Module: 7	Demand Management	

Balancing supply and demand-Economic theory of supply and demand-management by use of tariffs-Timing, long- term, operational time-frame-Crisis management-Cost of water-Future trends-Economic value of water-Loss control- Water harvesting.

Rain Harvesting

Rain Harvesting

The availability of water on Earth is theoretically sufficient to meet the needs of its population. However, the challenges lie in the distribution of water in terms of space, time, and affordability.

Annual global river runoff = 40,000 km^3

Annual global domestic use = 200 km^3

Annual global industry use = 2000 km^3

Annual global agriculture use = 4000 km^3

Rain Harvesting

- Rainwater harvesting (RWH): technology used for collecting and storing rainwater for human use from rooftops, land surfaces or catchments.
- One of the world's most important ancient water supply techniques (practiced for more than 4,000 years), is beginning to enjoy a resurgence in popularity.
- Rainwater is an important water source in many areas with significant rainfall but lacking any kind of conventional, centralised supply system.
- Rainwater is also a good option in areas where good quality fresh surface water or groundwater is lacking.
- It could be used as a supplement to piped water supply e.g. for toilet flushing, washing and garden spraying
- RWH is a decentralised, environmentally sound solution, which can avoid many environmental problems often caused in centralised conventional large-scale water supply projects.

Basic Components of RWH

1. Rainfall
2. Collection of water from surface catchment
3. Water storage or Groundwater Recharge
4. Distribution of water

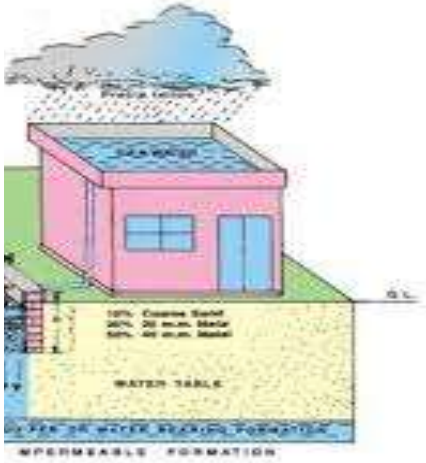
Rain Harvesting : Storage

1. Store in tanks, sums, reservoir, pond, check dam, lake, etc
2. Recharge the under groundwater

Rainwater Harvesting - Techniques

1. Capturing runoff from rooftops – Roof water harvest
2. Capturing runoff from local catchments – Land harvest
3. Capturing seasonal rain waters from local streams
4. Conserving rain water through watershed management

Capturing runoff from rooftops



Gutter

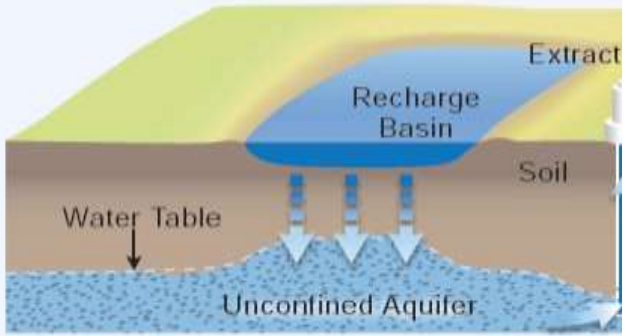
Downspout

Capturing runoff from rooftops

This method of rainwater harvesting involves collecting rainwater directly from rooftops, which serve as the catchment area.

1) **Catchment area (roof)**: decide which portion of your roof will collect rainwater. Ensure the roof material is suitable for harvesting (avoid asbestos & painting in roofs).
2) **Gutters and downspouts**: install gutters along the edges of the roof to collect water and direct it to downspouts.
3) **Filters and screens**: use mesh screens to prevent debris from entering the storage tank. Install a first flush diverter to divert initial runoff that contains pollutants.
4) **Storage tanks**: Assessing water needs (i.e. demand) and potential collection capacity (i.e. availability) is a crucial step in designing an effective rainwater harvesting system at home. This assessment helps determine the necessary storage capacity for harvested water.

