

CONSERVATION OF NATURAL RESOURCES

BCV755B

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SYLLABUS

MODULE 1:

Land: Land as a resource, types of lands, conservation of land forms, deforestation, effect of land use changes. Soil health, ecological and economic importance of soil, impact of soil degradation on agriculture and food security, need for soil conservation, sustainable land use planning.



MODULE 1

WHAT IS CONSERVATION OF NATURAL RESOURCES?

- The conservation of natural resources refers to the sustainable management and responsible use of Earth's limited resources to ensure their availability for future generations.
- These resources include air, water, land, minerals, plants, and animals.
- Conservation aims to prevent depletion, degradation, or loss of these resources by employing various strategies such as reducing consumption, recycling, protecting habitats, implementing sustainable practices in agriculture and industry, and promoting environmental awareness and education.



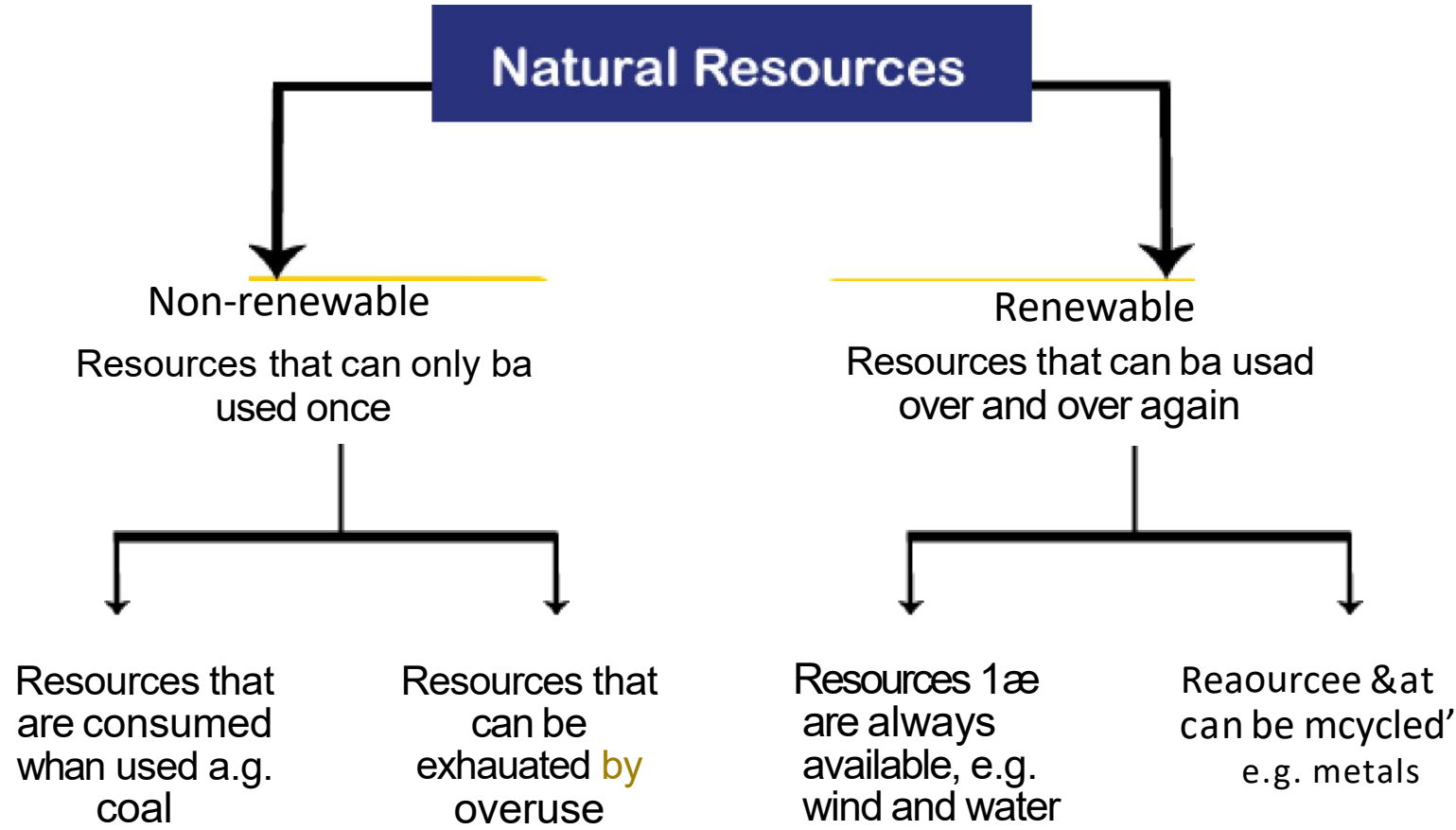
WHY SHOULD WE CONSERVE NATURAL RESOURCES?

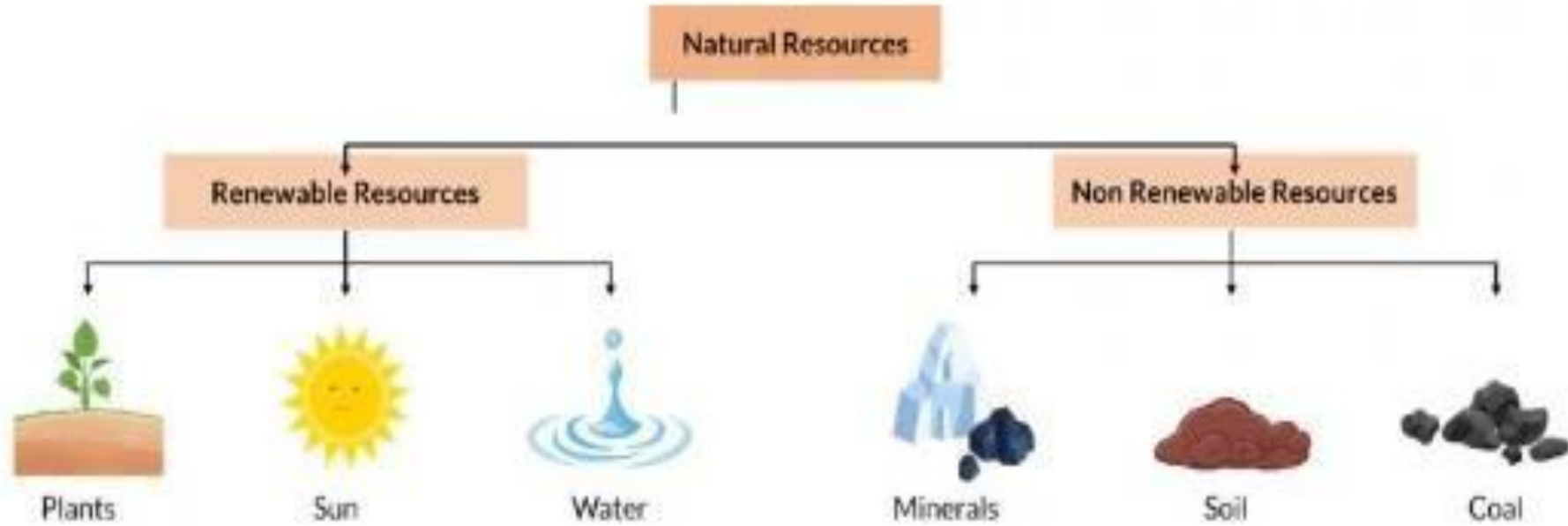
- To maintain ecological balance for supporting life
- To preserve different types of biodiversity
- To preserve the natural resources for the present and future generations.
- To ensure the survival of human race.



WHAT IS NATURAL RESOURCES?

- Natural resources are those that exist in nature without any human intervention or effort. This covers all desirable traits like magnetic, electrical, and gravitational forces, among others.
- When referring to Earth, it is understood to include all the water, sunlight, atmosphere, land, and minerals, as well as all of the plants, crops, and animal life that naturally exist on or within these recognized and identifiable elements.
- Natural resources are those that can be found in nature but do not require human involvement to be developed. Air, sunlight, soil, water, plants, animals, and fossil fuels are a few common examples of natural resources.
- Natural resources are substances that exist naturally. Many of them directly benefit people, while others can still benefit from the use of various technology.





NATURAL RESOURCES ARE SPLIT INTO TWO GROUPS: RENEWABLE AND NON-RENEWABLE:

- ❖ Natural resources that can be generated after usage are known as **renewable resources**. Sunlight, water, and wood are a few examples of renewable natural resources.

Advantages	Disadvantages
Sustainable	Difficult to produce large quantities
Requires little maintenance	The reliability of supply is often dependent on weather
Produces little waste	

❖ **A nonrenewable resource** is a naturally occurring substance that cannot be replenished at the rate that it is depleted.

One example of this is **natural gas**. **Coal** is another example of a non-renewable natural resource. There are numerous other natural resources, similar to coal, that are finite and cannot be reprocessed. Since the majority of these non-renewable natural resources cannot be recycled, it is crucial to conserve them. There are some natural resources that are in great demand but are less common.

Advantages	Disadvantages
Supplies are abundant so the cost is cheap	Non sustainable . We will run out
Can produce large amounts of energy	The use of them can produce pollutants

SOME IMPORTANT NATURAL RESOURCES ARE:

- ❖ LAND RESOURCES
- ❖ WATER RESOURCES
- ❖ AIR RESOURCES
- ❖ FOREST RESOURCES
- ❖ WILDLIFE RESOURCES
- ❖ MINERAL RESOURCES
- ❖ ENERGY RESOURCES
- ❖ MICROBIAL RESOURCES

LAND AS A RESOURCE:

- ❖ Land is regarded as a the greatest among the natural resources. It is one of the important component of life support system.
- ❖ Land is most simply defined as “ **The solid portion of the earth surface**”.
- ❖ It is a significant natural resources which plays an important role in the development of human society.



IMPORTANCE OF LAND:

- It sustains many of the living beings.
- Agricultural activities , animal husbandry
- It supports forests and grasslands
- Human settlement and wildlife depends on land
- Industrialization , urbanization
- Construction of roads and railway lines is possible due to availability of land.

USES OF LAND:

- Land is used for agriculture.
- Land contains huge amount of minerals
- It also contains water in the form of underground water
- Most of the animals have their habitat on land
- Land provides all the resources required to fulfil the basic needs of human civilization such as food, cloth and shelter.

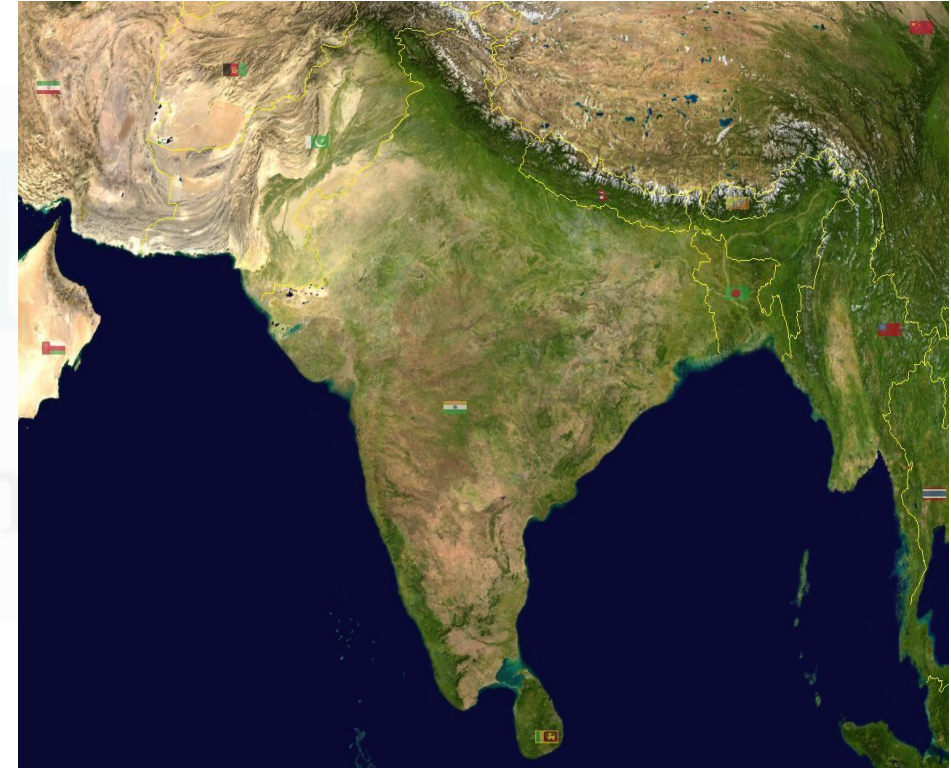
TYPES OF LAND:

- Agricultural Land
- Residential land
- Commercial land
- Industrial Land
- Agricultural land conversion to non agricultural use
- Forest
- Desert
- Special Economic zones
- Eco-sensitive and reserved lands

