WATER RESOURCES MANAGEMENT

SATAVHANA UNIVERSITY

UG SEMESTER VI (UNDER CBCS)

GENERIC ELECTIVE II

(FOR ALL FACULTTIES)

WATER RESOURCES MANAGEMENT

UNIT-I

1. Importance of Natural Resources – Different Types and Resources

2. Significance of Water Resources and their uses

3. Conservation of water and recycling of the water – Global distribution of water

4. Water shed programmes and their management

5. Storing the rain water in tanks and recharging ground water

Unit-II

6. Rain water harvesting in rural areas (*chekdam, trenches* etc.,)

7. Overuse of surface and ground water and control measures.

8. Aims, objectives and implementation of *Mission Bhagiratha* (Telangana Government Drinking water programme)

9. Aims, objectives and implementation of *Mission Kakatiya* (Telangana Government minor irrigation programme)

10. Issues and challenges in Water Resources Management

Unit-I

Introduction:

Water is life sustaining liquid. It is one of the most important natural resources which is essential for the existence of living organisms.

Water is the most widely distributed key resource to meet the basic needs of a growing population, social and economic ambitions, demanding agriculture, expanding urbanization, increasing industrialization and many other causes.

The demands for water is becoming more and more challenging day by day. Hence water in all its forms (solid, liquid and gas) should be harnessed properly.

Water has at least three important physical attributes with a bearing on management:

• Fresh water is vital to sustain life, for which there is no substitute. This means that water has a value to its users.

• Although water is a renewable resource, it is practically speaking finite. The use of water is therefore subtractible, meaning that the use by somebody may preclude the use by somebody else.

• Water is a fugitive resource. It is therefore difficult to assess the (variations in) stock and flow of the resource, and to define the boundaries of the resource, which complicate the planning and monitoring of withdrawals as well as the exclusion of non-members.

Its finite nature confers to it properties of a private good, as it can be privately appropriated and enjoyed.

The fugitive nature of water, and the resulting high costs of exclusion, confers to it properties of a common pool resource.

Water resources management aims to reconcile these various attributes of water. This is obviously not a simple task.

There is growing awareness that comprehensive water resources management is needed, because:

• fresh water resources are limited;

• those limited fresh water resources are becoming more and more polluted, rendering them unfit for human consumption and also unfit to sustain the ecosystem;

• those limited fresh water resources have to be divided amongst the competing needs and demands in a society

• many citizens do not yet have access to sufficient and safe fresh water resources

• techniques used to control water (such as dams and dikes) may often have undesirable consequences on the environment

• there is an intimate relationship between groundwater and surface water, between coastal water and fresh water, etc.

Regulating one system and not the others may not achieve the desired results.

Hence, engineering, economic, social, ecological and legal aspects need to be considered, as well as quantitative and qualitative aspects, and supply and demand. Moreover, also the 'management cycle' (planning, monitoring, operation & maintenance, etc.) needs to be consistent

Institutional aspects of Integrated Water Resources Management

The growing complexity of water management inspires a need for management at the lowest appropriate level, resulting in central government delegating functions to the decentralised organisational (regulatory) and operational levels. In general, the organizational level may have a mandate over a river basin, while at the operational level concessions may have been delegated to sub-catchment areas or to user groups (municipalities, irrigation districts).

Thus, in managing the resource, a functional differentiation is made between constitutional issues organizational issues and operational issues

These issues will then be handled at three different levels:

• **Constitutional level**: In this Level the activities being governed by conventions of international organisation, bilateral or multilateral treaties and agreements, the national constitution, national legislation or national policy plans.

• **Organisational level:** In this Level activities at this level are governed by state regulation, ministerial regulation, functional public body regulation or plan, provincial regulation or plan.

• **Operational level:** In this Level activities being governed by sub catchment-, district-, town regulations, bye-laws of semi-public or private water users organisations etc.

Water Allocation Principles

An important purpose of water management is to match or balance the demand for water with its availability, through suitable water allocation arrangements. Water availability is dealt with in other courses (e.g. Hydrology).

There are a large number of types of water use. Among these are:

- Hydropower
- Irrigation
- Domestic use in urban centres
- Domestic use in rural areas
- Livestock
- Industrial use
- Commercial use
- Institutions (e.g. schools, hospitals etc.)
- Cooling (e.g. for thermal power generation)
- Waste and wastewater disposal
- Navigation
- Recreation
- Fisheries
- The environment (wildlife, nature conservation etc.)

Demand for water is the amount of water required at a certain point. The use of water refers to the actual amount reached at that point.

We can distinguish withdrawal uses and non-withdrawal (such as navigation, recreation, waste water disposal by dilution) uses; as well as consumptive and non-consumptive uses. Consumptive use is the portion of the water withdrawn that is no longer available for further use because of evaporation, transpiration, incorporation in manufactured products and crops, use by human beings and livestock, or pollution.

The terms “consumption”, “use” and “demand” are often confused. The amount of water actually reaching the point where it is required will often differ from the amount required. Only a portion of the water used is actually consumed, i.e. lost from the water resource system.

Balancing demand and supply

There are various ways how to allocate water. The challenge is to find an optimal allocation that, firstly, adheres to laid-down legal and other regulations, and secondly, satisfies the water demand of all users as much as possible. Or, "to balance properly between a whole set of obligations: to international conventions, to human basic rights for well-being of both upstream and downstream societies, for protection of land productivity, for delivery of ecological goods and services from both terrestrial and aquatic ecosystems, and for resilience of ecosystems to both natural and man-made disturbances."

Natural Resources:

Natural resources refer to the things that exist freely in nature for human use and don’t necessarily need the action of mankind for their generation or production. The key aspect of natural resources is that they dictate the survival of humans and other life forms on earth. These resources include land, rocks, forests (vegetation), water (ocean, lakes, streams, seas, and rivers), fossil fuel, animals (fish, wild life, and domesticated animals), minerals, sunlight and air.

Some examples of natural resources are:

1. Air which provides wind energy
2. Coal which act as an input for electricity
3. Forests which provide paper, wood and various medicines
4. Water which is used for drinking and production of hydroelectric energy
5. Sunlight that is used for drying clothes, photosynthesis and solar energy.

They are known as Natural Resources because they provide for the basis of life on earth. It is from the natural resources that humans obtain and produce the components and materials found within our environments. Every artificial product is made from the natural resources. The materials may be used as they occur naturally or may be transformed in other forms.

However, most natural resources are prone to depletion and degradation which has brought about worldwide concerns for their sustainable usage and management. Still, there are other very few resources that are regarded to be inexhaustible such as sunlight and geothermal energy. Air is also inexhaustible but it has to be free from pollution. Natural resources are categorized in various categories as outlined and discussed below.

Wikipedia defines *Natural Resources* as,

"Natural resources are resources that exist without the actions of humankind. This includes all valued characteristics such as magnetic, gravitational, and electrical properties and forces. On earth we include sunlight, atmosphere, water, land, air (includes all minerals) along with all vegetation and animal life that naturally subsists upon or within the heretofore identified characteristics and substances."

Types of Natural Resources

1. *Renewable and Non-renewable Natural Resources*
2. *Biotic and Abiotic Natural Resources*
3. *Stock Natural Resources*

1. Renewable and Non-renewable Natural Resources

a. Renewable natural resources

Renewable resources are the ones that are consistently available regardless of their use. They can be fairly recovered or replaced after utilization. Examples include vegetation, water, and air. Animals can also be categorized as renewable resources because they can be reared and bred to reproduce offspring to substitute the older animals.

As much as these resources are renewable, it may take tens to hundreds of years to replace them. The renewable raw materials that come from living things namely animals and trees are termed as organic renewable resources while those that come from non-living things such as sun, water and wind are termed as inorganic renewable resources.

b. Non-renewable natural resources

Non-renewable resources are the ones that cannot simply be substituted or recovered once they have been utilized or destroyed. Examples of such natural resources include fossil fuels and minerals. Minerals are categorized as non-renewable because, even though they take shape naturally through the rock cycle, their formation periods take thousands of years. Some animals mostly the endangered species are similarly regarded as non-renewable because they are at the verge of extinction.

It brings about the many reasons the endangered species have to be protected by all means. The non-renewable materials that come from living things such as fossil fuels are known as organic non-renewable resources while those that come from non-living things such as rocks and soil are referred to as inorganic non-renewable resources.

