

7 Rainwater harvesting

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7.1 Introduction

Rainwater catchment and storage reservoirs have been constructed since ancient times in several parts of the world. Some have been preserved to this day. Rainwater is harvested as it runs off roofs, or over natural ground, roads, yards, or specially pre-prepared catchment areas. Historical sources mention the use of rainwater for domestic water supply some 4000 years ago in the Mediterranean region. Roman villages and cities were planned to take advantage of rainwater for drinking water supply. In the hills near Bombay in India, the early Buddhist monastic cells had an intricate series of gutters and cisterns cut into the rock to provide domestic water on a year-round basis.

In Europe and Asia rainwater harvesting was used widely for the provision of drinking water, particularly in rural areas. In many countries it is still being practised. However, where piped water supplies have been provided, the importance of rainwater as a source of supply has diminished.

On some tropical islands rainwater continues to be the only source of domestic water supply. In arid and semi-arid areas where people mostly live in scattered or nomadic settlements, rainwater harvesting can be a necessary means of providing water for domestic purposes. This is especially the case where groundwater resources are unavailable or costly to develop. In many developing countries, rainwater is used to supplement the piped water supply.

Rainwater harvesting means capturing the rain where it falls or capturing the runoff in farms, villages or towns and taking measures to store that water and keep it clean. Rainwater harvesting can be undertaken through a variety of ways:

- Capturing run-off from roof tops
- Capturing run-off from local catchments
- Capturing seasonal floodwater from local streams
- Conserving water through watershed management

Harvesting rainwater has several functions:

- Providing water to people and livestock
- Providing water for food and cash crops
- Increasing groundwater recharge
- Reducing storm water discharges, urban floods and overloading of sewage treatment plants
- reducing seawater ingress in coastal areas

Rainwater harvesting should be considered as a source of domestic water in countries where rain comes in storms of considerable intensity, with intervals during which there is little or no rainfall. It requires adequate provision for the interception, collection and storage of the water.

Food security is also a great concern in countries where population pressure is growing while food production declines. Among other things, decreased agricultural production is due to poor soil fertility management. Soil loss and reduced moisture retention of the soil occur because of accelerated run-off. There is an urgent need to halt progressive soil degradation through more and better rainwater harvesting systems. If storm water run-off is controlled and stored in water harvesting systems, it can be used to improve water and food security.

The goal of good watershed management is to hold water where it falls as precipitation, at the same time protecting the land from erosion. By various technical and vegetative measures, the water can be slowed down on its path towards the main stream in the valley and redirected to feed a series of land and water harvesting structures at each level and to replenish the groundwater table. There is, therefore, eminent sense - ecological, financial and political - in promoting community and household-based water harvesting systems.

A domestic rainwater harvesting system can consist of a collection surface, a storage tank, and guttering or channels to transport the water from one to the other. Other peripheral equipment is sometimes incorporated, such as a first-flush system to divert the initial dirty water that contains roof debris built up during prolonged dry periods; filtration equipment; and settling chambers to remove debris and contaminants before the water enters the storage tank or cistern.

User regimes

Rainwater harvesting is used in many different ways. In some parts of the world with abundant rainfall and short dry spells, only a small storage capacity is required. However, in arid areas where people will depend totally on rainwater harvesting to supply their domestic water needs throughout the dry season, a sufficiently large collection surface area and storage capacity will be required to provide enough water to meet the needs of the user. Between these two extremes, a wide variety of different user patterns or regimes are possible.

Some of the variables that determine the patterns of usage for rainwater harvesting are:

- Total rainfall quantity
- Rainfall pattern
- Collection surface area

- Storage capacity
- Daily consumption rate and number of users
- User demands from men and women
- Socio-economic differences in demand
- Cost of the system(s)
- Alternative water sources
- Restricted use options
- Unplanned water use
- Intermittent use options
- Partial use of rainwater
- All water needs from harvested rainwater

7.2 Collection surface

Roof of a house/dwelling

For domestic rainwater harvesting the most common surface for collecting water is the roof of the dwelling. Many other surfaces can be and are used. Reasonably pure rainwater can be collected from house roofs made of tiles, slates, (corrugated) galvanised iron, aluminium or asbestos cement sheeting. Most thatched roofs are not suitable because of the colouring and increased turbidity of the water caused by organic material. However, thatched roofs made of certain palm leaves can make good catchments. With very corrosive rainwater, the use of asbestos cement sheeting for roof catchment requires some caution. Asbestos fibres may be leached from the roof material leading to relatively high asbestos concentrations in the collected rainwater. However, there is no evidence that asbestos fibres in drinking water pose adverse health effects. On the other hand, inhalation of high concentrations of asbestos fibres present in the air may cause lung cancer. As a result, production of asbestos products has been banned and removal of old asbestos cement sheeting needs special care. Plastic sheeting is economic but often not durable. Newly developed roofing materials are bituminous felt and sisal-reinforced paper. Painting the roof for water-proofing may impart taste or colour to the collected rainwater, and should be avoided.

Ground catchment

Ground catchments are used for collecting rainwater run-off. Part of the rainfall will be lost as it serves to wet the ground, is stored in depressions, or disappears through evaporation. Laying tiles, concrete, asphalt, or plastic sheeting to form a smooth impervious surface on the ground can reduce such losses considerably. Sometimes simply compacting the surface is adequate.

The amount of rainwater that can be collected in a ground catchment depends on whether the catchment is flat or sloping, and on the water tightness of the top layer.

Through preparation of the ground surface, a sufficiently rapid flow of the water to the point of collection and storage can be assured in order to reduce evaporation and infiltration losses. The portion of rainfall that can be harvested ranges from about 10% for a pervious, flat ground catchment, to some 90% for a sloping strip catchment covered with impervious materials.