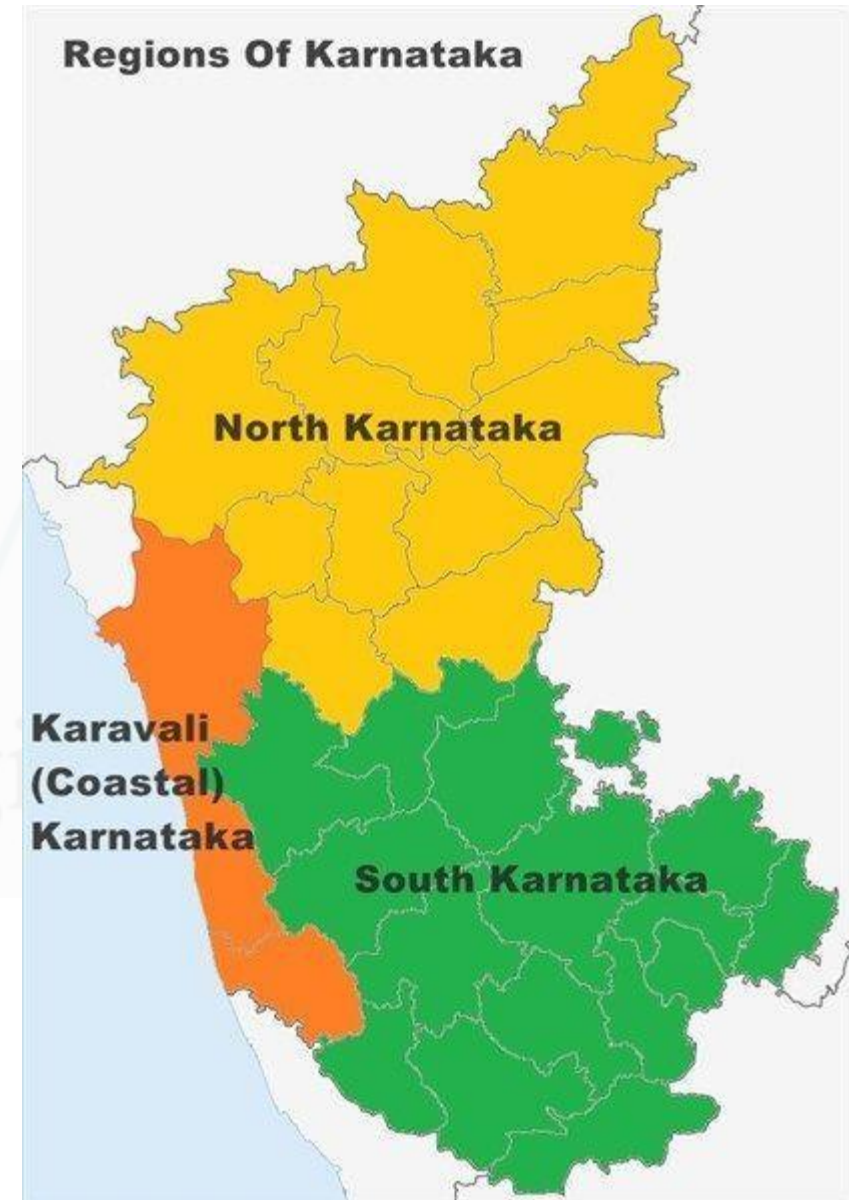
- Earth's land covers 29.2%, or 149 million km² (58 million sq mi) of Earth's surface.
- The largest country in the world is Russia with a total area of 17,098,242 Km² (6,601,665 mi²) and a land area of 16,376,870 Km² (6,323,142 mi²).
- Vatican City, which is the world's smallest country. It covers just 0.17 square mile (0.44 square km).



- **India** covers an area of 32,87,263 sq. km (91% land area), extending from the snow-covered Himalayan heights to the tropical rain forests of the south.
- **Rajasthan** is the largest state of India in terms of area. It covers an area of more than 342,000 square kilometers. 10.4% of the country's land area is in Rajasthan.
- **Goa** is the smallest state in India, with an area of 3702 sq - km. The state is on the Indian coast in the south-west corner.



- **Karnataka's** total land area is 1,91,791 sq.km, accounting for 5.83 percent of the total area of the country (32.88 lakh sq.km) and ranks eighth among major States in terms of size.
- Belagavi is the largest district in Karnataka. It is around 13,400 square kilometer in area.
- Bengaluru Urban is the smallest district in Karnataka. It is around 2196 square kilometer in area.



- ❖ **Agricultural land** is typically land devoted to agriculture, the systematic and controlled use of other forms of life—particularly the rearing of livestock and production of crops—to produce food for humans. It is generally synonymous with both farmland or cropland, as well as pasture or rangeland
- ❖ **A residential area** is a land used in which housing predominates, as opposed to industrial and commercial areas. It includes all places where people live. Generally largest land use in most cities often taking up to 40% or more of the developed land. The two factors which influence residential density are **cost of land** and **age of the neighborhood**.



- ❖ **Commercial land** is a distinct category of investment properties that are meant to be income-producing. Commercial land is appraised differently than residential land and also treated differently by municipalities and infrastructure providers. The value of residential real estate tends to rise every year but commercial land can fluctuate wildly based on where it is located and what other properties are located (or going to locate) nearby.



❖ **Industrial property** refers to land that is used for industrial purposes. It includes small, large and enormous.

- **Small industrial sites:** These sites include single or double-storey buildings zoned for industrial use. These often have flexible interior space, usually a mix of warehouse and office space. These spaces are commonly used by businesses like mechanics, start-ups and laboratories.
- **Large industrial sites:** These sites include medium to large warehouses and factories that manufacture or store goods. They also include distribution companies such as third party logistics.
- **Enormous spaces:** Enormous industrial spaces are preferred by logistics and distribution companies that hold and distribute finished goods to stores and/or directly to customers.



- ❖ **Agricultural land conversion to non agricultural use** in some cases agricultural land may be converted to non agricultural use, such as commercial or residential purposes. This process involves obtaining necessary **approvals** and **adhering** to the land use regulations set by local authorities.
- ❖ **Forests :** A forest is a complex ecological system in which trees are the dominant life-form. A forest is nature's most efficient ecosystem, with a high rate of photosynthesis affecting both plant and animal systems in a series of complex organic relationships.
- ❖ **Deserts:** A desert is a barren area of landscape where little precipitation occurs and, consequently, living conditions are hostile for plant and animal life. Deserts are formed by weathering processes as large variations in temperature between day and night put strains on the rocks, which consequently break in pieces.

- ❖ **Special Economic zones (SEZ's)** are designated areas within the country aimed at promoting export oriented industries and boosting economic growth. They offer various incentives, such as tax benefits and simplified customs procedures to attract investments and facilitate trade.
- ❖ **Eco-sensitive and reserved lands** to preserve the environment and protect natural habitats and certain areas are marked as eco sensitive and reserved lands. These regions may include wildlife sanctuaries, national parks and forests reserves where development is restricted to ensure ecological balance and conserve biodiversity.

LAND FORMS:

- ❖ Landforms are features on the Earth's surface that make up the terrain, such as mountains, valleys, plains or plateau.
- ❖ They also include coastal features, such as peninsulas or bays, and underwater features, such as ocean basins and mid-ocean ridges.
- ❖ Landforms are categorized by characteristic physical attributes such as elevation, slope, orientation, stratification, rock exposure, and soil type

CONSERVATION OF LAND FORMS:

- ❖ Conservation of land resources is the sustainable use and management of land resources.
- ❖ It includes the conservation of soil, water, plants, and animals.
- ❖ Conservation of land resources helps to protect the environment and to ensure that there is enough food and water for future generations.

There are many ways to conserve land resources,

1. Reduce the use of harmful chemicals
2. Prevent or reduce soil erosion
3. Reduce deforestation



PROTECTION OF LAND FORMS:



SLOPE PROTECTION



GLACIER PROTECTION



CAVE PROTECTION



RIVER BANK PROTECTION



WETLAND PROTECTION



FOREST PROTECTION

TYPES OF LAND FORMS:



EXAMPLES IN INDIA LANDFORM:

- ☐ The Great mountains through Sikkim.
- ☐ The Thar Desert through Rajasthan.
- ☐ The Great Northern Plains through Delhi.
- ☐ The Peninsular Plateau through Maharashtra.
- ☐ The Coastal Areas and Islands through Andaman and Nicobar Island

DEFORESTATION:

- ❖ **Deforestation**, the clearing or thinning of forests by humans. Deforestation represents one of the largest issues in global land use.
- ❖ Estimates of deforestation traditionally are based on the area of forest cleared for human use, including removal of the trees for wood products and for croplands and grazing lands.
- ❖ In the practice of clear-cutting, all the trees are removed from the land, which completely destroys the forest.
- ❖ In some cases, however, even partial logging and accidental fires thin out the trees enough to change the forest structure dramatically.

CAUSES OF DEFORESTATION:

1. Shifting cultivation or jhum cultivation:

- ❖ This practice is prevalent in tribal areas where forest lands are cleared to grow subsistence crops.
- ❖ It is estimated that principle cause of deforestation in tropics in Africa, Asia and tropical America is estimated to be 70, 50, and 35% respectively.
- ❖ Shifting cultivation which is a practice of slash and burn agriculture are possess to clear more than 5 lakh hectares of land annually.
- ❖ In India, shifting cultivation is prevalent in northeast and to limited extent in M.P, Bihar and Andhra Pradesh and is contributing significantly to deforestation.

2. Commercial logging

- ❖ It is an important deforestation agent. It may not be the primary cause but definitely it acts as secondary cause, because new logging lots permits shifting cultivation and fuel wood gatherers access to new logged areas.

3. Need for fuel wood

- ❖ Increased population has lead to increasing demand for fuel wood which is also acting as an important deforestation agent, particularly in dry forest.

4. Expansion for agribusiness

- ❖ With the addition of cash crops such as oil palm, rubber, fruits and ornamental plants, there is stress to expand the area for agribusiness products which results in deforestation.

5. Development projects and growing need for food

- ❖ The growing demand for electricity, irrigation, construction, mining, etc. has lead to destruction of forest. Increased population needs more food which has compelled for increasing area under agriculture crops compelling for deforestation.

6. Raw materials for industrial use

- ❖ Forest provides raw material for industry and it has exerted tremendous pressure on forest. Increasing demand for plywood for backing has exerted pressure on cutting of other species such as fir to be used as backing material for apple in J&K and tea in northeast states.

MAJOR EFFECTS OF DEFORESTATION:

Deforestation adversely and directly affects and damages the environment and living being.

1. Soil erosion and loss of soil fertility .
2. Decrease of rain fall due to effect of hydrological cycle.
3. Expansion of deserts.
4. Climate change and depletion of water table.
5. Loss of biodiversity, flora and fauna.
6. Environmental changes and disturbance in forest ecosystems.

HOW TO AVOID DEFORESTATION:

- The best way to stop deforestation is replanting.
- Ban on cutting of trees and new trees and planting more.
- There should be an implementation of regulations of laws at organizational and governmental levels due to the extent of deforestation.
- Spread the awareness about sensitization and organize educative campaigns about the effects of deforestation.

LAND USE & LAND USE CHANGE:

- ❖ **Land use** describes the human purposes for which an area of land is managed, such as for agricultural, industrial, recreational, or residential activities.
- ❖ Land use is separate from “**land cover**”, which describes the physical type of land rather than what it is used for.
- ❖ When reporting on national GHG emissions, countries sort land use into the following categories as forest land, cropland, grassland, wetlands, settlements, and other lands.
- ❖ **Land use change** refers to the conversion of an area of land's use by humans from one state to another. Land may be converted from grassland to cropland, or from wilderness to land to graze cattle.

EFFECTS OF LAND USE CHANGE:

- ❖ Ecosystems such as peatlands, grasslands, and forests are typically natural carbon “sinks,” that they absorb more carbon than they release.
- ❖ Clearing vegetation, draining wetlands, cutting down trees, and plowing soil so that wild areas can be converted to farmland releases stored carbon into the atmosphere, mainly in the form of carbon dioxide, and reduces the capacity of the land to sequester **human-caused carbon emissions**.
- ❖ Land use changes are a key source of carbon dioxide, nitrous oxide, and methane, accounting for an estimated 23 percent of global greenhouse gas emissions, but can impact the climate in other ways too.
- ❖ Land use change often causes land cover change, which is in turn closely linked with climate change.

- ❖ The conversion of tropical forests to agricultural land impacts the climate of a region by disrupting these natural processes. Changes in vegetation cover affect Earth's surface energy balance which can result in warmer or cooler surface temperatures.
- ❖ Land use change has an enormous **negative** impact on the **natural environment**. The conversion of wildlife habitats to farmland and the increasingly intensive use of existing agricultural land drive which causes of land degradation.
- ❖ Land use change for agriculture, especially meat and dairy production, is harming the planet (and all who live on it) in numerous ways.



SOIL HEALTH:

- ❖ Soil health is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans. Creating and maintaining a healthy soil is more than just reducing erosion. The benefits of a healthy soil go far beyond crop production.



