

## Water harvesting in Hilly Area

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**Abstract**— 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.

**Key words:** The Rainwater harvesting, the agricultural purpose, Land Surface Catchments

### I. INTRODUCTION

Water is essential for the environment, food security and sustainable development. All the known civilizations have flourished with water source as the base and it is true in the present context too. Availability of drinking water and provision of sanitation facilities are the basic minimum requirements for healthy living. Water supply and sanitation, being the two most important urban services, have wide ranging impact on human health, quality of life, environment and productivity. Despite the technological advancements, the global scenario still remains grim, as all the inhabitants of the world do not have access to safe water and adequate sanitation.

In most urban areas, the population is increasing rapidly and the issue of supplying adequate water to meet societal needs and to ensure equity in access to water is one of the most urgent and significant challenges faced by the policy-makers.

With respect to the physical alternatives to fulfill sustainable management of freshwater, there are two solutions: finding alternate or additional water resources using conventional centralized approaches; or utilizing the limited amount of water resources available in a more efficient way. To date, much attention has been given to the first option and only limited attention has been given to optimizing water management systems. Among the various technologies to augment freshwater resources, rainwater harvesting and utilization is a decentralized, environmentally sound solution, which can avoid many environmental problems often caused by conventional large-scale projects using centralized approaches.

Rainwater harvesting, in its broadest sense, is a technology used for collecting and storing rainwater for human use from rooftops, land surfaces or rock catchments

using simple techniques such as jars and pots as well as engineered techniques. Rainwater harvesting has been practiced for more than 4,000 years, owing to the temporal and spatial variability of rainfall. It is an important water source in many areas with significant rainfall but lacking any kind of conventional, centralized supply system. It is also a good option in areas where good quality fresh surface water or ground water is lacking. The application of appropriate rainwater harvesting technology is important for the utilization of rainwater as a water resource.

### II. CONCEPT AND TECHNOLOGY OF RAINWATER HARVESTING

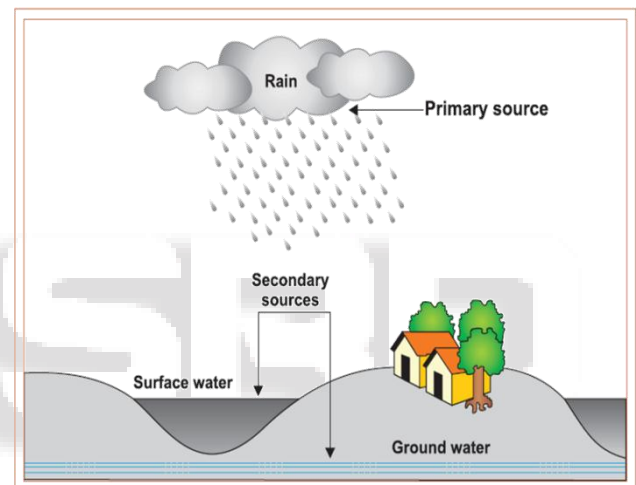


Figure Where does all our water come from?

Rainwater is a free source of nearly pure water and rainwater harvesting refers to collection and storage of rainwater and other activities aimed at harvesting surface and ground water. It also includes prevention of losses through evaporation and seepage and all other hydrological and engineering interventions, aimed at conservation and efficient utilisation of the limited water endowment of physiographic unit such as a watershed. In general, water harvesting is the activity of direct collection of rainwater. The rainwater collected can be stored for direct use or can be recharged into the ground water. Rain is the first form of water that we know in the hydrological cycle, hence is a primary source of water for us (see *figure*).

Rivers, lakes and ground water are all secondary sources of water. In present times, we depend entirely on such secondary sources of water. In the process, generally, it is forgotten that rain is the ultimate source that feeds all these secondary sources. Water harvesting means making optimum use of rainwater at the place where it falls so as to attain self-sufficiency in water supply, without being dependent on remote water sources.

Cities get lots of rain, yet cities have water shortage. Why? Because people living there have not reflected enough on the value of the raindrop. The annual