Fig. 7.1. Simple roof catchment and storage

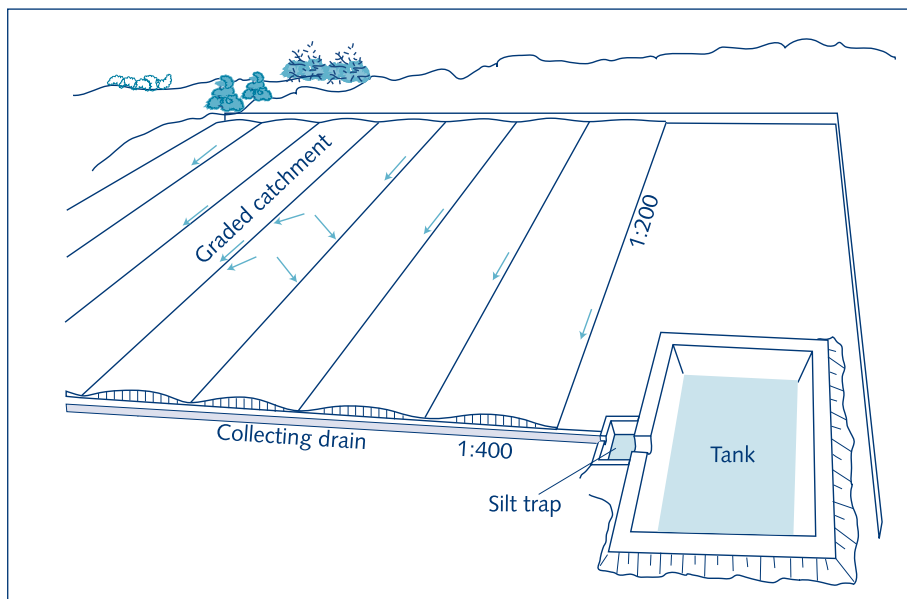


Fig. 7.2. Large ground catchment

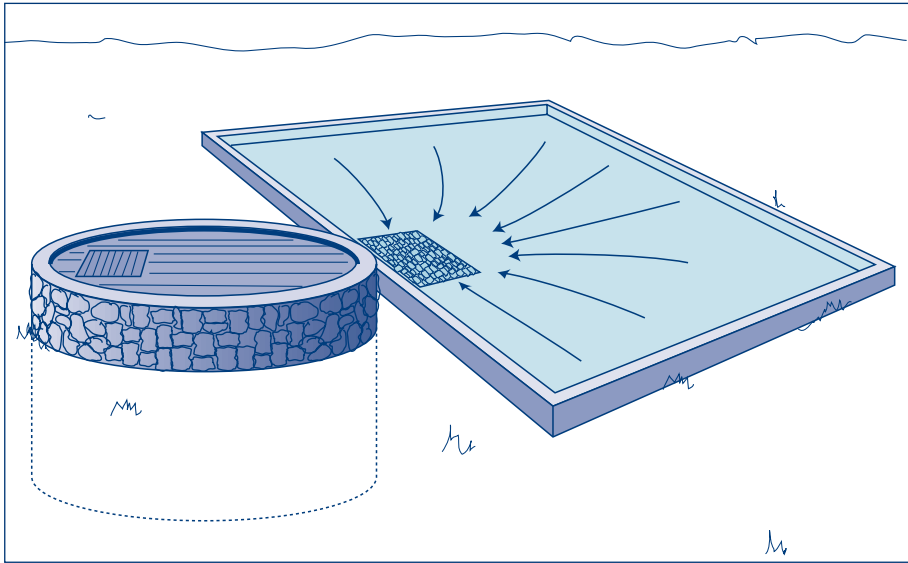


Fig. 7.3. Small ground catchment

Land alteration for run-off in surface water catchment systems includes constructing ditches along contours, clearing rocks and vegetation, and simple soil compacting. Attempts are often made to achieve reduced infiltration losses of rainwater in the ground catchment area. In rolling hills careful soil compacting may be sufficient to attain good catchment efficiency. In flat terrain, sub-division into small, sloping strips will be needed as well as appropriate preparation of the ground surface.

Rock catchment

Some places such as at the tops of bare hills with rock outcrops or low lands (e.g. around inselbergs) are suitable to form a ground catchment referred to as a rock catchment. Dips and gullies form good sites for reservoirs. Run-off water intercepted by the rock is channelled through stone gutters and bunds across contours of the slopes to reservoirs where water is stored for use. The site for the dam and the bottom of the reservoir should be devoid of rock fissures or fractures that might drain the water away from the site. From the reservoir, water may be channelled by gravity to communities living downstream. The type, size and shape of the storage facility depend on site characteristics and water demands.

Transport of rainwater

For harvesting rainwater from roofs, guttering is used to transport the water to the storage vessel. Guttering comes in a wide variety of shapes and forms, ranging from the factory type made of PVC, zinc, copper or aluminium to home-made guttering using bamboo, ferro-cement, timber or folded metal sheets. Guttering is usually fixed by hooks to the building just below the roof and catches the water as it falls from the roof. The roof guttering should slope evenly towards the down-pipe (at 0.8-1% slope)