2. Biotic and Abiotic Natural Resources

a. Biotic natural resources

The Biotic natural resources are the ones that come from the ecosphere (organic and living materials). These include resources such as animals, forests (vegetation), and other materials obtainable from them. Fossil fuels such as petroleum, oil, and coal are also included in this grouping because they are generated from decayed organic matter.

b. Abiotic natural resources

The abiotic natural resources are the ones that come from non-organic and non-living materials. Examples of abiotic natural resources are water, land, air and heavy metals like iron, copper, silver, gold, and so on.

3. Stock Natural Resources

Stock natural resources are those that are present in the environment but t the necessary expertise or technology to have them exploited. Hydrogen is an example of a stock natural resource.

Threats to Natural Resources

1. Overpopulation Which Brings About Over-exploitation

As the human population keeps on enlarging, there is a lot of pressure on the utilization of almost all natural resources. This often causes over-exploitation of the natural resources. To worsen matters, exhaustible natural resources such as arable land, coral reefs, fresh water, fossil fuels, and wilderness forests drop sharply due to over-exploitation to sustain the ever increasing population. This creates competitive demands on the vital life-sustaining resources and contributes to an incredible decline in the quality of life.

According to a study by the UNEP Global Environment Outlook, excessive human consumption of the naturally occurring non-renewable resources can outstrip available resources in the near future and remarkably depletes them for future generations. Overpopulation typically heightens the demands of natural resources such as food, timber, fish, clothes, leather, natural gas, electrical equipment and so on.

2. **Intensive Agricultural and Farming Practices**

Intensive agricultural practices have claimed much space of the natural resources because farmers resort to converting forests and grasslands to croplands. In the modern world, the pressure to convert lands into resource areas for producing priced foods, crops, and livestock rearing has increasingly led to the depreciation of natural resources especially forests, wild life and fertile lands. Runoff of agricultural waste, fertilizers, and pesticides into marine and freshwater environments has also negatively threatened various natural crop species, natural water resources and aquatic life.

3. Climate Change and Global Warming

The severe changes in climate patterns as a result of human activities and overpopulation that generate greenhouse gases and carbon footprint in the atmosphere threatens biodiversity as well as other numerous natural resources. Species that have acclimatized to specific environments are highly affected as the climate change and global warming alters the favorable survival conditions.

The profound effect of climate change and global warming is habitat loss to an extent of threatening biodiversity and the survival of species. For instance, wildlife that requires cool temperatures of high elevations such as the rock rabbit and mountain gorillas may in the near future run out of habitat due to global warming.

4. Environmental Pollution

The majority of natural resources have been destroyed and a large portion is under immense threat due to the toxic substances and chemicals emitted from industries, homemade utilities, and agricultural products among other processed materials. Land, air, and water pollution pose long-term cumulative impacts on the natural resources and the quality of the environments in which they occur.

Seriously polluted natural resources have become obsolete in value because pollution makes it harsh for the sustainably of biotic and abiotic components. Pollution impacts the chemical compositions of lands, soil, ocean water, underground water and rocks, and other natural processes. A good example is an acidic lake which cannot support aquatic life forms.

5. Land Use and Development

The conversion of lands into urban settings, housing development projects, office spaces, shopping malls, industrial sites, parking areas, road networks, and so on takes away the naturally occurring land that provided habitat for wildlife and other living organisms. This practice has substantially led to the loss and destruction of millions of acre of natural habitable environments.

6. The 20th Century Lifestyle

Human lifestyle in the 20th century tremendously threatens the sustainability of natural resources. In this era, humans demand more comfortable living in terms of education, entertainment, recreation, transport, clothing, and shelter which will demand use of more resources and more production. Accordingly, it simply means more industrial processes which will definitely demand more energy, more natural resources and more raw materials. The solution is adopting a sustainable lifestyle.

Importance of Natural Resources

Natural resources play a very important role in every sector of the national economy like in industry, agriculture, transport, commercial and domestic needs.

Natural resources also play a vital role in the economic development by increasing agriculture trade which is imported and exported to the other countries, this type of products the available in our country also attract the foreign investors.

Natural resources is very important so that environment will be in balance. If we continuesly misuse or over use the natural resources like water, fuel, minerals, soil etc, it can affect the environment and all living things.

All the things we need in our daily life that such as food, water, air, fuel comes from natural resources.

Natural resources provide every daily needs of human like shelter, food, clothes etc.

There are lots of ***importance of Natural Resources***, such as It help to the boosting up of the economy from farm product like rubber, lac, coal which can be exported to other country, this type of products that available in our country also attract the foreign investor.

Without natural resources living things could not survive, power plants are the important part of human day to day life but it use natural resources to generate power. Power plants run on coal and we also know that coal is a natural resources.

Minerals are natural resources that are very ***Importance of Natural Resources***, but minerals are non-renewable resource and are running out.

There are so many different type of natural resources and theirs importance :-

Forest Resources

- Forest is the important natural resources which helps in the economic development. In India about 21 % of land comes under forest.
- Forest provide a large number of row material like paper, furniture, rayon, matchbox, timber, etc. Forest are also the richest source for the valuable plants like medicine, spices, bamboo, gum, lac etc.
- Forest play a very important role in balancing the ecosystem and environment from soil erosion to Wildlife protection, industrial row material, water sheds, balance the nature.

Water Resources

A vital natural resources is very essential for multi-purpose like drinking, agriculture irrigation, power generation, transportation, industrial use, household use. All the living things needed water to survive. Water is needed for life to exist.

Land Resources

Land resources is important because human being lives here. Land resources support natural vegetation, wildlife, transport. Our basic needs like food, cloth, shelter obtained from the land.

About 43% of the land used for agriculture and we know how much agriculture product is important for us. Our daily need like grain, cereal, pulses etc obtained from agriculture.

Mineral Resources

Rocks: Rocks are used to build house, bridge and other structure. A very important building material is concrete which is made from cement and cement is made from the sedimentary rock which called limestone.

Glass and other ceramics are also made from Rocks by treating them with heat. Rocks have been used as tools and weapons from the very long time.

Rocks are composed of one or more mixture of minerals in any proportion. Rocks are forms from the minerals like quartz, feldspar and Mica.

All the natural resources used by human including fuel, metal, Minerals are ultimately comes from the Earth.

Rocks and Minerals necessary for life. Rocks and Minerals support all living things and are the source of soil in which the plant grow properly.

Our Earth has a wide range of natural resources that are essential for daily life.

Over the year, we have increasing relied on natural resources. It is very "importance of natural resources" to conserve, we should reduce the wastage in our daily life, reuse everything which it possible to use and protect the forest and other natural resources which is non renewable we should save water gas and electricity.

In a report, it is estimated that oil reserves of the world will be run out in the next 56-60 years, so it very important that these natural resources like coal, petroleum, should be conserved in order to survive.

Coal: The earth crust contain large deposit of coal. Coal is very important natural resources that is used in day to day life. coal is used in houses, industries in many ways.

Coals are used for cooking food, in blast furnance of making Steel, in railways engine to produce steam and so many other purposes like generating electricity.

We should also know that coal's by-product are used in making fertilizer, medicines, synthetic fibre etc.

Coal is a non-renewable resources which means it cannot be used again and again. It can be used only one time and it also cannot be replaced and cannot be produced, re-grown or regenerated. So it is very important to conserve it and used it in a very sustainable manner.

Coal is important as electricity. It is available in abundance, it is cheap and easy to transport and store.

Petroleum: Petroleum is also called Rock oil. It takes thousand of years for oil to form. The remains of creature that existed millions of years ago change chemically and it become compressed into sedimentary rocks.

Once the location of oil found, digging begins and pumps are used to extract both oil and gas into reservior.

Petroleum is used in many ways like it is used as fuel for motor,car, scooter, bikes and aeroplane. Petroleum is also distilled into Liquefied Petroleum Gas (LPG) which is commonly used for cooking food.
Significance of Water Resources and their uses

Natural water resources include lakes, rivers, streams, ice pack, groundwater, precipitation and oceans. As global climate change begins to affect the distribution of water resources in the United States, water use in all sectors is coming under increasing scrutiny. Residential, commercial and industrial users often compete with agricultural irrigation, hydropower production and navigation for water resources.

