonly available sand as filter media. Sand filters are easy and inexpensive to construct. These filters can be employed for treatment of water to effectively remove turbidity (suspended particles like silt and clay), colour and microorganisms.



Water harvesting manual for urban areas

In a simple sand filter that can be constructed domestically, the top layer comprises coarse sand followed by a 5-10 mm layer of gravel followed by another 5-25 cm layer of gravel and boulders.

How much water can be harvested?
The total amount of water that is received in the form of rainfall over an area is called the *rainwater endowment* of that area. Out of this, the amount that can be effectively harvested is called the *water harvesting potential.*

Water Harvesting potential = Rainfall (mm) X Collection efficiency

An example of potential for rainwater harvesting[2]:
Consider a building with a flat terrace area of 100m^2. The average annual rainfall in Delhi is approximately 600 mm (24 inches). In simple terms, this means if the terrace floor is assumed impermeable, and all the rain that falls on it is retained without evaporation, then, in one year, there will be rainwater on the terrace floor to a height of 600 mm.

Area of the plot = 100 m^2
Height of annual rainfall = 0.6 m (600 mm or 24 inches)
Volume of rainfall over the plot = Area of plot X Height of rainfall
= 100 m^2 X 0.6 m
= 60 m^3 (60,000 litres)

Assuming that only 60 percent of the total rainfall is effectively harvested,
Volume of water harvested = 36,000 litres

This volume is about twice the annual drinking water requirement of a 5-member family. The average daily drinking water requirement per person is 10 litres[3].

I.QUALITY OF STORED WATER

Rainwater collected from rooftops is free of mineral pollutants like fluoride and calcium salts that are generally found in groundwater. But, it is likely that to be contaminated with these types of pollutants:

1. Air Pollutants
2. Surface contamination (e.g., silt, dust)

Such contaminations can be prevented to a large extent by flushing off the first rainfall. A grill at the terrace outlet for rainwater can arrest leaves, plastic bags and paper pieces carried by water. Other contamination can be removed by sedimentation and filtration. Disinfectants can remove biological contamination.

Cost Analysis

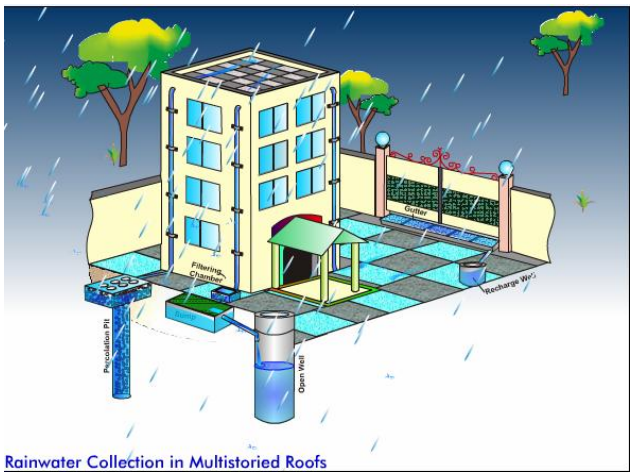
1. Cost of a Rainwater harvesting system designed as an integrated component of a new construction project is generally low.
2. Designing a system onto an existing building is costlier because many of the shared costs (roof and gutters) can be designed to optimise system.
3. In general, maximising storage capacity and minimising water use through conservation and reuse are important rules to keep in mind.
4. With careful planning and design, the cost of a rainwater system can be reduced considerably.

Cost of installation

Estimated average cost of installing a Water Harvesting System for[4]:

1. **An individual house** of average area of 300-500 m^2, the average cost will be around Rs. 20,000-25,000. A recharge well will be constructed near the existing borewell. The roofwater through PVC pipe will be diverted to recharge well.
2. **An apartment building,** the cost will be less since the many people will share the cost. More over in

apartments there are separate storm water drains, which join the MCD drains in the main road. Here along with recharge well, recharge trench and percolation pits can be constructed. The cost will be around 60 to 70 thousand.



Rainwater Collection in Multistoried Roofs

3. **A colony,** the cost will be much less. For instance, around 36 recharge wells were installed at the cost of 8 lakh, which is around Rs 500-600 per house. In many colonies storm water drains are present but it is difficult to isolate them from sewage drains because there has been violation of the drainage master plan. Also, these drains are not properly maintained. Hence, care needs to be taken while using storm water for water harvesting.
   Rooftop harvesting is preferred because the silt load is less. In storm water drain the silt load is high and generally the municipality does not maintain the storm drains properly.
4. **An institution** with campus, the cost was around 4 lac. Here two recharge wells and three trenches cum percolation pits were constructed.

Average annual maintenance cost would be around Rs 200-300 for two labourers once in a year to remove the pebbles and replace the sand from trenches.

Case Study

In thane in the year 2003 Rain water Harvesting project was done in VIKAS Complex B wing for five buildings 9 storage each. They had dug 3 bore wells and a pit of 6ft X 4ft pit. So total cost was around Rs. 300000 including the piping. Due to this they have 5000 liters of output in the morning and evening. So total 10000 liters per day. So the total 5 building supply per day was 50000 per day.
For instant from the year 2003 they receive 50000 liters of water non stop every day.

Concluding Remarks

It is no denying that sustaining and recharging the groundwater along with judicious use of the limited fresh water resources is the need of the hour. If sufficient measures are not taken up immediately, we will face a crisis which will be detrimental to the very survival of mankind. Efficient management of water resources and education about judicious utilization of water resources along with measures of harnessing, recharging and maintaining the quality of water and water bodies has to be taken up on war footing.
One of the most logical steps towards this goal would be acknowledging the importance of rainwater harvesting. This should not only encompass rooftop rainwater harvesting but also storm water harvesting systems. Storm water harvesting is yet to be acknowledged as a better alternative over rooftop water harvesting. One of the major hurdles in storm water harvesting is the poor state of storm water drain systems in India. A planned approach is hence needed in order to fully utilise the potential of rainwater to adequately meet our water requirements. Hence, an equal and positive thrust is needed in developing and encouraging both the types of water harvesting systems. We have to catch water in every possible way and every possible place it falls.

It can be concluded from above findings that rainwater, if conserved and utilized using the rainwater harvesting technology, can be an effective tool of replenishing ground water resources

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