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DEPARTMENT OF FORESTS, ECOLOGY & ENVIRONMENT, GOVERNMENT OF KARNATAKA
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Blessing from the blue

Of all the natural resources on earth, water is the most vital. Unfortunately, we forget that this resource is limited. We can use a mere 0.3 per cent of the water available, though water covers 70 per cent of the earth's surface. Salt water in the oceans and fresh water polar ice caps account for the bulk of the water. Besides ourselves, a number of organisms need a share of that 0.3 per cent water

Rainwater harvesting (RWH) is the process of collecting and storing rainwater in a scientific and controlled manner for future use. The harvested rainwater is either stored in tanks or channeled to recharge ground water.

Why rainwater harvesting?

- The rapid rise in human population has made optimum use of fresh water imperative.
- Urban water supply systems in particular are under tremendous pressure to meet the needs of the population as well as industry and large-scale construction.
- Groundwater is getting depleted and polluted
- Unchecked runoff is causing soil erosion.
- Consumption of polluted water is beset with health hazards.

The demand for water always exceeds supply in urban areas. As surface water is inadequate to meet this demand, we have to depend on ground water. Due to rapid urbanization, infiltration of rainwater into the subsoil has decreased drastically and recharging of ground water has diminished. This situation warrants an alternative source to bridge the gap between demand and supply.

Benefits of rainwater harvesting

- Environment friendly and easy approach for water requirements
- RWH is an ideal solution for water requirements in areas having inadequate water resources
- Increases ground water level
- Raises ground water quality
- Mitigates the effects of drought
- Reduces runoff, which otherwise floods storm water drains
- Reduces flooding of roads and low-lying areas
- Reduces soil erosion
- Cost effective and easy to maintain
- Reduces water and electricity bills

Potential to harvest rainwater

Bangalore receives rain from the south-west and north-east monsoons, spread over an average of 60 days between April and November. About 80 per cent of the annual rainfall occurs between June and November. Bangalore also receives considerable pre-monsoon showers.

Rainwater can meet over 40 per cent of Bangalore's water needs. Thanks to its moderately deep, well-grained, gravelly, clay-mixed soil, and unique undulating terrain, Bangalore is ideally suited to reap the many benefits of rainwater harvesting.

Rainwater harvesting methods

Rooftop harvesting: Bangalore's extensive built-up area can be put to good use by collecting and storing rainwater or by recharging aquifers. This would reduce the storm water discharge and consequent flooding of low areas.

Rooftop rainwater harvesting in Bangalore can yield a maximum of 77,600 litres a year from a roof surface of 100 square metres. This would meet almost four months' water needs of a family cost-effectively. A water storage facility of around 8,000 to 10,000 litres capacity can meet the secondary water requirements of a house.

Channeling of rainwater: PVC, HDFE or asbestos cement can be used for channeling rainwater from

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February 28, 2007

Bangalore is one of the developing cities in Asia. The erstwhile Bangalore Mahanagara Palike was upgraded to Bruhat Bangalore Mahanagara Palike a few weeks ago to ensure systematic development of the city and its outlaying areas.

With this our commitment to providing drinking water to the city's ever-increasing population has multiplied manifold.

As our existing water sources reservoirs and the River Cauvery will not be able to meet the city's demand for water in the days to come, BBMP has effected an amendment in building bye-laws making Rain Water Harvesting mandatory in all new buildings.

It is the primary responsibility of the citizens to ensure that RWH initiatives yield the desired results. I am confident that this newsletter will be read with interest and be of use to the reader.

(K. JAIRAJ)

rooftops to filter systems before storage. The roof area determines the diameter of the pipes.