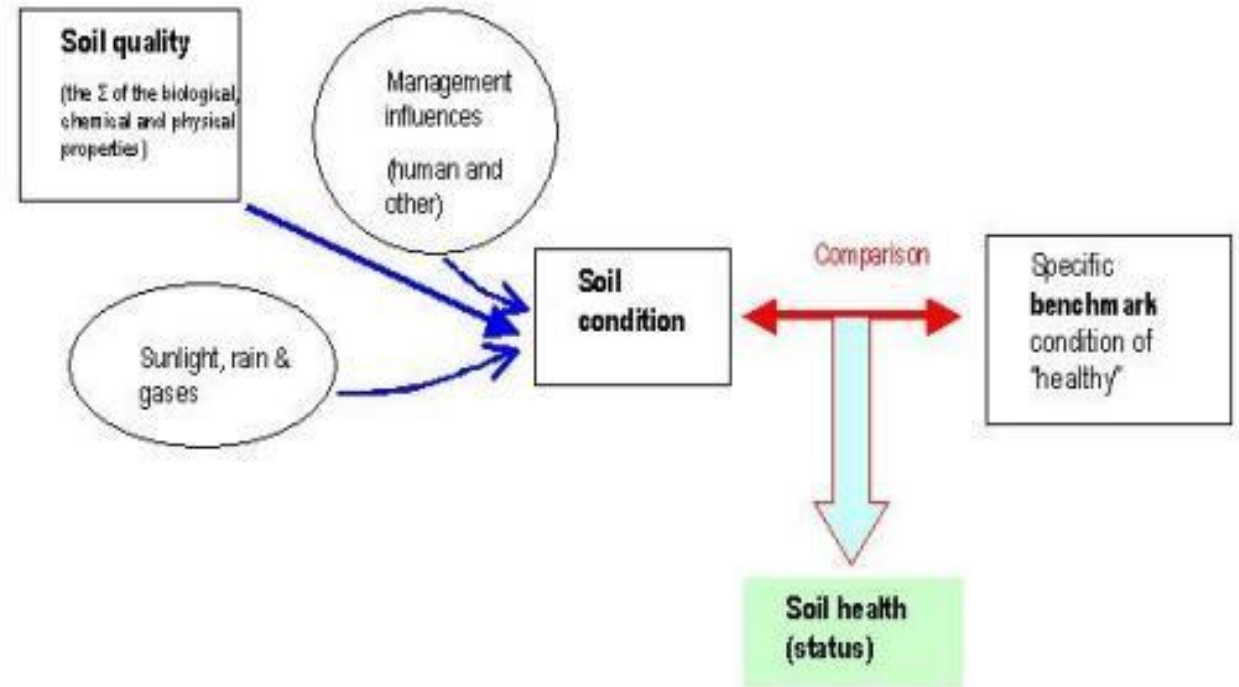
The USDA Natural Resources Conservation Service (NRCS) has identified four principles for improving soil health and sustainability:

1. Use plant diversity to increase diversity in the soil.
2. Manage soils more by disturbing them less.
3. Keep plants growing throughout the year to feed the soil.
4. Keep the soil covered as much as possible.
5. Integrate livestock to recycle nutrients and increase plant diversity.

A healthy soil has good water infiltration and retention. The biological activity within the soil increases soil fertility and helps build good soil structure. These things reduce the need for expensive inputs and increase plant resilience to drought, pests and intense rains.

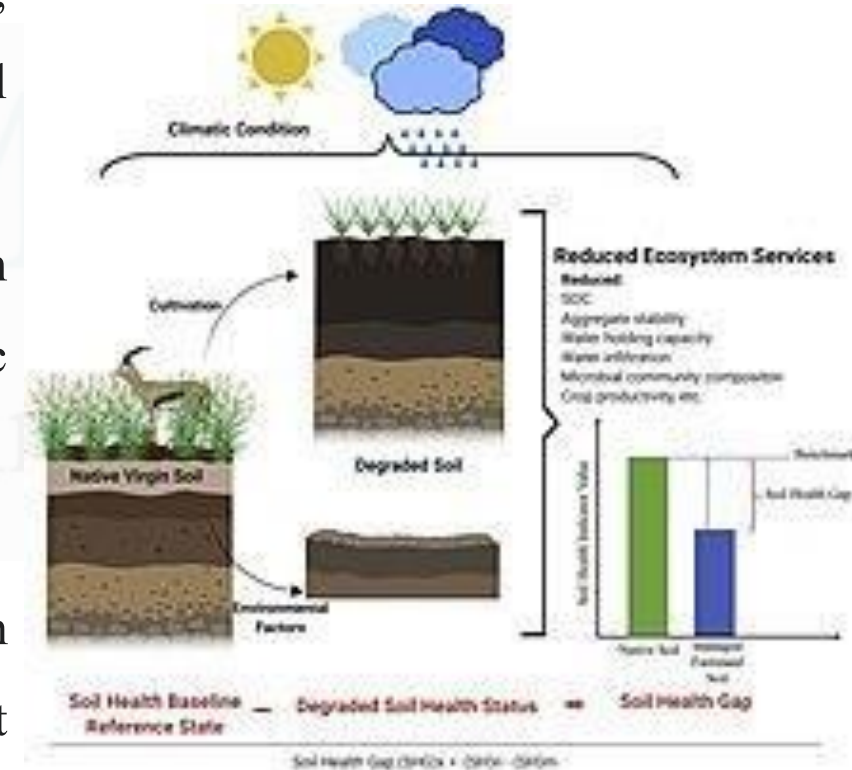
The generic aspects defining a healthy soil can be considered as follows:

- ❑ “Productive” options are broad
- ❑ Life diversity is broad
- ❑ Absorbency, storing, recycling and processing is high in relation to limits set by climate
- ❑ Water runoff quality is of high standard
- ❑ Low entropy and
- ❑ No damage to or loss of the fundamental components



SOIL HEALTH GAP:

- ❖ Importance of soil for global food security, agro-ecosystem, environment, and human life has exponentially shifted the trends of research towards soil health.
- ❖ However, lack of a site/region specific benchmark has limited the research effort towards understanding the true effect of different agronomic managements on soil health.
- ❖ In 2020, Maharjan and his team, introduces a new term and concept "Soil Health Gap" and described how native land in particular region can help in establishing the benchmark to compare the efficacies of different management practices and at the same time it can be used in understanding quantitative difference in soil health status.



ECOLOGICAL AND ECONOMIC IMPORTANCE OF SOIL:

Ecological Importance:

- ❖ Advances in watershed, natural resource, and environmental sciences have shown that soil is the foundation of basic ecosystem function.
- ❖ Soil filters our water, provides essential nutrients to our forests and crops, and helps regulate the Earth's temperature as well as many of the important greenhouse gases.
- ❖ As our awareness of the value of natural and managed ecosystems services grows, new biodiversity, carbon, and water markets are emerging, such as the Chicago Climate Exchange, and the nutrient trading programs under the new
- ❖ Executive Order on the Protection and Restoration of the Chesapeake Bay. These markets place an economic value on management practices which increase those ecosystem services, producing goods that enhance human and environmental health.



Economic Importance:

- ❖ Soil plays a crucial role in the economy of countries. Farming and agricultural industries are probably the most reliant upon soil, particularly in respect to crop production, which has risen dramatically in the last 50 years in order to cope with the demands of an equally rapidly growing global population.
- ❖ The demand for more crops has increased the demand for plant nutrients in the form of fertilisers. For a long time, many farms relied on animal manure for this. However most farms in the west now use artificial fertilisers, because it allows more control over which nutrients should be applied to the soil and when.
- ❖ There are many other economic land uses that are dependent on the soil, particularly forestry. Trees are usually longer term 'crops' in which an important relationship is built up with the soil to establish a nutrient balance.

IMPACT OF SOIL DEGRADATION ON AGRICULTURE AND FOOD SECURITY

- ❖ Soils are essential natural resources that serve as the foundation for all terrestrial life, making the prevention of soil degradation crucial for our well-being.
- ❖ Soil degradation describes what happens when the quality of soil declines and diminishes its capacity to support animals and plants. Soil can lose certain physical, chemical or biological qualities that underpin the web of life within it.
- ❖ Soil erosion is a part of soil degradation. It's when the topsoil and nutrients are lost either naturally, such as via wind erosion, or due to human actions, such as poor land management.
- ❖ Soil degradation can have disastrous effects around the world such as landslides and floods, an increase in pollution, desertification and a decline in global food production. One of the biggest threats to our future food security is land degradation and the associated loss in soil productivity.

SOIL DEGRADATION CAN INVOLVE,

- ❖ Water erosion (includes sheet, rill and gully erosion)
- ❖ Wind erosion
- ❖ Salinity (includes dry land, irrigation and urban salinity)
- ❖ loss of organic matter
- ❖ fertility decline
- ❖ soil acidity or alkalinity
- ❖ structure decline (includes soil compaction and surface sealing)
- ❖ Mass movement
- ❖ Soil contamination

IMPACT OF SOIL DEGRADATION ON AGRICULTURE:

1. The effects of soil erosion go beyond the loss of fertile land.
2. It has led to increased pollution and sedimentation in streams and rivers, clogging these waterways and causing declines in fish and other species. And degraded lands are also often less able to hold onto water, which can worsen flooding.
3. Because soil degradation contributes to land degradation, it also means that it creates a significant loss of arable land. As stated earlier, about 40% of the world's agricultural land is lost on the account of soil quality depreciation caused by agrochemicals and soil erosion.
4. Most of the crop production practices result in the topsoil loss and the damage of soil's natural composition that makes agriculture possible.

5. Widespread land degradation has a direct and adverse impact on the food and livelihood security of farmers. Basically, degradation is caused by erosion, which results in the loss of topsoil through the action of water and wind, or waterlogging, which results in soil salinization.
6. Sustainability of agricultural production systems depends on their carbon (C) footprint and the C output-input ratio.
- i) The C-sustainability index was high in 1960, and was indicative of the minimum usage of inputs prior to the onset of the Green Revolution
 - (ii) Thereafter, the C-sustainability index decreased because of greater C-based inputs, in which a linear relationship exists between C inputs and C outputs.

IMPACT OF SOIL DEGRADATION ON FOOD SECURITY:

- ❖ Soils constitute the foundation for agricultural development, essential ecosystem functions and food security and hence are key to sustaining life on Earth that get disturbed.
- ❖ Experts warn us that addressing the stagnating yields of our most important croplands is of paramount importance; failure to identify and alleviate the causes of yield stagnation, or reduction, will have a major impact on the future of global food security.
- ❖ Many issues, including yield reduction, have coalesced to determine agricultural trends in recent decades (e.g., population pressure, water supply, markets, policies, climate).
- ❖ Soil degradation is causing a decline in crop productivity and huge economic Sustainability loss, putting the food security and livelihood of farmers at risk need for soil conservation sustainable land use planning.

- ❖ The overall effects of soil degradation pose a major threat to food security especially in poor regions. FAO (The Food and Agriculture Organization of the United Nations) highlights that there is a strong relation between land degradation and poverty. It is urgent, therefore, to act to halt soil degradation and adopt practices to improve soil health.
- ❖ Arable land is regarded as the best and most productive land available; it is generally cropped with cereals or highly profitable crops. Therefore, a reduction in arable land on a per capita basis may affect food production and, most importantly for the poor countries, food security. A reduction in arable land per capita generally forces a country to increase land productivity (increasing the inputs), expand the land used for production (possible marginal land, or converting forests) and/or rely on imports.

SOIL CONSERVATION

- ❖ Soil conservation is the prevention of soil loss from erosion or the prevention of reduced fertility caused by overuse, acidification, salinization, or other chemical soil contamination.
- ❖ It is the process of protecting soil from damage caused by natural or human activities. This includes preventing soil erosion, improving soil quality, and maintaining soil health.

Reduce Soil
Erosion

improve Soil
Fertility

increase Crop Yield

Increase water
Infiltration and
Storage

Providing
Wildlife Habitat



NEED/IMPORTANCE OF SOIL CONSERVATION

- ❑ Soils are critical for the existence of life on earth. Plants grow on soils, and they are a source of food for both man and animals. Moreover, the soil is the primary habitat for many organisms.
- ❑ Soils help in the percolation of water and maintain groundwater levels. If soil would not have been there, recharging groundwater would be difficult, and we would have faced water shortage.
- ❑ Soils also act as a natural filtration system for surface water. They absorb all the impurities and leave behind fresh, pure water on the surface for our use.
- ❑ Soils have a major role in maintaining the climate of the Earth; they are the second largest carbon sink after oceans. Carbon dioxide is stored in the soil by plants through the process of photosynthesis. As per some estimates, the carbon pool in soil stands at 2500 billion tonnes.
- ❑ Soils absorb excess rainwater and play an important role in mitigating floods.
- ❑ The fertile alluvial soils of Indo-Ganga Plains and coastal deltaic region support a significant population as it is ideal for practice farming. Moreover, soils also support development and economic growth as all infrastructure stands on soil only.
- ❑ Soil conservation is important as degradation and acidification of soil are permanent phenomena and cannot be reversed. Once we lose an inch of soil, we will never be able to retrieve the same.