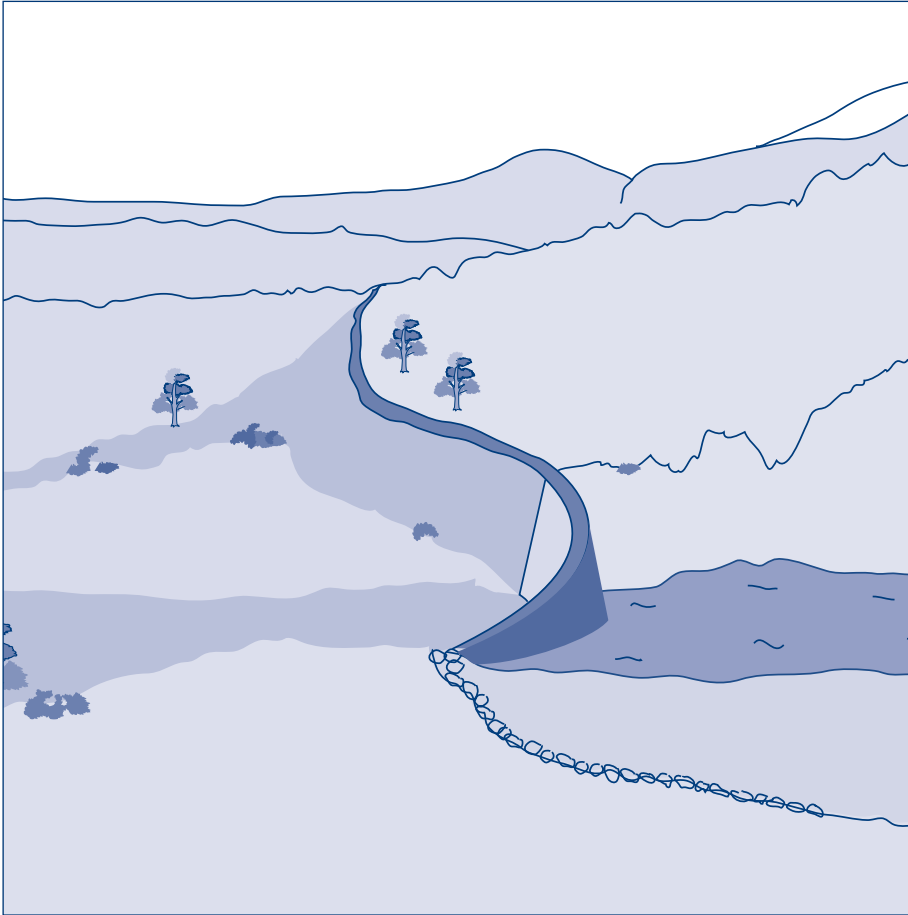


Fig. 7.4. Rock catchment

because if it sags, pools will form that can provide breeding places for mosquitoes. For the same reason, pools of stagnant water from the overflow must be avoided. Gutters and down-pipes in normal circumstances will cost between 5 and 15% of the total system cost depending on local prices and conditions.

Run-off coefficient

The run-off coefficient is the ratio of the volume of rainwater that runs off a surface to the volume of rainwater that falls on that surface (Gould and Nissen-Petersen, 1999). This includes also losses from spillage in the gutter system. A carefully designed and constructed gutter system is essential for any catchment system to operate effectively. A properly fitted and maintained gutter down-pipe system is capable of diverting more than 90% of all rainwater run-off from a good roof catchment made of corrugated iron into the storage tank, but the long-term collection efficiency is usually between 80 and 90% (Ree, 1976). Table 7.1 gives the ranges of run-off coefficients for roof and ground catchments.

Table 7.1 Run-off coefficients for selected surfaces

Roof catchments	
Sheet metal	0.8-0.9
Cement tile	0.60-0.70
Clay tile (machine made)	0.30-0.40
Clay tile (hand-made)	0.25-0.30
Ground catchments	
Concrete-lined	0.75
Cement soil mix	0.30-0.40
Buried plastic sheet	0.30-0.35
Compacted loess soil	0.10-0.20

Sources: Zhu and Liu, 1998 and others

Foul flush

Dust, dead leaves and bird droppings will accumulate on the roof during dry periods. The first new rains will wash these off. It may be helpful to arrange the down pipe so that the first water from each shower (the "foul flush") can be diverted from the clear water container and allowed to run to waste. To safeguard the quality of the collected rainwater, the roof and guttering should be cleaned regularly. In Jamaica, for example, bird droppings have been reported to cause health hazards (salmonellosis) when harvesting rainwater from roofs. A wire mesh should be placed over the top of the down-pipe to prevent it from becoming clogged with washed off material.

The simplest way of diverting the first flush is to turn the inflow pipe away from the inlet of the storage tank, and put it back when the water is clean. This, however, requires that somebody is around at the moment the rains start.

A simple system is to collect a certain volume (about 20 litres) of first flush in a plastic or metal container (e.g. attached to the wall) (Fig. 7.5); when it is full the floating rubber ball closes off the container and "clean" rainwater flows to the storage tank. The tank can be easily drained. Another, more expensive, arrangement for diverting the first rainwater running from the roof is shown in figure 7.6. There are several other diversion systems.

Another arrangement is an underground storage tank receiving rainwater that overflows from a vessel placed above the ground (Fig. 7.7). The surface vessel thus occasionally contributes water to the underground tank.