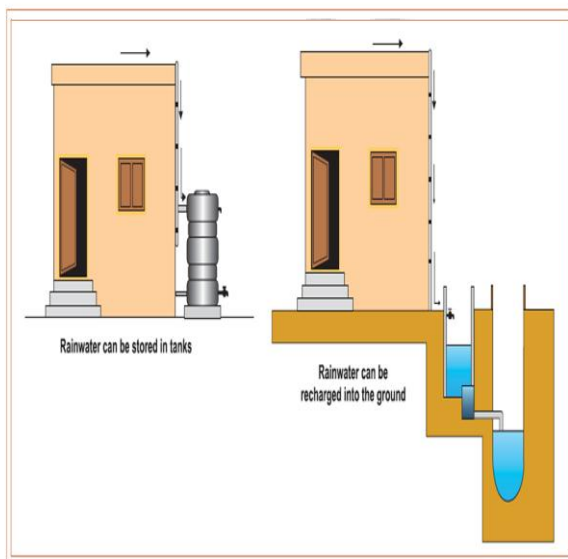
rainfall over India is computed to be 1,170 mm (46 inches). This is higher compared to the global average of 800 mm (32 inches). However, this rainfall occurs during short spells of high intensity. Because of such intensities and short duration of heavy rain, most of the rain falling on the surface tends to flow away rapidly, leaving very little for the recharge of ground water. This makes most parts of India experience lack of water even for domestic uses. Ironically, even Cherra punji, India, which receives about 11,000 mm of rainfall annually, suffers from acute shortage of drinking water. This is because the rainwater is not conserved and is allowed to drain away. Thus it does not matter as to how much rain falls at a place, if it is not captured or harvested there for use. This highlights the need to implement measures to ensure that the rain falling over a region is tapped as fully as possible through water harvesting, either by recharging it into the ground water aquifers or storing it for direct use. Many urban centers in Asia and other regions are facing an ironical situation today. On the one hand there is an acute water scarcity and on the other, streets are generally flooded during rains. This has led to serious problems with quality and quantity of ground water. One of the solutions to the urban water crisis is rainwater harvesting -capturing the runoff. The advantage of Rainwater Harvesting is more where surface water is inadequate to meet our demand and exploitation of ground water resource has resulted in decline in water levels in most part of the country.

#### A. From Where We Can Harvest Rainwater:

Rainwater can be harvested from the following surfaces:

##### 1) Rooftops:

If buildings with impervious roofs are already in place, the catchment area is effectively available free of charge and they provide a supply at the point of consumption.



##### 2) Paved And Unpaved Areas:

i.e., landscapes, open fields, parks, storm water drains, roads and pavements and other open areas can be effectively used to harvest the runoff. The main advantage in using ground as a collecting surface is that water can be collected from a larger area. This is particularly advantageous in areas of low rainfall.

##### 3) Water Bodies:

The potential of water bodies such as lakes, tanks and ponds to store rainwater is immense. The harvested rainwater can be used not only to meet water requirements of the city; it also recharges ground water aquifers.

##### 4) Storm Water Drains:

Most of the residential colonies have proper network of storm water drains. If maintained neatly, these offer a simple and cost effective means for harvesting rainwater.

### III. TYPES OF RAINWATER HARVESTING SYSTEMS

Typically, a rainwater harvesting system consists of three basic elements: the collection system, the conveyance system, and the storage system. Collection systems can vary from simple types within a household to bigger systems where a large catchment area contributes to an impounding reservoir from which water is either gravitated or pumped to water treatment plants. The categorization of rainwater harvesting systems depends on factors like the size and nature of the catchment areas and whether the systems are in urban or rural settings. Some of the systems are described below.

#### A. Simple Roof Water Collection Systems:

While the collection of rainwater by a single household may not be significant, the impact of thousands or even millions of household rainwater storage tanks can potentially be enormous. The main components in a simple roof water collection system are the cistern itself, the piping that leads to the cistern and the appurtenances within the cistern. The materials and the degree of sophistication of the whole system largely depend on the initial capital investment. Some cost effective systems involve cisterns made with Ferro-cement, etc. In some cases, the harvested

Rainwater may be filtered. In other cases, the rainwater may be disinfected.

#### B. Larger Systems For Educational Institutions, Stadiums, Airports, And Other Facilities:

When the systems are larger, the overall system can become a bit more complicated, for example rainwater collection from the roofs and grounds of institutions, storage in underground reservoirs, treatment and then use for non-potable applications.

#### C. Roof Water Collection Systems For High-Rise Buildings In Urbanised Areas:

In high-rise buildings, roofs can be designed for catchment purposes and the collected roof water can be kept in separate cisterns on the roofs for non-potable uses.

#### D. Land Surface Catchments:

Rainwater harvesting using ground or land surface catchment areas can be a simple way of collecting rainwater. Compared to rooftop catchment techniques, ground catchment techniques provide more opportunity for collecting water from a larger surface area. By retaining the flows (Including flood flows) of small creeks and streams in small storage reservoirs (on surface or underground) created by low cost (e.g., earthen) dams, this technology can meet water demands during dry periods. There is a possibility of high rates of water loss due to infiltration into the ground, and because of the often marginal quality of the water

collected, this technique is mainly suitable for storing water for agricultural purposes.

