



# Environment: An Introduction

Dr. Prasenjit Adak



# What We Have Done!



**This PPT should be used as reference only. Reading books (mentioned in syllabus) is mandatory for the preparation of the examinations.**



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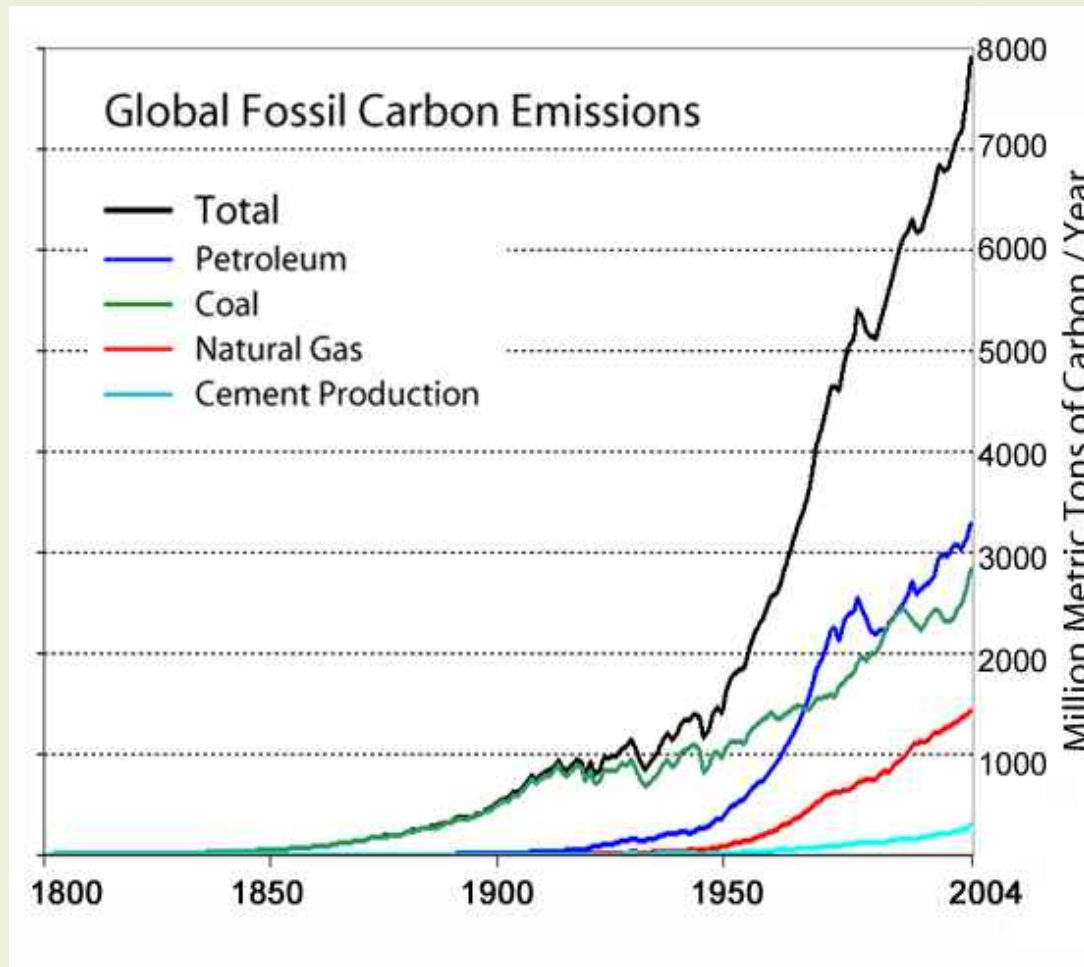


