Journal of Progress in Civil Engineering ISSN: 2322-0856
DOI: 10.53469/jpce.2025.07(09).05

Rainwater Harvesting Management Systems: A Comprehensive Technical Review

Arti Saxena Oluwatusin[1], Ashok Uppin Chavan[2]

[1]Student, Department of Civil Engineering Alard College of Engineering and Management
oluwatusin232@gmail.com

[2]Professor, Department of Civil Engineering Alard College of Engineering and Management, Marunji Pune, India
chavan1223201@gmail.com

Abstract: ***The lack of proper water supply and sanitation services turns the surroundings into polluted, unhealthy and undignified places to live in and degrades water quality in lakes, rivers and seas. Water management is that the activity of designing , developing, distributing and optimum use of water resources under defined water polices and regulations Water management is very much necessary in future development. The need to improve these services is now recognized as a critical component of poverty, reduction as well as being necessary for progress in health, education, and environmental sustainability. Wastewater treatment, water conservation and hygiene play a vital role in providing healthy living conditions for all in a sustainable way.***

Keywords: management of water treatment of beverage, industrial water, sewage or wastewater, management of water resources, management of flood protection, management of irrigation

1. Introduction

Water is a key element in all growing enterprises. If you are a grower, you probably have over the years developed an impressive patchwork of water systems and solutions. It might be time to sit back and have a good look at that whole water scene from source to nozzle to ditch. Water Management means integrating the parts, addressing bottlenecks, and continuously matching your water resources with your irrigation needs. Smart water management will bring you considerable savings, improved plant quality, lower risk of disease, happier employees and reduced environmental impact.

Basic Facts of water

- 75% of the surface is roofed with water.
- More than 97% of the earth's water is in its oceans.
- Water regulates the Earth's temperature. It also regulates the temperature of physical body, carries nutrients and oxygen to cells, cushions joints, protects organs and tissues, and removes waste.
- Animals which have bllod and plants sap contain mainly water.
- A dripping tap can waste up to six litres of water during a day.
- More than half the living on the Earth are found under water.
- This planet i.e. Earth the life is due to Water.
- Within the summer our bodies require about 2 litres of water daily. Here is that the water content of some foods (approximate) - 95% in tomato, 65% in mango, 95% in watermelon and 87% in pineapple.

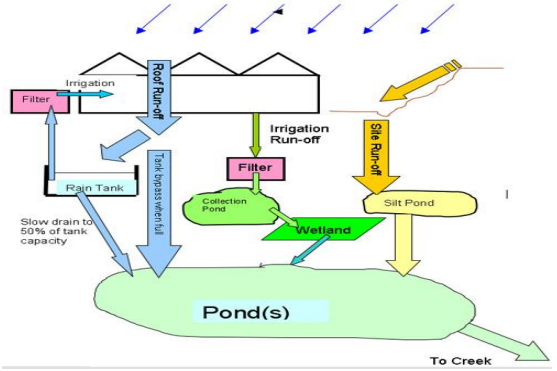
Component	Percentage
Oceans.	97 %
Ice sheets.	1.72%
Fresh water.	2.5 %
Vapour.	0.001 %
Ground water.	0.74 %

Water management plays a key role in the future to ensure the safety of all creature on earth to balance an eco system.

Causes of Water Scarcity

- **Heavy extraction of water from rivers:** Some of the rivers have no river flow left during the summer season as all the water in these rivers is used up for various purposes
- **Heavy extraction of groundwater**: Due to heavy extraction, the ground water table is falling rapidly in many parts of the country.

The diagram below is an actual example of managing run-off from rain and irrigation, with the aim to reduce erosion, creek contamination, and supplying additional irrigation water.



Need for water management

As a 21st century issue, fresh water scarcity is ranked second to Global warming in an international Council for Science survey of environmental experts from more than 50 countries.

The rate of water withdrawal in many large cities is 300 – 600 litres per day in industrially developed countries by the end of the century. By the year 2025, about 2/3 rd of the world's population will face scarcity of water and the problem may become aggravated in Afro-Asian countries.

In 1985, there were 750 villages with no water sources and in 1996, the number increased to 65,000.