SUSTAINABLE LAND USE PLANNING

- ❖ Land use refers to the manner of utilization of land including its allocation, development and management.
- ❖ Land development can adversely impact water resources but there are many ways to protect natural resources while encouraging economic growth.
- ❖ Planning is expected to integrate environmental, socials and economic values, resolve conflicts, build common land use objectives, ensure openness and inclusiveness as well as adopt to global, national and local needs and preferences.

OBJECTIVES- SUSTAINABLE LAND USE PLANNING

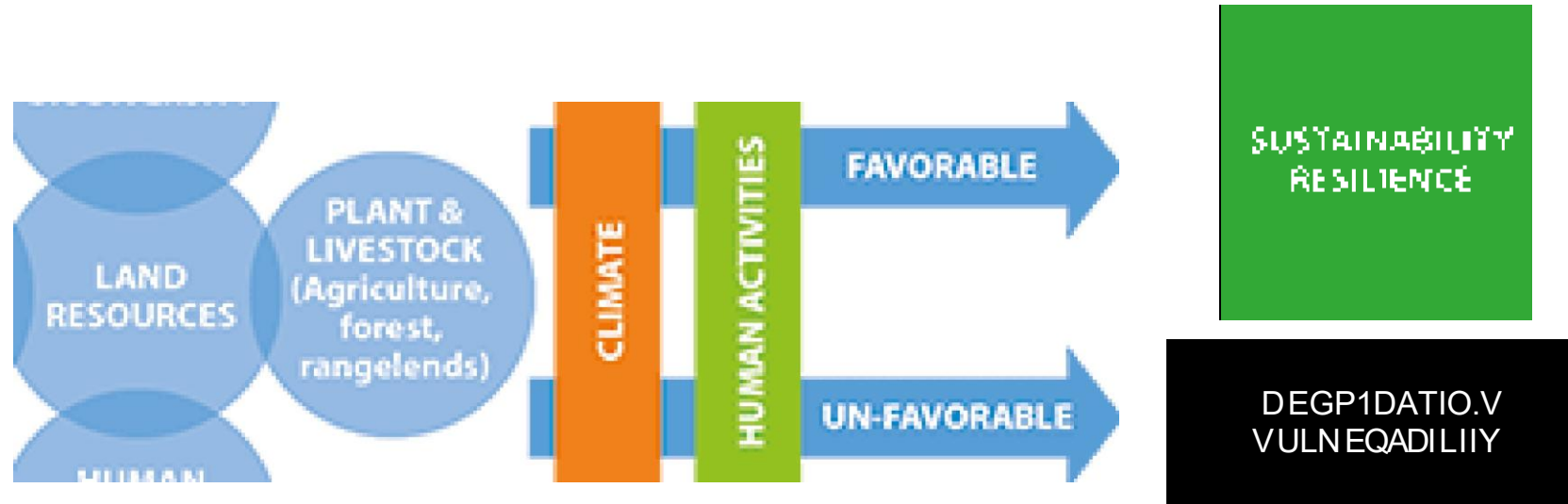
- ❖ To promote efficient utilization, acquisition and disposition of land ensure the highest and best use of land.
- ❖ To direct, harmonize and influence discussions and activities of the private and public sectors relative to the use and management of lands.
- ❖ To reconcile land use conflicts and proposal between and among individuals , private and government entities relative to the present and future need for land.
- ❖ To promote desirable patterns of land uses to prevent wasteful development and minimize the cost of public infrastructure and utilities and other social services.
- ❖ To preserve areas of ecological, aesthetic, historical and cultural significance.

NEED FOR LAND USE PLANNING

- ❖ Land use planning finds its origin in the increasing scarcity of land, the competition for that land by a growing number of users, and the risk that this situation might lead to conflicts.
- ❖ It is equally associated with the growing concern for a protection of the environment and a more sustainable use of space. Farmers have been planning the use of their land for thousands of years. The application of scientific principles to the land use planning process is relatively recent.

LAND USE PLANNING PRINCIPLES

- ❖ Evaluate and record unique features.
- ❖ Preserve unique cultural or historical features
- ❖ Conserve open space and environmental features
- ❖ Calculate additional charges for altering land.
- ❖ Plan for mixed uses in close proximity.
- ❖ Plan variety of transportation options.
- ❖ Set limits and manage growth patterns.
- ❖ Encourage development in areas of existing infrastructure.





CONSERVATION OF NATURAL RESOURCES

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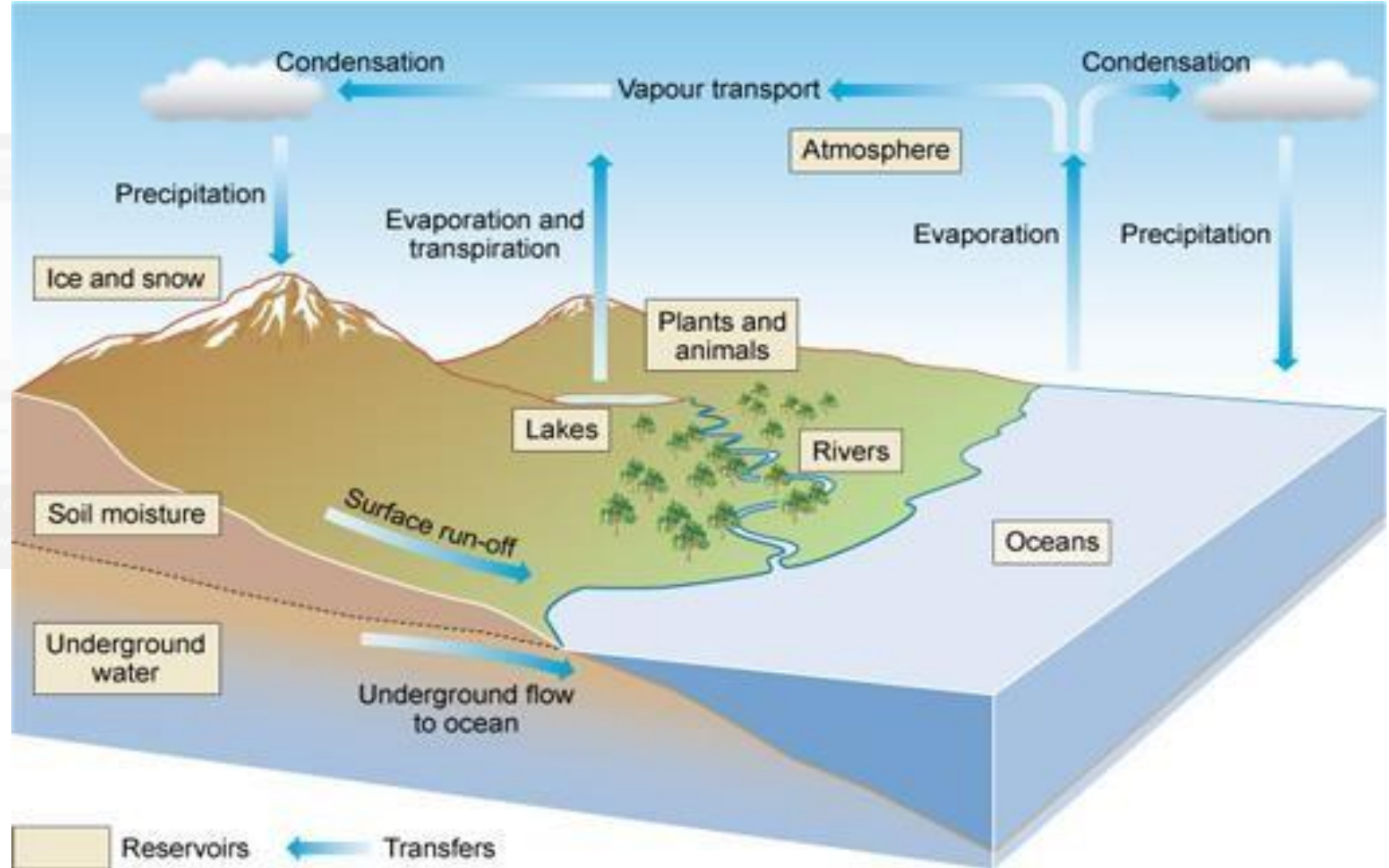
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SYLLABUS

MODULE 2

Water: Global water resources, Indian water resources, Resources system planning. Water use sectors- domestic, industrial, agriculture. Water deficit and water surplus basins in India, equitable distribution, Inter-basin water transfers, Interlinking of rivers – Himalayan component, peninsular component, issues involved. Ground water, its potential in India, conjunctive use, recharge of ground water. Contamination of ground water, sea water ingress, problems and solutions.

WATER RESOURCES



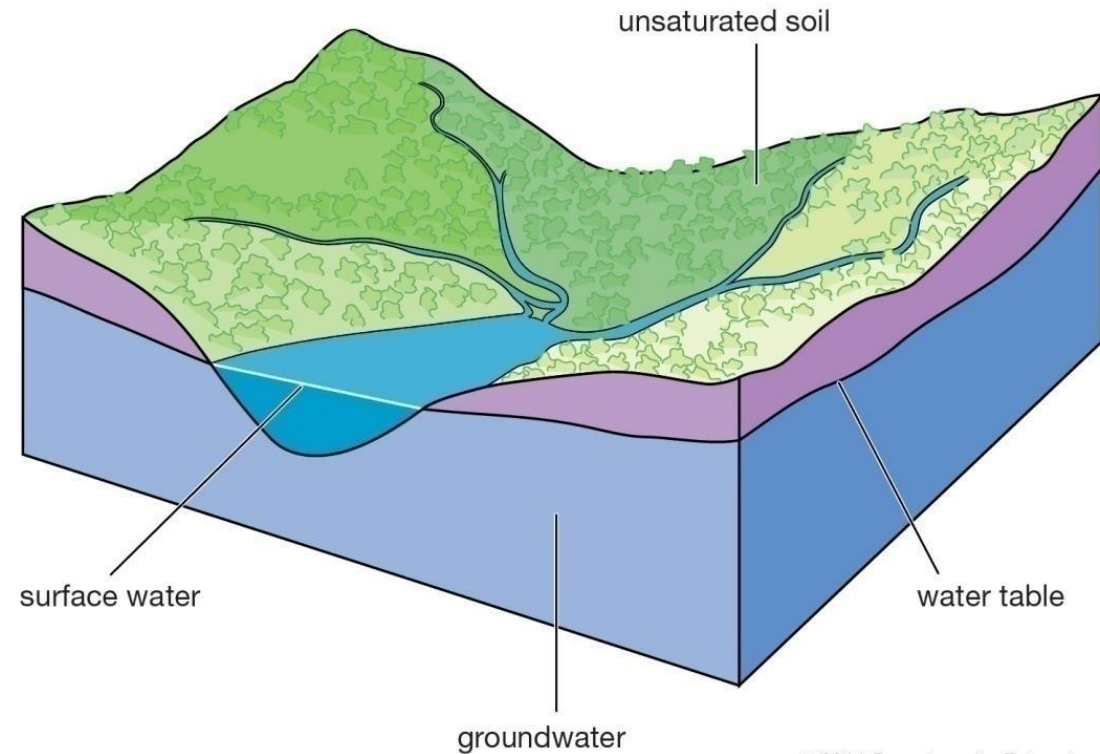
There are two main sources of water: surface water and groundwater.

- **Surface Water** is found in lakes, rivers, and reservoirs.
- **Groundwater** lies under the surface of the land, where it travels through and fills openings in the rocks.
- The rocks that store and transmit groundwater are called aquifers.
- Groundwater must be pumped from an aquifer to the earth's surface for use

SOURCES OF WATER

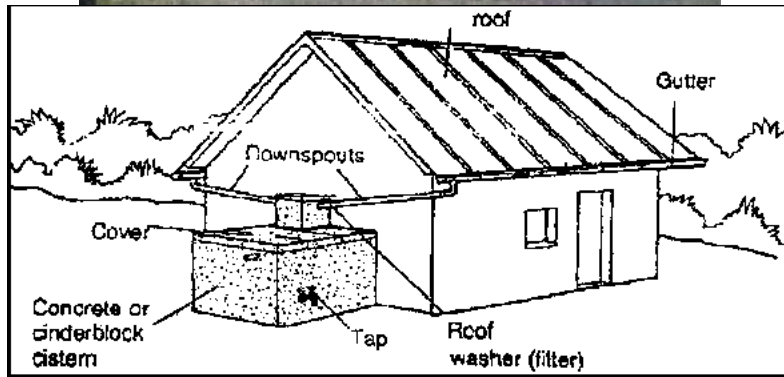
1. Rain Water
2. Surface Water
3. Ground Water
4. Water obtained from reclamation

How the water table looks in a cross section of land



1. RAIN WATER

From the roofs of the houses and dwellings – collected and stored in underground tank or cistern for individual supply



From Prepared catchments – given a suitable lining and slope, collected in small reservoirs for community supply



2. SURFACE WATER

From rivers by continuous draft – without any diversion works. Intakes can be used.



From river diversions- routed through canal into treatment plant.