#### E. Collection of Storm Water In Urbanised Catchments:

The surface runoff (Box 2.1) collected in storm water ponds/reservoirs from urban areas is subject to a wide variety of contaminants. Keeping these catchments clean is of primary importance, and hence the cost of water pollution control can be considerable.

#### F. Rainwater Harvesting Potential:

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. Among the several factors that influence the rainwater harvesting potential of a site, climatic conditions specially rainfall and the catchment characteristics are considered to be the most important.

#### G. Rainfall:

##### 1) Quantity:

Rainfall is the most unpredictable variable in the calculation and hence, to determine the potential rainwater supply for a given catchment, reliable rainfall data are required, preferably for a period of at least 10 years. Also, it would be far better to use rainfall data from the nearest station with comparable conditions.

##### 2) Pattern:

The number of annual rainy days also influences the need and design for rainwater harvesting. The fewer the annual rainy days or longer the dry period, the more the need for rainwater collection in a region. However, if the dry period was too long, big storage tanks would be needed to store rainwater. Hence in such regions, it is more feasible to use rainwater to recharge ground water aquifers rather than for storage.

### IV. STORING RAINWATER OR RECHARGING GROUND WATER AQUIFERS

Rainwater can be stored for direct use or alternatively it can be charged into the ground water aquifers. This can be done through any suitable structures like dug wells, bore wells, recharge trenches and recharge pits. The decision whether to store or recharge water depends on the rainfall pattern of a particular region. For example, in places like Kerala and Mizoram in India, rain falls throughout the year, barring a few dry periods. In such places, one can depend on a small domestic-sized water tank for storing rainwater, since the period between two spells of rain is short. On the other hand, in dry areas like Delhi, Rajasthan and Gujarat, the total annual rainfall occurs only during 3 or 4 months of monsoon. The water collected during the monsoon has to be stored throughout the year; which means that huge volumes of storage containers would have to be provided. In Delhi, it is more feasible to use rainwater to recharge ground water aquifers rather than for storage. Selection of a recharge location has to be done intelligently so as to ensure maximum collection of the rainwater runoff from the catchment area as well as to facilitate the maximum possible recharge. Scientifically there are various techniques available for geologically determining an ideal recharge

location which is usually at the lowest point in the complex nearest to the existing out drainage point that shall facilitate collection of maximum rainwater runoff. Situating a recharge bore next to an existing tube well also enhances the rate of recharge into the ground and helps to sustain the existing ground water withdrawals. However, it is always advisable to maintain a minimum safe distance between the two bores. Subsequent chapters of this book focus on various techniques for aquifer recharging. Generally, only runoff from paved surfaces is used for storing, since it is relatively free of bacteriological Contamination. Drainpipes that collect water from the catchment (rooftop) are diverted to the storage container.

#### A. Restoring the Hydrological Cycle:

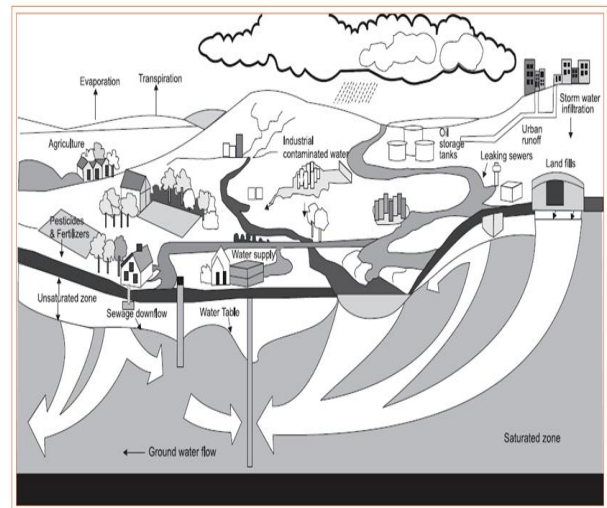


Diagram of the Hydrological Cycle (detail)

#### B. The Concept of "Cycle Capacity":

In thinking about sustainable development, one must view environmental capacity from a dynamic perspective and consider the time required for the restoration of the hydrological cycle. "Cycle capacity" refers to the time that nature needs to revive the hydrological cycle. The use of ground water should be considered from the point of view of cycle capacity. Rain seeps underground and over time becomes shallow stratum ground water. Then, over a very long period of time, it becomes deep stratum ground water. For sustainable use of ground water, it is necessary to consider the storage capacity for ground water over time. If this is neglected and ground water is extracted too quickly, it will disappear within a short time.