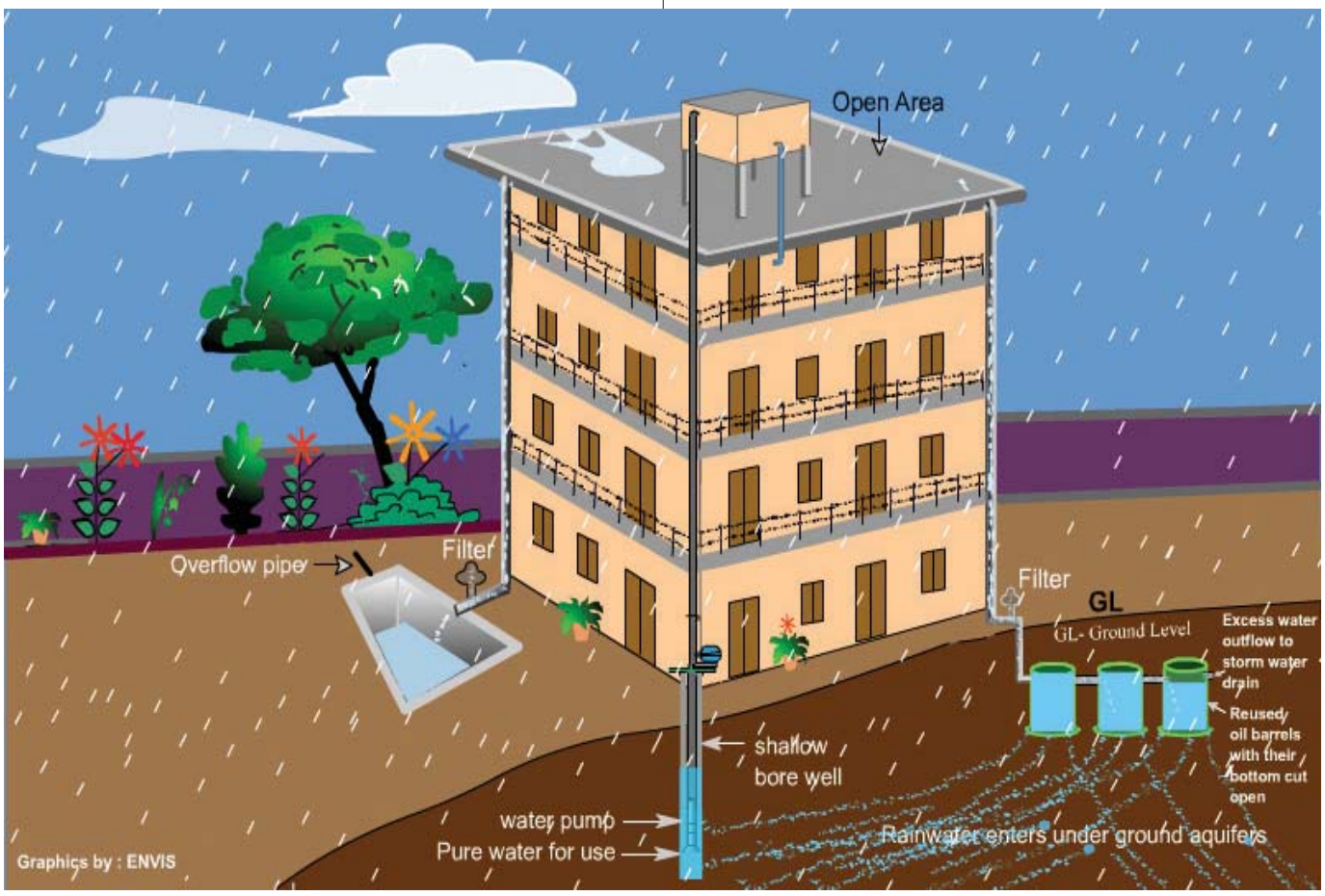
Filtering:, A pop-up filter or a sand-bed filter at the termination of the water pipes is essential to ensure that relatively clean water enters the storage system.

Storage: Harvested rainwater can be stored at five levels:

1. Roof slab level
2. Ground level
3. Partially above ground
4. Partially below ground
5. Below the ground as a sump.

The stored water can be kept clean over a period of five to six months in an enclosed area protected from sunlight. This water can be used for washing, gardening, flushing toilets etc.

Rainwater harvesting in parks and open spaces
Micro-watershed management methods that allow



60% of borewells dug in GujaratSaurashtra yield no water even at a depth of 1200 ft

rainwater infiltration and percolation into the ground are employed for rainwater harvesting in parks and open spaces. The runoff has to be minimized by providing adequate number of percolation pits and dispersion trenches. In large parks, storage of rainwater in small ponds is also possible since the ponds can be integrated with the landscape of the park. Mapping of the contours, planning for rainwater outflow in consonance with natural drainage patterns, identifying appropriate areas for percolation pits/dispersion trenches will be required.