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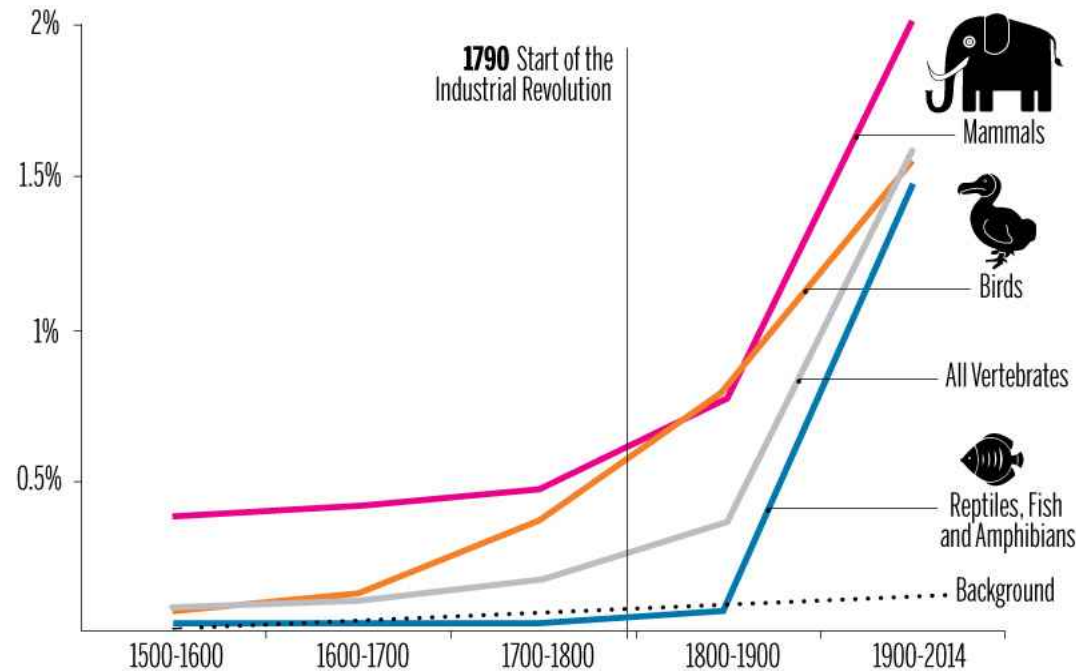


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# What We Have Done!

## VERTEBRATE SPECIES EXTINCTION RATES

Cumulative, recorded as “extinct” or “extinct in the wild”



SOURCE: Ceballos et al. Sci. Adv. 2015;1:e1400253 | GRAPHIC: Amanda Shendruk

MACLEAN'S

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# What We Have Done!

“For what I've done  
I start again  
And whatever pain may come  
Today this ends  
I'm forgiving what I've done”