#### C. Quality Considerations in Utilizing Rainwater:

It is generally believed that rainwater can provide clean, safe and reliable water which can be consumed without pre-treatment. This however may be used in some areas that are relatively unpolluted. Rainwater collected in many locations contains impurities. Therefore, in order to ensure quality of water, the collection systems will have to be properly built and maintained and the water shall also have to be treated appropriately for intended uses. Once rain comes in contact with a roof or collection surface, it can wash many types of bacteria, molds, algae, protozoa and other contaminants into the cistern or storage tank. Indeed, some samples of harvested rainwater have shown detectable levels of these contaminants.

#### D. Rain Water Harvesting System:

All sources of water are ultimately rain. Therefore, all water supply systems are, in effect, rainwater-harvesting systems. A proper definition for this term to understand its spirit would, in effect, necessarily have to take into consideration the difference in catchments. While previously catchments were typically far off from the urban area they served, now the city itself is seen as a catchment for its water requirement. Rooftops, paved areas and unpaved areas and the entire city itself is, therefore, to be managed as a water provision area. As the Centre for Science and Environment, Delhi (India) puts it 'CATCH WATER WHERE IT FALLS' would be a good definition of rainwater harvesting.

The process of rainwater harvesting would encompass catching rainwater, directing it to an appropriate location, filtering it if required and storing it for use. Storage could be in tanks, sumps, ponds or lakes wherever appropriate and conditions permitting recharge of ground water would also qualify as storage. Harvested water could be used immediately as a first choice thus saving city level supplies or ground water for a future date or a decision could be taken to store it for later use, say during water shortage days. Domestic rainwater harvesting or rooftop rainwater harvesting is the technique through which rainwater is captured from roof catchments and stored in tanks/reservoirs/ground water aquifers. It also consists of conservation of roof top rainwater in urban areas and utilizing it to augment ground water storage by artificial recharge. It requires connecting the outlet pipe from rooftop to divert collected water to existing well/tube well/bore well or a specially designed well. Rooftop harvested rainwater is more safe for drinking purposes than the runoff harvested water.

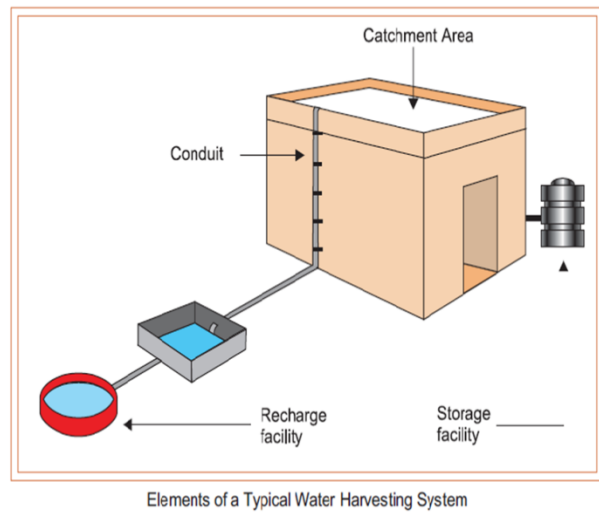
Rooftop harvesting needs to have safe storage facilities to keep the water fit for drinking. First flush of rainwater is discarded. A number of alternative technologies are available for rooftop harvesting and storage to suit the varying situations and the budgets.

#### V. COMPONENTS OF A RAINWATER HARVESTING SYSTEM

All rainwater-harvesting systems comprise six basic components irrespective of the size of the system.

- (1) Catchment area/roof: The surface upon which the rain falls; the roof has to be appropriately sloped preferably towards the direction of storage and recharge.
- (2) Gutters and downspouts: The transport channels from catchment surface to storage; these have to be designed depending on site, rainfall characteristics and roof characteristics.
- (3) Leaf screens and roof washers: The systems that remove contaminants and debris; a first rain separator has to be put in place to divert and manage the first 2.5 mm of rain.
- (4) Cisterns or storage tanks: Sumps, tanks etc. where collected rain-water is safely stored or recharging the ground water through open wells, bore wells or percolation pits etc.;
- (5) Conveying: The delivery system for the treated rainwater, either by gravity or pump;

- (6) Water treatment: Filters to remove solids and organic material and equipment, and additives to settle, filter, and disinfect.



#### A. Catchment Surface:

The catchment area of a water harvesting system is the surface, which receives rainfall directly and contributes the 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. Temporary structures like sloping sheds can also act as catchments. In Botswana, house compounds and threshing floors are surfaced with clay / cow dung plaster and used effectively as rainwater catchments. Rainwater harvested from catchment surfaces along the ground, because of the increased risk of contamination, should only be used for non-potable uses such as lawn watering. For in house uses, rooftop harvested rainwater is safer for drinking purposes than the runoff harvested water.

