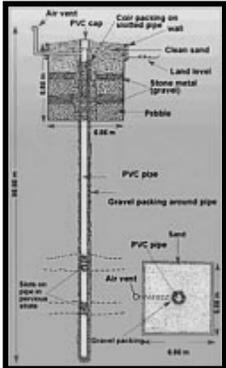
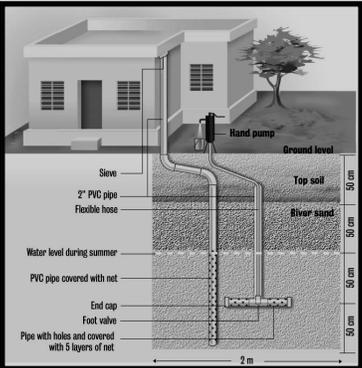
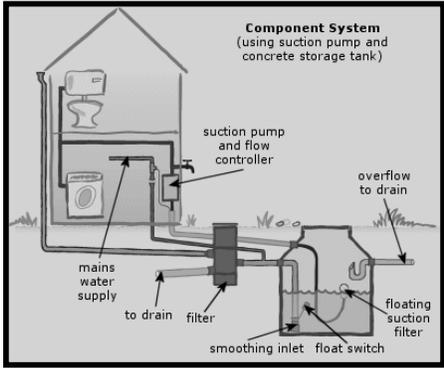
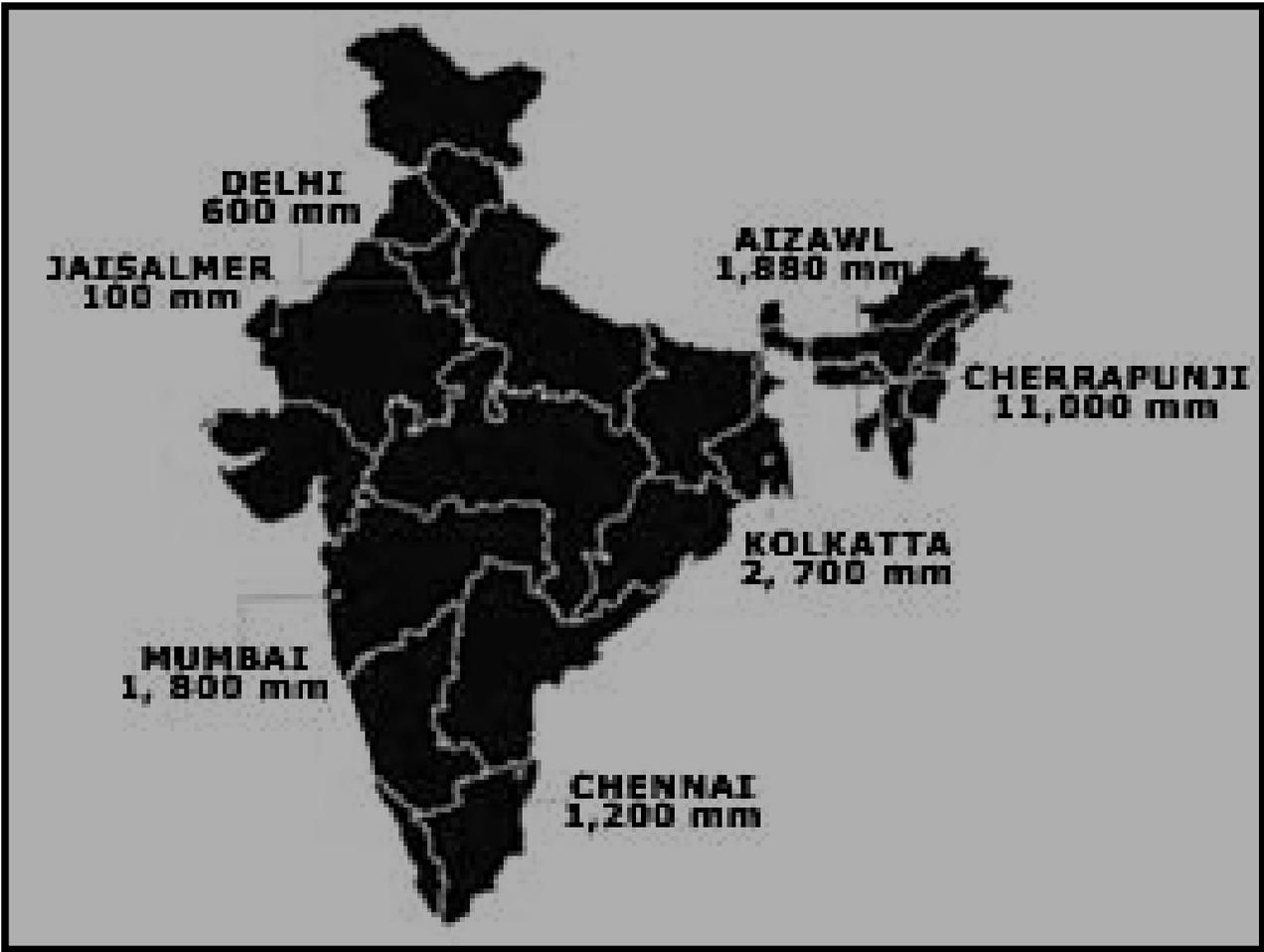


ROOFTOP RAINWATER HARVESTING



Technical details

Rooftop Rainwater Harvesting System

What is rainwater harvesting?