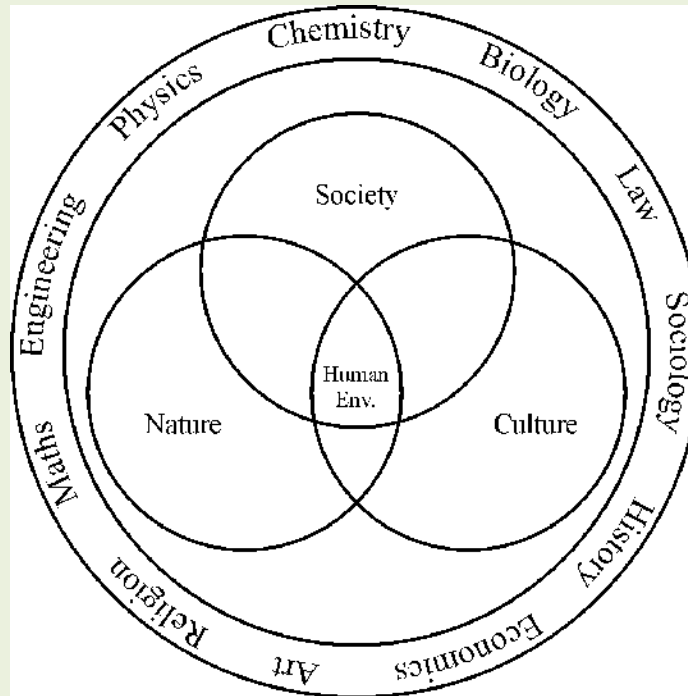
- *Linkin Park*



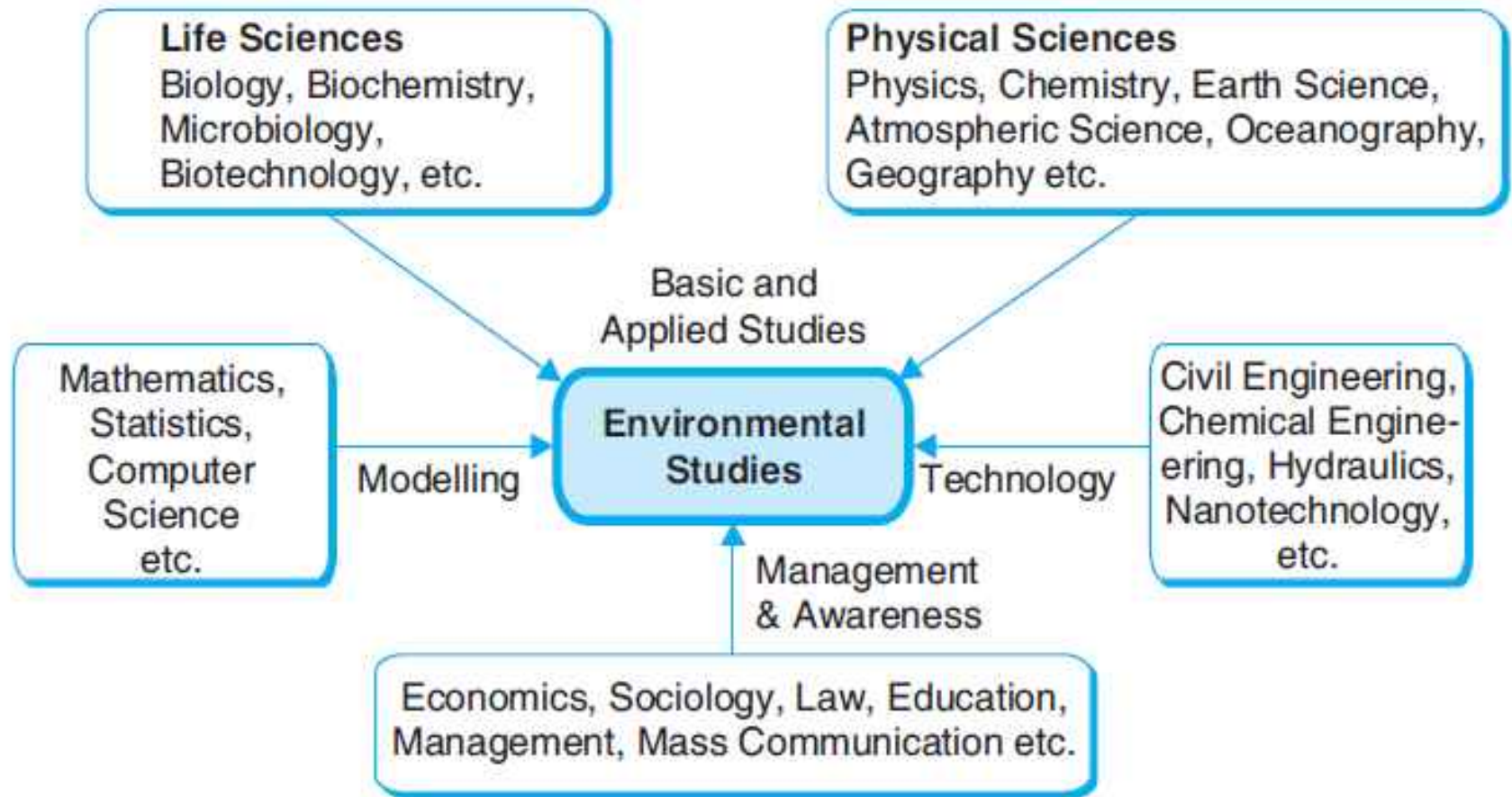


# Why we are studying this subject?

- “Environmental Studies” is a Multidisciplinary subject.