#### B. Catchment Area Size:

The size of a roof catchment area is the building's footprint under the roof. The catchment surface is limited to the area of roof which is guttered. To calculate the size of the catchment area, multiply the length times the width of the guttered area.

#### C. Conveyance Systems:

Conveyance systems are required to transfer the rainwater collected on catchment surfaces (e.g. rooftops) to the storage tanks. This is usually accomplished by making connections to one or more down-pipes connected to collection devices (e.g. rooftop gutters). The pipes used for conveying rainwater, wherever possible, should be made of plastic, PVC or other inert substance, as the pH of rainwater can be low (acidic) and may cause corrosion and mobilization of metals in metal pipes. When selecting a conveyance system, consideration should be given to the fact that when it first starts to rain, dirt and debris from catchment surfaces and collection devices will be washed into the conveyance systems (e.g. down-pipes). Relatively clean water will only be available sometime later in the storm. The first part of each rainfall should be diverted from the storage tank. There are several possible options for selectively collecting clean

water for the storage tanks. The common method is a sediment trap, which uses a tipping bucket to prevent the entry of debris from the catchment surface into the tank. Installing a first flush (or foul flush) device is also useful to divert the initial batch of rainwater away from the tank. Gutters and down-pipes need to be periodically inspected and carefully cleaned. A good time to inspect gutters and down-pipes is while it is raining, so that leaks can be easily detected. Regular cleaning is necessary to avoid contamination.

*D. Cleaning And Maintenance Of Storage Tanks:*

Open containers are not recommended for storing water for drinking purposes. A solid and secure cover is required to avoid breeding of mosquitoes, to prevent insects and rodents from entering the tank, and to keep out sunlight to prevent the growth of algae inside the tank. The storage tank should be checked and cleaned periodically. All tanks need cleaning and their designs should allow for thorough scrubbing of the inner walls and floors. A sloped bottom and the provision of a sump and a drain are useful for collection and discharge of settled grit and sediment. An entrance hole is required for easy access for cleaning. The use of a chlorine solution is recommended for cleaning, followed by thorough rinsing. Chlorination of the cisterns or storage tanks is necessary if the water is to be used for drinking and domestic uses. Dividing tanks into two sections or dual tanks can facilitate cleaning. Cracks in the storage tanks can create major problems and should be repaired immediately.

*E. Water Treatment:*

Before making a decision about what type of water treatment methods to use, water should be got tested by an approved laboratory and determine whether the water could be used for potable or non-potable uses. The types of treatment (Table 3.6) discussed are filtration, disinfection, and buffering for pH control. Dirt, rust, scale, silt and other suspended particles, bird and rodent feces, airborne bacteria and cysts will inadvertently find their way into the cistern or storage tank even when design features such as roof washers, screens and tight-fitting lids are properly installed. Water can be unsatisfactory without being unsafe; therefore, filtration and some form of disinfection is the minimum recommended treatment if the water is to be used for human consumption (drinking, brushing teeth, or cooking). The types of treatment units most commonly used by rainwater systems are filters that remove sediment, in consort with either ultraviolet light or chemical disinfection.

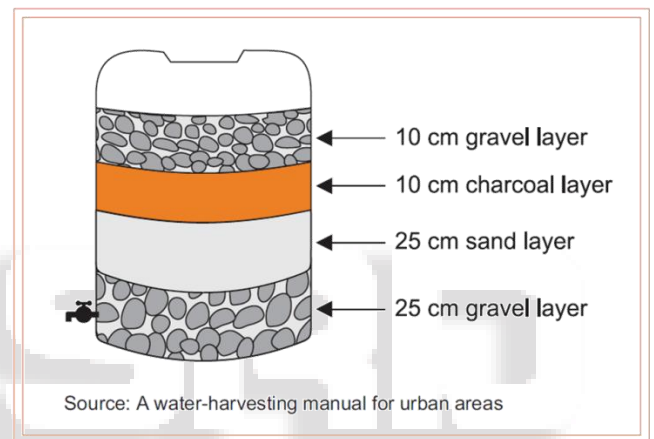
*F. Filters:*

A filter is an important part of the inflow structure of a RWH System. Once screens and roof washers remove large debris, other filters are available which help improve rainwater quality. Keep in mind that most filters available in the market are designed to treat municipal water or well water. Therefore, filter selection requires careful consideration. Screening, sedimentation, and pre-filtering occur between catchment and storage or within the tank. A cartridge sediment filter, which traps and removes particles of five microns or larger is the most common filter used for rainwater harvesting. Sediment filters used in series, referred to as multi-cartridge or inline filters, sieve the particles from increasing to decreasing size.