Rainwater harvesting is the collection of raindrops. In most cases, a roof is used for this purpose. The rainwater then flows through the gutters, into a collection tank. The collected water can be used for small-scale irrigation (of vegetable gardens etc.), clothes washing, bathing and after treatment also for drinking and food preparation.

Why Rainwater?

Rainwater offers advantages in water quality for both irrigation and domestic use. Rainwater is naturally soft (unlike well water), contains almost no dissolved minerals or salts, is free of chemical treatment, and is a relatively reliable source of water for households.

Why harvest rainwater?

- Bangalore gets most of its drinking water from a distance of 95 kms. and a depth of 500 Mts.
- A total of 858 million liters of water is being pumped every day to the city through the four Cauvery Stages.
- The T G Halli Reservoir, the second source, responsible for 20 percent of city's requirement (western parts of the city) has been dried up
- Every drop of water supplied to city is through pumping done in three stages, which consumes 60 percent of BWSSB's total revenue towards power charges every month.
- It makes ecological and financial sense not to waste a pure natural resource available in large quantity on one's roof.
- In the case of a homebuilder, at an initial stage of construction, investments in time, design and money are minimal for adopting roof rainwater harvesting.
- Ground water sources are increasingly getting depleted or are getting polluted. Borewells are either silting up, getting short of water or are drawing polluted water.
- Private purchase of water from tankers is unreliable in quality and is also expensive.
- It encourages water conservation and self-dependence.
- Rainwater collected and used on site can supplement or replace other sources of household water and prevent ground water depletion.

The advantages of rainwater harvesting

- One of the beauties of rainwater harvesting systems is their flexibility. A system can be as simple as a barrel placed under a rain gutter downspout for watering a garden or as complex as an engineered, multi-tank, pumped and pressurized construction to supply residential and irrigation needs.
- Rainwater harvesting systems are integrated with the house, which makes the water easily accessible.
- Rainwater harvesting systems are personal, which prevents arguments about who should take care of maintenance.
- One time Installation cost, roughly some 2500 to 5000 Rs per system including a slow sand filter while sustainability of the construction is larger than that of a pump or well.
- The used materials can be kept simple, are obtainable nearly everywhere at local (low) cost price.
- The construction is easy and cheap in maintenance.

Facts about Bangalore

- Population 6 Million
- High altitude city 300 feet above sea level
- No perennial river source nearby
- Rapidly growing population
- Increasing industrial demand
- Traditional sources neglected
- No pronounced aquifer
- Pollution of ground and underground sources

Main natural source of water for Bangalore is its lakes and tanks, which is reducing in numbers year by year.

Lakes and tanks

Year	On of lakes and tanks
1960	261
1997	81
2000	55

Borewell drill leaves water table dry

The unchecked sinking of Borewells has resulted in a sharp decline in a sharp decline in Bangalore's water table, according to a survey conducted by the Central Ground Water Board (CGWB).

The CGWB, which conducted the survey in April-May this year (2003), collected samples from over 104 test wells –both Borewells and open wells – in and around the city.

The surveyors found more than 50 percent of the wells had gone dry and the water level in other wells had dropped by an average of over five meters.

The increasing demand for water the unrestricted growth of the city erratic supply of water and the current dry spell has resulted in panic drilling of Borewells, which has caused depletion of the water table the only way to improve ground water levels is by harvesting rainwater.

Water level * in wells in the past 3 years

Location	May 2001	May 2002	May 2003
Dasanapura	16.59	22.90	31.74
Hebbal	14.41	13.48	14.22
Yelahanka	23.11	22.53	25.29
Indiranagar	02.25	-----	10.71
Jayanagar	06.51	07.83	08.65
Lalbagh	02.41	02.67	02.66

All readings are from ground to the surface of water.

*In meters

Rainfall pattern in Bangalore

Month	Days	Mm
Jan	0.2	2.70
Feb	0.5	7.20
Mar	0.4	4.40
Apr	3.0	46.30
May	7.0	119.60
Jun	6.4	80.80
Jul	8.3	110.20
Aug	10.0	137.00
Sep	9.3	194.80
Oct	9.0	180.40
Nov	4.0	64.50
Dec	1.7	22.10
Total	59.8	970.00

With Bangalore having about 60 rainy days in a year, it is estimated that residences with a 100 sq. m roof can gather about 97,000 litres of water per annum which will take care of the water needs for about 200 day

Maximum rainfall occurs between June and Nov of the year

The Bangalore Mahanagara Palike has decided to adopt this technology in parks and gardens. Considering the fact that the city has 400 parks, the savings on water costs will be enormous. The Government is also considering making the harvesting system mandatory in all new construction projects (both residences and commercial).

Possible collection

Year	Rainy days	Rainfall (mm)	liters/100sq.m
1990	42	509.40	40,752
1991	65	1338.50	1,07,080
1992	56	844.60	67,568
1993	65	1059.70	84,776
1994	45	587.10	46,968
1995	61	1072.20	85,776
1996	64	1173.30	93,864
1997	52	717.40	57,392
1998	68	1431.80	1,14,544
1999	52	1009.40	80,720
Average	57	974.34 mm	77,947

80% capture efficiency

Area of roof X height of rainfall
 100sq.m X 9.7434 mt = 974.34cu.mt
 (97,434 lts)
 80% of capture efficiency =77947 lts

How much water do we use?