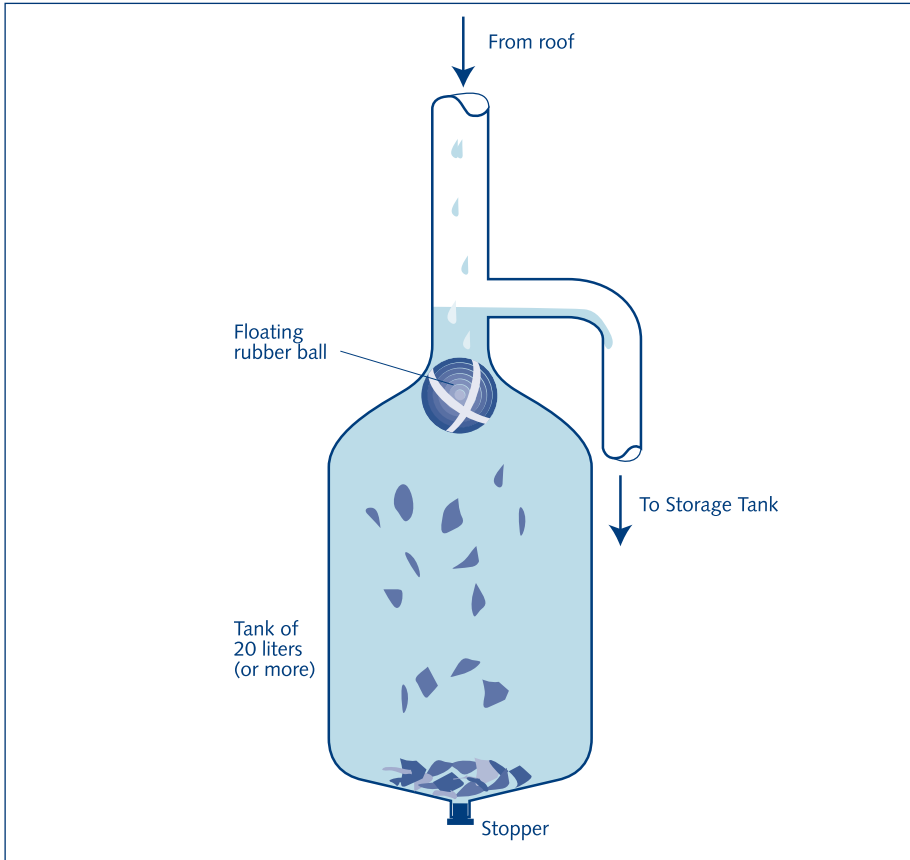


Fig. 7.5. Simple first flush diversion system.

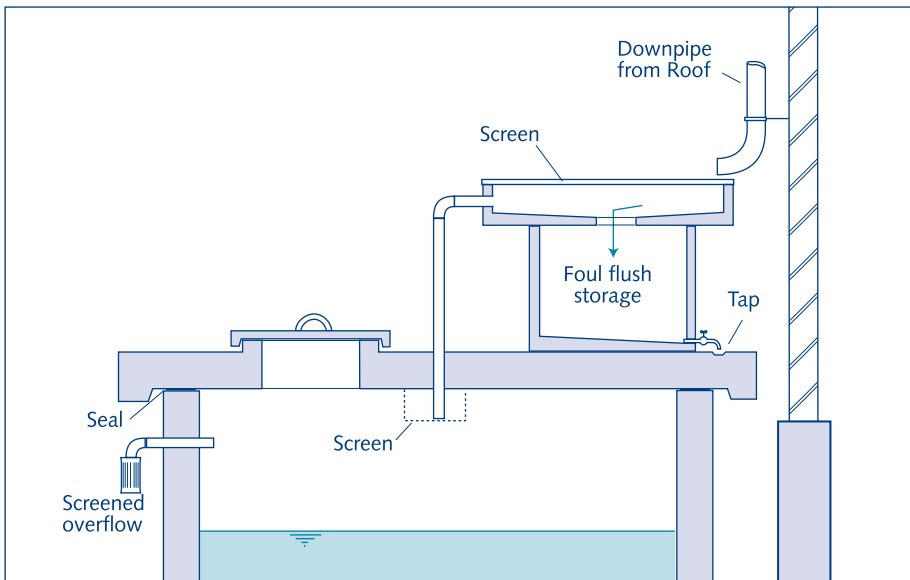


Fig. 7.6. Arrangement for diverting the first foul flush

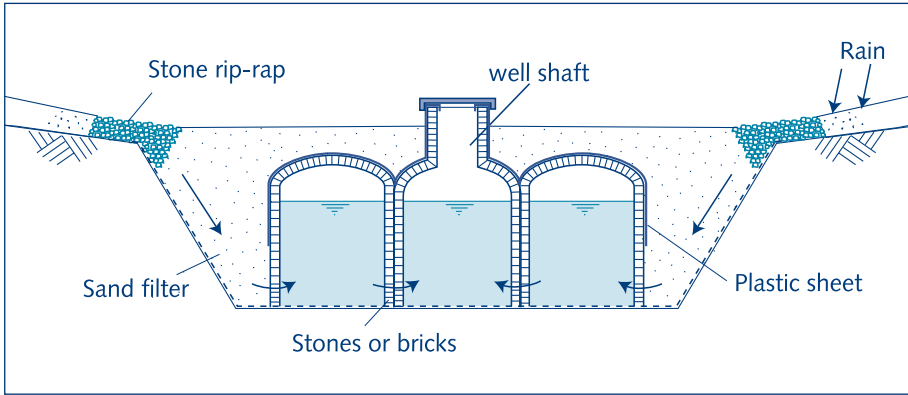


Fig. 7.7. Roof catchment and storage of rainwater (withdrawal by simple handpump)

7.3 Filtration systems and settling tanks

A wide variety of systems are available for treating water before, during and after storage. The level of sophistication also varies from extremely high tech to very simple techniques. An ingenious filter has been developed that fits into a vertical down-pipe and acts as both filter and first flush system.