VI. TYPES OF FILTRATION SYSTEMS

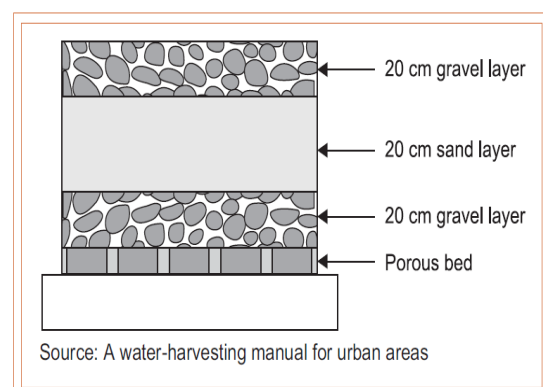
*A. Gravity Based Filter:*

This consists of construction of an underground / above ground filtration chamber consisting of layers of fine sand / coarse sand and gravel. The ideal depths from below are 60 cm thick coarse gravel layer, 40 cm coarse sand and 40 cm fine sand. Alternatively only fine sand can also be used along with the gravel layer. Further deepening of the filter media shall not result in an appreciable increase in the rate of recharge and the rate of filtration is proportional to the surface area of the filter media. A unit sq.m. surface area of such a filter shall facilitate approx. 60 litres./hr of filtration of rainwater runoff. In order to determine the optimum size of the surface area just divide the total design recharge potential with this figure. A system of coarse and fine screen is essential to be put up before the rainwater runoff is allowed to flow into the filtration pit. A simple charcoal 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.



*B. Sand Filters:*

Sand filters are commonly available, 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. In a simple sand filter that can be constructed domestically, the top layer comprises of coarse sand followed by a 5-10 mm layer of gravel followed by another 5-25 cm layer of gravel and boulders. These filters are manufactured commercially on a wide scale. Most of the water purifiers available in the market are of this type.



### C. Pressure based filter:

Pressure based filters facilitate a higher rate of filtration in a pressurized system. It requires a siltation pit of about 6-15 cu.m. in capacity so as to facilitate sedimentation before it is pumped through the filter into the ground. Being a pressure based system it involves a pump of capacity 0.5-1 hp. The rate of filtration is evidently high and the quality of water is also claimed to be as per WHO guidelines. They are successful for areas with larger rainwater runoff (>6 cu.m./hr) and limited space availability. Also these filters can be put in combination with an existing tube well so as to recharge water into the same bore.

## VII. TECHNIQUES OF ARTIFICIAL AQUIFER RECHARGE

Artificial recharge to ground water is a process by which the ground water reservoirs is augmented at a rate exceeding that obtaining under natural conditions or replenishment. Any man-made schemes or facilities that add water to an aquifer may be considered to be artificial recharge systems. To ensure that rainwater percolates into the ground instead of draining away from the surface, various kinds of recharge structures are possible. Some structures like recharge trenches and permeable pavements promote the percolation of water through soil strata at shallower depth, while others like recharge wells carry water to greater depths from where it joins the ground water. At many locations, existing structures like wells, pits and tanks can be modified to be used as recharge structures, eliminating the need to construct any new structures. A few commonly used recharging methods are explained here. Innumerable innovations and combinations of these methods are possible. Rainwater may be charged into the ground water aquifers through any suitable structures like dug wells, bore wells, recharge trenches and recharge pits.

A wide spectrum of techniques is in vogue in different countries to recharge ground water reservoirs. Similar to the variations in hydro geological framework, the artificial recharge techniques too vary widely. The artificial recharge techniques can be broadly categorized as follows:

### A. Direct Surface Techniques/Spreading Methods:

- Flooding techniques
- Basins or percolation tanks
- Stream augmentation/channel method
- Ditch and furrow system
- Over irrigation

### B. Direct Sub-Surface Techniques/Pit Method:

- Injection wells or recharge wells
- Recharge pits and shafts
- Dug well recharge
- Bore hole flooding
- Natural openings, cavity fillings.
- Combination of surface-cum-sub-surface techniques/well method
- Basin or percolation tanks with pit shaft or wells.
- Indirect techniques
- Induced recharge method
- Aquifer modification