Use	Liters/person	Percentage
Drinking	3	2.23%
Cooking	4	2.96%
Bathing	20	14.81%
Flushing	40	29.63%
Washing clothes	25	18.51%
Washing utensils	20	14.81%
Gardening	23	17.03%
Total	135 lts	100%

We use major part (80%) pure drinking water for flushing, washing clothes & utensils and gardening. For these purpose one can use harvested rainwater

It is possible to collect rainwater in Bangalore throughout the year and use the same for: Gardening, car washing and domestic non-potable purpose like washing clothes, dishes, bathing, toilet, swabbing the floor, etc
 For all purposes including potable purpose i.e. drinking

Technical Description

A rooftop rainwater harvesting system consists the following elements:

- Collection area,
- Conveyance system,
- Filtration /treatment
- Storage
- Usage/ Recharge

The **collection area** in most cases is the roof of a house or a building. The effective roof area and the material used in constructing the roof influence the efficiency of collection and the water quality.

A **conveyance system** usually consists of gutters or pipes that deliver rainwater falling on the rooftop to cisterns or other storage vessels. Both drainpipes and roof surfaces should be constructed of chemically inert materials such as wood, plastic, aluminum, or fiberglass, in order to avoid adverse effects on water quality.

The water ultimately is stored in a **storage tank or cistern**, which should also be constructed of an inert material. Reinforced concrete, fiberglass, or stainless steel are suitable materials. Storage tanks may be constructed as part of the building, or may be built as a separate unit located some distance away from the building.

Requirements

- Most effective process has been proven to be to start with an example and then spread the technology around the area. It is therefore necessary to spread information and knowledge.
- When incomes are very low among members of the target group one can make use a finance system like a bank, a savings deposit of a farmers or womens group. Of course an outside finance programme is suitable but personal inputs enhance the 'bond' with the construction and thus strengthens the sustainability.
- Someone is to teach the members of the target group how to construct a rainwater harvesting installation. This person or these people shall have to be very enthusiastic rather than skillful and able to reflect this upon the target group.

Design Tips

Design your roof well for rainwater collection

A flat roof can be gently sloped to drain water towards the storage system. A 'nahani trap' or 'floor trap' can be placed at the time of casting the roof just near the inlets of the down water pipes

Sloping roofs should have a gutter of PVC or zinc sheet to collect water & channel it to the down water pipe system.

Roofs should be uncluttered & should be easy to clean by sweeping & swabbing if necessary.

Down water pipes should be designed well

90mm dia. PVC pipes resistant to UV rays appear to be the best bet as downwater pipes. Of course, this depends upon the roof area to be drained.

3 to 4 downwater pipes seem sufficient for 1000 to 1200 sft area

Filter the rainwater before storage

Filtering can be as basic as a floor trap placed before the water enters the downwater pipe or a piece of sponge placed at the inlet of the downwater pipe

- a PVC bucket with gravel, sand & charcoal is a good filter before rainwater is stored
- a PVC drum with sponge at the inlet & outlet is also a filter
- a small two chamber inspection/ filter tank can also be devised

Try to determine your storage system at the planning stage itself.

Would it be a:

- Roof level storage tank
- Ground level drum or masonry tank
- Below the ground sump
- Partially below ground and partially above ground tank

Locate the storage system properly

- Roof level storage tanks may need to be at the rear of the house or on the sides so that it is neither obtrusive nor visually offensive.
- Ground level drums or tanks occupy space and should not hinder movement or appear unsightly.
- Below the ground sump is a good option since most new constructions in Bangalore go in for sumps anyway. Sumps are hidden from view, less costly to build and do not obstruct movement.

Note: always provide for an outlet for excess collection of water from the storage system

Further treatment of excess rainwater

It is a common perception that water stored for long goes bad. If water does not contain any organic material and if it is stored in a clean container it can stay for a long time.

Some small treatment like 'alum dosing' or 'chlorination' can also be done to stored water to improve its quality.

Addition of a small quantity of alum dissolved in half a bucket of water will bring down the suspended solids and clear the stored rainwater.

Similarly adding a small quantity of bleached powder to half a bucket of water and then mixing it with the stored rainwater will kill bacterial contamination.

Great care should be exercised while chlorinating and it is not particularly recommended. It is always recommended that water used for drinking should be boiled and filtered invariably.

and cooking but only after boiling and filtering the water.

Tanks

The size of the tank is dependent of the amount and purpose of the water but also of the annual rainfall and the size of the roof. **A normal sized tank for a roof of 20 to 40 square metres is 10 cubic metres.**

All rainwater tank designs should include as a minimum requirement:

- A solid secure cover
- A coarse inlet filter
- An overflow pipe
- A manhole, sump, and drain to facilitate cleaning
- An extraction system that does not contaminate the water; e.g., a tap or pump
- A soak away to prevent spilled water from forming puddles near the tank

Additional features might include:

- A device to indicate the amount of water in the tank
- A sediment trap, tipping bucket, or other "foul flush" mechanism
- A lock on the tap
- A second sub-surface tank to provide water for livestock, etc

Plastic tanks:

Available as finished products in various capacities. The cost of these tanks ranges from Rs 2/litre to about Rs 3.5/litre.

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:

Sizing of rainwater pipe for roof drainage

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

mm/ h - millimeters per hour; m - meters

Filters and separators

Despite the roof being higher than the ground, dust and other debris can be blown onto it, especially if the roof is near to a roadway. Leaves can also fall onto the roof from nearby trees and flying and climbing animals can defecate upon it. The quality of water can be much improved if this debris is kept out of the system. To accomplish this filters and separators can be added to a rainwater harvesting system at the inlet, outlet or both. Filters simply remove the debris and allow all water to flow; separators remove the debris and wash it away in a portion of the water.

