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RAINWATER HARVESTING IN HILLY AREA

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ABSTRACT: The present study has been undertaken to evaluate the performance of rainwater harvesting nearJaypee Cement Plant located at Himachal Pradesh. The harvesting of rainwater simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use.Water is our most precious natural resource and something that most of us take for granted. Water can be store in reservoir for cement plant usage as well as village daily usage for drinking and agriculture purpose. Surface water and ground water are two major sources of water. Due to over population and higher usage levels of water in urbanareas, water supply agencies are unable to cope up demand from surface sources like dams, reservoirs, rivers etc.

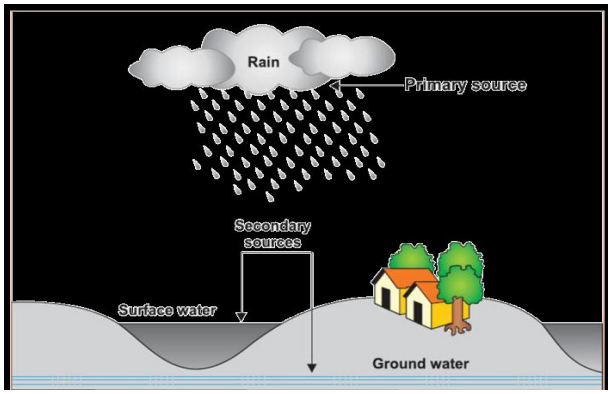
During the monsoons lots of water goes waste into the gutters. And this is when Rain water Harvesting proves to be the most effective way to conserve water. We can collect the rain water into the tanks and prevent it from flowing into drains and being wasted. It is practiced on the large scale in the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

Key Words: The Rainwater Harvesting, agricultural purpose, cement plant usage, land surface catchment, drinking purpose

I. INTRODUCTION

Water is the most common or major substance on earth, covering more than 70% of the planet's surface. All living things consist mostly of water. For example, thehuman body is about two third water. 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



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).

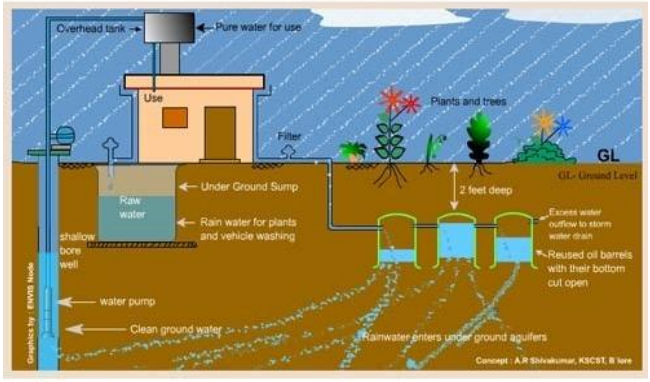
Rivers, lakes and ground water are all secondary sources of water. In present times, we depend entirely on such secondary sources of water. In the process, generally, it is forgotten that rain is the ultimate source that feeds all these secondary sources. Water harvesting means making optimum use of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

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.

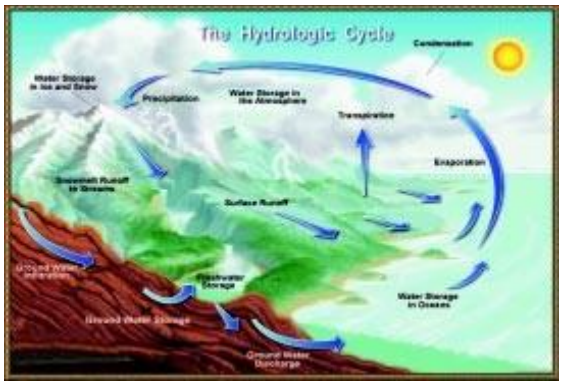


2) Paved And Unpaved Areas:
i.e., landscapes, open fields, parks, storm water drains, roads and pavements and other open areas can be effectively used to harvest the runoff. The main advantage in using ground as a collecting surface is that water can be collected from a larger area. This is particularly 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 IN HILLY AREA