### C. Water Use Management

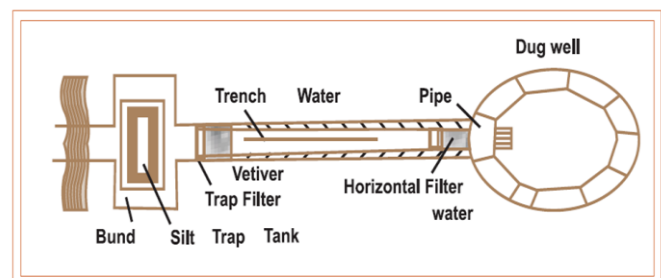
Water harvesting is the deliberate collection and storage of rainwater that runs off on natural or manmade catchment areas. Catchment includes

- Rooftops
- Compounds
- Rocky surface or hill slopes or
- Artificially prepared impervious/ semi-pervious land surfaces.

## VIII. RAINWATER HARVESTING INITIATIVES IN INDORE, MADHYA PRADESH, CENTRAL INDIA

The commercial capital of the state of Madhya Pradesh has been facing acute shortage of drinking water. This is reflected in the wide gap in the demand and supply of 152 MLD drinking water in the city. The ever-growing water demand made the administration think about rainwater harvesting. Indore, one of the cities in Madhya Pradesh, is located on the basaltic lava flows of the Deccan Trap. Weathered/vesicular/fractured and jointed basalt form aquifers in the area. The average annual rainfall in this area is 930 mm and one-hour peak rainfall is 35 mm. Indore has got large areas of roofs and paved areas and hence a large quantum of runoff is produced from these areas during the rainy season. This runoff goes waste as overland flow and also creates problems of flooding in low-lying streets. In such a scenario, rooftop water harvesting provides the desired solution. Essentially aquifer recharging practices are being used. In order to motivate the public, Indore Municipal Corporation (IMC) has announced a rebate of 6 per cent on property tax for those who have implemented the rainwater harvesting work in their house/bungalow/building. To operate these activities three committees – technical, education and execution – were formed by the IMC in which various experts of this field were involved. The various methods of ground water recharge used are open wells, soak pit, recharge shaft/trench with and without injection well, lateral recharge shaft, injection wells and in big schemes suitable combination of different methods of RWH are employed.

### A. Techniques of Water Recharge Used In Indore:



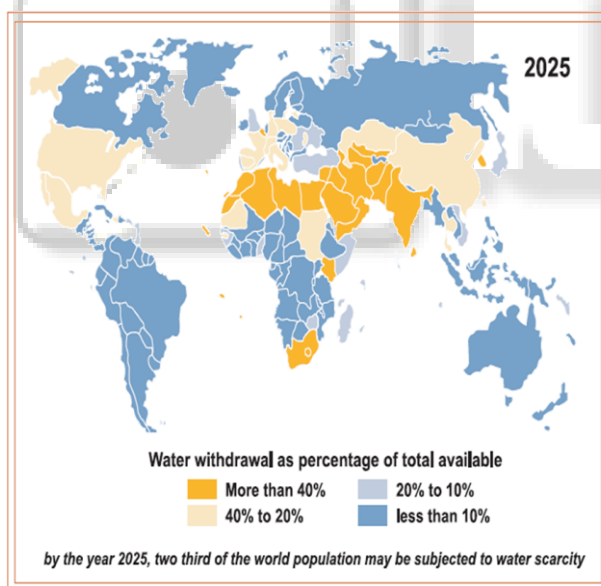
Elements of the Typical Water Harvesting System

The technique essentially comprises diverting rainwater through trench or swale into silt trap tank. Water from the silt trap tank is allowed to pass through a sand filter (sand, medium and big size pebbles). A cement pipe of 300 mm diameter, fitted with wire net (10 mm mesh) has been fitted on the wall of wells through which rainwater flows into the well.

### B. Aizawl (North-East India):

The water supply system in the capital of Mizoram, originally designed in 1988 for 80,000 people, is now catering to the needs of over 150,000 residents, making it grossly inadequate. Due to inadequate and unreliable water supply people are resorting to rooftop water harvesting, the most convenient and economical water supply system. Mizoram receives an average rainfall of 2,500 mm annually which is distributed throughout the year. The major advantage is that most of the buildings are constructed with sloping roofs that use Corrugated Galvanised Iron (CGI) sheets which are conducive to rainwater harvesting. Even today, most buildings in Aizawl are constructed with sloping roofs that use Corrugated Galvanised Iron sheets. Rain gutters either of PVC pipes or bamboo are used to drain water into the cylindrical storage tanks with galvanised iron semi-circular rain gutters to catch rainwater. Gradually, reinforced cement concrete (RCC), ferrocement and plastic tanks are being introduced. Tanks of 10,000 litres capacity are commonly used. At present, Aizawl has more than 10,000 rainwater harvesting tanks in individual houses which have been constructed by the residents at their own expense or with state government assistance. In a pollution-free state like Mizoram where major industries are yet to come, rainwater is free from undesirable chemicals and is of potable quality.