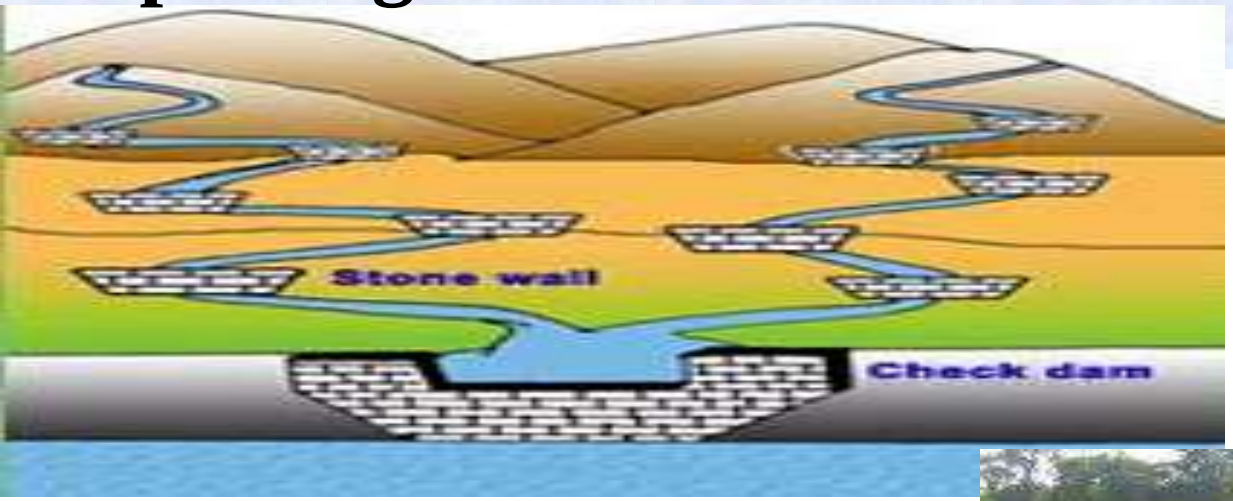
Capturing runoff from local catchments – Land harvest



Capturing runoff from local catchments – Land harvest

Capturing runoff from local catchments involves various methods to collect and manage rainwater from various surfaces like roads, parking lots, and open land before it enters larger water systems. Techniques include constructing retention ponds, installing vegetated ditches, building rain gardens, and implementing permeable pavement. These approaches help mitigate flooding, improve water quality, and enhance groundwater recharge in urban and suburban areas.

Capturing seasonal floodwaters from local streams



Check Dam

Capturing seasonal rain waters from local streams

- Capturing seasonal rainwaters from local streams with check dams involves strategically placing low, temporary barriers across the stream channel to slow down water flow and allow sediment deposition.
- Diverting water into floodplain areas or using detention basins or ponds helps absorb floodwaters by providing temporary storage and allowing gradual release.
- These techniques technique helps retain water during floods, reducing downstream erosion and providing opportunities for groundwater recharge and soil moisture retention.

Conserving rain water through watershed management

Conserving water through watershed management

- Conserving rainwater through watershed management via dams and reservoirs involves capturing and storing excess rainfall for later use.
- Dams are built across rivers to create reservoirs, which store water during rainy seasons and release it gradually during dry periods.
- This stored water serves various purposes, including irrigation, drinking water supply, flood control, hydropower generation, and recreation. By strategically managing water resources in this way, communities can enhance water security, mitigate floods, and support sustainable development.
- Shortcomings in this approach include large submergence of land, environmental disruption, social displacement, siltation reducing storage capacity, water allocation conflicts, vulnerability to climate change, high construction coast, and operational complexities.

Advantages of implementing rain-water harvesting

These techniques can serve the following the following purposes:

Reduced Water Bills: Rainwater harvesting systems are cost-effective, provide high-quality water, lessens dependence on wells and are considerably easy to maintain since they are not utilized for drinking, cooking or other sensitive uses.

Ecological benefit: Storing water underground is environment-friendly. The ecological benefits of rainwater harvesting are immense.

Reduces erosion and flooding around buildings: It reduces soil erosion and flood hazards by collecting rainwater and reducing the flow of storm water to prevent urban flooding.

An adequate means for Irrigation purpose: Harvesting rainwater allows the collection of large amounts of water and mitigates the effects of drought.