# Multidisciplinary Nature of Environmental Studies





# They are not the same

- **Environmental Studies**

- It is a broad interdisciplinary field of study which studies the interaction of human beings with the environment.

- **Environmental Science**

- It is an interdisciplinary academic field that integrates physical, chemical and biological sciences to address the environmental problems.

- **Environmental Engineering**

- It is the application of science and engineering principles to improve the quality of environment to provide healthy living conditions.

# Importance of Environmental Studies

- To get basic knowledge of our surroundings.
- To develop skills for identifying and solving environmental problems in our surroundings.
  - **World population** is increasing at an alarming rate especially in developing countries.
  - The **natural resources** endowment in the earth is limited.
  - The methods and **techniques of exploiting** natural resources are advanced.
  - The resources are **over-exploited** and there is no foresight of leaving the resources to the **future generations**.
  - The urban area, coupled with industries, is major sources of **pollution**.
  - The pollution and degraded environment seriously **affect the health** of all living things on earth , including man.
  - Education and training are needed to save the biodiversity and **species extinction**.



# Importance of Environmental Studies

- To maintain ecological balance and to strive to achieve sustainable development.
- To educate people for their duties towards environmental protection.

# Scope of Environmental Studies

- Ecosystem and Biodiversity protection
- Natural resource conservation
- Environmental pollution control
- Environmental management
- Industry
- Research and development
- Social development
- Environmental journalism
- Environmentalist / Consultant
- Green advocacy
- Green marketing



# What is environment?

- Everything that surrounds and affects living organism is called Environment.
- It is the sum total of all social, economical , biological , physical and chemical factors which constitute the surroundings of humans, who are both the creators and moulders of the environment.

# Types of Environment

- **Natural Environment**

- Components such as air, water, soil, land, forest, wildlife, flora , fauna, etc. constitute the Natural Environment.

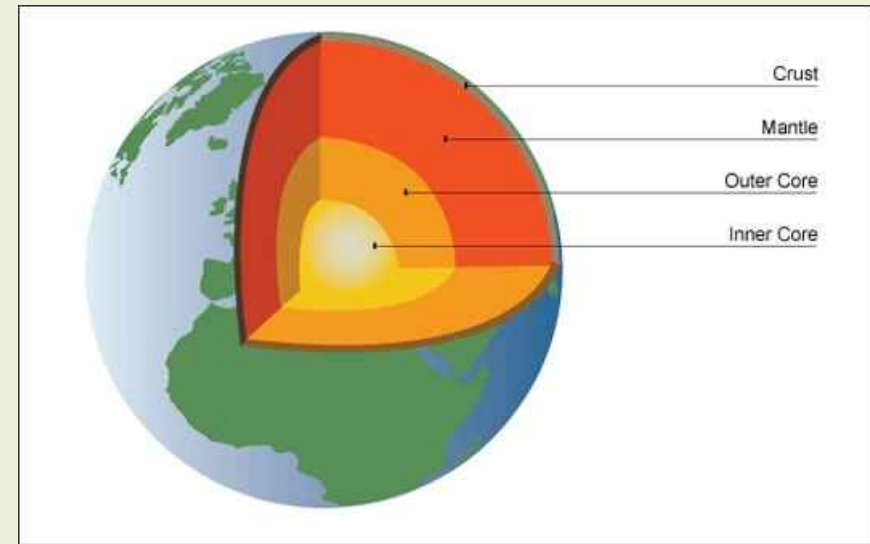
- **Anthropogenic Environment**

- Alteration of the natural environment to serve specific uses by the human beings is termed as Anthropogenic Environment. For eg agricultural field is an anthropogenic environment and so are the gardens and aquaculture farms.