The first line of defence is a coarse leaf filter. The filter can be installed anywhere from the gutter to the entrance to the tank. The most popular positions are in the gutter, at the beginning of the downpipe, in the downpipe, in the ground before the tank and at the entrance to the tank itself. Of these, the tank entrance is by far the most common in very low cost systems.

Whatever location is chosen for the filter, there are several criteria that should be met for good design:

- The filter should be easy to clean or largely self-cleaning
- It should not block easily (if at all) and blockages should be obvious and easy to rectify
- It should not provide an entrance for additional contamination

The cost should not be out of proportion with the rest of the system - user surveys have shown that people in southern Uganda will only spend about 5% of the cost of the system on filtering, users in Sri Lanka will spend closer to 10%.

Contaminants from a roof are usually concentrated in the first run off from the roof. After this runoff has passed and washed the roof the water is considerably safer. The amount to be removed varies and a number of studies have had differing results. Despite this uncertainty, first flush systems are a popular method of improving the quality of roof runoff prior to storage, particularly in Asian countries. There are basically four methods of separating the first flush;

1. Manual, 2. Fixed volume, 3. Fixed mass and, 4. Flow rate.

The **manual method** is the simplest and widely recommended it does, however rely on the user both being home and prepared to go out into the rain to operate the device much reducing its usefulness.

The **fixed volume method**, which relies on the water simply filling a chamber of a set size (usually a length of downpipe) until it overflows, is the "automatic" method usually applied in low cost systems. The method can be used either with or without a floating ball seal which helps in reducing mixing between early dirty water and later clean water, however Michaeledes (1987) has found that this mixing is transient. They are also found with either automatic draining over a period of time or require manual draining. Manual draining systems have little to recommend them as if left to drain will not only fail to work for the next storm, but can cause additional pollutants to be washed in to the tank from the first flush device itself.

The **fixed mass system** has also been promoted. The devices, usually relying on a mass of water to tip a bucket or seesaw tend to be unreliable and users inevitably disable the system. A newer first flush concept is to use the changes in flow rate over the course of a storm. Stormwater management designers have been using a **flow rate model** of first flush for some time to reduce the large land areas required for "volumetric" facilities. Australian Company has developed a system whereby flow rate is used for roof runoff. The SafeRain system balances the rate of water intake into a suspended hollow ball against its leakage, raising its weight and stretching its suspension until it descends into a recess, blocking the opening and allowing water into the tank. The system has the advantage of being self-cleaning and removes the need for any storage of the first flush water (and its subsequent drainage).

Finer filtering can remove small sediment which would otherwise either be suspended in the water or settle to the bottom of the tank leaving a sludge. The techniques are well known, employing gravel, sand or fine screens but the needs of rainwater harvesting systems are unique, as in a tropical downpour flow rates can be very high - with short-term peaks of more than 1.5 l s^{-1} . This calls for either very large surface areas or courser screens. A filter consisting of a $\text{Ø}300\text{mm}$ tube filled with 150mm sand on a bed of 200mm of pebbles has been used in Sri Lanka which copes with all but the very highest peak flows, however the filters were often bypassed or filled with courser material when user saw water overflowing the filter during heavy downpours.

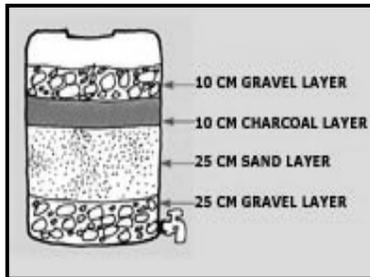
Another problem of fine filters is cleaning. As all water passes through most designs of fine filter, particles become trapped in the filter requiring periodic cleaning. If this is not carried out, the filter will eventually block

and simply overflow which has resulted in filters being emptied of media and abandoned. In developed countries self-cleaning filters are available with a fine mesh screen (typically 0.4mm). These screens use the first flow of water from a storm to flush the filter of debris or have a continual washing action using about 10% of the water. In VLC systems there is usually a significant overflow of water and these types may be viable if suitable filter mesh or cloth is available locally.

Filters

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.

Source: A water harvesting manual for urban areas



Charcoal water filter

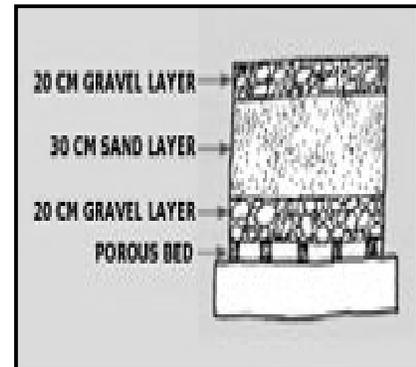
A simple charcoal filter can be made in a drum or an earthen pot. The filter is made of gravel, sand and charcoal, all of which are easily available.