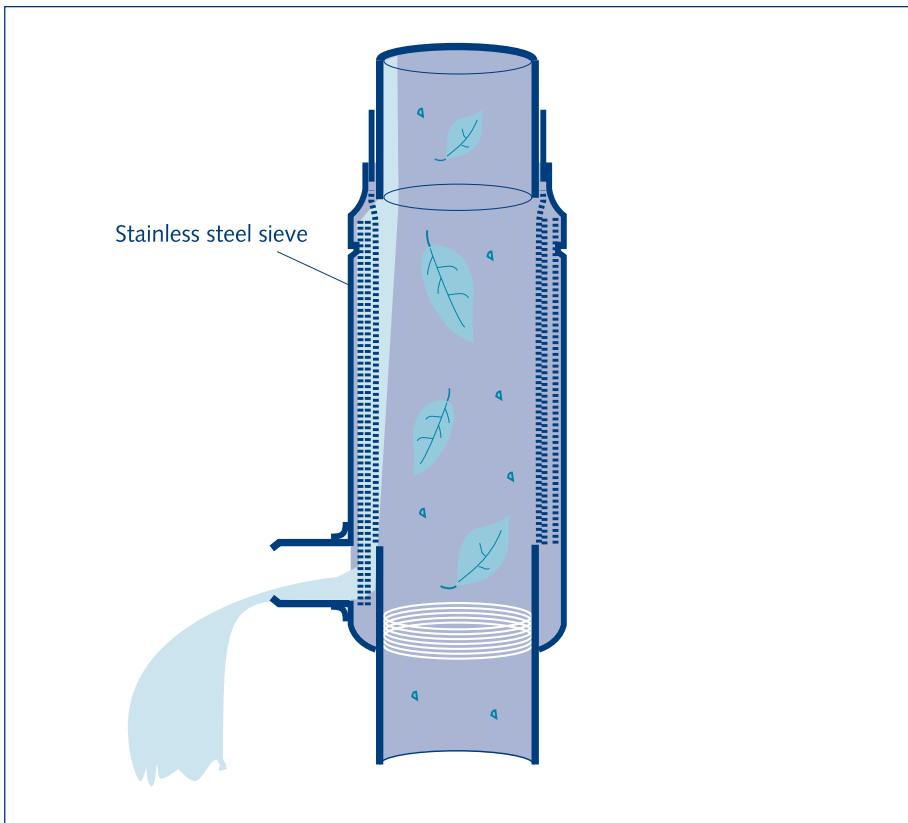


Fig. 7.8. Rainwater filter system built in down-pipe (Adapted from WISY-Catalogue, Frankfurt, Germany)

Filtration systems using sand, stone, gravel or charcoal or a combination of these as filter material filter are often used for filtering rainwater entering a tank. This type of filter is only useful where the inflow is slow, otherwise the system can overflow.

Settling tanks and partitions can be used to remove silt and other suspended solids from water. These are effective but add significant additional cost.

7.4 Storage provisions

The storage tank is usually the biggest capital investment element of a rainwater harvesting system for domestic water. It therefore requires the most careful design to provide optimal storage capacity while keeping the cost as low as possible.

There are an almost unlimited number of options for storing water. For small storage capacities in many developing countries you will find plastic bowls and buckets, jerry cans, clay or ceramic jars, cement jars, and old oil drums. For storing larger quantities of water, the system will usually require a tank or a cistern. Storage tanks are classified as (i) above-ground storage tanks and (ii) cisterns or underground storage vessels. These facilities can vary in size from one cubic metre to up to hundreds of cubic metres for large projects.

The shapes also vary: cylindrical, spherical, square, rectangular or a combination of them. The choice of materials, size and shape, of tank or cistern varies widely depending on locally available materials and technical and economic considerations.

Whichever type of storage is selected, adequate enclosure should be provided to prevent any contamination from humans or animals, leaves, dust or other pollutants entering the storage container. A tight cover should ensure dark storage conditions so as to prevent growth of algae and breeding of mosquito larvae. Open containers or storage ponds are generally unsuitable as sources of drinking water.

Below-ground storage facilities have the general advantage of being cool, and they will suffer practically no loss of water through evaporation. Provided that certain soil conditions are satisfied, underground storage tanks are substantially cheaper than above-ground tanks. There can also be a further saving in space and cost of construction where the container is moulded directly in the ground by simply compacting the earth. An example - shown in figure 7.9 - is feasible if the soil is soft, stable and fairly permeable.

In many African countries semi-spherical underground water tanks have been constructed. In this case a roofing material becomes necessary to control evaporation.

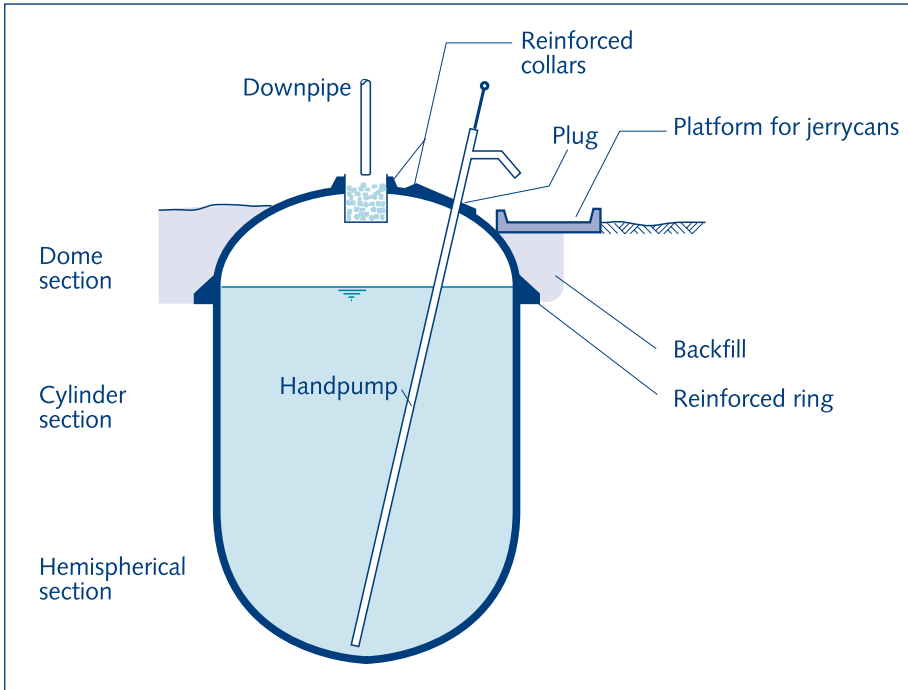


Fig. 7.9. Simple underground rainwater storage well (Adapted from Development Technology Unit, School of Engineering, University of Warwick <http://www.eng.warwick.ac.uk/DTU/pubs/wp/wp49/index.html>)