From the birth of our planet the quantum of water available is unchanged till this day. But due to growing population, rapid rate of urbanization, growing agricultural needs, concretization etc, the balance of water in the environment gets disturbed. The water scarcity can create serious problems. As per recent surveys, it is apparent that future causes of wars will be water availability. Also, excessive tapping of ground water through numerous bore wells and tube wells has led to a decline of the water table.

Water conservation can be done by having good leak detection facility, repairing visible as well as underground leaks in time, recycling of sewer water, levying heavy penalty for wastage.

There are many ways of saving day-to-day used water by adopting the water saving gadgets and good saving habits. The young generation shall be properly trained form schooldays to realize the value of this precious resource. All over the world, the scientists are involved in research on the possibilities of getting fresh water by artificial means such as cloud seeding and desalination of sea water, spending millions of dollars. On the other hand, rainwater harvesting is the most cost effective and efficient way of water management.

Types of Water Management

1) Rural rainwater harvesting system.
2) Urban rainwater harvesting system

Rural rainwater harvesting:-

India is today facing a huge water crisis. Water sources are rendered unfit for use due to pollution and overexploitation. Large number of villages fined it difficult to get clean drinking water.

Different methods for Rural water harvesting:-

It is heartening to ascertain the revival of traditional water harvesting systems in various ecological zones of India. Communities within the face of adversity have revived or created new water harvesting systems. They have made check dams and other structures to harvest every drop of drain. Some of them have even harvested outer surface of roof runoffs. In many places these efforts have withstood the consequences of recurring drought.

These are the methods for Rural water harvesting:

1) Paar system
2) Saza kuwa
3) Rapat
4) Kunds / Kundis

Urban Rainwater Harvesting:

- Catchments
- Gutters.
- Conduits
- First flushing
- Filter
- Storage facility

Paar system

Paar is a common water harvesting practice in the western Rajasthan region. It is a common place where the rainwater flows from the agar (catchment) and in the process percolates into the sandy soil. In order to access the rajani pani (percolated water) kuis or beris are dug in the agor (storage area). Kuis or beris are normally 5 meters (m) to 12 m deep. The structure was constructed through traditional masonary technology. Normally six to ten of them are constructed in a paar. However depending on the size of the paar the numbers of kuis or beris are decided. Bhatti mentions that there are paars in Jaisalmer district where there are more than 20 kuis are in operation. This is the most predominant form of rainwater harvesting in the region. Rainwater harvested through PAAR technique is known as Patali paani.

Saza Kuva

An open well with multiple owners (saza = partner), saza kuva is the most important source of irrigation in the Aravalli hills in Mewar, eastern Rajasthan. The soil dug out to make the well pit is used to construct a huge circular foundation or an elevated platform sloping away from the well. The first is built to accomodate the rehat, a traditional water lifting device; the sloping platform is for the chada, in which buffaloes are used to lift water.

Saza kuva construction is generally taken up by a group of farmers with adjacent landholdings; a harva, a man with special skills in groundwater detection, helps fix the site.

Rapat

A rapat is a percolation tank, with a bund to impound rainwater flowing through a watershed and a waste weir to dispose of the surplus flow. If the height of the structure is small, the bund may be built of masonary, otherwise earth is used. Rajasthan rapats, being small, are all masonry structures. Rapats and percolation tanks do not directly irrigate land, but recharges well within a distance of 3-5 km downstream. Silting is a serious problem with small rapats and the estimated life of a rapat varies from 5 to 20 years.

Kunds / Kundis

A kund or kundi looks like an upturned cup nestling in a saucer. These structures harvest rainwater for drinking, and dot the sandier tracts of the Thar Desert in western Rajasthan and some areas in Gujarat.

Essentially a circular underground well, kunds have a saucer-shaped catchment area that gently slopes towards the centre where the well is situated. A wire mesh across water-inlets prevents debris from falling into the well-pit. The sides of the well-pit are covered with (disinfectant) lime and ash. Most pits have a dome-shaped cover, or at least a lid, to protect the water. If need be, water can be drawn out with a bucket. The depth and diameter of kunds depend on their use (drinking, or domestic water requirements). They can be owned by only those with money to invest and land to construct it. Thus for the poor, large public kunds have to be built.