Sand filters

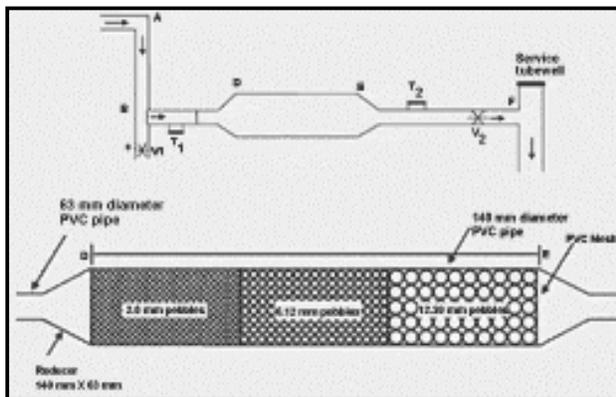
Sand filters have commonly available sand as filter media. Sand filters are easy and inexpensive to construct. These filters can be employed for treatment of water to effectively remove turbidity (suspended particles like silt and clay), colour and microorganisms.

Source: A 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.



Dewas filters



Most residents in Dewas, Madhya Pradesh, have wells in their houses. Formerly, all that those wells would do was extract groundwater. But then, the district administration of Dewas initiated a groundwater recharge scheme. The rooftop water was collected and allowed to pass through a filter system called the Dewas filter, designed by Mohan Rao, district collector of Dewas, and engineers of the rural engineering services. The water thus filtered is put into the service tubewell.

The filter consists of a polyvinyl chloride (PVC) pipe 140-mm in diameter and 1.2m long. There are three chambers. The first purification chamber has pebbles varying between 2-6 mm, the second chamber has slightly larger pebbles, between 6 and 12 mm and the third chamber has the largest - 12-20 mm pebbles. There is a mesh at the outflow side through which clean water flows out after passing through the three chambers. The cost of this filter unit is Rs 600.

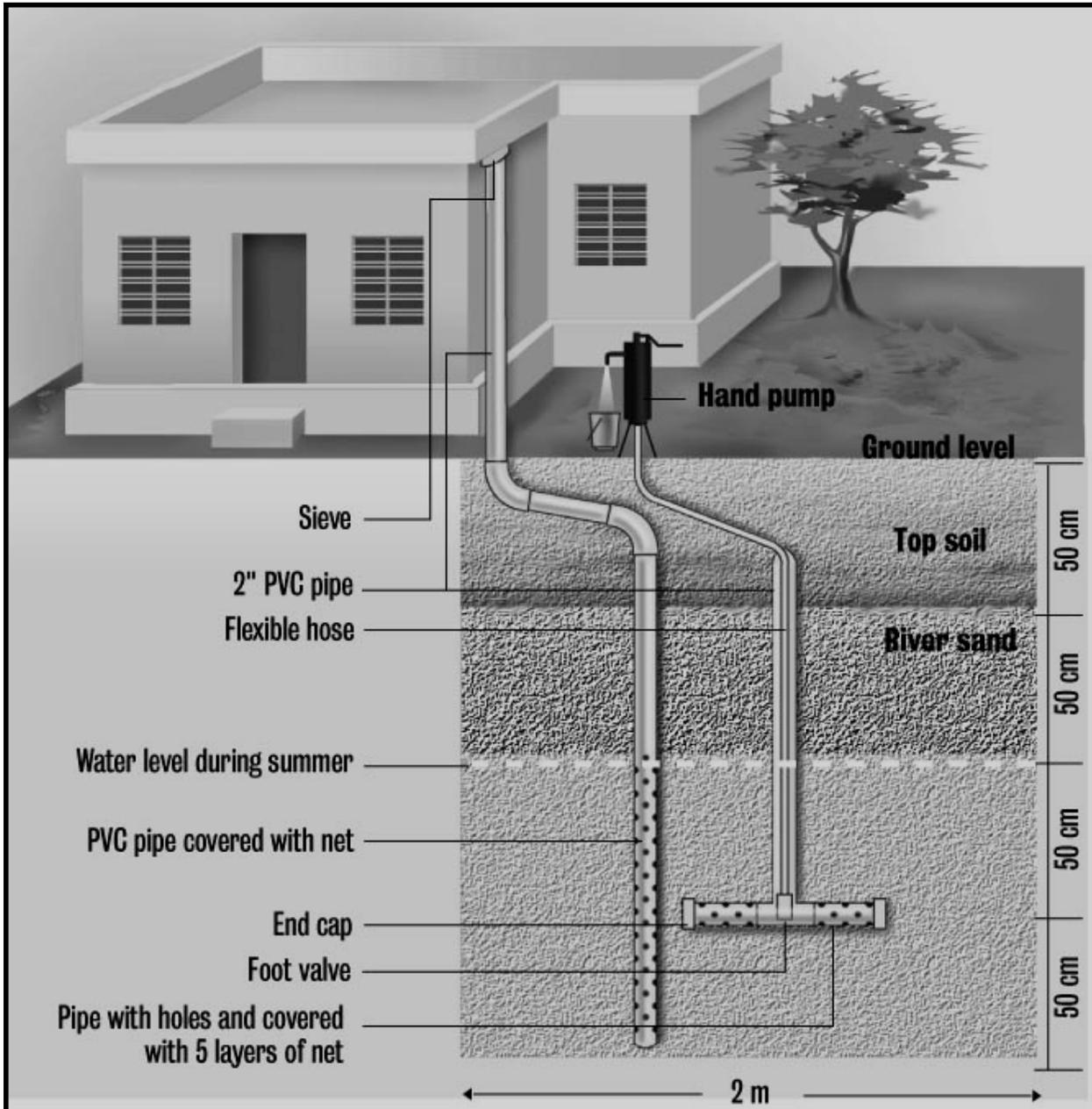
Varun: S Vishwanath, a Bangalore water-harvesting expert, has developed a rainwater filter "VARUN". According to him, from a decently clean roof 'VARUN' can handle a 50-mm per hour intensity rainfall from a 50 square meter roof area. This means the product is relatively standardised. For new house builders we therefore can recommend the number of downpipes they have to optimise on and the number of filters they will need.