Requirements:

- Creation of water harvesting ponds in low-lying areas.
- Allowing groundwater recharge by the creation of seepage pits.
- Allowing surface runoff to enter existing wells or artificial water bodies.

Natural flow of water:

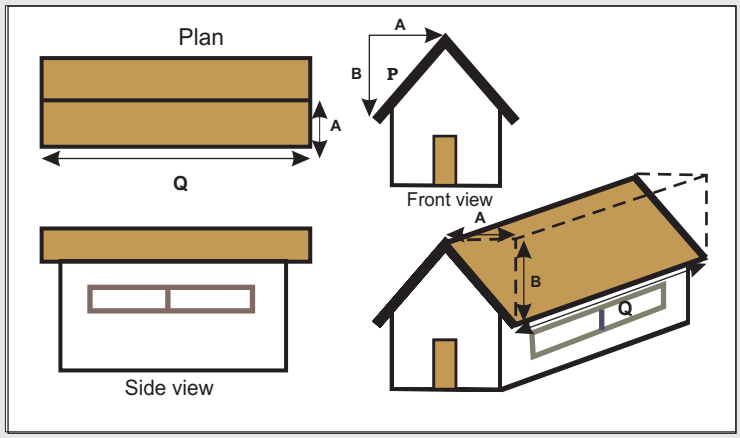
- Surface runoff water should be trapped in ponds, tanks and lakes when available, so that it can be used for maintenance during dry periods.
- This practice is similar to dry land technology of agricultural belts.
- Low-lying areas and drainage channels are earmarked and convenient micro-watersheds are prepared.
- Water harvesting is followed, based on natural flow and surface accumulation of the runoff water.
- Water follows the lowest contour gradient available in an area.
- These structures not only provide water for the park, but also increase groundwater recharge.
- Providing a borewell in these areas will enhance the availability of water in its vicinity.
- Rainwater run-off from open space and paved areas can be stored in underground sumps by filtering through sand-bed filters and guiding the filtered water through channels.

Recharge of pits or trenches:
Ground water recharge in parks can be enhanced by a simple technique of providing recharge pits or a trench.

- Width of pit: 1.2 to 1.5 m. Depth: 2.5 to 3 m.
- Material: 40-60 mm coarse gravel followed by 20 mm cobbles and 2 mm sand. Pits are conveniently made at suitable low-level micro-watershed locations as collection centers of surface runoff.
- A splash pad is provided on top of the sand layer to cut off the velocity of entry of water to the pit.
- The number of such pits is based on the park area and the small rivulets dissecting the landscapes into micro-watersheds.

Calculation of effective roof area for sloped roof

Divide the roof area into convenient grids and calculate each grid area by taking projected length & breadth. Actual surface area i.e. **P x Q** is not considered for the calculation of the roof area but the projected area **A x Q** is considered.



Example:

When both the sides of roof are equal:

A1 - Area of one part of the roof = A x Q.
A2 - Area of other part of roof = A x Q.
Total area = 2 x A x Q.

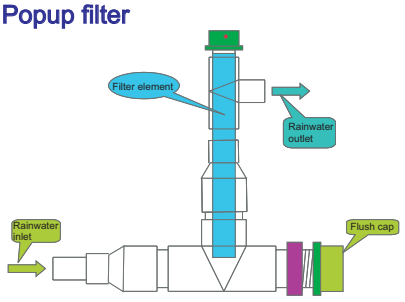
When both the sides of roof are not equal:

A1 - Area of one part of the roof = A x Q.
A2 - Area of other part of roof = A x Q.
Total area = (A x Q) + (A x Q).

Rainwater harvesting from roads
In the recent past, rapid growth in the urban areas has led to asphalted roads and stone slabs or pavers for footpaths.

Filters

Popup filter



Sand bed filter

This accounts for nearly 10 per cent of the total area of Bangalore. As a result, rainwater run-off has increased and ground water recharge has declined.

As the roads are built sloped towards the sides, rainwater falling on the road is guided to the side drains. When it rains, water flows from the apex to the sides and collects in the sidewalk area and subsequently flows to the storm water drains.

To increase ground water recharge by percolation and decrease the flooding of storm water drains, an infiltration trench could be built by the side of the drain all along the road, wherever possible. The infiltration trench can be 2 feet wide and 2 feet deep and filled with pebbles or aggregates with a top layer of coarse river sand.