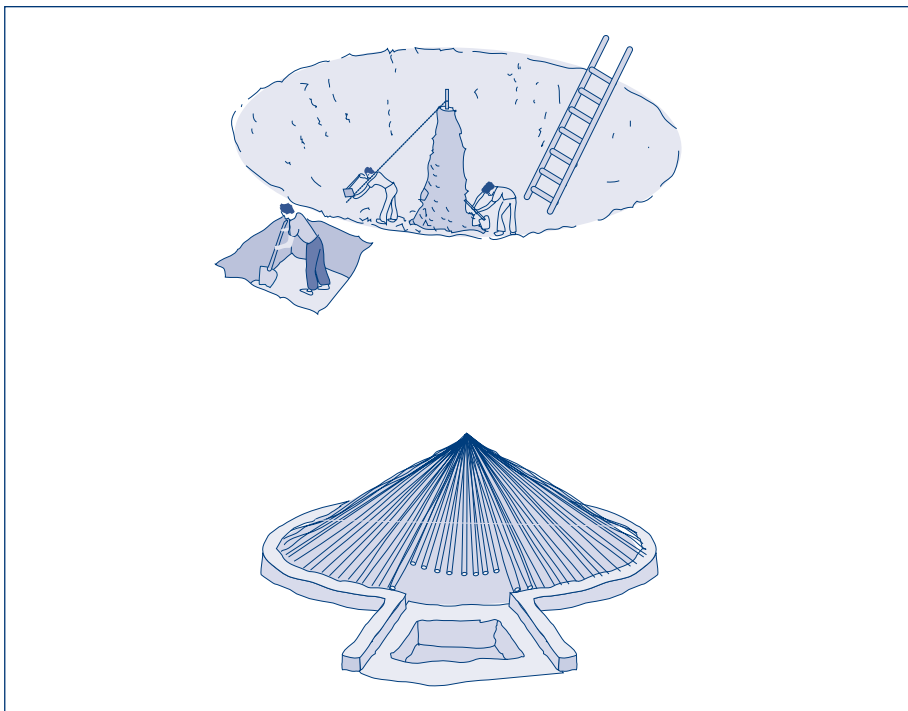


Fig. 7.10. Semi-spherical underground water tank (Adapted from UNICEF, 1986)

Materials used for storage tanks

Galvanised iron sheets were used until plastic technology came onto the market in the early 1990s. The plastic tanks have solved one major problem experienced in corrugated iron tanks, which is the rusting of the tank causing it to leak. This problem usually occurs within 3-5 years, if the tank is not cleaned after every season, or at least once a year. Other common construction materials are masonry, reinforced concrete and ferro-cement.

For larger storage volumes, tanks or cisterns constructed of brick or stone masonry are used most. Typically the walls are cylindrical and bonded by cement mix. Where large storage volumes are built, and certainly for tank heights exceeding 2 m, reinforcement along the outside edges becomes necessary. This can be conveniently provided by means of one or more tightened steel bands around the outer circumference of the tank. Placing some suitable cover (e.g. galvanised iron sheets) over a supporting framework commonly provides the roofing of this type of tank.

Increasingly popular are ferro-cement tanks in which wire is used for the reinforcement of walls and bottom that are formed by plastering cement. Such tanks are quite economical although competition comes from the plastics. The most common tank size range is between 1000 and 5000 litres. Although ferro-cement tanks are technically feasible up to 100 m³, most have a volume less than 12 m³. The construction of ferro-cement tanks requires good skills for the correct application of the reinforcement (weld mesh, chicken mesh and galvanised wire) and the correct mixing and application of the cement mortar. Cracks are easily repaired with mortar, and leaks are sealed by applying sealant on the inside of the tank.

There are a number of reasons why these materials are preferred over plastics or galvanised iron. Benefits accrue from the way building a tank is organised. Plastic tanks have to be brought from outside the village, and so local labour is minimal. With ferro-cement tanks, although the cement and reinforcement come from outside, the labour is local and benefits the village economy. Women's groups in the rural areas participate much more in a ferro-cement tank than they do in a plastic one. Future maintenance of the ferro-cement tanks can also be carried out in the village, unlike repair of a leaking plastic tank.

In some areas, like Kenya, plastic tanks cost twice as much as the ferro-cement tank per cubic metre capacity. Ferro-cement rainwater jars of 2500 litres have been very popular in Thailand and Myanmar, where millions of these tanks have been constructed. A ferro-cement jar and cistern are shown in figure 7.11. Detailed technical information on storage tanks and simple lifting devices is available from the Development Technology Unit, Warwick University (see web sites).