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

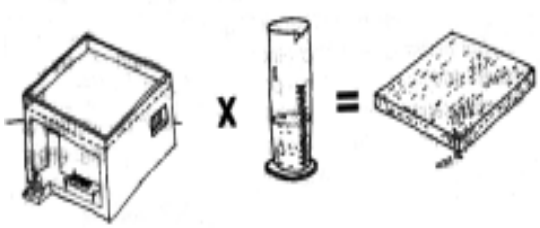
Rainwater Harvesting Potential:
Rainfall: Thetotalamountofwaterthatisreceivedintheformof rainfalloveranareaiscalledtherainwaterendowmentofthat area.Outofthis,theamountthatcanbeeffectivelyharvestedis calledrainwaterharvestingpotential.
Area of catchment x Amount of rainfall = rain water endowment



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.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.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.
Hydrologiccycle
The never-ending exchange of water from the atmosphere to the oceans and back is known as the hydrologic cycle This cycle is the source of all forms of precipitation (hail, rain, sleet, and snow), and thusof all the water. Precipitation stored in streams, lakes and soil evaporates while water stored in plants transpires to form clouds which store the water in the atmosphere.



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. 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.

V. COMPONENTS OF A RAINWATER HARVESTING SYSTEM

CATCHMENT AREA
A catchment is an area where water is collected by the natural landscape. The outside edge of a catchment is always the highest point. Gravity causes all rain and run-off in the catchment to run downhill where it naturally collects in creeks, rivers, lakes or oceans.Rain falling outside the edge of one catchment is falling on a different catchment, and will flow into other creeks and rivers.A catchment area is a hydrological unit. Each drop of precipitation that falls into a catchment area eventually ends up in the same river going to the sea if it doesn't evaporate.

WATERSHED
A group of sub-watersheds form a watershed.A watershed is an area of land that feeds all the water running under it and draining off of it into a body of water. It combines with other watersheds to form a network of rivers and streams that progressively drain into larger water areas.

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.;

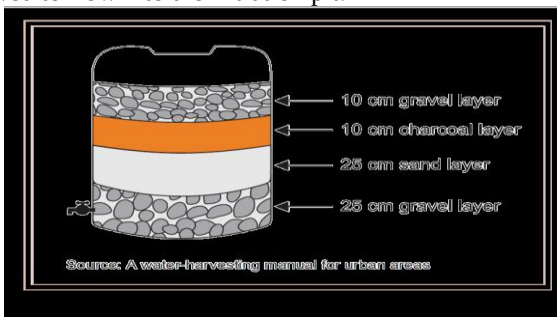
CONVEYANCE SYSTEM:
The delivery system for the treated rainwater, either by gravity or pumpare required to transfer the rainwater collected on catchment surfaces (e.g. rooftops) to the storage tanks. This is usually accomplished by making connections to one or more down-pipes connected to collection devices. 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

WATER TREATMENT: Filters to remove solids and organic material and equipment, and additives to settle, filter, and disinfect.The water treatment process may vary slightly at different locations, depending on the technology of the plant and the water it needs to process, but the basic principles are largely the same. This section describes standard water treatment processes.

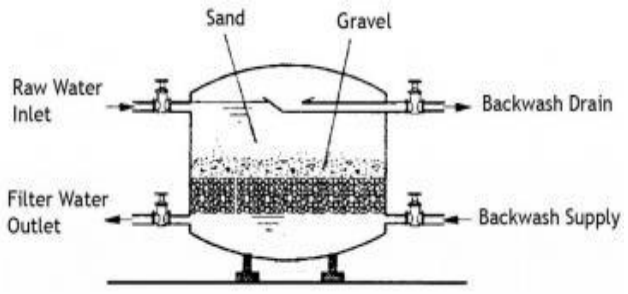
FILTERS:
A filter is an important part of the inflow structure of a RWH System. Once screens and roof washers remove large debris, other filters are available which help improve rainwater quality. Keep in mind that most filters available in the market are designed to treat municipal water or well water. 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 system of coarse and fine screen is essential to be put up before the rainwater runoff is allowed to flow into the filtration pit.