As the rainwater from the road flows into the infiltration trench, water percolates into the ground. During heavy rainfall, excess water spills over to storm water drains. The infiltration trenches store water temporarily during rainfall and later for infiltration. These infiltration trenches may be exposed as walk ways or paved with inter-locking pavers, specially designed with gaps in between for water to flow into the infiltration trenches.

Rainwater harvesting in residential layouts
'Layout' refers to a geographical area encompassing sites, roads, drains, civic amenities and parks.
Rainwater harvesting in layouts can be done using the 'Cascade capture method.'

In this process, rainwater can be harvested on a plot or through recharge of ground water. The run-off from the plot could be captured by storm water drains and directed into artificial infiltration or percolation pits. The overflow from the storm water drains and infiltration system could be captured in lakes and tanks. The method of rainwater harvesting involves contour mapping, defining a drainage pattern, determining a storage point / ground water recharge facility and ensuring segregation of sewage/ sullage from storm water run-off.

Ground water recharge
Water from the rooftop can be filtered and directly put into an open well or a percolation pit or a dispersion trench.
Ground water recharge methods:

- Used plastic barrels.
- Infiltration gallery with aggregates and sand.
- Recharge soak pits.
- Trenches.
- Direct recharge of open wells.

Attributes of ground water:

- There is more ground water than fresh surface water.
- Less expensive.
- Sustainable and reliable source.
- Relatively less vulnerable to pollution.
- Usually of high bacteriological purity.
- Free of pathogenic organisms.
- No treatment before use.
- No turbidity and colour.
- Instantly usable.
- Low vulnerability to drought.
- The key to life in arid and semi-arid conditions.

Traditional rainwater harvesting
India has an age-old tradition of water harvesting. The earliest reference to this practice is in mythology. King Bhageerath is supposed to have arrested the waters of River Ganga in its upper reaches and diverted the river to a different course either by constructing a barrier across it or by selectively breaching the natural barrier across it because of a landslide. This venture was considered to be on such a majestic scale that any stupendous effort (or Herculean effort) is referred to in Sanskrit as Bhageerath Prayatna (effort).

However, rainwater harvesting is not such a Herculean task and recorded evidence of water harvesting is found in pre-Harappan civilizations and dating back to 4,000 to 6,000 years. Mohenjadaro, the largest among cities belonging to Harappan culture, had over 700 open wells

Kunds of Thar desert

Water makes up 60% - 75% of the adult human body - 82% of blood, 70% of the brain and 90% of the lungs.

Standard for Physical and Chemical quality of drinking water				
Quality	W.H.O. International Standards, 1971		Indian Standards Institution, 1983	
	Highest desirable	Maximum permissible	Highest desirable	Maximum permissible
Physical Turbidity (JTU units)	5	25	10	25
Colour, Hazen-units (on platinum cobal scale)	5	50	5	50
Taste and odour	Unobjectionable	-	-	Unobjectionable
Chemical PH	7.0-8.5	6.5-9.2	6.5-8.5	6.5-9.2
Total dissolved solids (mg/1)	500	1500	500	1500
Total hardness as $CaCO_3$ (mg/1)	100	500	300	600
Calcium (mg/1)	75	200	75	200
Magnesium (mg/1)	<30 if SO_4 is 250mg/1, upto 150mg/1 if SO_4 is less than 250 mg/1	150	30	100
Iron (as Fe) (mg/1)	0.05	1.5	0.3	1.0
Manganese (as Mn) (mg/1)	0.1	1.0	0.1	0.5
Copper (as Cu) (mg/1)	0.05	1.5	0.05	1.5
Zinc (as Zn) (mg/1)	5.0	15.0	5.0	15.0
Chloride (mg/1)	200	600	250	1000
Sulphate (mg/1)	200	400	150	Upto 400 if mg does not exceed 30 mg/1
Phoenolic substances (as phenol) (mg/1)	0.00	0.00	0.001	0.00
Flourides (mg/1)	0.6-0.9	0.8-1.78	0.6-1.2	1.5
Nitrates (mg/1)	-	45.00	45.00	No relaxation
Toxic constitutuents (mg/1)				
* Arsenic (mg/1)	-	0.05	0.05	No relaxation
* Mercury (mg/1)	-	0.001	0.001	No relaxation
* Cadmium (mg/1)	-	0.01	0.01	No relaxation
* Chromium (hexavalent) (mg/1)	-	-	0.05	No relaxation
* Cyanide (as CN) (mg/1)	-	0.05	0.05	No relaxation
* Lead (mg/1)	-	0.1	0.1	No relaxation
* Selenium (mg/1)	-	0.01	0.01	No relaxation
Radioactivity				
Gross alfa-emitters (Pci/1)	-	3	-	-
Gross alfa-emitters (Pci/1)	-	30	-	-