From reservoir storage

From direct intake from natural lakes



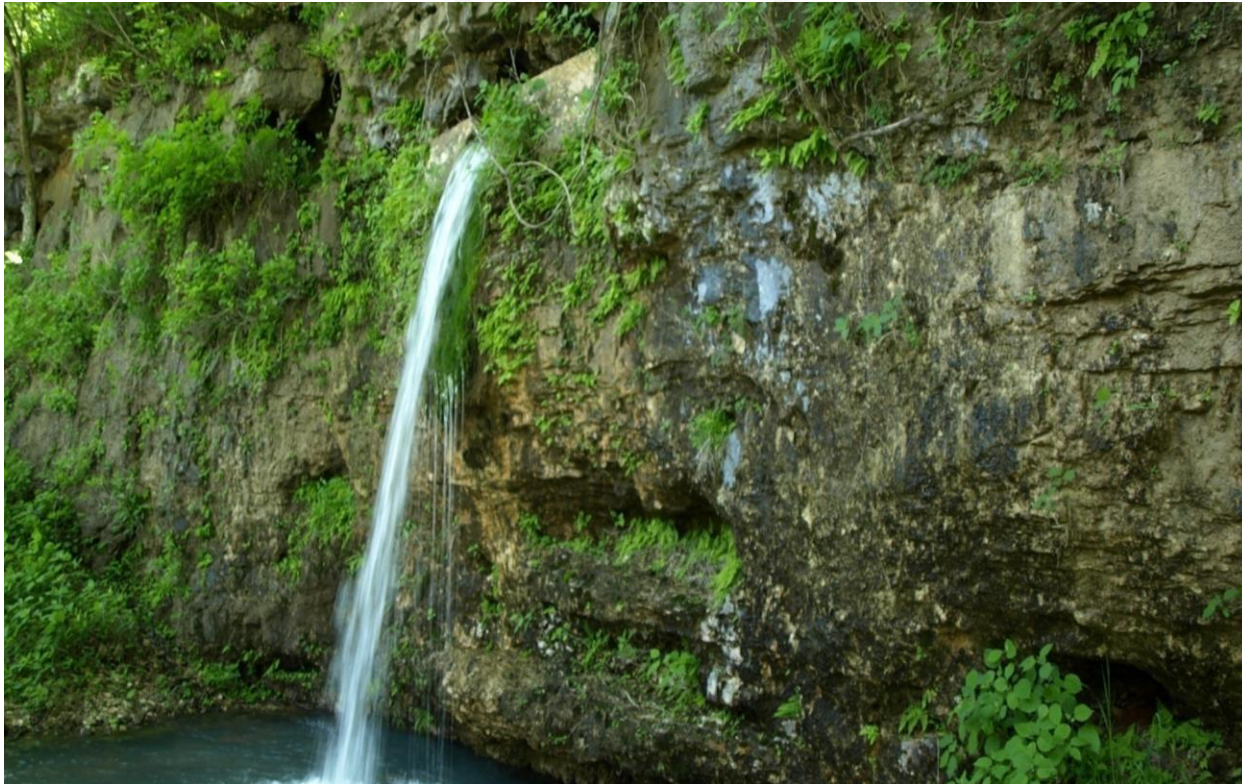
3 GROUND WATER

- a. From natural springs
- b. From wells and bore wells
- c. From infiltration galleries
- d. From river side radial collector wells

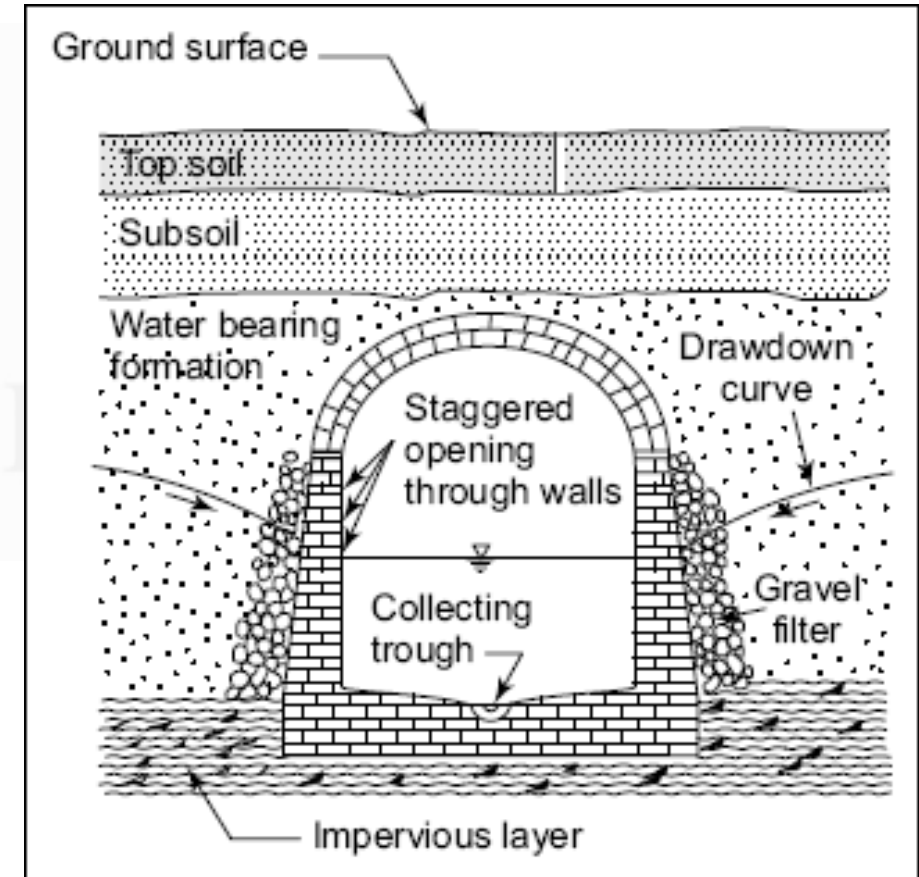
4 WATER OBTAINED FROM RECLAMATION

- a. Desalination
- b. Re-use of treated waste water

NATURAL SPRING



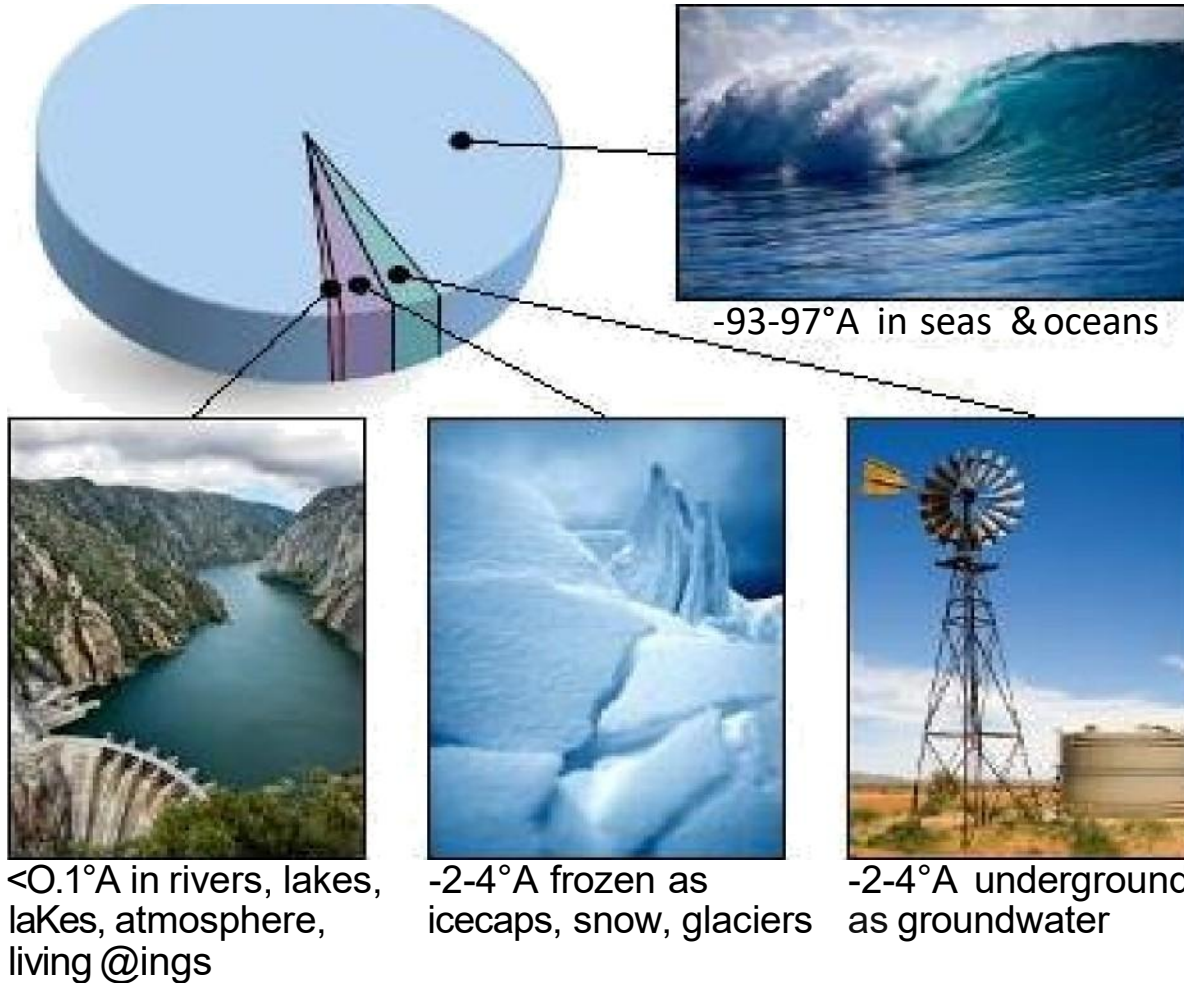
INFILTRATION GALLERIES

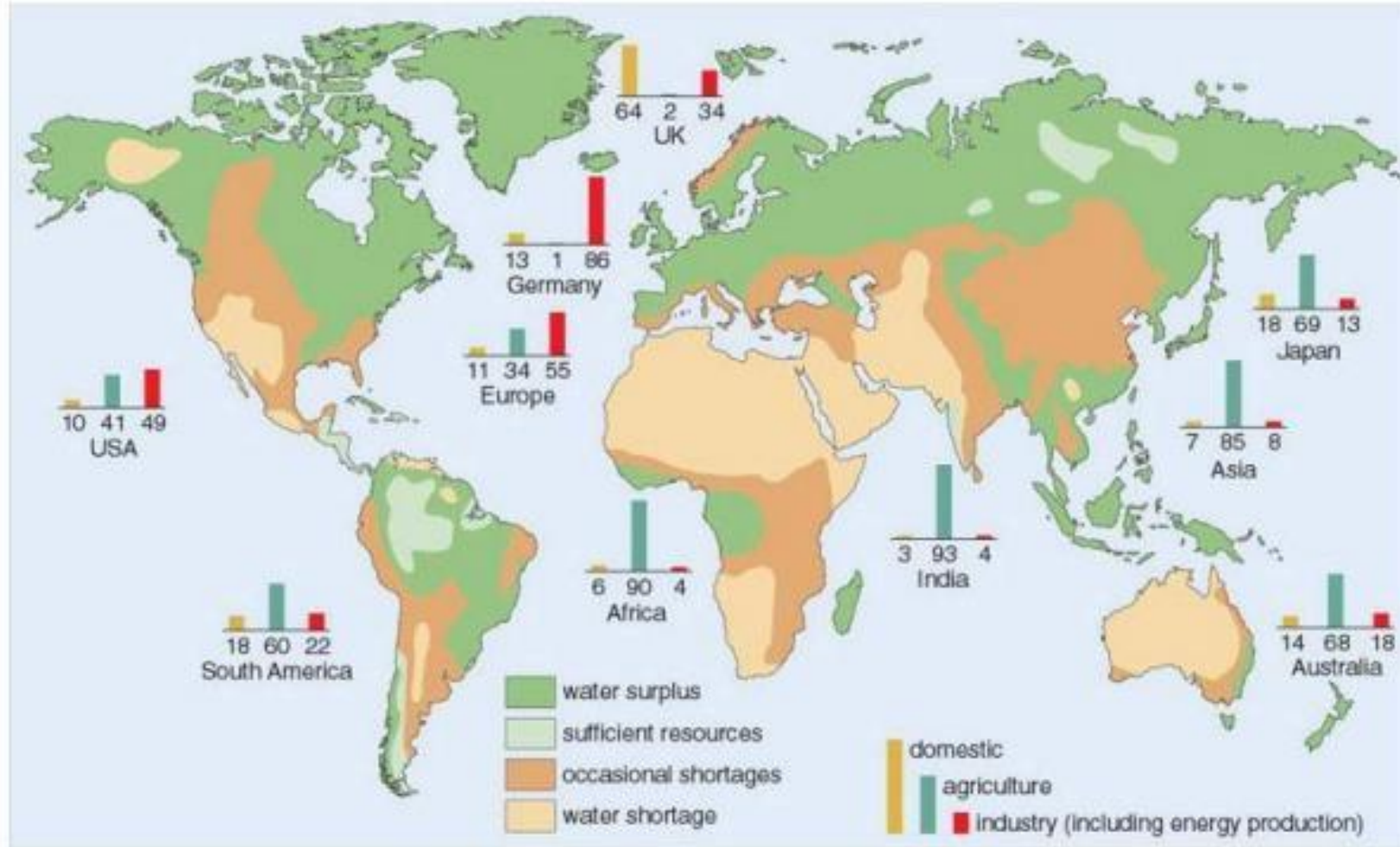


GLOBAL WATER RESOURCES

- ❖ Water resources are natural resources of water that are potentially useful for humans, for example as a source of drinking water supply or irrigation water.
- ❖ 97% of the water on the Earth is salt water and only three percent is fresh water; slightly over two thirds of this is frozen in glaciers and polar ice caps.
- ❖ The remaining unfrozen freshwater is found mainly as groundwater, with only a small fraction present above ground or in the air. Natural sources of fresh water include surface water, under river flow, groundwater and frozen water.
- ❖ Artificial sources of fresh water can include treated wastewater (wastewater reuse) and desalinated seawater. Human uses of water resources include agricultural, industrial, household, recreational and environmental activities.