'VARUN' is made from a 90-litre High-Density polyethylene (HDPE) drum. The lid is turned over and holes are punched in it. This is the first sieve, which keeps out large leaves, twigs etc. Rainwater coming out of the lid sieve then passes through three layers of sponge and a 150-mm thick layer of coarse sand. Presence of sponge makes the cleaning process very easy. Remove the first layer of sponge and soak /clean it in a bucket of water (which you then don't waste but use it for plants). The sand needs no cleaning at all. The basic cost of the filter is about Rs 2250/-

Recharge structures

Rainwater may be charged into the groundwater aquifers through any suitable structures like dugwells, Borewells, recharge trenches and recharge pits.

Various recharge structures are possible - some which promote the percolation of water through soil strata at shallower depth (e.g., recharge trenches, permeable pavements) whereas others conduct water to greater depths from where it joins the groundwater (e.g. recharge wells). At many locations, existing structures like wells, pits and tanks can be modified as recharge structures, eliminating the need to construct any structures afresh. Here are a few commonly used recharging methods:



1. Recharging of dugwells and abandoned tubewells.

In alluvial and hard rock areas, there are thousands of wells which have either gone dry or whose water levels have declined considerably. These can be recharged directly with rooftop run-off. Rainwater that is collected on the rooftop of the building is diverted by drainpipes to a settlement or filtration tank, from which it flows into the recharge well (borewell or dugwell).

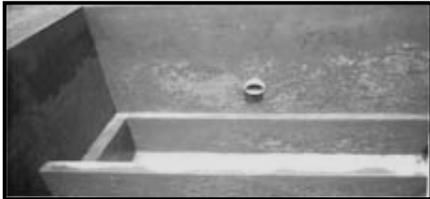
If a tubewell is used for recharging, then the casing (outer pipe) should preferably be a slotted or perforated pipe so that more surface area is available for the water to percolate. Developing a borewell would increase its recharging capacity (developing is the process where water or air is forced into the well under pressure to loosen the soil strata surrounding the bore to make it more permeable).

If a dugwell is used for recharge, the well lining should have openings (weep-holes) at regular intervals to allow seepage of water through the sides. Dugwells should be covered to prevent mosquito breeding and entry of leaves and debris. The bottom of recharge wells should be desilted annually to maintain the intake capacity.

Providing the following elements in the system can ensure the quality of water entering the recharge wells:

1. Filter mesh at entrance point of rooftop drains
2. Settlement chamber
3. Filter bed

2. Settlement tank (chamber)



Settlement tanks are used to remove silt and other floating impurities from rainwater. A settlement tank is like an ordinary storage container having provisions for inflow (bringing water from the catchment), outflow (carrying water to the recharge well) and overflow. A settlement tank can have an unpaved bottom surface to allow standing water to percolate into the soil.

In case of excess rainfall, the rate of recharge, especially of borewells, may not match the rate of rainfall. In such situations, the desilting chamber holds the excess amount of water till it is soaked up by the recharge structure. Thus, the settlement chamber acts like a buffer in the system.

Any container, (masonry or concrete underground tanks, old unused tanks, pre-fabricated PVC or ferrocement tanks) with adequate capacity of storage can be used as a settlement tank.

3. Recharging of service tubewells.

In this case the rooftop runoff is not directly led into the service tubewells, to avoid chances of contamination of groundwater. Instead rainwater is collected in a recharge well, which is a temporary storage tank (located near the service tubewell), with a borehole, which is shallower than the water table. This borehole has to be provided with a casing pipe to prevent the caving in of soil, if the strata is loose. A filter chamber comprising of sand, gravel and boulders is provided to arrest the impurities.

4. Recharge pits

A recharge pit is 1.5m to 3m wide and 2m to 3m deep. The excavated pit is lined with a brick/stone wall with openings (weep-holes) at regular intervals. The top area of the pit can be covered with a perforated cover. Design procedure is the same as that of a settlement tank.

5. Soakaways / Percolation pit

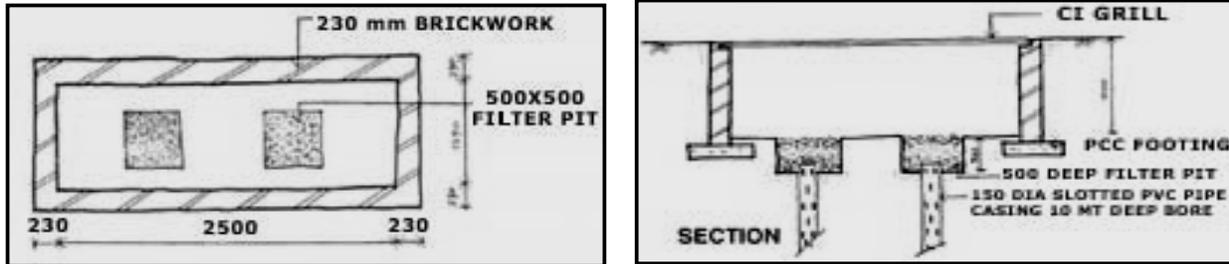
Percolation pits, one of the easiest and most effective means of harvesting rainwater, are generally not more than 60 x 60 x 60 cm pits, (designed on the basis of expected runoff as described for settlement tanks), filled with pebbles or brick jelly and river sand, covered with perforated concrete slabs wherever necessary.