Uses of Natural resources

Residential, Commercial and Industrial Use

Residential water use includes drinking, cleaning, personal hygiene, lawn care and car washing. We Indians get water from public water systems and from private supplies such as wells. In the commercial and industrial sectors, most water is used for processing products, with cooling coming in second. Water is also used for laundry, sanitation and landscaping.

Hydropower

Hydroelectric facilities use the power of flowing water to turn turbines that produce electricity. According to the Department of Energy, the U.S. produces 95,000 megawatts of hydropower per year -- enough to power 28 million households or replace 500 million barrels of oil. Hydropower has come under scrutiny from environmentalists, but new technologies promise to increase the efficiency of power generation while simultaneously decreasing the impact of hydroelectricity on the environment.

Irrigation

Only 15 percent of cropland in the United States is irrigated, but that still totals about 55 million acres, including land in highly productive areas such as California. Water for irrigation comes from either groundwater or surface water, raising concerns that heavy use could deplete water supplies in a region to the extent that nonagricultural users are negatively affected. Irrigation has also been linked to increased soil salinity and contamination of groundwater with fertilizers and chemicals through runoff.

Navigation

Navigable waterways are defined as watercourses that have been or may be used for transport of interstate or foreign commerce. Agricultural and commercial goods are moved on water on a large scale in the United States, making navigation an important economic concern. Navigation interests may come into direct conflict with other interests, including hydropower and wildlife conservation.

Conservation of water and recycling of the water – Global distribution of water

Water Conservation in India

Water is a crucial resource for the country today. It is thus essential to not only conserve water but also use it effectively. Due to the growing population, increasing industrialisation, and escalating agriculture scenario, the demand for water has clearly increased over the years. Thus, water conservation is evidently the need of the hour. Although efforts are being made by building dams, wells, and reservoirs, there is still a long way to go.

If the situation persists, clean water is predestined to become one of the rarest commodities soon. So, the people need to be educated about the significance of storing, recycling and reusing water. WaterAid India's initiative in making water, sanitation, and hygiene accessible for all, endeavours to address the water problems across some of the most marginalized areas.

WaterAid's approach to conserving water focuses on –

- Building the capacity of local government and community members;
- Mapping of water resources and their usage;
- Motivating the communities to adopt water conservation practices, such as rainwater harvesting;
- Water budgeting[2] and allocation;
- Improving access to water supply by leveraging government resources; and
- Advocacy for regulations of water use in water stressed areas and protection of groundwater.

WaterAid India also provides technical support to the local partners and communities across the areas of our work. Capacity building, preparing knowledge banks and behaviour change communication documents, joint impact monitoring and research for community based process are some of the highlights of our work.

Conserving Our Water Resources is Important

Our ground water and surface water supplies are at risk of overuse in many areas. The demand can be greater than the amount supplied by rain and snowmelt. Water conservation, wastewater recycling, and reuse is becoming more important due to increases in:

- Demand on potable water resources,
- The cost of treating wastewater,
- Regulations requiring greater flows for streams and rivers, which reduces irrigation sources, and
- The demand for sustainable building options.
- Keep in mind that it is often cheaper, easier, and safer to use less water in the first place than to recycle or reuse wastewater. However, there are many ways for homeowners and water system managers to conserve water.

Water Recycling is Important

By design, on-site sewage systems, also known as septic systems, naturally recycle wastewater by recharging ground water with appropriately treated effluent. To ensure on-site sewage systems are treating waste effectively and not polluting the ground water, building and home owners must make sure their systems are working properly.

Rainwater harvesting

In urban areas, the construction of houses, footpaths and roads has left little exposed earth for water to soak in. In parts of the rural areas of India, floodwater quickly flows to the rivers, which then dry up soon after the rains stop. If this water can be held back, it can seep into the ground and recharge the groundwater supply.

This has become a very popular method of conserving water especially in the urban areas. Rainwater harvesting essentially means collecting rainwater on the roofs of building and storing it underground for later use. Not only does this recharging arrest groundwater depletion, it also raises the declining water table and can help augment water supply. Rainwater harvesting and artificial recharging are becoming very important issues. It is essential to stop the decline in groundwater levels, arrest sea-water ingress, i.e. prevent sea-water from moving landward, and conserve surface water run-off during the rainy season.

Town planners and civic authority in many cities in India are introducing bylaws making rainwater harvesting compulsory in all new structures. No water or sewage connection would be given if a new building did not have provisions for rainwater harvesting. Such rules should also be implemented in all the other cities to ensure a rise in the groundwater level.

Realizing the importance of recharging groundwater, the CGWB (Central Ground Water Board) is taking steps to encourage it through rainwater harvesting in the capital and elsewhere. A number of government buildings have been asked to go in for water harvesting in Delhi and other cities of India.

All you need for a water harvesting system is rain, and a place to collect it! Typically, rain is collected on rooftops and other surfaces, and the water is carried down to where it can be used immediately or stored. You can direct water run-off from this surface to plants, trees or lawns or even to the aquifer.

Some of the benefits of rainwater harvesting are as follows

- Increases water availability
- Checks the declining water table
- Is environmentally friendly
- Improves the quality of groundwater through the dilution of fluoride, nitrate, and salinity
- Prevents soil erosion and flooding especially in urban areas

Rainwater harvesting: a success story

Once Cherrapunji was famous because it received the largest volume of rainfall in the world It still does but ironically, experiences acute water shortages. This is mainly the result of extensive deforestation and because proper methods of conserving rainwater are not used. There has been extensive soil erosion

and often, despite the heavy rainfall and its location in the green hills of Meghalaya, one can see stretches of hillside devoid of trees and greenery. People have to walk long distances to collect water.

In the area surrounding the River Ruparel in Rajasthan, the story is different - this is an example of proper water conservation. The site does not receive even half the rainfall received by Cherrapunji, but proper management and conservation have meant that more water is available than in Cherrapunji.

The water level in the river began declining due to extensive deforestation and agricultural activities along the banks and, by the 1980s, a drought-like situation began to spread. Under the guidance of some NGOs (non-government organizations), the women living in the area were encouraged to take the initiative in building johads (round ponds) and dams to hold back rainwater. Gradually, water began coming back as proper methods of conserving and harvesting rainwater were followed. The revival of the river has transformed the ecology of the place and the lives of the people living along its banks. Their relationship with their natural environment has been strengthened. It has proved that humankind is not the master of the environment, but a part of it. If human beings put in an effort, the damage caused by us can be undone

Agriculture:

Conservation of water in the agricultural sector is essential since water is necessary for the growth of plants and crops. A depleting water table and a rise in salinity due to overuse of chemical fertilizers and pesticides has made matters serious. Various methods of water harvesting and recharging have been and are being applied all over the world to tackle the problem. In areas where rainfall is low and water is scarce, the local people have used simple techniques that are suited to their region and reduce the demand for water.

- In India's arid and semi-arid areas, the 'tank' system is traditionally the backbone of agricultural production. Tanks are constructed either by bunding or by excavating the ground and collecting rainwater.
- Rajasthan, located in the Great Indian Desert, receives hardly any rainfall, but people have adapted to the harsh conditions by collecting whatever rain falls. Large bunds to create reservoirs known as khadin, dams called johads, tanks, and other methods were applied to check water flow and accumulate run-off. At the end of the monsoon season, water from these structures was used to cultivate crops. Similar systems were developed in other parts of the country. These are known by various local names ¾ jal talais in Uttar Pradesh, the haveli system in Madhya Pradesh, ahar in Bihar, and so on.

Reducing water demand

Simple techniques can be used to reduce the demand for water. The underlying principle is that only part of the rainfall or irrigation water is taken up by plants, the rest percolates into the deep groundwater, or is lost by evaporation from the surface. Therefore, by improving the efficiency of water use, and by reducing its loss due to evaporation, we can reduce water demand.

There are numerous methods to reduce such losses and to improve soil moisture. Some of them are listed below.