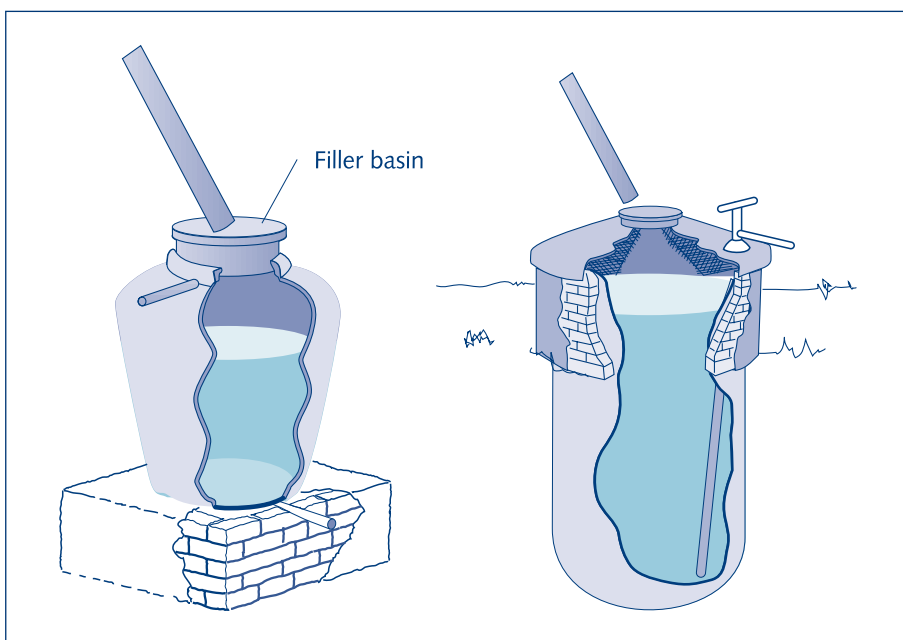


Fig. 711. (a) Ferro-cement jar and (b) partially underground tank
 (Adapted from: *Ferro-Cement Jar (TR-RWH06) and Partially Below Ground tank (TR-RWH01)*
 Development Technology Unit, School of Engineering, University of Warwick)

Sand dams and subsurface dams

Although sand dams and subsurface dams are mainly used for retaining groundwater flow, they are mentioned here because the water often comes from rainwater run-off. In the case of a subsurface dam, the water in the river is trapped in the sand riverbed by an underground dyke (constructed of clay, masonry or concrete). In the case of a sand dam, a low dam is built across the river (often on hard formations). The dam blocks the flow of sand (and water). The height of the sand dam can be gradually increased over the years, and more sand (and water) is retained by the sand dam. The retained water in the sand body can be collected through wells or other collection systems. More details are given in chapter 6 on artificial recharge.

Gender aspects

In many places, such as Kenya in East Africa, Kerala in India and the Fiji islands, women's groups or cooperatives construct rainwater tanks. The technology builds on women's tasks and skills in plastering and their gender needs for a nearby source of high quality drinking water. Culturally, it is also often more acceptable that women masons construct rainwater tanks in compounds when the men in the households are away during the day.

7.5 Sizing a rainwater harvesting system

Usually the main calculation when designing a water harvesting system will be to size the water tank, cistern, or subsurface dam correctly to give adequate storage capacity. The storage requirement will be determined by a number of interrelated factors. They include:

- Local rainfall data and weather patterns
- Collection surface (roof or ground) or size of reservoir possible in case of a subsurface dam
- Run-off coefficient (varies from 0.15-0.9 depending on collection surface and slope)
- User numbers and consumption rates or water needs for other uses including productive use

The following are additional rainwater harvesting features that also affect tank sizing:

- Where users are able and willing to adjust their consumption downwards during dry seasons or when they find water levels in the tank lower than average, tank size can be reduced
- Partial rainwater harvesting systems, either where it is accepted that rainwater will not meet all needs throughout the year or where rainwater is only used to meet specific water needs like cooking/drinking
- The reliability of the alternative used where the tank runs dry

Estimating domestic water demand

Estimating household annual water demand simply means multiplying mean daily water use per person by the number of household members and by 365 days. Because of the scarcity of water, people in arid and semi-arid regions usually consume very little water, far less than the official design figures of about 40 lcd. The daily water use differs by season, being less in the cooler periods than in the warmer seasons. Water consumption also depends on the availability of water. Provision of better water supply, including easier access and more water of better quality, is likely to raise the consumption per capita. Therefore, having water in a tank next to the house will increase the consumption, particularly during the rainy season when the tank will be filled up again. The current household water consumption is best assessed by a survey among households. The survey needs to include different water uses, including productive uses.

Determination of the capacity of the storage tank and the surface of the catchment

The required storage capacity depends on many factors, including domestic water demand and its seasonal variation; availability of other (seasonal) water sources (and distance, quantity and quality); characteristics of the dry season(s) (e.g. distinctive short periods without any rain); rainfall characteristics (total rainfall and intensity); and availability of catchment area, type of catchment and roofing/surface material used.

The simplest method to calculate the required water volume is to use the following formula:

$$V = (t \times n \times q)$$

Where:

V = volume of tank

t = number of days in the dry period

n = number of people using the tank

q = total average consumption per capita per day (including for productive use)

To be on the safe side, a 20% increase of tank volume is suggested.

If there are no reliable monthly rainfall data, the tank volume can be established by assuming that the tank will be full at the start of the dry season and only has to satisfy the water needs for the dry period.

The required roof catchment can be calculated from the expected annual water demand to be met by rainwater (including for productive use but also considering other water sources).

Annual consumption is $Q_a = n \times q \times 365$

Required roof catchment is $A = Q_a / (C_r \times p)$

where:

C_r = run-off coefficient

p = annual precipitation

Another simple method that can be used to estimate the most appropriate storage tank capacity for maximising supply is to represent roof run-off and daily water consumption graphically. (Gould and Nissen-Petersen, 1999). This method will give a reasonable estimation of the storage requirement, but daily or weekly data should be used for a more accurate assessment, especially for climates with year-round rainfall.

Other methods are mass curve analysis, statistical methods and computer-based methods. They all need accurate rainfall data. Rainwater catchment models need reliable data otherwise the results from the model (e.g. from computer-based methods) are unreliable. But if correctly applied, computer-based models may give optimum cost-effective designs (see relevant web sites listed at the end of the chapter).

7.6 Health and water quality

Health benefits

Rainwater harvesting has several benefits for family health:

- Women and other drawers of water spend less time collecting water and so save time for household tasks, income-generating activities, and rest, all of which have health benefits for them and for the whole family
- Fewer accidents to unattended infants because water is available at the home yard
- Better nutritional status of the family because saved time can go to keeping a vegetable garden (also using the stored rainwater if there is enough)
- Fewer female and child back injuries resulting from long and steep journeys with heavy water loads
- Health benefits arising from use of more water, and clean and safe water
- More water available for productive use that has an effect on the general well-being of the family, including health

Quality concerns

There have been concerns that rain may pick up unhealthy substances whilst falling through the atmosphere, running down a roof or whilst resting in a storage tank. The probability of finding truly airborne indigestible pathogenic viruses or bacteria seems low and of finding larger airborne pathogens negligible. Interest therefore focuses mainly upon contamination from roofs and the influence of water storage on reducing or increasing pathogens.