(kuas). The qanats are underground channels constructed to collect water at the foot of the hills and transferred to a habitat through an elaborate system of channels. They are found in India from 300 BC and are in working condition even today, in cities like Aurangabad in Maharashtra.

An elaborate system of tanks diverting River Ganga for domestic use has been discovered in excavations at Sringaverapura in Allahabad, Uttar Pradesh. This system flourished in 12th Century BC. Raja Bhoja constructed a huge lake at Bhopal covering an area of 65,000 hectares in the 11th Century AD.

The 'kunds' of Thar desert

In the sandier tracts, the villages of the Thar desert had evolved an ingenious system of rainwater harvesting known as 'kunds' or 'kundis.' Kund, the local name given to a covered underground tank, was developed primarily for tackling the drinking water problem.

Usually constructed with local material or cement, kunds were more prevalent in the western arid regions of Rajasthan, and in areas where the limited ground water available is moderate to highly saline. Groundwater in nearly 76 per cent of the Barmer district area, for instance, has total dissolved salts (TDS) ranging from 1,500 to10,000 parts per million (ppm). Under such conditions, kunds provided convenient, clean and sweet water for drinking.

Nadi, a small pond dug at a natural depression in land with a depth of 1 metre to 4 metres, can store between

15,000 and 2.5 cubic metres (cu.m) of water, depending on the size of the catchments area and slope.

Khadin is a water harvesting structure developed for the purpose of runoff agriculture in Jaisalmer area of the Thar desert. There are about 500 khadins in Jaisalmer.

Rapat is a small tank or pond prevalent in Ajmer district of Rajasthan. The storage capacity of a rapat is about 30,000 cu.m.

Bamboo irrigation in Meghalaya

An ingenious system of tapping of stream and spring water by using bamboo pipes to irrigate plantations is widely prevalent in Meghalaya. It is so perfect, that about 18 to 20 litres of water entering the bamboo pipe system per minute gets transported over several hundred metres.

In-situ water harvesting in Cherrapunji, Meghalaya

Cherrapunji has the distinction of receiving the highest rainfall in the world, with annual rainfall put at about 11,000 mm. Still, it faces drinking water shortage in the pre-monsoon months. Rainwater harvesting introduced by the Public Health Engineering Department, Meghalaya, comprises collection of rainwater from house rooftops through gutters, its filtration and subsequent storage in a reservoir with an average storage of 7 cu.m. These systems are designed to supply 10 litres per capita per day for 90 days. The life span of the system is about 15 years. The cost worked out to Rs.14,000 per cubic metre in 1991.

Quality of rainwater harvested

As the primary source of water, rainwater is the purest from of water. Rainwater harvesting not only augments a community's water resource, but it also provides good quality water.

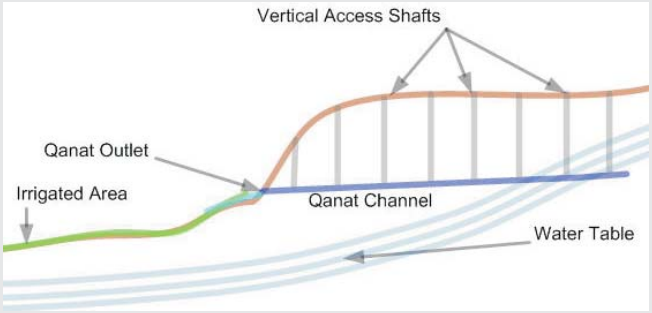
However, you need to take certain precautions to ensure that the water is not polluted. The measures suggested are:

- Keep the roof or the water collection area clean before the rains
- Drain off the rainwater collected in the first few minutes.
- Store the collected rainwater subsequently in a closed container (avoid sunlight).
- The quality of water deteriorates in the presence of sunlight and air.
- Water can be kept clean over a period of five to six months in a clean container stored in an enclosed area protected from sunlight.