- Mulching, i.e., the application of organic or inorganic material such as plant debris, compost, etc., slows down the surface run-off, improves the soil moisture, reduces evaporation losses and improves soil fertility.
- Soil covered by crops, slows down run-off and minimizes evaporation losses. Hence, fields should not be left bare for long periods of time.
- Ploughing helps to move the soil around. As a consequence it retains more water thereby reducing evaporation.
- Shelter belts of trees and bushes along the edge of agricultural fields slow down the wind speed and reduce evaporation and erosion.
- Planting of trees, grass, and bushes breaks the force of rain and helps rainwater penetrate the soil.
- Fog and dew contain substantial amounts of water that can be used directly by adapted plant species. Artificial surfaces such as netting-surfaced traps or polyethylene sheets can be exposed to fog and dew. The resulting water can be used for crops.
- Contour farming is adopted in hilly areas and in lowland areas for paddy fields. Farmers recognize the efficiency of contour-based systems for conserving soil and water.
- Salt-resistant varieties of crops have also been developed recently. Because these grow in saline areas, overall agricultural productivity is increased without making additional demands on freshwater sources. Thus, this is a good water conservation strategy.
- Transfer of water from surplus areas to deficit areas by inter-linking water systems through canals, etc.
- Desalination technologies such as distillation, electro-dialysis and reverse osmosis are available.

- Use of efficient watering systems such as drip irrigation and sprinklers will reduce the water consumption by plants.

WATER CONSERVATION

The most important step in the direction of finding solutions to issues of water and environmental conservation is to change people's attitudes and habits¾this includes each one of us. Conserve water because it is the right thing to do. We can follow some of the simple things that have been listed below and contribute to water conservation.

- Try to do one thing each day that will result in saving water. Don't worry if the savings are minimal ¾ every drop counts! You can make a difference.
- Remember to use only the amount you actually need.
- Form a group of water-conscious people and encourage your friends and neighbours to be part of this group. Promote water conservation in community newsletters and on bulletin boards. Encourage your friends, neighbours and co-workers to also contribute.
- Encourage your family to keep looking for new ways to conserve water in and around your home.
- Make sure that your home is leak-free. Many homes have leaking pipes that go unnoticed.
- Do not leave the tap running while you are brushing your teeth or soaping your face.
- See that there are no leaks in the toilet tank. You can check this by adding colour to the tank. If there is a leak, colour will appear in the toilet bowl within 30 minutes. (Flush as soon as the test is done, since food colouring may stain the tank.)
- Avoid flushing the toilet unnecessarily. Put a brick or any other device that occupies space to cut down on the amount of water needed for each flush.
- When washing the car, use water from a bucket and not a hosepipe.
- Do not throw away water that has been used for washing vegetables, rice or dals¾use it to water plants or to clean the floors, etc
- You can store water in a variety of ways. A simple method is to place a drum on a raised platform directly under the rainwater collection source. You can also collect water in a bucket during the rainy season.

WATER RECYCLING:

Water recycling is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing, and replenishing a ground water basin (referred to as ground water recharge).

For example, when an industrial facility recycles water used for cooling processes. A common type of recycled water is water that has been reclaimed from municipal wastewater, or sewage. The term water recycling is generally used synonymously with water reclamation and water reuse.

Water recycling offers resource and financial savings.

Recycled water for landscape irrigation requires less treatment than recycled water for drinking water. Gray water, or grey water, is reusable wastewater from residential, commercial and industrial bathroom sinks, bath tub shower drains, and clothes washing equipment drains. Gray water is reused onsite, typically for landscape irrigation. Use of non-toxic and lowsodium (no added sodium or substances that are naturally high in sodium) soap and personal care products is required to protect vegetation when reusing gray water for irrigation

Environmental Benefits of Water Recycling:

In addition to providing a dependable, locally-controlled water supply, water recycling provides tremendous environmental benefits. By providing an additional source of water, water recycling can help us find ways to decrease the diversion of water from sensitive ecosystems. Other benefits include decreasing wastewater discharges and reducing and preventing pollution. Recycled water can also be used to create or enhance wetlands and riparian habitats.

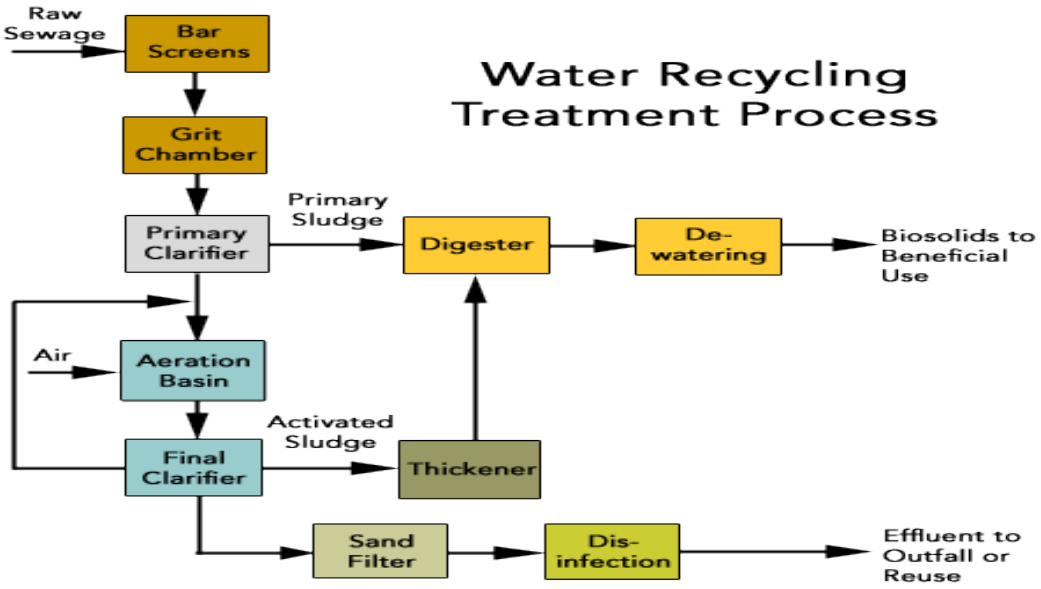
Recycling water on site or nearby reduces the energy needed to move water longer distances or pump water from deep within an aquifer. Tailoring water quality to a specific water use also reduces the energy needed to treat water.

USES OF RECYCLED WATER

- agriculture ,landscape, public parks , golf course irrigation, cooling water for power plants and oil refineries, processing water for mills, plants, toilet flushing, dust control, construction activities, concrete mixing, artificial lakes

WATER RECYCLING TREATMENT PROCESS

The water recycling process utilizes very basic physical, biological and chemical principles to remove contaminants from water. Use of mechanical or physical systems to treat wastewater is generally referred to as ***primary treatment***. Use of biological processes to provide further treatment is referred to as ***secondary treatment***. Additional purification is called ***tertiary*** or ***advanced treatment***.



Primary Treatment

Primary treatment uses simple mechanical and physical processes to remove approximately half of the contaminants from wastewater.

Bar screens: To begin the water recycling process, incoming raw sewage is routed through mechanical bar screens, removing large solids such as sticks, rags, and plastic material from the wastewater stream. A horizontal rake on a toothed gear drive rakes the bars and removes the captured
material to a conveyor that deposits the material into a dumpster for removal to the sanitary landfill.

Grit chamber: As wastewater flow enters aerated grit chambers, the stream is saturated with fine air bubbles to encourage the settling of fine grit particles.

Primary clarification: The wastewater continues to primary clarifiers, where the flow velocity is slowed to promote solids settling. Biosolids removed at this point are digested, dewatered, and used for beneficial purposes like conditioning soil or composting.

Secondary Treatment or "Bug Farming"

Secondary treatment uses biological processes to remove most of the remaining contaminants. Many operators of WRC's consider themselves "bug farmers" since they are in the business of growing and harvesting a healthy population of microorganisms.

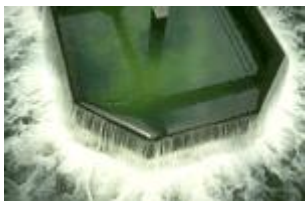
Aeration Basins: Water flows into aeration basins where oxygen is mixed with the water. Bacterial microorganisms consume the organic material as food. They convert non-settleable solids to settleable solids and are later themselves captured in final clarifiers, ending up in wastewater biosolids.

Final Clarifiers: Most of the solids that settle out in final clarifiers are thickened and digested, but some are returned to the aeration tank to reseed incoming water with hungry microorganisms.

Advanced Treatment and Disinfection

After the bugs do their work, water is filtered through sand before undergoing chemical disinfection in chlorine contact chambers, used to kill any remaining microorganisms. It is not desirable to have residual chlorine in the rivers and lakes, so chlorine is then removed using sulfur dioxide. This protects the aquatic life in the receiving stream.