Global water resources

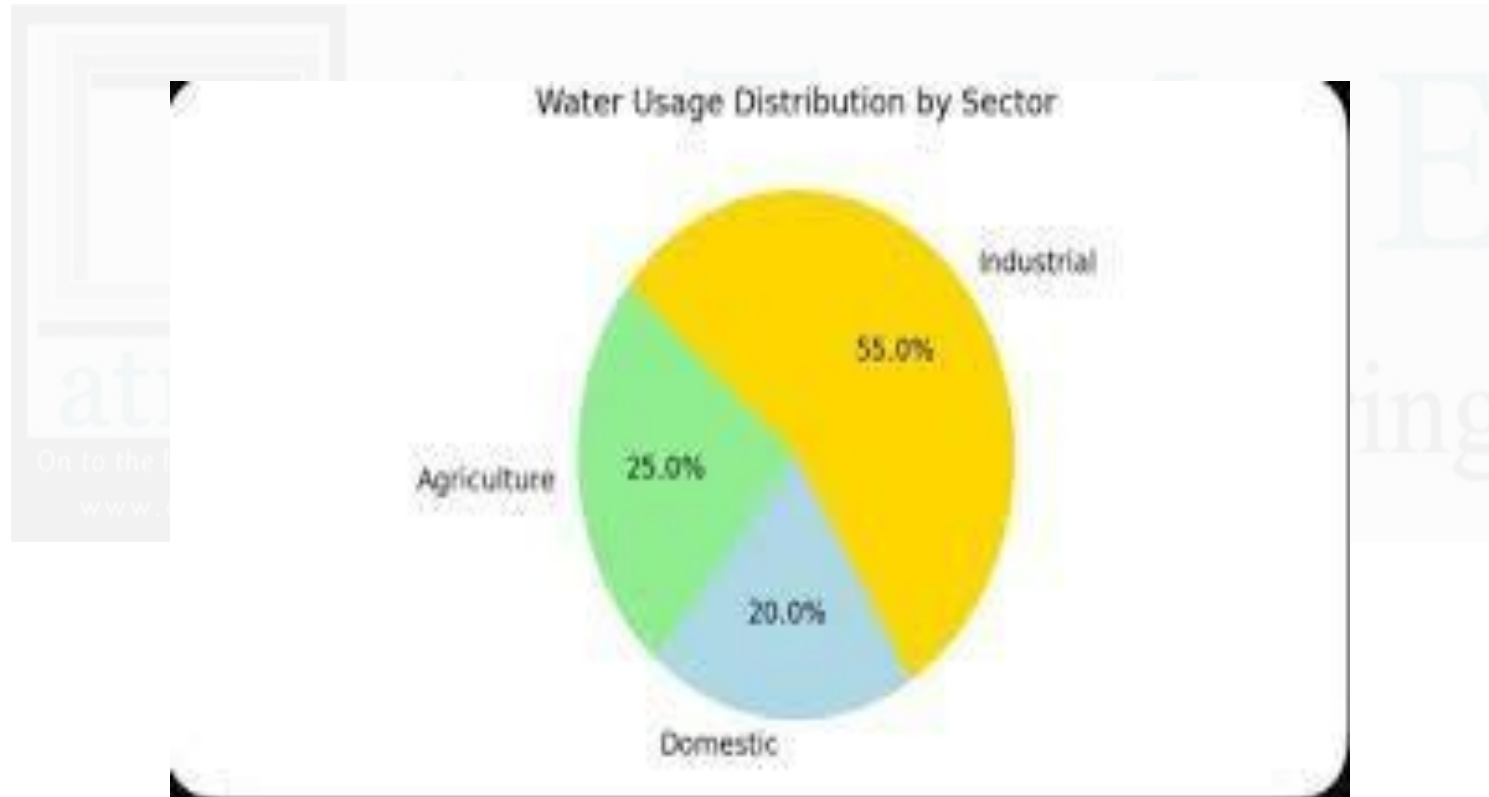




Global water use & distribution

- ❑ Water resources are under threat from water scarcity, water pollution, water conflict and climate change.
- ❑ Fresh water is a renewable resource, yet the world's supply of groundwater is steadily decreasing, with depletion occurring most prominently in Asia, South America and North America, although it is still unclear how much natural renewal balances this usage, and whether ecosystems are threatened.
- ❑ The framework for allocating water resources to water users (where such a framework exists) is known as water rights.

WATER USE SECTORS



DOMESTIC WATER USE

Domestic (household/municipal) water use refers to water supplied for everyday human needs.

- **Drinking and Cooking:** Clean, safe water is essential for drinking and food preparation.
- **Sanitation:** Bathrooms, toilets, and personal hygiene (bathing, washing hands).
- **Household Chores:** Washing clothes, dishes, and cleaning.
- **Gardening and Outdoor Use:** Watering plants, lawns, and small-scale domestic animals.
- **Urban Supply:** Piped water systems, tankers, and borewells supply most households in cities.

INDUSTRIAL WATER USE

Industries require water for **manufacturing, processing, and cooling**.

- **Cooling and Power Generation:** Thermal power plants and large factories use water as a coolant.
- **Processing:** Textile, paper, steel, cement, and chemical industries consume huge quantities.
- **Cleaning and Washing:** Equipment and raw materials are washed regularly.
- **Product Ingredient:** Beverages, pharmaceuticals, and food industries use water as a direct input.
- **Wastewater Discharge:** A significant portion becomes effluent and needs treatment.

AGRICULTURAL WATER USE

Agriculture is the **largest consumer of water**, especially in India.

- **Irrigation:** Major share for canals, borewells, and tube wells to grow crops.
- **Crop Types:** Water-intensive crops (rice, sugarcane, cotton) require more irrigation.
- **Livestock:** Water is needed for drinking, washing, and maintaining animal shelters.
- **Aquaculture:** Fish farming is also a growing water-use sector.
- **Methods:** Traditional flood irrigation wastes water; modern methods (drip, sprinkler) save up to 40–50%

NAME OF INDIAN WATER RESOURCES

RIVERS OF INDIA

India is blessed with many rivers. Land slope determines the river to which the rain falling on an area will eventually flow. A river basin, also called catchment area of the river, is the area from which the rain will flow into that particular river. The shape and size of the river basin is determined by the topography. Following are the major river basins groups in India.

- **Indus system**

This comprises the river Indus and its tributaries like the Jhelum, Chenab, Ravi, Beas and Sutlej. These originate in the North and generally flow in a West or South-West direction to eventually flow into Arabian Sea through Pakistan.

❑ **Ganga-Brahmaputra-Meghana**

system

The main river Ganga and its tributaries like the Yamuna, Sone, Gandak, Kosi and many others; similarly main rivers Brahmaputra, Meghna and their tributaries. All these eventually flow into Bay of Bengal, through Bangladesh. Some of the tributaries of these rivers are larger than other independent rivers. e.g. Yamuna, a tributary of Ganga, has a larger catchment area than the Tapi, a small peninsula river.

❑ **Rivers of Rajasthan and Gujrat:**

Mahi, Sabarmati, Luni etc. These are rivers of arid regions, they carry relatively little flow, some of them flow to Arabian Sea through Gujrat while some are land-locked and their flow is lost through percolation and evaporation in the vast arid regions.

❑ **East Flowing Peninsular Rivers**

The important members of this group are :Damodar, Mahanadi, Brhamanai, Baitrani, Subarnarekha, Krishna-Godavari and Kaveri. The all flow in to Bay of Bengal at various places along the Eastern coast of India.

❑ **West Flowing Peninsular Rivers**

Narmada and Tapi. These originate in Central India and flow in a Western direction to meet Arabian Sea south of Gujrat.

❑ **Western Coast Rivers**

A large number of rivers in the Western Coast – i.e. coastal Maharashtra and Karnataka, and entire Kerala. These rivers are small in length but carry a significant amount of water due to very high rainfall in western ghats. They drain only 3 % of the India's land area but carry 11 % of India's water resources.

RESOURCES SYSTEM PLANNING

- ❑ The main sources of water supply are **surface and ground water** which have been used for a variety of purposes such as drinking, irrigation, hydroelectric energy, transport, recreation etc.
- ❑ Often, human activities are based on the usual or normal range of river flow conditions. However, flows and storage vary spatially and temporally; and also they are finite (limited) in nature i.e., there is a limit to the services that can be expected from these resources.
- ❑ Rare or Extreme“ flows or water quality conditions outside the normal ranges will result in losses to river-dependent, human activities. Therefore, **planning is needed to increase the benefits from the available water source.**

The purpose of water resources planning and management activities is to determine:

1. How can the renewable yet finite resources best be managed and used?
2. How can this be accomplished in an environment of uncertain supplies and uncertain and increasing demands, and consequently of increasing conflicts among individuals having different interests in the management of a river and its basin.

NEED FOR PLANNING AND MANAGEMENT

- ☐ Severity of the adverse consequences of droughts, floods and excessive pollution.
- ☐ Degradation of aquatic and riparian systems due to river training and reclamation of floodplains for urban and industrial development, poor water quality due to discharges of pesticides, fertilizers and wastewater effluents etc.
- ☐ While port development requires deeper rivers, narrowing the river for shipping purposes will increase the flood level.
- ☐ River bank erosion and degradation of river bed upstream of the reservoirs may increase the flooding risks.
- ☐ Sediment accumulation in the reservoir due to poor water quality.

SYSTEM COMPONENTS

1. **Natural river subsystem** in which the physical, chemical and biological processes takes place .
2. **Socio-economic subsystem**, which includes the human activities related to the use of the natural river system.
3. **Administrative and institutional subsystem** of administration, legislation and regulation, where the decision, planning and management processes take place.

USES OF WATER

- **Productive use:** water is primarily used for irrigation of food crops, fodder crops, medicinal herbs, etc.
- **Consumptive use:** water is consumed in exhaustive quantities for domestic purposes such as drinking, cooking, washing etc. water find its application in almost all the processes in industries, starting from the manufacturing processes to housekeeping activities.
- **Commercial use:** Water consumed for carrying out commercial and recreational activities.
- Many uses of water include agricultural, industrial, household, recreational and environmental activities. Virtually all of these human uses require fresh water. The framework for allocating water resources to water users (where such a framework exists) is known as water rights.

- **AGRICULTURAL**

It is estimated that **69% of world-wide water use is for irrigation**. In some areas of the world irrigation is necessary to grow any crop at all, in other areas it permits more profitable crops to be grown or enhances crop yield.

- **INDUSTRIAL**

It is estimated that **15% of world-wide water use is industrial**. Major industrial users include power plants, which use water for cooling or as a power source (i.e. hydroelectric plants), ore and oil refineries, which use water in chemical processes, and manufacturing plants, which use water as a solvent. The portion of industrial water usage that is consumptive varies widely, but as a whole is lower than agricultural use.

- **Household Drinking water**

It is estimated that **15% of world-wide water use is for household purposes**. These include drinking water, bathing, cooking, sanitation, and gardening. Basic household water requirements have been estimated at around 50 liters per person per day, excluding water for gardens.

- **Recreation**

Recreational water use is usually a very small but growing percentage of total water use. Recreational water use is mostly tied to reservoirs. If a reservoir is kept fuller than it would otherwise be for recreation, then the water retained could be categorized as recreational usage. Other examples are anglers, water skiers, nature enthusiasts and swimmers.

WATER DEFICIT AND WATER SURPLUS BASINS IN INDIA



- India has 1/6th of the global population and used water resources more, but **the water availability is highly uncertain both in time and space due to its peculiar monsoonal climate.**
- **About 70 % of the population directly or indirectly depends on agriculture,** in the back drop of economic growth from industrialization.
- The **urban population in the country is increasing at faster rate** which requires the establishment of basic infrastructure, amenities and increase in food production.
- It is essential to convert rain fed crops into irrigation crops

- The irrigation commission in 1972 has identified 67 drought prone districts comprising 326 taluks located in 8 states having an area of 49.73 M Ha
- The revised study made by Central Water Commission (CWC) in 2006 reveals that 51.12 M Ha area is drought affected in 74 districts. Thus in comparison to total geographical area of the country about 1/6th is drought prone area
- As per international standards per capita water requirement is **1700 m³ per year**. If the availability is less than 1000 m³, it is considered as water scarcity.
- If it ranges between 1000-1700 m³ it is treated as water stressed. India with present availability of about **1600 m³ is under water stress condition**.