6. Recharge trenches

A recharge trench is a continuous trench excavated in the ground and refilled with porous media like pebbles, boulders or broken bricks. A recharge trench can be 0.5 m to 1 m wide and 1 m to 1.5 m deep. The length of the recharge trench is decided as per the amount of runoff expected. The recharge trench should

be periodically cleaned of accumulated debris to maintain the intake capacity. In terms of recharge rates, recharge trenches are relatively less effective since the soil strata at depth of about 1.5 metres is generally less permeable. For recharging through recharge trenches, fewer precautions have to be taken to maintain the quality of the rainfall runoff. Runoff from both paved and unpaved catchment can be tapped.

7. Recharge troughs



To collect the runoff from paved or unpaved areas draining out of a compound, recharge troughs are commonly placed at the entrance of a residential/institutional complex. These structures are similar to recharge trenches except for the fact that the excavated portion is not filled with filter materials. In order to facilitate speedy recharge, boreholes are drilled at regular intervals in this trench. In design part, there is no need of incorporating the influence of filter materials. This structure is capable of harvesting only a limited amount of runoff because of the limitation with regard to size.

8. Modified injection well

In this method water is not pumped into the aquifer but allowed to percolate through a filter bed, which comprises sand and gravel. A modified injection well is generally a borehole, 500-mm diameter, which is drilled to the desired depth depending upon the geological conditions, preferably 2 to 3 m below the water table in the area. Inside this hole a slotted casing pipe of 200-mm diameter is inserted. The annular space between the borehole and the pipe is filled with gravel and developed with a compressor till it gives clear water. To stop the suspended solids from entering the recharge tubewell, a filter mechanism is provided at the top.

Maintenance

Rainwater harvesting systems require few skills and little supervision to operate. Major concerns are the prevention of contamination of the tank during construction and while it is being replenished during a rainfall. Contamination of the water supply as a result of contact with certain materials can be avoided by the use of proper materials during construction of the system. The main sources of external contamination are pollution from the air, bird and animal droppings, and insects. Bacterial contamination may be minimized by keeping roof surfaces and drains clean but cannot be completely eliminated. If the water is to be used for drinking purposes, filtration and chlorination or disinfection by other means (e.g., boiling) is necessary. The following maintenance guidelines should be considered in the operation of rainwater harvesting systems:

- A procedure for eliminating the "foul flush" after a long dry spell deserves particular attention. The first part of each rainfall should be diverted from the storage tank since this is most likely to contain undesirable materials, which have accumulated on the roof and other surfaces between rainfalls. Generally, water captured during the first 10 minutes of rainfall during an event of average intensity is unfit for drinking purposes. The quantity of water lost by diverting this runoff is usually about 14l/m² of catchment area.
- The storage tank should be checked and cleaned periodically. All tanks need cleaning; their designs should allow for this. Cleaning procedures consist of thorough scrubbing of the inner walls and floors. Use of a chlorine solution is recommended for cleaning, followed by thorough rinsing.
- Care should be taken to keep rainfall collection surfaces covered, to reduce the likelihood of frogs, lizards, mosquitoes, and other pests using the cistern as a breeding ground. Residents may prefer to take care to prevent such problems rather than have to take corrective actions, such as treating or removing water, at a later time.
- Gutters and downpipes need to be periodically inspected and cleaned carefully. Periodic maintenance must also be carried out on any pumps used to lift water to selected areas in the house or building. More often than not, maintenance is done only when equipment breaks down.
- Households must establish a maintenance routine that will be carried out by family members.

As has been noted, in some cases the rainwater is treated with chlorine tablets. However, in most places it is used without treatment. In such cases, residents are advised to boil the water before drinking. Where cistern users do not treat their water, the quality of the water may be assured through the installation of commercially available in-line charcoal filters or other water treatment devices.

Required materials

- Rain. And really lots of it, throughout the year, favorably some two metres of it!
- A catchment area, usually a roof of 15-20 square metres or above is sufficient.
- Roof-gutters, those can consist of bent metal sheets or even large PVC pipes 'tubes' (the gutters should have a large enough capacity to prevent overflow during rainfall).
- Pipelines or gutters (PVC) that lead from the roof-gutters to the storage tank.
- Storage tank; because of the size (between 5.000 and 12.000 liters) a concrete, a Ferro cement or a PVC tank. Do mind that a manhole should be present for inside-cleaning purposes. And the outlet is situated at the bottom, it must remain accessible.

Materials required for rainwater harvesting system

No	Material	Size	Rate
1	Water pipe HDPE/PVC	50 – 150 mm dia pipe	15-30 Rs. (Running feet)
2	PVC Tank	1000 ltrs	Rs. 2.55 per liter
3	Ferrocement tank	5000 ltrs	Rs. 250 per liter
4	Elbows & Tees		20.00 – 75.00
5	Filter drum		700.00
6	Filters		1500.00
7	First flush	50 liters	750.00
8	Motor pump	½ HP (Kirloskar)	1800.00
		1 HP (Kirloskar)	3500.00
9	Ultraviolet light system water purifier		8000.00

Costing

Rainwater harvesting methods are site specific and hence it is difficult to give a generalised cost. But first of all, the major components of a rainwater harvesting system - rain and catchment area - are available free of cost. A good proportion of the expenses would be for the pipe connections. By judiciously fixing up the slopes of roofs and location of rainwater outlets, this could be brought down considerably. However the cost varies widely depending on the availability of existing structures like wells and tanks which can be modified and used for water harvesting.