Sand Filters: When the flow leaves the final clarifiers it enters into effluent sand filters, any remaining particulate matter is filtered out. Sand filtering is the most common type of gravity filtration system. An advantage of the gravity filter is that part of its operation can be easily observed visually. Sand filters are generally placed between the final clarifier and disinfection.



Disinfection and Dechlorination: After 20 minutes of chlorination to ensure the destruction of any pathogenic organisms, it's then dechlorinated with sulfur dioxide to safeguard the receiving stream.

Outfall: The water, now fully treated and recycled, is ready for release to the environment. The point where recycled water is discharged to a stream or body of water is called the outfall.

Solids Processing

The by-product of treated residues generated during the water recycling process are called biosolids. As a natural organic fertilizer and soil conditioner, biosolids provide a full complement of the essential nutrients and micronutrients necessary for healthy plant growth and can be used in agriculture (direct land application) or they can be made into compost for application on lawns, gardens, and trees.

Thickener: Air is forced into water in a pressure chamber where the air becomes dissolved in the liquid. The mixture is then released into the sludge where the tiny air bubbles rise and carry the solids with them to the surface.

Anaerobic Digester: Settled sludge in the primary clarifiers is pumped to anaerobic digesters for stabilization. The tank is usually completely sealed to keep air from getting inside. Anaerobic bacteria thrive in an environment without dissolved oxygen by using the oxygen which is chemically combined with their food supply.

De-watering: Digested sludge is de-watered by either squeezing the water out of the sludge using mechanical means like a belt-filter press, or letting mother nature do the job by pouring the sludge onto drying beds.

Treatment Benefits

Water, when used, becomes contaminated. Before it can be returned to the environment or reused, most of the contamination must be removed. Wastewater treatment, also called "water recycling", separates and removes contaminants from water. The end product of water recycling is a clean water product, ready to be

reused or returned to the environment. The by-products of water recycling are called biosolids. Biosolids contain high-quality organic nutrients and can be used to condition soil for growing non-food crops or made into compost for application on lawns and trees.

The benefits of water recycling include:

- Protection of public health from waterborne disease
- Protection of the natural environment and the wildlife that depends on it
- Protection of downstream water supplies
- Removal of toxic and hazardous materials that might accumulate in the environment
- Protection of water sources for recreational use

WATER RESOURCE MANAGEMENT IN INDIA:

Watershed management is the process of guiding and organizing the use of land and other resources in a watershed to provide desired goods and services without adversely affecting soil and water resources. Each project under the programme is a micro-level effort to achieve this objective by treating the under productive or unproductive land and taking up allied activities for the benefit of the landless. The programmes adopt a common strategy of multi resource management involving all stakeholders within the watershed who, together as a group, co-operatively identify the resource issues and concerns of the watershed as well as develop and implement a watershed plan with solutions that are environmentally, socially and economically sustainable.

To accelerate the pace of development of wastelands/degraded lands the Government had set up the National Wastelands Development Board in 1985 under the Ministry of Environment and Forests. Later a separate Department of Wastelands Development in the Ministry of Rural Development and Poverty Alleviation was created in 1992 and the National Wastelands Development Board was transferred to it. In April 1999, Department of Wastelands Development was renamed as the Department of Land Resources to act as the nodal agency for land resource management. Consequently, all land-based development programmes and the Land Reforms Division were brought under this department. Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP) and Integrated Wastelands Development Programme (IWDP) were the watershed management programmes implemented by the department. Later for optimum use of resources, sustainable outcomes and integrated planning, DPAP, DDP and IWDP were consolidates as the Watershed Development Component of Prime Minister Krishi Sinchayee Yojna (WDC-PMKSY).

Neeranchal Watershed Program

Neeranchal is a World Bank assisted National Watershed Management Project. Neeranchal is designed to further strengthen and provide technical assistance to the Watershed Component of PMKSY, in particular and all components of PMKSY, in general, to enhance its delivery capacity. The programme is being implemented in nine participating states - Andhra Pradesh, Chattisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Rajasthan and Telangana.

For achieving the major objectives of the Watershed Component of the Pradhan Mantri Krishi Sinchayi Yojana (PMKSY) and for ensuring access to irrigation to every farm (Har Khet Ko Pani) and efficient use of water (Per Drop More Crop),

Neeranchal is primarily designed to address the following concerns:

- bring about institutional changes in watershed and rainfed agricultural management practices in India
- build systems that ensure watershed programmes and rainfed irrigation management practices are better focussed, and more coordinated, and have quantifiable results
- devise strategies for the sustainability of improved watershed. management practices in programme areas, even after the withdrawal of project support
- through the watershed plus approach, support improved equity, livelihoods, and incomes through forward linkages, on a platform of inclusiveness and local participation.

Storing the rain water in tanks and recharging ground water

Every year in Monsoon our nature gives us our life in the form of rainfall but little beat of it is stored in the soil, damps, lakes etc. and remaining water get wasted in rivers. At the time of rainfall we didn't even recognize that running water but when the water level of our well's goes down then we think on it but at

that time we can't do anything so we face water scarcity, only mean to say "When the well is dry, we learn the value of water".

Now days we are reaching to the heights of development and covering all the earth surface by cement and concrete material but we are forgetting that we are closing the route of water to get entered in the earth's surface and it directly affects on our ground water level and we need face water scarcity. If this condition goes on then our new generation will face a high water problems for drinking and Agriculture purpose.

In ancient times the water cycle was properly going on but due to the interruption of mankind the Ground water level is going down and down. It was difficult to imagine few years before that you will require to buy drinking water but now we need to buy it everywhere we travel. Today Fresh water is a scarce resource, and it is being felt the world over. More than 2000 million people would live under conditions of high water stress by the year 2050, according to the UNEP (United
Nations Environment Programme), which warns water could prove to be a limiting factor for development in a number of regions in the world Actually water harvesting means a system that collects rainwater from where it falls doesn't allow it to drain out. It may include water that is collected within the boundaries of a property, from roofs, agriculture land and surrounding surfaces.

NEED FOR ROOF TOP RAINWATER HARVESTING:

To meet the ever increasing demand for water
To reduce the runoff which chokes storm water drains
To avoid flooding of roads
To augment ground water storage
To reduce the soil erosion
To supplement domestic water requirement during crisis
To improve the quality of ground water

Advantages of rainwater harvesting

1. Recharge to groundwater and built up in ground water levels.
2. Rejuvenation of dried up wells.
3. Improvement in the yields of wells.
4. Improvement in the quality of ground water through dilution.
5. Helps in reducing inundation of roads and flood hazards.
6. Save future generations from water scarcity problem.
7. Reduce power Consumption.
8. Collection of roof top water in to a sump and recharge pit facilitates direct use of rainwater apart from recharge to ground water. This helps in reducing the water bill and huge investments on purchase of water through tankers in scarcity areas.
9. The structures recommended for rainwater harvesting area simple, economical and echo- friendly.

COMPONENTS OF A RAINWATER HARVESTING SYSTEM

A rainwater harvesting system comprises components of various stages - transporting rainwater through pipes or drains, filtration, and storage in tanks for reuse or recharge. The common components of a rainwater harvesting system involved in these stages are illustrated here.

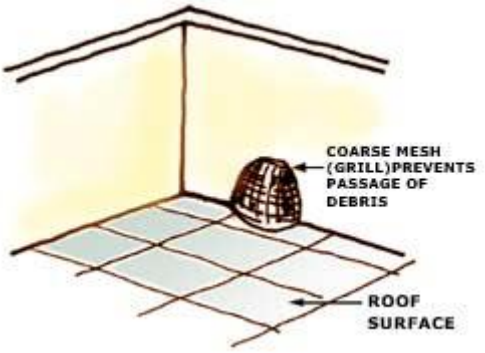
1. Catchments: The catchment of a water harvesting system is the surface which directly receives the rainfall and provides water to the system. It can be a paved area like a terrace or courtyard of a building, or an unpaved area like a lawn or open ground. A roof made of reinforced cement concrete (RCC), galvanised iron or corrugated sheets can also be used for water harvesting.

2. Coarse mesh: at the roof to prevent the passage of debris

3. Gutters: Channels all around the edge of a sloping roof to collect and transport rainwater to the storage tank. Gutters can be semi-circular or rectangular and could be made using:

- Locally available material such as plain galvanised iron sheet (20 to 22 gauge), folded to required shapes.
- Semi-circular gutters of PVC material can be readily prepared by cutting those pipes into two equal semi-circular channels.
- Bamboo or betel trunks cut vertically in half.