Contamination of water might arise from the roofing material itself or from substances that have accumulated on a roof or in a gutter. Roof paints including bitumen may entail some risk to health and/or may impart an unpleasant taste to roof water and should be avoided. Not surprisingly the safety of water harvested from “asbestos” (asbestos-reinforced cement mortar) roofs has been queried, but the consensus is that the danger of developing cancer from ingested asbestos is very slight (Campbell, 1993). The danger from inhaled asbestos dust is, however, so high that working with asbestos sheeting, for example sawing it, without special protection is now generally banned in industrialised countries. The iron in a rusting roof will also enter the run-off, but in such small quantities that it does not prejudice either health or taste.

Metal roofs are comparatively smooth and are therefore less prone to contamination by dust, leaves, bird droppings, and other debris than rougher tile roofs. They may also get hot enough to sterilise themselves. However, contamination may be substantial on all roof types and it has been common for many years to design *first-flush diverts* into rainwater harvesting systems. During a dry spell, debris builds up on roofs, so that the initial run-off during the first following rainfall can be full of sediment and highly turbid.

Overhanging trees make this sediment problem worse, as well as increasing the likelihood of bird and rodent droppings. A common strategy therefore is to divert to waste the first, say, 20 litres of run-off at the beginning of each rainfall. This can be done automatically using appropriate devices, of which some are commercially available (see section 7.2 and 7.3). Where the rainy seasons are well defined, it can be done manually by temporarily displacing the down-pipe. If this first flush is excluded, rainwater gives modest levels of turbidity and typically medium levels of bacterial contamination (e.g. <10 FC per 100 ml). Modern “no-maintenance” separators, or more traditional screens, cloth or sand filters will reduce turbidity and contamination further and any good tank design will reduce it further still.

7.7 Integrated and holistic nature of rainwater harvesting

Watershed approach

Run-off arising from uncontrolled rainwater is the greatest agent of soil erosion, which subsequently gives rise to other forms of land degradation. This is especially so in arid and semi-arid lands where the rainfall is erratic and the soil fragile. In order to sustain the productive natural resource base of the areas concerned, controlling and conserving water from run-off must conserve the environment. The amount of water resulting from rain on a bare soil is about 50% of the rainfall. Water harvesting therefore serves the dual purpose of preserving the environment and providing water which can also be used for productive purposes.

Groundwater recharge

Properly managed rainwater is essential for groundwater recharge. Good soil and water conservation and agro-forestry practices facilitate infiltration of rainwater to recharge groundwater. The upper ten metres or so of groundwater is shallow groundwater and is the main source of water for trees, hand-dug wells, subsurface dams and shallow boreholes. More details can be found in chapter 6, “Artificial recharge”.

Other activities related to rainwater harvesting

Run-off farming, micro-irrigation and flood diversion are methods of putting rainwater to good use whenever it falls or immediately afterwards. All these activities are captured in a new approach to land rehabilitation and people's development called watershed management. See chapter 5, “Integrated Water Resources Management”.

7.8 Conclusions and recommendations

Organisation and development

The main goal of watershed management that includes rainwater catchment is to hold the water where it falls as precipitation, and to protect the land from erosion at the same time. In this way water becomes available for domestic and productive uses with many benefits that significantly contribute to poverty alleviation in rural areas and small towns. For individual households it is often not possible to work on the improvement of their water situation for domestic and productive use. But by grouping in grassroots groups in which members continue to work together and support each other after the NGO or government department has left, initiatives around rainwater catchments become very feasible and sustainable. Hundreds of projects have shown that to be true. But there are certain points, such as leadership, trust, ownership, etc., that need to be seriously addressed. Strong institutional bedding of the community-based organisation and the supporting organisations is needed. More details on a participatory approach are in chapter 2 on planning and management.

Finance

Although the initial capital costs of rainwater harvesting may be high, it yields benefits whose value may exceed the cost of the system. Rainwater harvesting systems are suitable for an incremental approach. If used for income generating activities, the rainwater harvesting system pays back within 2-4 years; returns can be partly re-invested. Nevertheless, small subsidies for rainwater harvesting are cost effective, as they make smaller systems more feasible. Direct funding to community groups is efficient, provided there is an effective and transparent backup system provided by a trusted NGO or consultant. Micro-financing should be considered for small rainwater-based enterprises.

Housing policy

In view of the seriousness of the water and food crisis in both rural and urban areas, governments should seriously consider including domestic rainwater harvesting systems in all new public housing projects and advocating (and subsidising) these systems in private housing. Rainwater harvesting contributes also to a reduced demand from the municipal piped water supply.

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Web sites

Rainwater research and publications: <http://www.eng.warwick.ac.uk/DTU/pubs/rwh.html>

Garnet: <http://www.lboro.ac.uk/departments/cv/wedc/garnet/tncrain.html>

IRCSA (International Rainwater Harvesting Systems Association):
<http://ms2.pccu.edu.tw/~98710704/>

CSE (Centre for Science and Environment): <http://www.cseindia.org/>

Simtanka - free software for simulating performance of rainwater harvesting systems:
<http://www.geocities.com/RainForest/Canopy/4805/>

Discussion groups

Discussion forum on rainwater: <mailto://rwh-request@jiscmail.ac.uk> or
<http://info.lut.ac.uk/departments/cv/wedc/garnet/rwheconf.html>