### C. The World Water Crisis:



Rapid population growth, combined with industrialisation, urbanisation, agricultural intensification and water intensive lifestyles is resulting in a global water crisis. In 2000, at least 1.1 billion of the world's people – about one in five – did not have access to safe water. Asia contains 65 per cent of the population without safe water and Africa 28 per cent. During the 1990s, there were some positive developments: about 438 million people in developing countries gained access to safe water but due to rapid population growth, the number of urban dwellers lacking access to safe water increased by nearly 62 million.

Falling water tables are widespread and cause serious problems, both because they lead to water shortages

and, in coastal areas, to salt intrusion. Both contamination of drinking water and nitrate and heavy metal pollution of rivers, lakes and reservoirs are common problems throughout the world. The world supply of freshwater cannot be increased. More and more people are becoming dependent on limited supplies of freshwater that are becoming more polluted. Water security, like food security, is becoming a major national and regional priority in many areas of the world.

### IX. SCENARIO IN SELECTED CITIES

In **Kolkata, India**, about half the population that lives in the slum or squatter settlements collect water from stand posts. The rest of the slum population do not have access to the municipal water supply and have to make their own arrangements – for instance relying on hand pumps/drawing from tube wells. In **Bangalore, India** a city of some 6 million inhabitants, it is estimated that more than half depends on public fountains. Almost a third of the population has partial or no access to piped water. In **Dhaka, Bangladesh** it is estimated that in 2002 there were 2.5 million people in its 'slum' areas with most having very inadequate provision for water and sanitation. Tens of thousands of children die each year in Dhaka because of waterborne diseases and polluted water. In **Pakistan** more than half of **Karachi's** 12 million inhabitants live in *katchi abadis*. Only half the *katchi abadis* have piped water. In **Faisalabad, Pakistan** some two thirds of the city's two million inhabitants live in largely unserved areas. Over half have no piped water supply. In **Kampala (Uganda)** only inhabitants of affluent and middle-income districts in central and residential areas have private connections serviced by National Water & Sewerage Corporation. More than half the population in **Nairobi (Kenya)** depend on standpipe vendors for access to water; 30% of the population have a connection to the official network. In **Lima (Peru)** almost 2 million inhabitants have no water supply and 30% of those who do receive water (1996) is of dubious quality. The water shortage in **Tugucigalpa (Honduras)** is particularly acute as there is not even enough water to supply to consumers already having municipal water connections. To further illustrate, **India's** population as per 2001 census is 1027.02 million. Over 60 per cent of households in India meet their drinking water requirements from underground water sources such as hand pumps, tube wells and wells. In urban areas while 68.7 per cent households use tap water, 29 per cent of the households directly use those underground water resources. Intense use of underground water has resulted in depletion of sub-terrene water resources in many parts of India.

### X. RAINWATER HARVESTING - MULTIPLE BENEFITS

- Improvement in the quality of ground water
- Rise in the water levels in wells and bore wells that are drying up
- Mitigation of the effects of drought and attainment of drought proofing
- An ideal solution to water problems in areas having inadequate water resources
- Reduction in the soil erosion as the surface runoff is reduced

- Decrease in the choking of storm water drains and flooding of roads
- Saving of energy, to lift ground water. (One-meter rise in water level saves 0.40-kilowatt hour of electricity)

The rainwater collected can be stored for direct use or can be recharged into the ground water to improve the quality of ground water and rise in the water levels in wells and bore wells that are drying up as well as reduce the soil erosion as the surface runoff is reduced. Rainwater harvesting is an ideal solution to water problems in areas having inadequate water resources and helpful in mitigation of the effects of drought and attainment of drought proofing. Water harvesting provides an alternative source for good quality water (rainwater is the cheapest form of raw water) seasonally or even the year round. This is relevant for areas where ground water or surface water is contaminated by harmful chemicals or pathogenic bacteria or pesticides and/or in areas with saline surface water. The rainwater harvesting systems can be both individual and community/utility operated and managed. Rainwater collected using various methods has less negative environmental impacts compared to other technologies for water resources development. The physical and chemical properties of rainwater are usually superior to sources of ground water that may have been subjected to contamination. Rainwater is relatively clean and the quality is usually acceptable for many purposes with little or even no treatment.

#### XI. CONCLUSIONS

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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