The size of the gutter should be according to the flow during the highest intensity rain. It is advisable to make them 10 to 15 per cent oversize.



Source: A water harvesting manual for urban areas

4. 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:

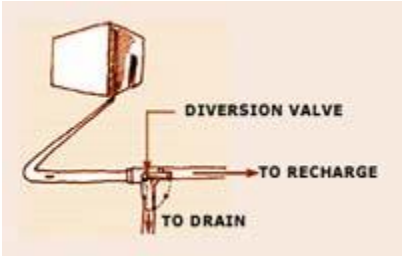
Sizing of rainwater pipe for roof drainage

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

Source: National Building Code

5. First-flushing: A first flush device is a valve that ensures that runoff from the first spell of rain is flushed out and does not enter the system. This needs to be done since the first spell of rain carries a relatively larger amount of pollutants from the air and catchment surface.



Source: A water harvesting manual for urban areas

6. Filter: 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.

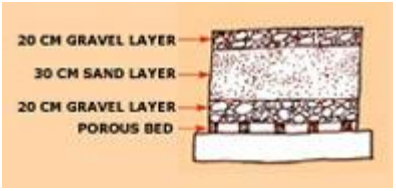
Source: A water harvesting manual for urban areas

(i) 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.

(ii) 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 removeturbidity (suspended particles like silt and clay), colour and microorganisms.



7. Storage facility: There are various options available for the construction of these tanks with respect to the shape, size and the material of construction.

Shape: Cylindrical, rectangular and square.
Material of construction: Reinforced cement concrete, (RCC), ferrocement, masonry, plastic (polyethylene) or metal (galvanised iron) sheets are commonly used.
Position of tank: Depending on space availability these tanks could be constructed above ground, partly underground or fully underground. Some maintenance measures like cleaning and disinfection are required to ensure the quality of water stored in the container.

8. 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).

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

A settlement chamber

2. Settlement tank: 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:

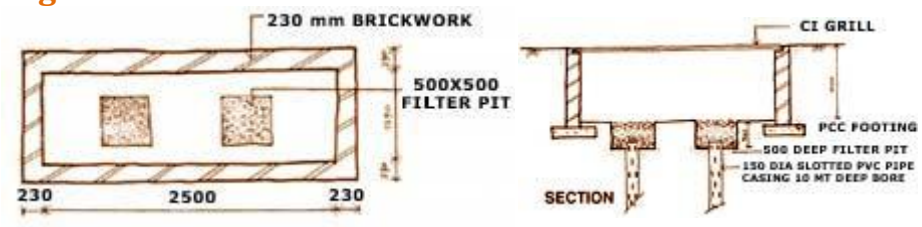
Filter materials in a soakaway

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 catchments can be tapped.

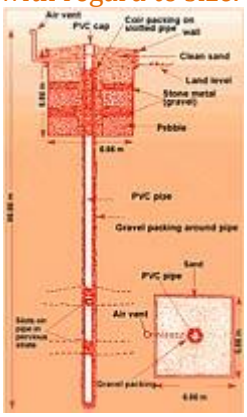
7.Recharge troughs



Source: A water harvesting manual for urban areas

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.

Unit-II

Rain water harvesting in rural areas (*chekdam, trenches* etc.,)

Check dams:

A check dam is generally constructed on small streams and long gullies formed by the erosive activity of water. The ideally a check dam is located in a narrow stream with high banks.

A check dam serves many purposes.

- It cuts off the runoff velocity and reduces erosive activity
- The water stored improves soil moisture of the adjoining areas and allows percolation to recharge the aquifers

While constructing a series of check dams on along stream course, the spacing between two check dams should be beyond their water spread. The height of the check dam should be such that even during the highest flood, water does not spill over the banks.

Contour trenches: Contour trenches are used both on hill slopes as well as on degraded and barren waste lands for soil and moisture conservation and afforestation purposes. The trenches break the slope and reduce the velocity of surface runoff. It can be used in all slopes irrespective of rainfall conditions (i.e., in both high and low rainfall conditions), varying soil types and depths.

Specifications: Trenches can be continuous or interrupted. The interrupted one can be in series or staggered, continuous one is used for moisture conservation in low rainfall areas and require careful layout. Intermittent trenches are adopted in high rainfall areas. The trenches are to be constructed strictly on contours irrespective of the category.

Layout: The size of the trench depends upon the soil's depth. Normally 1,000 sq cm to 2,500 sq cm. in cross section are adopted. The trench may be of 30 cm base and 30 cm top width and square in cross section or it can be trapezoidal with side slopes 1:1. Based on the quantum of rainfall to be retained, it is possible to calculate the size and number of tren

ches.

Slope of the land	20 %	45 %	50 % (with soil of 30cm depth)	60 % (with soil of 30cm depth)
Horizontal interval	7.5m	9m	7.5m	9m
Vertical interval	1.5m	4m	3.75m	5.85m

Bunding

Bunds are small earthen barriers provided in agricultural lands with slopes ranging from 1 to 6 percent. They control the effective length of slope and thereby reduce the gain in velocity of runoff flow to avoid gully formations. Bunds are constructed with the following objectives:

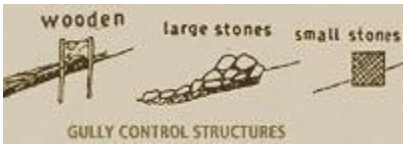
- To increase the time of concentration of rainwater where it falls and thereby allowing rainwater to percolate into the soil
- Converting a long slope into several ones as to minimise velocity and thereby reducing the erosion by runoff water
- To divert runoff either for water harvesting purposes

Types of bunds

a) Graded bunds: Graded bunds are constructed in medium to high rainfall area - having annual rainfall of 600mm and above - and in soils with poor permeability or those having the crust formation tendency.
b) Contour bunds: Contour bunds are constructed in relatively low rainfall areas- having annual rainfall of less than 600 mm ; particularly in the areas having light textured soils. They are essentially meant for storing rainwater received during a period of 24 hours at 10 years recurrence interval. The major considerations are maximum depth of water to be impounded, design depth of flow over waste weir and desired free board

Contour Stone wall: It is constructed with stones across the hill slopes thereby intercepting the surface runoff. These terraces help in retarding the soil loss and conserving soil moisture. Spacing of such stone walls are not rigid. Spacing ranging from 10 m to 30 m can be adopted depending upon slope of the terrain. For the construction, a shallow trench has to be dug and the stones collected and packed directly on to the foundation and in the super structure to form the terrace. The stones should be properly interlocked. The soil excavated to form the foundation for the terrace is used for forming a small bund on the upstream side of the terrace. Terrace is stabilized by planting suitable vegetation on the bund.

Gully control : Gully erosion generally starts as small rills and gradually develop into deeper crevices. Ravines are a form of extensive gully erosion. Gully erosion not only damages the land resources but the same time contribute larger amount of sediment load to river system.



Classification of gullies:

For the purpose of gully control measures gullies are classified based on several factors. One method takes into consideration the gully depth and catchment area. The following table give the classification of gullies:

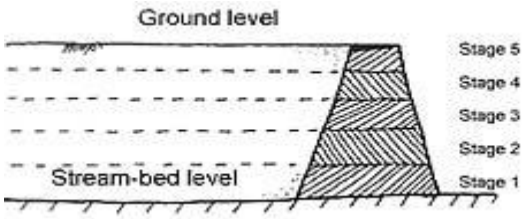
Description	Gully depth	Catchment area
Small	1m or less	2 ha. Or less
Medium	1 to 5m	2 – 20 ha.
Large	Greater than 5m	Greater than 20 ha

Gully plugs are earthen embankments usually constructed for blocking the active and erosion prone gullies for their 20tabilization.
a) brushwood dams b) loose rock dams c) woven wire dams
Use locally available vegetative cutting in their construction. In the woven dam a wire mesh is used to hold the stone in place. All the check dams involving stones are to be adopted in areas where stones are available easily and in plenty. The rock fill dam and the woven wire dam are more lasting than the loose rock dam. There are no standard principles of the design of these structures. These are to be designed and constructed based on the needs and availability of materials in a given situation. The overall height of temporary check dams use for this purpose should not be more than 75 cms; an effective height of about 30 cms is satisfactory

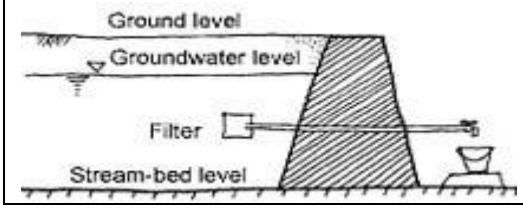
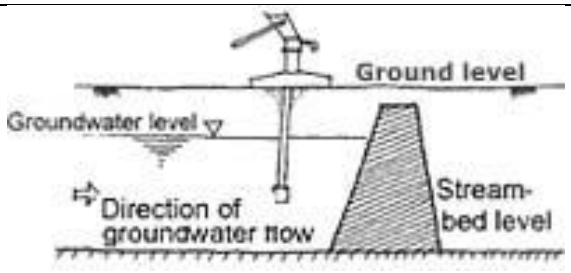
Sub-Surface Dams: Groundwater dams are structures that intercept or obstruct the natural flow of groundwater and provide storage for water underground. They have been used in several parts of the

world, notably India, Africa and Brazil. Their use is in areas where flows of groundwater vary considerably during the course of the year, from very high flows following rain to negligible flows during the dry season.