Water Balance: This is the balance between the inputs and outputs of a drainage basin. Water balance is expressed as:

$P = Q + E$ (+/- change in storage), Where P = precipitation, Q = run-off, E = evapotranspiration.

Key terms to describe various water balance conditions are:

1. **Water Surplus:** there is excess water available to the system. This occurs when precipitation exceeds evapotranspiration and the excess is not being used by plants.
2. **Deficiency:** there is a reduction of water available within the system. This occurs when evapotranspiration exceeds precipitation.
3. **Recharge:** after a period of deficiency precipitation will occur and replace the lost water in the soil. This needs to occur before a period of surplus can reoccur.
4. **Field capacity:** the maximum amount of water that soil can hold before it becomes saturated. A water surplus can result in wet soils, high river levels and additional run-off whereas a deficit leads to dry soil, falling river levels and possibly a drier micro-climate.

WATER STORAGE IN MAJOR INDIAN RIVER BASINS DEPLETING,

- ❑ River basin is considered as the basic hydrological unit for planning and development of water resources. Recent data from the Central Water Commission (CWC), released on **February 15, 2019**, brings forth an alarming situation of water storage in premiere river basins of India.
- ❑ In more than 60 per cent of the basins, the water storage is much lesser when compared to the average water storage over the last 10 years, data shows.



- ❑ The entire country has been divided into **22 basins as per Central Water Commission**.

EQUITABLE DISTRIBUTION

Right to water or equitable distribution needs to be seen as every community. Having a proportional right to water as part of a collective right to assured to all people.

Water Scarcity Effects on Equitable Water Distribution:

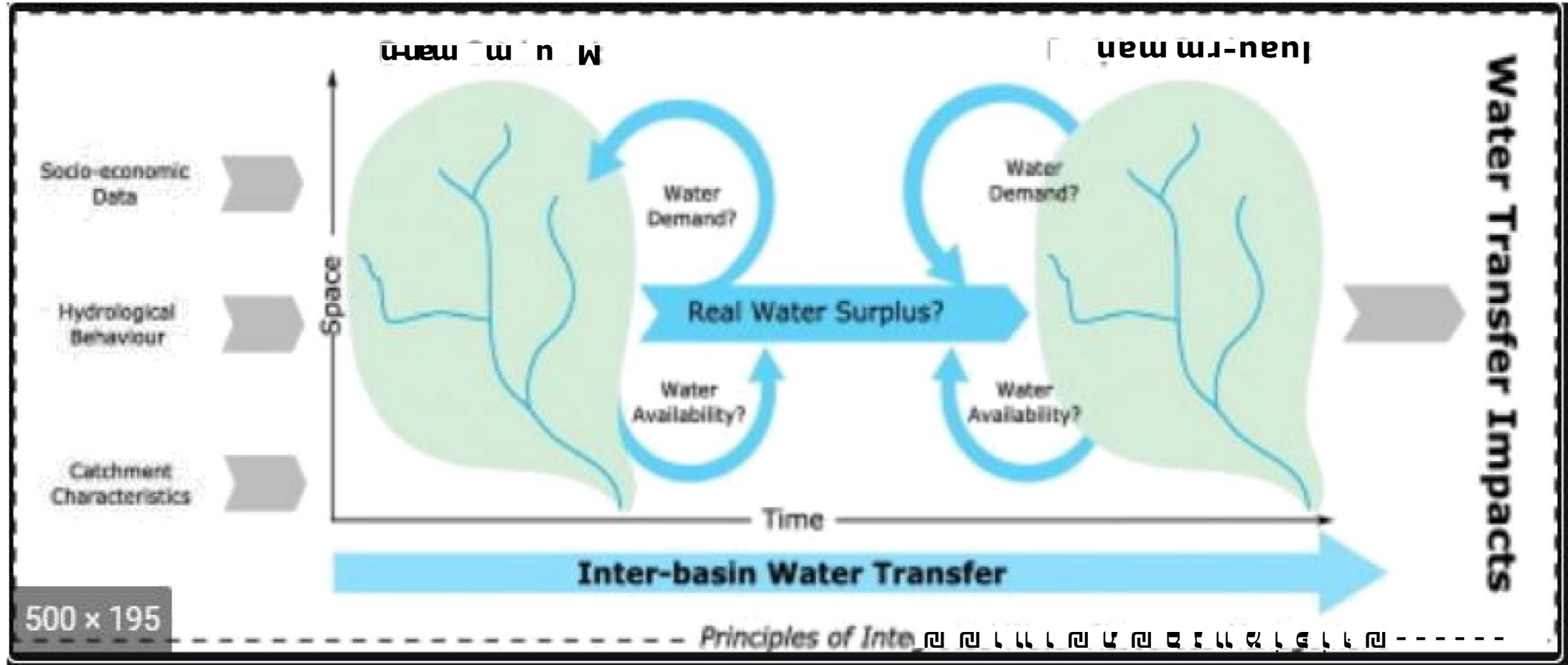
- ✓ Water Scarcity Effects on Equitable Water Distribution and Land Use in a Major Irrigation Project.
- ✓ The equity of water distribution is expected to change in response to interannual fluctuations in water supply. In many river basins, upstream development and interannual variations in rainfall can cause both episodic and chronic shortages in water supply downstream.
- ✓ Variability in water supply is also linked with the issue of equity, and the spatial uniformity of water supply can be expected to change under different water supply regimes.
- ✓ Equitable allocations could be achieved by improving the water distribution efficiency of the canal network during normal years and by crop diversification and introduction of alternative water sources during water shortage years.

INTER BASIN WATER TRANSFER

- The concept of the Inter basin water transfer is to be explored and implemented to ensure uniform distribution of available natural water resource and to mitigate the consequences of hydrologic extremes of floods and droughts.
- The implementation of Inter basin water transfer is the need for the overall development of a country like India in which population is growing at an alarming rate.
- Also the Inter basin water transfer helps to prevent the formation of deltas along the coast line and migration of people from drought affected region.

Examples of Inter basin water transfer in India

- Periyar - Vaigai project (Kerala state 1985)
- Kurnool – - Cuddapah Canal (Andhra Pradesh 1863-1870)
- Parambikulam - Aliyar project (1962-82)
- Beas – - Sutlej Link (1983)
- Indira Gandhi Nahar project (Rajasthan canal, 1958)
- Sarada - Sahayak Project (1960)
- Ramganga – - Ganga Link (1978)
- Tungabhadra – - Pennar project
- Mahi project
- Tehri Multipurpose project



INTER LINKING OF RIVERS

NWDA (National Water Development Agency) was formed in 1980 to further investigate and explore the possibilities of interlinking of rivers.

The broad objectives of NWDA are,

1. To promote systematic and scientific study of interlinking of rivers.
2. To carryout detailed study, survey, investigations of Peninsular and Himalayan rivers.
3. To identify possible water transfer projects/links to carry water from surplus basin to deficit one after meeting the existing and proposed needs.
4. To prepare feasibility reports of various components of Himalayan and Peninsular rivers.

After thorough investigations NWDA proposed to transfer water through 12,500 Km length of canal.

As per NWDA, Inter basin water transfer is proposed in two components namely,

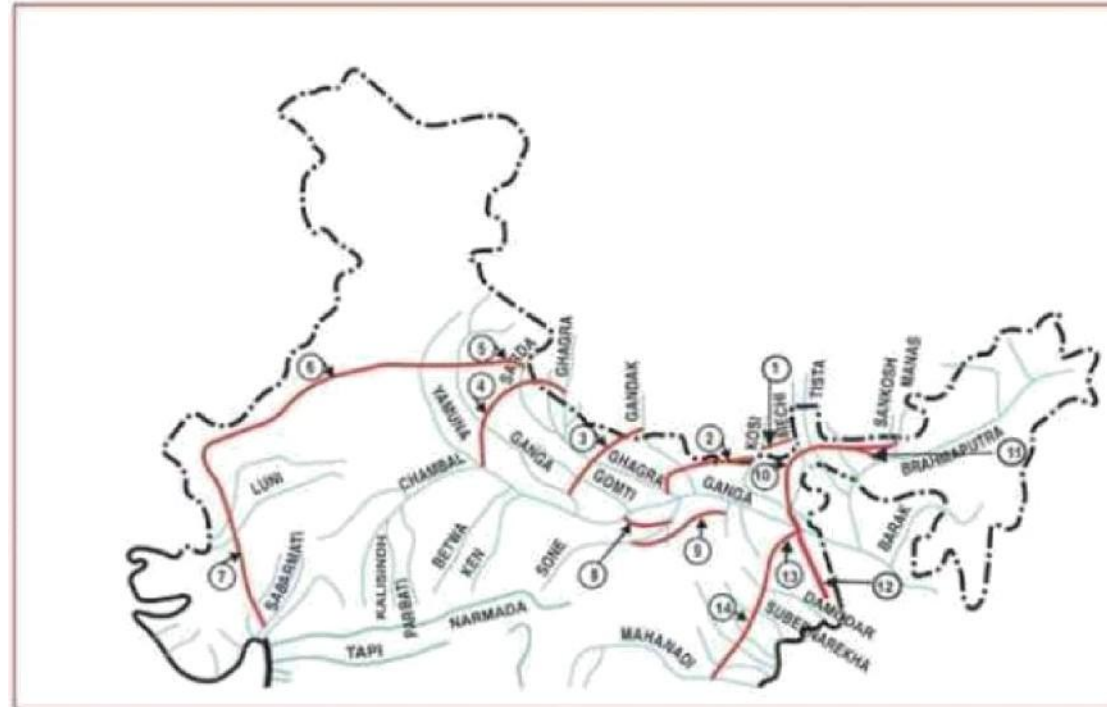
- (1) Himalayan component and
- (2) Peninsular component.

- This component mainly proposes to link Brahmaputra and its tributaries with the river Ganga and Ganga with Mahanadi.
- In addition it also proposes to transfer surplus flows of the Eastern tributaries of Ganga to the West.
- This component envisages construction of canal systems and storage reservoirs on the principal tributaries of Ganga and Brahmaputra rivers in India, Nepal and Bhutan .
- This component would provide additional irrigation to about 22 MHa and power generation of about 30000 MW besides flood control in Brahmaputra and Ganga basins

"Table 4: Himalayan Component

1 Brahmaputra-Üanga	£ Yalnuna-Rajastana
2 kosi-Ghagra	7 Rajastana-Sabaramati
3 Gandak-Üanga	fi C“hcmar- Sonc barragc link
4 ühagra- Yamuna	9 Sonc dam-southcm Ganga
é Sarada-Yamuna	10 üanga —Damodar — 5ubcrnarckha
1 Subcrnarckha- Mahanadi	13 Narakka-Sunderban
12 Kosi-Mcchi	14 Brahtnaputra-Üanga(Jogighopa- Tista-L“vakka)

PROPOSED INTER BASIN WATER TRANSFER LINKS HIMALAYAN COMPONENT



1. Hosi - Mochi
2. Hosi - Ghagra
3. Gandak - Ganga
4. Ghagra - Yamuna
5. Sarla - Yamuna
6. Yamuna - Rajasthan
7. Rajasthan - Sabarmati
8. Chunar - Sane Barrage
9. Sane Dam - Southern Tributaries of Ganga
10. Manas - Sonkoth - Tista - Ganga
11. Jogbhan - Tista - Farakka (Alternate)
12. Farakka - Sunderbans
13. Ganga (Farakka) - Damodar - Subarnarekha
14. Subarnarekha - Mahanadi
15. Subarnarekha - Mahanadi

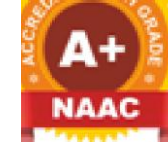
PENINSULAR COMPONENT

- In this component a network of interconnected river basins of Peninsular India is considered.
- NWDA carried out water balance studies of all the major river basins such as Mahanadi , Godavari , Krishna ,Pennar , Cauvery , Vaigai, West flowing rivers of Kerala , Karnataka , North of Bombay and South of Tapi and Southern tributaries of Yamuna to find out water surplus and deficit basins.
- The 16 links of Peninsular component are given.
- From Peninsular Component it is possible to irrigate about 13 M Ha and about 4000 MW of Hydropower can be generated.
- The Peninsular component utilizes 69.6 TMCum of water.
- This component involves the construction of storage reservoirs at potential sites in addition to the existing /ongoing reservoirs and a network of canals for water transfer