Urban rainwater harvesting system:-

The components of a typical urban rainwater harvesting system are as follows: -

- **Catchments:** - It is the surface that directly receives the rainfall and provides water to the system. It can be in the form of a terrace or a lawn or open ground. A roof made up of reinforced cement concrete (RCC), galvanized iron or corrugated sheets can also be used for rainwater harvesting.
- **Gutters:** The channels around the edge of a sloping roof are called as gutters. The main functions of gutters are to collect and transport rainwater to the storage tank. Gutters can be in semi – circular or rectangular in shape. It could be made either using galvanized iron sheets or PVC material. The size of the gutter should be according to flow during the highest intensity rain. It is advisable to make them 10 to 15 % oversize. It is important to support the gutters so as to prevent them from falling off due to water load.
- **Conduits:** These are the pipelines or drains used to carry rainwater from the catchment area to the storage tanks. Polyvinyl chloride (PVC) and galvanized iron are the common material used to prepare the conduits.
- **First flushing:** A first flush device is a valve that ensures that runoff from the first spell of rain is flushed out and do not enter the system. The first spell of rain carries large amount of pollutants from the air and catchment area and hence first flushing is very essential.
- **Filter:** The filter is used to remove suspended matter present in the rainwater. 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 recharges structure. Charcoal can be added for additional filtration. When rainwater is harvested in a large rooftop area, the filtering system consists of 3 concentric circular chambers in which the outer chamber is filled with sand, the middle one with coarse aggregate and inner most layer with pebbles.
- **Storage facility:** The shape of these tanks can be cylindrical, rectangular or square. Commonly used material of construction includes reinforced cement concrete (RCC), plastic and metal sheets. Depending upon the availability of space, these tanks could be constructed above ground, partly underground or fully underground.

Maintenance Tips for Rainwater harvesting structures

1) Always keep the surroundings of the tank clean and hygienic.
2) Remove Algae from the roof tiles and asbestos sheets before the monsoon.
3) Drain the tank completely and clean from inside thoroughly before the monsoon
4) Clean the water channels (gutters) often during rainy season and definitely before the first monsoon rain
5) Avoid first 15 or 20 minutes of rainfall depending on the intensity of rain. Use the first flush arrangement to drain off this first rainwater.
6) Change the filter media every rainy season
7) Cover all inlet and outlet pipes with closely knit nylon net or fine cloth or cap during non-rainy season to avoid entry of insects, worms and mosquitoes.
8) Withdraw water from the system at the rate of 5 liters/head/day. This will ensure availability of water throughout the water scarcity period.
9) Leakage of cracks in the ferrocement storage tank shall be immediately attended to by cement plastering. This will avoid major repairs due to the propagation of cracks.
10) Heavy loads should not be applied on the lid; particularly many people should not stand on the lid.
11) Water should not be allowed to stagnate in the collection pit.
12) The tap should have lock system so that pilferage or waste of water is avoided.
13) The filter materials shall be washed thoroughly before replacing in the filter bucket
14) The coconut coir in the filter unit definitely needs regular replacement in rainy season, because, in wet conditions it rots and spoils water quality.
15) In coastal areas, the tank may be painted outside by corrosion resistant paint once in 3 years and in other areas lime (Calcium Carbonate) based white wash may be applied not only for beauty but also for cleanliness.

2. Conclusion

On this 21st century the population is increasing day to day because this demand of water is increasing. The ground water level is decreases. Hence water management is necessary.

By management of water, ground water level increases. This makes water available for further used. This water is used for drinking purpose after several filtrations.

Rain water harvesting increases the ground water table. Rain water harvesting is an effective economical concept for recharge of ground water.

References

[1] Samaha J., Kayassi., Achkar.,R.Azar 2000 (Book of water management)
[2] www.indiaenvironment Portal.org.in
[3] www.dewindia.org.in
[4] UEMHomepage
[5] *Hari Srinivas - hsrinivas@gdrc.org*
[6] Awulachew, S.B., Lemperiere, P. & Tulu, T. (2009): Training manual on agricultural water management
[7] Water- depletion and pollution, Millennium Report 2003 is the International Year of Freshwater