The basic principle of the groundwater dam is that instead of storing the water in surface reservoirs, water is stored underground. The main advantages of water storage in groundwater dams is that evaporation losses are much less for water stored underground. Further, risk of contamination of the stored water from the surface is reduced because as parasites cannot breed in underground water. The problem of submergence of land which is normally associated with surface dams is not present with sub-surface dams.



There are two main types of groundwater dam: ***the sub-surface dam and the sand storage dam***. A sub-surface dam intercepts or obstructs the flow of an aquifer and reduces the variation of the level of the groundwater table upstream of the dam. It is built entirely under the ground

The sand storage dam is constructed above ground. Sand and soil particles transported during periods of high flow are allowed to deposit behind the dam, and water is stored in these soil deposits.	The sand storage dam is constructed in layers to allow sand to be deposited and finer material be washed downstream.
	

A groundwater dam can also be a combination of these two types. When constructing a sub-surface dam in a river bed, one can increase the storage volume by letting the dam wall rise over the surface, thus causing additional accumulation of sediments. Similarly, when a sand-storage dam is constructed it is necessary to excavate a trench in the sand bed in order to reach bedrock, which can be used to create a sub-surface dam too. Groundwater dams are built across streams or valleys. A trench is dug across the valley or stream, reaching to the bedrock or other stable layer like clay. An impervious wall is constructed in the trench, which is then refilled with the excavated material. Various materials may be used for the construction of groundwater dams. Materials should be waterproof, and the dam should be strong enough to withstand the imposed soil and water loads. Dams may vary from 2 to 10 metres high. Materials include compacted clay, concrete, stones and clay, masonry wall or plastic sheets.

OVERUSE OF SURFACE AND GROUND WATER AND CONTROL MEASURES.

OVERUSE AND DEPLETION: Groundwater is the largest source of usable, fresh water in the world. In many parts of the world, especially where surface water supplies are not available, domestic, agricultural, and industrial water needs can only be met by using the water beneath the ground.

The U.S. Geological Survey compares the water stored in the ground to money kept in a bank account. If the money is withdrawn at a faster rate than new money is deposited, there will eventually be account-supply problems. Pumping water out of the ground at a faster rate than it is replenished over the long-term causes similar problems.

Groundwater depletion is primarily caused by sustained groundwater pumping. Some of the negative effects of groundwater depletion:

- **Lowering of the Water Table**: Excessive pumping can lower the groundwater table, and cause wells to no longer be able to reach groundwater.

- **Increased Costs:** As the water table lowers, the water must be pumped farther to reach the surface, using more energy. In extreme cases, using such a well can be cost prohibitive.
- **Reduced Surface Water Supplies:** Groundwater and surface water are connected. When groundwater is overused, the lakes, streams, and rivers connected to groundwater can also have their supply diminished.
- **Land Subsidence:** Land subsidence occurs when there is a loss of support below ground. This is most often caused by human activities, mainly from the overuse of groundwater, when the soil collapses, compacts, and drops.
- **Water Quality Concerns:** Excessive pumping in coastal areas can cause saltwater to move inland and upward, resulting in saltwater contamination of the water supply.

WAYS TO PROTECT AND CONSERVE GROUNDWATER

1. **Go Native:** Use native plants in your landscape. They look great, and don't need much water or fertilizer. Also choose grass varieties for your lawn that are adapted for your region's climate, reducing the need for extensive watering or chemical applications.
2. **Reduce Chemical Use:** Use fewer chemicals around your home and yard, and make sure to dispose of them properly - don't dump them on the ground!
3. **Manage Waste:** Properly dispose of potentially toxic substances like unused chemicals, pharmaceuticals, paint, motor oil, and other substances. Many communities hold household hazardous waste collections or sites - contact your local health department to find one near you.
4. **Don't Let It Run:** Shut off the water when you brush your teeth or shaving, and don't let it run while waiting for it to get cold. Keep a pitcher of cold water in the fridge instead.
5. **Fix the Drip:** Check all the faucets, fixtures, toilets, and taps in your home for leaks and fix them right away, or install water conserving models.
6. **Wash Smarter:** Limit yourself to just a five minute shower, and challenge your family members to do the same! Also, make sure to only run full loads in the dish and clothes washer.
7. **Water Wisely:** Water the lawn and plants during the coolest parts of the day and only when they truly need it. Make sure you, your family, and your neighbors obey any watering restrictions during dry periods.
8. **Reduce, Reuse, and Recycle:** Reduce the amount of "stuff" you use and reuse what you can. Recycle paper, plastic, cardboard, glass, aluminum and other materials.
9. **Natural Alternatives:** Use all natural/nontoxic household cleaners whenever possible. Materials such as lemon juice, baking soda, and vinegar make great cleaning products, are inexpensive, and environmentally-friendly.
10. **Learn and Do More!**
    Get involved in water education! Learn more about groundwater and share your knowledge with others.

MISSION BHAGIRATHA

Mission Bhagiratha is a project for safe drinking water for every village and city household in Telangana State, with a budget of ₹43,791 crores. The project is a brain child of Telangana Chief Minister, K. Chandrashekar Rao, that aims is to provide piped water to 2.32 crore people in 20 lakh households in urban and 60 lakhs in rural areas of Telangana. The ambitious project will supply clean drinking water to all households in the state through water sourced from River Godavari (53.68 TMC) and River Krishna (32.43TMC). The bulk supply is expected to be completed by May 2018 and intra-village, intra-locality works will be completed by December 2018.

The entire project is divided into 26 segments, comprising 25,000 habitations, at an estimated cost of ₹42,853 crore. The Krishna and Godavari rivers and existing reservoirs will be interlinked to collect, reserve and supply treated drinking water in the state, to every household in over 25,000 villages and 65 towns. The target is to provide 100 liters drinking water per person in rural areas, and 150 liters per person in urban areas. Around 4 TMC is planned for industrial use. The project had to take 13,000 permissions from various departments like railways, defense, national highways, forest, irrigation, panchayat raj, roads & buildings etc.

Telangana Drinking Water Supply Corporation (TDWSCL) was established by the government to implement Mission Bhagiratha. There are 59 overhead and ground-level tanks. 40 TMC water is sourced from tanks and reservoirs, area range from 100 acres to 10,000 acres.

The piping system runs through 1.697 lakh kilometers. The electricity required is 182 megawatts.

On 7 August 2016, Prime Minister Modi launched the Rs 42,000 crore piped drinking water project – 'Mission Bhagiratha', at Komatibanda village of Gajwel constituency, which is part of Medak district in Telangana. A dream project of Chief Minister K Chandrasekhar Rao, the ambitious piped drinking water supply project will cater to the drinking water needs of 67,000 urban households and 25,000 rural households in the Gajwel assembly constituency. This massive drinking water supply project was desperately needed for a state that has been a victim of erratic monsoon and poor infrastructure in harnessing rainwater. Mission Bhagiratha is slated to be completed in 2018, by when a large part of the state will be get not just piped drinking water but also water to meet the industrial and agricultural needs. The youngest state in India is blessed with two perennial rivers – Godavari and Krishna. The state however, has suffered from erratic monsoons that has resulted in drought-like situations in large parts of the state. Compounding the problem, around 973 villages have been dealing with contaminated ground water due to presence of high fluoride content. As a result, people have suffered from resulting diseases like fluorosis.