# Spheres of Earth

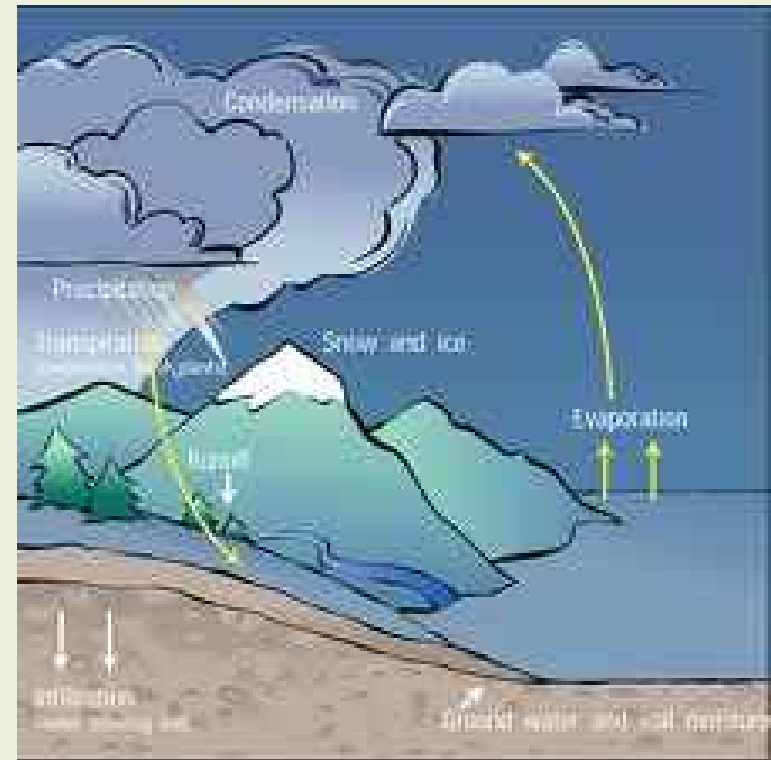
## ■ Lithosphere (Land)

- The lithosphere is made up of all the hard and solid land mass on the earth's surface, the semi-solid rocks (molten materials) underneath the earth crust, and the liquid rocks in the inner core of the earth. Lithosphere is further divided into sub-spheres namely the crust, the mantle, the outer core, and the inner core. The rock materials are divided into three primary categories based on how they are formed namely igneous rocks, sedimentary rocks, and metamorphic rocks.



# Spheres of Earth

- **Hydrosphere (Water)**
  - The hydrosphere includes all the gaseous, liquid, and solid water of the planet earth. The natural earth features depicting the hydrosphere are the rivers, streams, lakes, seas, oceans and the water vapor. Glaciers, which are the slowly moving masses of ice, are also part of the hydrosphere. The earth's temperature is highly influenced by the hydrosphere. The glaciers, icebergs, and icecaps are also categorically called the cryosphere.





# Spheres of Earth

- Atmosphere (Air)
  - All the air in the atmosphere makes up the atmosphere. The atmosphere is a mixture of nitrogen (about 78%), oxygen (about 21%), and other gasses (about 1%) such as carbon dioxide (0.039%), argon (0.93%) and the rest are trace gases (krypton, neon, helium, and xenon).
  - layers of the atmosphere include the troposphere, mesosphere, thermosphere, and the exosphere.



# Spheres of Earth

- **Biosphere (Living Things)**
  - All the living things in the planet are categorized under the biosphere. In this view, the biosphere includes all of the animals, plants, and microorganisms of earth. Biosphere interact with the physical aspects of the earth including the hydrosphere, lithosphere, and the atmosphere. Deserts, forests, grasslands, aquatic, tundra, and chaparral are the six main biomes that are present in the biosphere.