Reduces demand on Ground Water: Another vital benefit is that it increases the productivity of aquifer resulting in the rise ofgroundwater levels and reduces the need for potable water

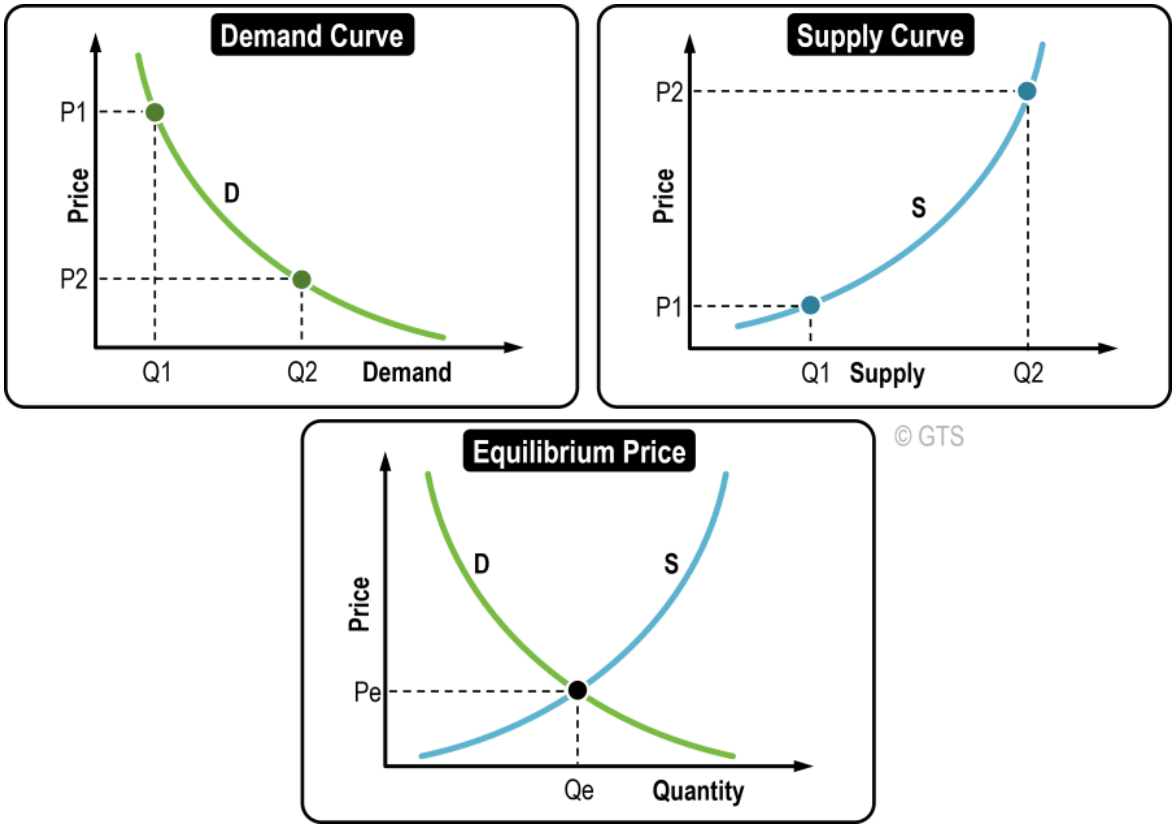
Advantages of implementing rain-water harvesting

- ✓ Provides self-sufficiency to water supply
- ✓ Reduces the cost for pumping of groundwater
- ✓ Provides high quality water, soft and low in minerals
- ✓ Improves the quality of ground water through dilution when recharged
- ✓ Reduces soil erosion in urban areas
- ✓ Rooftop rain water harvesting is less expensive
- ✓ Rainwater harvesting systems are simple which can be adopted by individuals
- ✓ Rooftop rain water harvesting systems are easy to construct, operate and maintain.
- ✓ In hilly terrains, rain water harvesting is preferred
- ✓ In saline or coastal areas, rain water provides good quality water and when recharged to groundwater, it reduces salinity and also helps in maintaining balance between the fresh-saline water interface

Limitations of RWH

- Complex constructions, there is a requirement for high costs, trained professionals.
- Maintenance costs may add to the monetary burden.
- If not maintained properly then it can cause various problems in terms of algal or bacterial growth.
- The water availability is limited by the rainfall intensity and available roof area.
- Mineral-free rainwater has a flat taste, which may not be liked by many.
- The poorer segment of the population may not have a roof suitable for rainwater harvesting.
- Domestic RWH will always remain a supplement and not a complete replacement for city-level piped supply or supply from more ‘reliable’ sources.