Typically, installing a water harvesting system in a building would cost between Rs 2,000 to 30,000 for buildings of about 300 sq. m. The cost estimate mentioned above is for an existing building. For instance, water harvesting system in the CSE building in Tughlakabad Institutional Area, Delhi, was set up with an investment of Rs 30,000 whereas those in the model projects ranged between Rs 70, 000 and Rs 8 lakh. The costs would be comparatively less if the system were incorporated during the construction of the building itself.

Some basic rates of construction activities and materials have been given here, which may be helpful in calculating the total cost of a structure. The list is not comprehensive and contains only important activities meant to provide a rough estimate of the cost.

a. Unit cost of construction activities.

Item	Unit Rate	(Rs.)
Excavation in soils	Cu. m.	90.00
Excavation in rock	Cu. m.	150.00
Brickwork with cement mortar(1:6)	Cu. m.	1400.00
Plain cement concrete (1:3:6)	Cu. m.	1500.00
Reinforced cement concrete (1:2:4)	Cu. m.	4700.00
Including steel bars, shuttering etc.	Cu. m.	4700.00
PVC piping for rainwater pipes	110 mm diameter	165.00
	200 mm diameter	275.00
Making borehole in meter 165.00Soft soil (with 150 mm diameter PVC casing)	Meter	180.00

b. Ferrocement tanks with skeletal cage

Total cost in rupees	Capacity of rooftop water harvesting system in liters				
	5,000 ltrs.	6,000 ltrs.	7,000 ltrs.	9,000 ltrs.	10,000 ltrs.
	12,430	12,975	13,970	14,380	15,800

Water conservation at a micro level

- (a) Close taps tightly. Fix leaking taps, pipes immediately and check regularly for leaks.
- (b) Replace damaged and leaking pipes, taps and valves to avoid overflow and wastage.
- (c) Choose plants that are drought-resistant. Water gardens during the coolest part of the day
- (d) Never put water down the drain when there may be another use for it.
- (e) Wash vehicles with a bucket and sponge instead of hose, which uses 400 liters of water. By using a bucket up to 300 liters can be saved.
- (f) Wash vegetables in a bowl of water, washing the cleanest ones first. Use this water for your plants.
- (g) Collect rainwater in large tubs or cans and use it to water your plants.
- (h) A leaking toilet can waste up to 16,000 liters of water per year.
- (i) Don't use your washing machine for one or two garments. Ensure you have a full load.
- (j) Harvest rainwater at home. Keep a large deep structure to collect rainwater for non-potable purposes. Rainwater harvesting is especially important in today's scenario since it recharges the ground water levels.

A collective effort will go a long way in ensuring that the city does not suffer water shortages.

Quick facts

- You need 100 drops of water to fill a teaspoon
- Less than 2 percent of the water on earth is freshwater. And most of that is locked up in the polar ice caps or is part of the ground water
- More than five million people, most of them children, die each year from illness caused from drinking unsafe water
- The privatisation of water industry a 400 billion dollar a year business globally one third larger than global pharmaceuticals
- Every year, the average Briton uses 10,000 gallons of water, 500 percent more than average Indian does
- The total wastewater generated in India is to the tune of 22900 million liters per day. Of this quantity a mere 5942 million liters per day is treated

RAINWATER HARVESTING Resource Pool

No	Person	Organisation	Address	Ph No.	Nature of resource
1	Manjunath	Environmental Management & policy research Institute	Urban Eco-Park 100ft Road, Peenya Indl Area, 3 rd Phase, Bangalore 560 058	O – 8372460 R – 3464418 F – 8377745	Trainer
2	A. R. Shiva Kumar	Karnataka State Council for Science & Technology	No. 44, Sourabha, Basaveshwara Layout Vijayanagar 2 nd Stage, Bangalore 560 040	O – 3348848 3341652 R – 3398655 F - 3461221	Trainer (Has done Research on Rainwater Harvesting)
3	K. Vishwanath	Rainwater Club	No. 264, 6 th Main, 6 th Block, B.E.L. Layout, Vidyaranyapura, Bangalore 560 097 Email. Chitravishwanath@vsnl.com Website. www.rainwaterclub.org	O – 3641690 3642435	Architect (Has done Research on Rainwater Harvesting)
4	Sudhakar	Veronica Inc	No 2/1, Meenakshi Koil Street, Shivajinagar Bangalore 560 051	O – 2864767 M – 94480 64767	Engineer

Companies involved in manufacturing rainwater harvesting system material

No	Contact Person	Organisation	Address	Ph No.	Material
1	M.K. Birad+ar (Engineer) Satish Kumar (Office administrator)	JAIN Irrigation System Lid.	No 219, Kamaraj Road, Bangalore 560 042 E mail: jislblr@hathway.com Website: www.jains.com	O - 5361257 5548921 F – 5548921	Rainwater harvesting system materials
2	Anada Kumar		Mathru Krupa No 1071, 8th main, 5th cross Vijayanagar Bangalore	O – 3104545	water purifier (Ultra violet light)
3	Bindu	Kisan Mouldings Ltd. (Kisan Barish rainwater system)		O - 227 2425 229 3226 f – 227 2238	Rainwater collection, storage, & rooftop harvesting systems