Tips for water conservation

- Verify that the plumbing is leak-free, as leakages lead to wastage of water.
- Use water conserving plumbing fixtures.
- Avoid flushing the toilet unnecessarily
- Do not run water continuously when washing dishes, brushing teeth, washing hands and face or shaving.
- Choose plants that are native to the area you live or plants that are drought resistant for landscaping and gardens.
- Don't over-water your lawns. A good rain eliminates the need for watering for as long as two weeks.

A **qanat** or **kareez** is a water management system used to provide a reliable supply of water to human settlements or for irrigation in hot, arid and semi-arid climates.



Qanats are constructed as a series of well-like vertical shafts, connected by gently sloping tunnels. This technique:

Taps into a subterranean water in a manner that efficiently delivers large quantities of water to the surface without need for pumping. The water drains relying on gravity, with the destination lower than the source, which is typically an upland aquifer.

Allows water to be transported over long distances in hot dry climates without losing a large proportion of the source water to seepage and evaporation.

It is very common in the construction of a qanat for the water source to be found below ground at the foot of a range of foothills of mountains, where the water table is closest to the surface. From this point, the slope of the qanat is maintained closer to level than the surface above, until the water finally flows out of the qanat above ground. To reach an underground aquifer, qanats must often be of extreme length.

Frequently Asked Questions

What is rainwater harvesting?

Rainwater harvesting is the process of collecting rainwater and storing it for future use.

How is rainwater harvesting done?

Rainwater is directly collected from the roof or open space and filtered before storing or recharging the

Pure water (solely hydrogen and oxygen atoms) has a neutral pH of 7, which is neither acidic nor basic.

Indo-Norwegian Environment Programme sponsored Rainwater Harvesting in Bangalore City, Implementing by : Karnataka State Council for Science and Technology, Bangalore.

Objectives of the projects

- Build awareness on rainwater harvesting in urban area.
- Status report on the existing water availability and usage pattern in Bangalore city.
- Demonstration of cost effective and sustainable methods of rainwater harvesting and groundwater recharge in the local context.
- Influence policy makers to promote rainwater harvesting and ground water Recharge

Sl. No.	INEP project demo plots in Bangalore
1	Karnataka State Council for Science and Technology, IISc
2	Kengeri beedi workers housing scheme
3	Gandhi Krishi Vignan Kendra
4	Fire Station
5	Vidhana Soudha
6a.	General Post Office
6b.	Mail Motor Service
7	Bangalore Mahanagara Palike Head Office
8	Office of Commisioner of Public Instruction
9	Kidwai Memorial Hospital
10	High Court

Financial status	
Project cost	47.00 Lakhs
INEP assistance	41.00 Lakhs
Local contribution	6.00 Lakhs

Outputs of the projects

- Rainwater harvesting demo plots to exhibit and advocate the concept built.
- Technical guidance on RWH being given to various organizations and individuals.
- Exposure programmes organized for policy makers and interactive sessions conducted to promote RWH.
- Awareness building campaigns on rainwater harvesting (RWH) in Bangalore urban area conducted, leaflets and other publicity material including several newspaper articles published.
- Status report on the existing water availability and usage pattern in Bangalore city published in "Amruthavarshini".
- Directorate of Municipal Administration (DMA) has mandated installing RWH system in all its public buildings.

ground water table.

What are the methods of rainwater harvesting?
There are three methods of rainwater harvesting. They are:

1. Rooftop
2. Open space
3. Ground water recharge

What are the advantages of rainwater harvesting?

- Rainwater harvesting has many advantages
- Augments existing water supply.
- Reduces water bill charges.
- Environment-friendly technique.
- Reduces effects of drought and flood.
- Improves ground water availability and quality.

Who can undertake rainwater harvesting?
Any individual or institution can take up rainwater harvesting. If you are planning to build a house, you can incorporate the system in the planning stage itself.

What is the cost of rainwater harvesting?
The cost of rainwater harvesting depends on the quantity of rainwater collected and the purpose required. It varies from Rs.2,000 to Rs.50,000 for residential buildings.

What are the space requirements?
For a residential building, a sump of 5,000-10,000 litres (6 x 6 x 10 feet) needs to be built for storing rainwater. The bigger the storage facility, the longer the availability of rainwater.