Balancing supply and demand by use of tariffs



Balancing supply and demand by use of tariffs

- A fundamental concept in economics is the law of supply and demand. According to the law, as the price of water increases (moving along the supply curve from left to right), producers are willing to supply more water because they can earn higher revenue from each unit sold. This relationship reflects the positive correlation between price and quantity supplied.
- Conversely, as the price of water increases (moving along the demand curve from left to right), consumers' demand for water decreases because higher prices make water more expensive relative to other goods and services. This relationship reflects the inverse correlation between price and quantity demanded.
- With increasing price, the reduction decreases because further reductions may require changes in behavior that are inconvenient or contrary to personal or social norms. And at even higher prices, there will be no reduction at all if it means cutting into essential uses like cooking and waste disposal. At low prices people will buy and use more water, but there is a limit on how much water anyone can use, even if it is free. So again as price falls, demand eventually drops off as well

Balancing supply and demand by use of tariffs

- The point where the supply and demand curves intersect represents the equilibrium price and quantity of water in the market. At this equilibrium point, the quantity of water supplied by producers matches the quantity demanded by consumers, resulting in market equilibrium. Changes in supply or demand conditions can shift the equilibrium point, leading to changes in the equilibrium price and quantity of water exchanged in the market.
- Overall, the law of supply and demand provides insights into the pricing mechanism and allocation of water resources in the market, highlighting the interplay between producers' willingness to supply water at different prices and consumers' willingness to demand water at those prices.

Timing of water tariff establishment

There are three stages during which the tariff for water needs consideration.

a) Long-term (planning and design)
b) Operational time-frame
c) Crisis management

Timing of water tariff establishment

Long-term (planning and design)

Capital Cost Evaluation: Before constructing a water scheme, the primary economic concern is the capital cost of the project. This includes the cost of building dams, conduits, and other infrastructure required for the scheme.

Running Costs Addition: The average running costs of operating the water scheme are added to the discounted capital cost of various alternative schemes. This helps in selecting the most economical option among different alternatives.

Rationing Consideration: If rationing (limiting the amount of water available to consumers) is being considered as an alternative to building larger resource schemes, its economic implications need to be evaluated. This involves assessing the true economic cost to consumers due to water shortfall.

Consumer Economic Cost: The economic cost to consumers due to water shortfall should be taken into account. This goes beyond just the income generated for the water supplier, as consumers may face additional expenses or inconveniences due to water shortages.

Timing of water tariff establishment

Operational time-frame

After a water scheme is commissioned, there's a shift in perspective as day-to-day operations and annual supply rates come into play.

Tariff Revision: With the commissioning of the water scheme, annual supply rates typically change. This may lead to tariff revisions, as the supply rate increases or decreases.

Operational Policy for Reservoirs: An operational policy for reservoirs may be designed to conserve water during droughts or periods of low supply. This policy could involve controlling usage through tariffs, among other measures.

Tariff Structure: The tariff structure may be consumer-oriented or tiered. A consumer-oriented tariff typically charges a fixed rate regardless of usage, while a tiered tariff system charges different rates based on levels of consumption

Timing of water tariff establishment

Crisis management

During a water shortage crisis (i.e. drought), authorities often face the challenge of meeting fixed costs while managing reduced water supply. Here are some crisis management strategies that can be considered. The tariff may have to be increased. Here are some crisis management strategies that can be considered:

Penalties Tariffs: Authorities may impose higher tariffs or penalties on water usage above a certain threshold to discourage excessive consumption during shortages. This approach aims to incentivize water conservation and generate additional revenue to cover fixed costs.

Purchase System: In a free market scenario, consumers could negotiate and purchase different allocations of water among themselves. This system allows for flexibility and efficient allocation of available water resources based on individual needs and preferences.

Timing of water tariff establishment

Crisis management

Shortfall Surcharge: To cover fixed costs despite lower water sales, water authorities may implement a shortfall surcharge by increasing tariffs in proportion to the shortfall in revenue. This ensures that the costs of providing water services are adequately covered, even during periods of reduced consumption.

Each of these strategies has its advantages and challenges. Implementing a combination of approaches, tailored to the specific circumstances and needs of the community, can help authorities effectively manage water shortages while ensuring the financial sustainability of water utilities. Additionally, public communication and stakeholder engagement are essential to garner support for these measures and promote water conservation behaviors among consumers.

Cost of Water

To control use of water by means of tariffs requires estimating the marginal value of water as well as the marginal cost.

- Capital costs
- Operating and maintenance costs
- Quality control, purification, pressure maintenance, supply rate including back-up for droughts.
- Funding of indirect projects such as redistribution of wealth or national improvement in health and economy.
- Deterrents for conserving resources such as a premium to reduce usage of water.
- Components to pay for environmental protection or reclamation.
- Community funding including training.
- Reserves for future expansion and to ensure continuity of supply or jobs.
- To cross-fund, e.g. other department's shortfalls, or redistribution of charges.