Highlights of Mission Bhagiratha

- Interlinking Krishna and Godavari rivers with reservoirs in the state to collect, conserve and supply much needed water to the state
- Total water pipeline length: 1,30,000 km – covering 26 internal grids, 62 intermediate pumping stations, 16 intake wells, 110 water treatment plants and 37,573 Overhead Service Reservoirs
- Total cost: Rs 42,000 crore
- Year of completion: 2018
- Based on detailed topography analysis, water to be pumped using gravity and minimal electricity (182 MW)
- Piped drinking water supply to : 67,000 urban households in Gajwel constituency at the rate of 150 liters per day per household, in areas under Municipal Corporations
- Piped drinking water supply to: 25,000 rural households at the rate of 100 litres per day per household
- Project water allocated for industrial use: 10%
- Women in villages empowered to oversee allocation and distribution of water in villages and collection of taxes
- Water drawn from Godavari river: 19.62 thousand million cubic feet (TMC)
- Water drawn from Krishna river: 19.65 thousand million cubic feet (TMC)

Optical Fibre Network integrated with Mission Bhagiratha

In a path breaking move that will revolutionize information technology in the state, Telangana is all set to implement the largest optical fibre based broadband network in India. The plan is to install optical fibre pipelines using the extensive water pipeline network being laid under Mission Bhagiratha. This will save the state a large amount of funds that would have been needed to install a separate OFC network. Once completed, low cost high speed data and video can be offered across the state where ever the water pipeline is laid. This will give a significant boost to e-governance, e-health services and e-education initiatives in Telangana. Other states like Bihar, West Bengal, U.P and M.P have taken inspiration from the project and are now planning to replicate the model in their respective states.

MISSION KAKATIYA (□□ □□□ □□ □□□□□□)

Mission Kakatiya is a program for restoring all the Minor Irrigation tanks and lakes in Telangana. The program helps in rejuvenating 46,531 tanks and lakes.

There were over 80,000 tanks, but half of them have vanished. Nearly 7 Crore tractor silt dug up from the tanks was used by the farmers on their fields to increase harvest. The project was taken up in four phases:

- Phase 1 - 8003 tanks
- Phase 2 - 8927 tanks
- Phase 3 - 5886 tanks
- Phase 4 - 6000 tanks
- Phase 5 - Remainder and New tanks creation

The big and large lakes with higher ayacut were taken up first. By March 2018, 27,713 lakes work was completed, spending ₹8700 crores, stabilizing and providing water for 20 lakh acres.
Over 2.88 lakh acres of new ayacut was stabilised and will reach 10 lakh acres by the completion of the project. The ground water table increased from 6.9% to 9.2%.
The crop yield for cotton had gone up by 11.6%, maize by 6.7% and paddy by 4.4%. And the fisherman's income went up by 30-35%.

Nature of work:

The scope of Mission Kakatiya includes Rejuvenation, Restoration and Repair of tanks by carrying out the following activities

1. Removal of deposited silt from tanks so as to increase the capacity of the tanks
2. Restoration and strengthening of Tank Bunds as to avoid breaching and to provide access to carts and tractors across the tanks
3. Repairing the sluices and its mechanical components for efficient water regulation.
4. Providing Cement Concrete guide walls to the canals so as to prevent leakage of water.
5. Beautification of tanks to promote tourism.

Mission Kakatiya is a scheme to restore silt-filled tanks and ponds meant for agricultural irrigation. Chief Minister K Chandrasekhar Rao christened the scheme after Kakatiya kings who ruled Telangana and other adjoining areas six centuries ago as they had paid top priority to tank and canal irrigation. Mission Kakatiya is to desilt all tanks and increase ground water table in rain fed areas of Telangana.

Tanks have been the life line of Telangana owing to the state's geographical positioning. The people of the state are highly dependent on the tanks which are spread across all the ten districts. The topography and rainfall pattern in Telangana have made tank irrigation an ideal type of irrigation by storing and regulating water flow for agricultural use.

Tank irrigation has huge bearing on generation of rural employment, poverty reduction and agricultural growth. The sheer size of command area under tank irrigation makes it a large center of agricultural production and provides a critical opportunity for commercial agriculture through market linkages.

The objective of "Mission Kakatiya" is to enhance the development of agriculture based income for small and marginal farmers, by accelerating the development of minor irrigation infrastructure, strengthening community based irrigation management and adopting a comprehensive programme for restoration of tanks.

The government has prioritised to take the restoration of minor irrigation tanks to restore them to store their original capacity and to effectively utilise 255 TMC of water allocated for minor irrigation sector under Godavari & Krishna River basins.

The minimum ayacut (the area served by an irrigation project such as a canal, dam or a tank) that can be irrigated with the above allocated water is about 20 lakh acres. But as per the statistics the ayacut now being irrigated is only about nine to ten lakh acres under minor irrigation tanks. Thus, there is a gap ayacut of about 10 lakh acres.

The reasons for this gap ayacut under minor irrigation tanks are due to loss of water storage capacity of tanks due to accumulation of silt in tank beds over a long period, due to dilapidated sluices, weirs and weak bunds, due to defunct of feeder channels, due to dilapidated condition of irrigation canals.

A reconciliation survey was conducted to identify the exact number of all types of Minor irrigation sources in Telangana state. As per survey 46,531 no. of M.I, small tanks, percolation tanks, private kuntas and small tanks (constructed by forest department) were identified for restoration.

The massive programme for Restoration of tanks is named as "Chinna Neeti Vanarula Punaruddarana" and it is renamed as "Mission Kakatiya".

The government is planned to restore 9,306 tanks every year (20% of total tanks) with an eventual target of restoring all 46,531 tanks in five years, in a phased manner
The present programme of "Mission Kakatiya" is to bring this gap ayauct of ten lakh acres in to command which requires no further allocation of water and also land acquisition.

This gap ayacut of 10 lakh acres under minor irrigation tanks can be brought to irrigation through various means such as: by de-silting the tank beds to restore original water storage capacity of tanks, by repairing dilapidated sluices, weirs etc., by strengthening the tank bunds to its original standards. by repairing the feeder channels to standards for getting water freely into tanks (part of chain of tanks), by re-sectioning of irrigation channels to standards & Repairs to CM & CD works for smooth distribution of water to fields according to their requirement.

It is programmed to publicise the importance of Chinna Neeti Vanarula Punaruddharana (restoration of minor irrigation sources) in the public through wide publicity to make them aware and participate in the massive programme designed by the government.

ISSUES AND CHALLENGES IN WATER RESOURCES MANAGEMENT

Following are the key issues of Water resource management

- **Climate change:** while we have always had to deal with a variable climate, the majority of studies, analyses and management techniques have been based on the belief that the hydrological series was stationary, i.e. while there may be fluctuations, the mean value would remain roughly the same. There is now mounting evidence of trends in hydrological series. Many areas face a drying and warming climate and thus potentially less water availability;
- **Increasing vulnerability to severe weather events:** the Intergovernmental Panel on Climate Change Technical Paper on Climate Change and Water highlights the potential for more frequent and more severe weather events. With increasing populations at risk and the potential for a shift in the risk profile in many areas, safety of life and property will remain high on the agenda;
- **Growing urban demand:** the population of urban centres continues to grow and urban areas continue to spread, thus placing greater pressure on water supply systems as well as reducing the availability of arable land, and, in some cases, placing increased pressure on water supply catchments;
- **Over-allocation of existing supplies:** the water in many supply systems has been allocated on the basis of past availability or existing demand and has not been kept in line with current or future availability; thus, many systems are over-allocated;
- **Unrestricted extractions:** in many areas, there are no management plans or restrictions on water extractions (for example, pumping from rivers and groundwater extractions). These have resulted in less water being available and have in some case led to mining of the resource. The expansion of farm dams in some areas also reduces the supply of water entering river systems;
- **Land-use change:** clear-felling, expanding plantations and the opening of new areas to agriculture all have impacts on the water resource; unintended events, such as bushfires, can lead to a reduction in the availability of water and water-quality problems. Changes to land use, even within agricultural areas, have implications for both water availability and water use;
- **Environmental requirements:** there has been an increasing emphasis on the requirement for environmental flows to maintain ecosystems such as wetland and in-stream environments. Community expectations are that we should see the environment as a rightful and high-priority user of water.

"Success touches the one who works Hard and Smart...."

All the best from

Team