For ground water recharge from a rooftop area of 100 square .metres an underground infiltration gallery using four plastic barrels can be created. (Dimensions: width - 2 feet, length - 6 feet and depth - 5 feet)

How does rainwater harvesting benefit me?

- The benefits of rainwater harvesting are:
- Immediate availability of fresh water
- Reduced water bill charges
- Reduced dependence on conventional water supply.
- Better living environment

What about the quality of water?

One inch of rainfall on a 1,000 ft surface will yield about 500 gallons of rain water.

Rainwater is the primary source and the purest form of water. You can collect rainwater and use it for drinking purposes. However, precautions need to be taken, to keep the water free from contaminants on the roof, open space, during channeling and storage.

Who can help me in rainwater harvesting?
With a little guidance, you can build a rainwater harvesting system on your own. In case you need help, you can contact an architect or an engineer who has expertise in rainwater harvesting. Many agencies take up rainwater harvesting on a turnkey basis.

How long can I store the collected water?
Since water does not get contaminated when it is stored away from sunlight and air, you can store water that's free from impurities for up to six months.

How can I use the harvested rainwater?
Rainwater can be used for practically all purposes.

What is the approximate quantity of rainwater I can harvest?
In a 100 square-metre.area and with a rainfall of 1000 mm, you can collect one lakh litres of rainwater annually.

On an average, how much can I save on water bill charges?
You can achieve savings of 20 to 70 per cent on water bill charges.

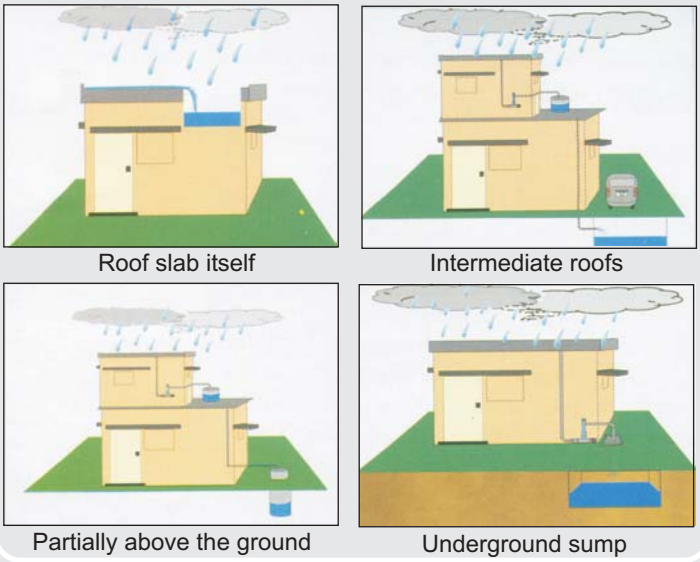
Are there any adverse effects of rainwater harvesting?

- If proper care is not taken, the following adverse effects could result.
- Contamination of water, if the rooftop is not clean.
- Water-logging, if ground water is not recharged properly.
- Flooding of roofs, if filters are not properly designed and cleaned frequently.

Is this a one-time or recurring investment?
Rainwater harvesting system is a one-time investment. The storage facility is the single most expensive component of rainwater harvesting. Recurring expenditure is in the form of cleaning the filters and pumping out of water.

Can rainwater be harvested in industries / institutions and multi-storey buildings?
Rainwater can be harvested in industries and institutions. Since the roof area and open area available are bigger, rainwater can be harvested on a large scale and the amount of savings will be huge.
In multi-storey buildings, it has to be a community initiative.

Storage of harvested rainwater at different levels



A flat or sloping roof, which is better suited for rainwater harvesting?
Both types of roofs are suitable.

Can the rainwater harvested be used to recharge ground water (borewell / open well)?
Yes, it can be done. In fact, many dried up wells have got a new lease of life after rainwater harvesting.

Can a family live entirely on rainwater?
Yes, it is possible. In fact, there are many households that do not depend on the public water supply system.

Do I need to take any permission from any department or neighbours to install a rainwater harvesting system for ground water recharge?
No permission is required.

Can sewage or any other water pollute ground water?
If proper care is not taken, leaking sewage pipes, toilet soak pits, industrial effluents etc. can pollute ground water.

Source:
Amruthavarshini- Rainwater Harvesting. Published by INEP and KSCST.
Wikipedia.org

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