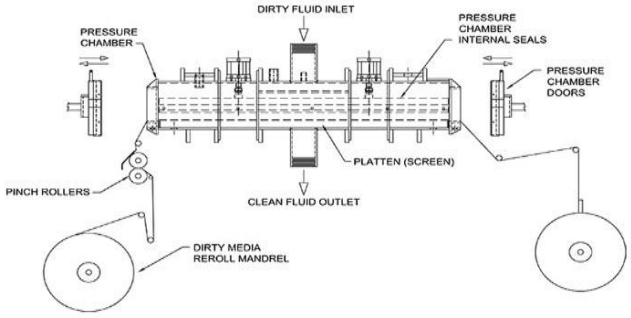


SAND FILTERS:
Sand filters are commonly available, easy and inexpensive to construct. These filters can beemployed for treatment of water to effectively remove turbidity (suspended particles like silt and clay), colour and microorganisms. In a simple sand filter that can be constructed domestically, 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



PRESSURE FILTERS

These filters consist of the sand through which water is being injected with pressure. These types of filters are fitted with pumps to pressurize the water through filter chamber. Main disadvantage of these filters is that they require energy for operation and these filters need to be back washed periodically to remove the finer material so that the rate of filtration is maintained. Filtration rate= 3000-5000lts/hour/m2.



VII. CHANNELS

An open channel is a physical system in which water flows with a free surface at the atmospheric pressure. In other words the pressure is impressed on free surface. A channel can be classified as either natural or artificial channel according to its origin. Natural channels include all watercourses of varying sizes from tiny hillside rivulets, streams, small and large rivers to tidal estuaries that exist naturally on the earth. Subsurface streams carrying water with a free surface are also treated as natural open channels. The cross sections of natural channel are irregular and hence hydraulic properties may vary from section to section, and reach to reach.

VIII. DRAINAGE SYSTEM

A drainage system is an arrangement to move liquids away from where they are not required for disposal in appropriate locations. A 'drainage system' can include anything from gutters and drains in houses to remove rain water, storm water systems to drain rainwater from roads into roadside drains and drainage systems to remove sewage from houses into municipal 'sewers' for disposal. Within the medical industry, 'drainage systems' can mean methods to drain unwanted fluids from the body, such as pus from wounds, colostomy bags to remove body wastes and fluids from internal abscesses and ulcers.

TYPES OF DRAINAGE

1. Surface drainage Surface drainage is the removal of excess water from the surface of the land. This is normally accomplished by shallow ditches, also called open drains. The shallow ditches discharge into larger and deeper collector drains. In order to facilitate the flow of excess water toward the drains, the field is given an artificial slope by means of land grading

2. Subsurface drainage Subsurface drainage is the removal of water from the rootzone. It is accomplished by deep open drains or buried pipe drains.

i. Deep open drains The excess water from the root zone flows into the open drains. The disadvantage of this type of subsurface drainage is that it makes the use of machinery difficult.

ii. Pipe drainsPipe drains are buried pipes with openings through which the soil water can enter. The pipes convey the water to a collector drain. Drain pipes are made of clay, concrete or plastic. They are usually placed in trenches by machines. In clay and concrete pipes (usually 30 cm long and 5 - 10 cm in diameter) drainage water enters the pipes through the joints (see Fig. 101, top). Flexible plastic drains are much longer (up to 200 m) and the water enters through perforations distributed over the entire length of the pipe

iii. Deep open drains versus pipe drainsOpen drains use land that otherwise could be used for crops. They restrict the use of machines. They also require a large number of bridges and culverts for road crossings and access to the fields. Open drains require frequent maintenance (weed control, repairs, etc.).In contrast to open drains, buried pipes cause no loss of cultivable land and maintenance requirements are very limited. The installation costs, however, of pipe drains may be higher due to the materials, the equipment and the skilled manpower involved.

IX. CONCLUSIONS

This is a universal fact that sustaining and recharging the groundwater 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 in hilly areas. A planned approach is 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 because it is well known that water is in abundant quantity in hilly areas.

It can be concluded from above findings that water in hills, if conserved and utilized using the rainwater harvesting technology, can be an effective tool of replenishing ground water resources and prove to be a boon for a developing country like India.

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