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U.Mahanadi (Manibhadra) Ciodavari (Doc.'lcswaram) Link	23.fi“auvcry (Kanalai) Vaigai - Ciundar Link
1fLCiodavari (Inchatnpalli) - Krishna (Naearjunasapar) Lnk	24.Kcn - Bc0va Link
17.Ciodavari (Inchatnpalli LOY•' Daln) Krishna (Na8arjunasa•par Tail pond) Link	25.Parbathi - kalisindh Link
18.Ciodavari (Polavaram) - Krishna (4"ijayauada Link}	26.Par —Tapi —Narmada
19.Krishna {Almatti) Pcrlnar (Bukkapatnaln) Link	27.Darnanganga Pinjal Link
20.Krishna (Srisailain) - Pcnnar (Mylai'arain)Lirik	28.Bcdti - Varda Link
21.Krishna (Naqarjunasapar) Pcnnar (Somasila)Link	29.fi ctravathi Hcrnas'athi Link
22.Pcnnar (Somasila) Cam cry (Cirand Anicut) Link	30.Pamba-Achankovil Vaippar Link

Table 6: salient features of inter basin water transfers in India

1.	Additional Irrigation	35 M Ha
2.	Hydropower generation	34000 to 40000 MW
3.	The Cost of the project	Rs 5.60.000 crores (as per 2002 estimate)
4.	Water utilization	20.96 MHa m
5.	Execution period	40 years
6.	Agricultural production	250 to 450 Million Tons
7.	Total length of canals	10880 Km
8.	Cost per Ha	Rs 75000
9.	Water availability	1122 m ³ / capita / year
10.	Flood control	
	Area can be protected	About 40 M Ha
	Population protected	About 260 Million
	Financial savings	About 1200 crores per year
11.	Drought protection	
	Population benefited	About 86 Million
	States benefited	14
	Districts benefited	116
	Financial benefit	About 1200 crores per year
12.	Rivers involved	37
13.	Reservoirs involved	60

MERITS OF INTER BASIN WATER TRANSFER

1. Possible to utilize the water resources uniformly and economically to yield Significant output.
2. Enhancement in Irrigation potential and power generation
3. Provides ample surface water to meet the growing needs of Domestic and Industries.
4. Scopes for Inland Navigation which reduces stress on existing communication system.
5. It minimizes the intensity of drought and floods.
6. It helps to increase per capita income.
7. Reduces the exploitation of ground water as surface water is made available in abundant.
8. Huge employment generation
9. Development of fisheries
10. Salinity control
11. Recreation facility
12. . Infrastructural development
13. Socio economic development
14. Considerable improvement in ground water potential

DEMERITS OF INTER BASIN WATER TRANSFER

1. Large area liable for submersion due to construction of reservoirs and canals
2. Adverse effects over ecological system
3. Difficult to solve Interstate or International water disputes
4. Legal problem in sharing the water
5. Cost of the project and recurring expenditure for maintenance are high
6. Water pollution in conveyance
7. Loss of water in conveyance through the canals
8. Land acquisition and rehabilitation problems

GROUND WATER

- Ground water is the water that seeps through rocks and soil and is stored below the ground .
- The rocks in which ground water is stored are called aquifers.
- Aquifers are typically made up of gravel, sand, sandstone or limestone.
- Water moves through these rocks because they have large connected spaces that make them permeable.
- The area where water fills the aquifer is called the saturated zone.
- The depth from the surface at which ground water is found is called the water table.
- The water table can be as shallow as a foot below the ground or it can be a few hundred meters deep.
- Heavy rains can cause the water table to rise and conversely, continuous extraction of ground water can cause the level to fall.

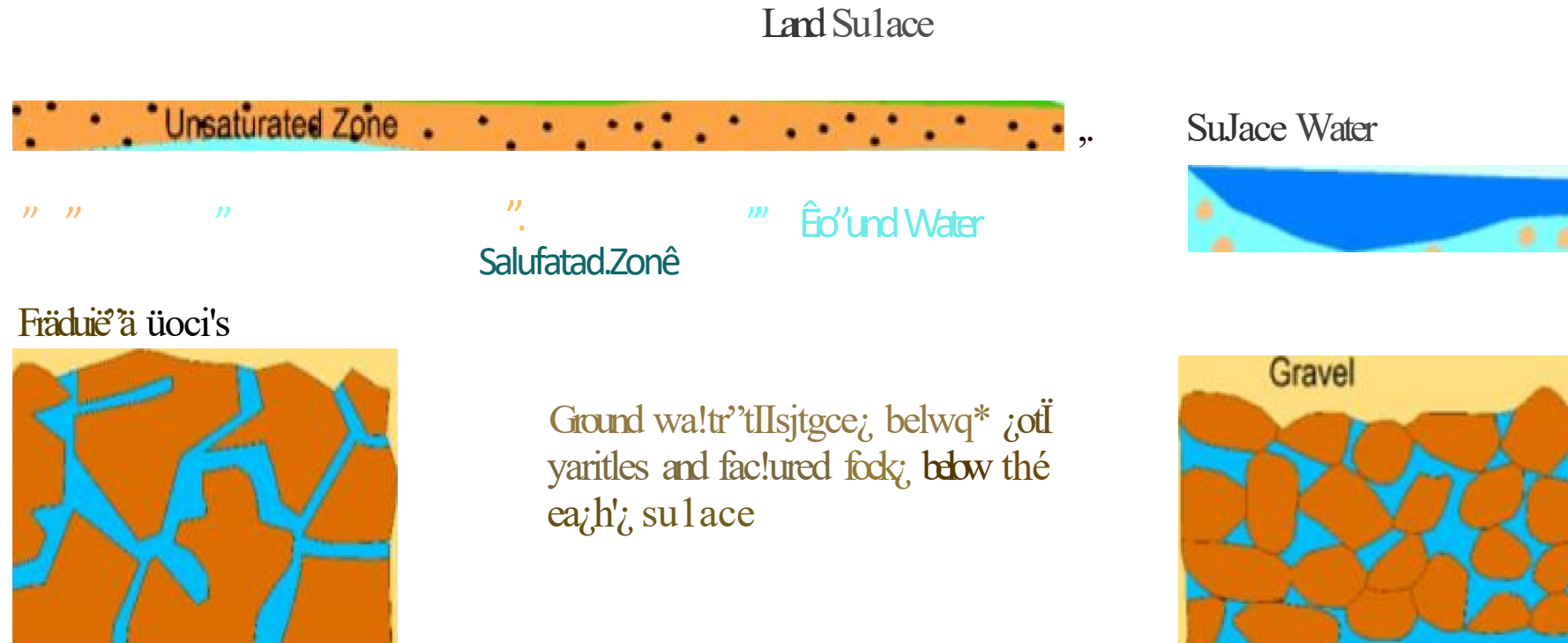


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Figure 1: Schematic representation of ground water and associated features



GROUND WATER POTENTIAL IN INDIA

Hard-rock aquifers of peninsular India:

- These aquifers represent around 65% of India's overall aquifer surface area.
- Most of them are found in central peninsular India, where land is typically underlain by hard-rock formations.
- These rocks give rise to a complex and extensive low-storage aquifer system, where in the water level tends to drop very rapidly once the water table falls by more than 2-6 meters.
- Ground water development is largely through dug wells.

Alluvial aquifers of the Indo-Gangetic plains :

- These aquifers, found in the Gangetic and Indus plains in Northern India have significant storage spaces, and hence are a valuable source of fresh water supply.
- However, due to excessive ground water extraction and low recharge rates, these aquifers are at the risk of irreversible overexploitation.
- This region encompasses an area of about 850,000 sq km covering states of Punjab, Haryana, Uttar Pradesh, Bihar, Assam and West Bengal.
- this accounting for more than one fourth of country's land area, comprises the vast plains of Ganges and Brahmaputra rivers and are underlain by thick piles of sediments .

NORTHERN MOUNTAINOUS TERRAIN AND HILLY AREAS:

- The highly rugged mountainous terrain in the Himalayan region in the northern part of the country extending from Kashmir to Arunachal Pradesh is characterized by steep slopes and high runoff.
- This region is underlain mostly by rocks such as granites, slate, sandstone and lime stone ranging in age from Paleozoic to Cenozoic.
- Though this area offers very little scope for groundwater storage, it acts as the major source of recharge for the vast Indo-Gangetic and Brahmaputra alluvial plains

COASTAL AREA (SALINE)

- Coastal areas have a thick cover of alluvial soil deposits of Pleistocene to Recent age and form potential multi-aquifer systems in the states of Gujarat, Kerala, Tamil Nadu, Andhra Pradesh and Orissa.
- However, inherent quality problems and the risk of seawater impose severe constraints in the development of these aquifers.
- In addition, the ground water overdevelopment in these areas entails the risk of saline water ingress.
- Ground water prospects in these aquifers vary widely depending on the local conditions and may range from 5-25 lps.

GROUND WATER AVAILABILITY

- As of April 2015, the water resource potential or annual water availability of the country in terms of natural runoff (flow) in rivers is about 1,869 Billion Cubic Meter (BCM)/year.
- However, the usable water resources of the country have been estimated as 1,123 BCM/year.
- This is due to constraints of topography and uneven distribution of the resource in various river basins, which makes it difficult to extract the entire available 1,869 BCM/year.

CONJUNCTIVE USE (SIMULTANEOUSLY)

- Conjunctive water use refers to simultaneous use of surface water and groundwater to meet crop demand.
- Each day, hundreds of thousands of farmers in canal, tank, and other surface irrigation systems combine surface water with groundwater.
- They do so in an individual manner, uncontrolled by any scheme or basin-level entity.
- To optimize conjunctive use of water, the best way forward is to concentrate on capacity building of irrigation system.
- To sustain groundwater use in tubewell-irrigated areas, enhancing recharge from precipitation and surface water imports is necessary.

MANAGEMENT OF GROUND WATER

- Management of ground water resources in the Indian context is an extremely complex proposition as it deals with the interactions between the human society and the physical environment.
- The highly uneven distribution of ground water availability and its utilization indicates that no single management strategy can be adopted for the country as a whole.
- On the other hand, each situation demands a solution which takes into account the geomorphic set-up, climatic, hydrologic and hydrogeologic settings, ground water availability, water utilization pattern for various sectors and the socio-economic set-up of the region.

GROUND WATER DEPLETION

- Indiscriminate ground water development has led to substantial ground water level declines both in hard rocks and alluvial areas threatening sustainability of this resource.
- Long-term decline of ground water levels is being observed in many areas, mostly in the states of Rajasthan, Gujarat, Tamil Nadu, Punjab, Delhi and Haryana.
- Apart from this, in most of the cities depending on ground water for drinking water supplies, water level declines up to 30 m and more have been observed.
- Water harvesting methods have been abandoned or defunct.

CONTAMINATION OF GROUND WATER

- Ground water contamination is the presence of certain pollutants in ground water that are in excess of the limits prescribed for drinking water.
- The commonly observed contaminants include arsenic, fluoride, nitrate and iron, which are geogenic in nature.
- Other contaminants include bacteria, phosphates and heavy metals which are a result of human activities including domestic sewage, agricultural practices and industrial effluents.
- The sources of contamination include pollution by landfills, septic tanks, leaky underground gas tanks, and from overuse of fertilizers and pesticides.
- It has been pointed out that nearly 60% of all districts in the country have issues related to either availability of ground water, or quality of ground water.

RECHARGE OF GROUND WATER

- Flow below the land surface takes place due to the process of infiltration.
- The recharge of aquifers takes place during the precipitation due to infiltration of water into the pores in the soil strata.
- The soil will not get completely saturated with water unless water supply is maintained for prolonged periods.

ARTIFICIAL RECHARGE OF GROUND WATER

- Artificial recharge can also be defined as a process of induced replenishment of the ground water reservoir by human activities.
- The process of supplementing may be either planned such as storing water in pits, tanks etc. for feeding the aquifer or unplanned and incidental to human activities like applied irrigation, leakages from pipes etc
- Artificial recharge aims at augmenting the natural replenishment of ground water storage by some method of construction, spreading of water, or by artificially changing natural conditions.

Artificial Recharge Techniques

Dirasl

Indir€«?:

Surface (Recharging)		Sub-surface	Induced Necharge
1-	Flooding	1 — RecreargP\gPlı	
2-	Basın» or Ppcq!glin T»nk	2 — Rer3targe Pı•/ Şhah	
3-	Siraam Augmenation	- Dug Well	
4-	DııCh6 FurrowSytiam		

SEA WATER INGRESS

- The ground water in coastal aquifers exists very near to the area of seawater.
- Indiscriminate exploitation of ground water from such aquifers can disturb this equilibrium condition.
- Result in the development of landward hydraulic gradient, ultimately leading to seawater intrusion into the fresh water aquifers.
- Coastal aquifers in parts of Gujarat, Tamil Nadu and Andhra Pradesh are already suffering from the problem of salinity ingress.

Measures to prevent/control saline water intrusion into coastal aquifers :

- Regulation of ground water development in coastal areas.
- Formation of a freshwater ridge parallel to the coast through artificial recharge.
- Formation of a pumping trough , through a series of pumping wells aligned parallel to the coast
- Reduce Water use
- Reduce Pump depth
- Pump less water more frequently
- Well location to be at least 50m from the coast
- Avoid deep wells close to the coast