# **SUSTAINABLE DEVELOPMENT**

Dr. Prasenjit Adak

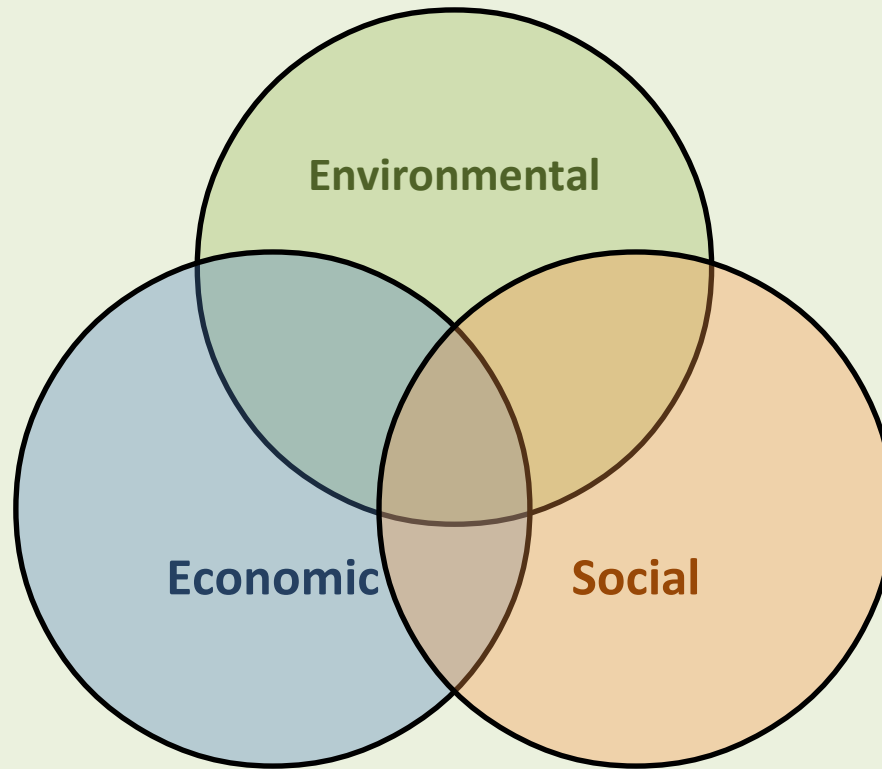
# What is Sustainability?

- Sustainability focuses on meeting the needs of the present without compromising the ability of future generations to meet their needs.





# What is Sustainability?



## Three pillars of Sustainability

# From unsustainable to sustainable development

- Does it protect our biodiversity?
- Does it prevent soil erosion?
- Does it slow down population growth?
- Does it increase forest cover?
- Does it cut off the emissions of CFC,  $\text{SO}_x$ ,  $\text{NO}_x$  and  $\text{CO}_2$ ?
- Does it reduce waste generation and does it bring benefits to all?

# Was Thanos Right?



This universe is finite, its resources, finite. If life is left unchecked, life will cease to exist.

# the key aspects for sustainable development

- **Inter-generational equity**
  - minimize any adverse impacts on resources and environment
  - stop over-exploitation of resources, reduce waste discharge and emissions and maintain ecological balance
- **Intra-generational equity**
  - minimize the wealth gaps within and between nations
  - The technology should address to the problems of the developing countries
    - producing drought tolerant varieties for uncertain climates
    - vaccines for infectious diseases
    - clean fuels for domestic and industrial use



# Measures for Sustainable Development

- Using appropriate technology
- Reduce, Reuse, Recycle approach
- Prompting environmental education and awareness
- Resource utilization as per carrying capacity
- Implementing effective planning for Population Control
- Less dependence on non-renewable natural resources

# Carrying capacity

- The carrying capacity of a biological species in an environment is the **maximum population size** of the species that the environment can sustain indefinitely, given the food, habitat, water, and other necessities available in the environment.
- Carrying capacity has two basic components
  - Supporting capacity (the capacity to regenerate)
  - Assimilative capacity (the capacity to tolerate different stresses)

# Urban Problems Related To Energy

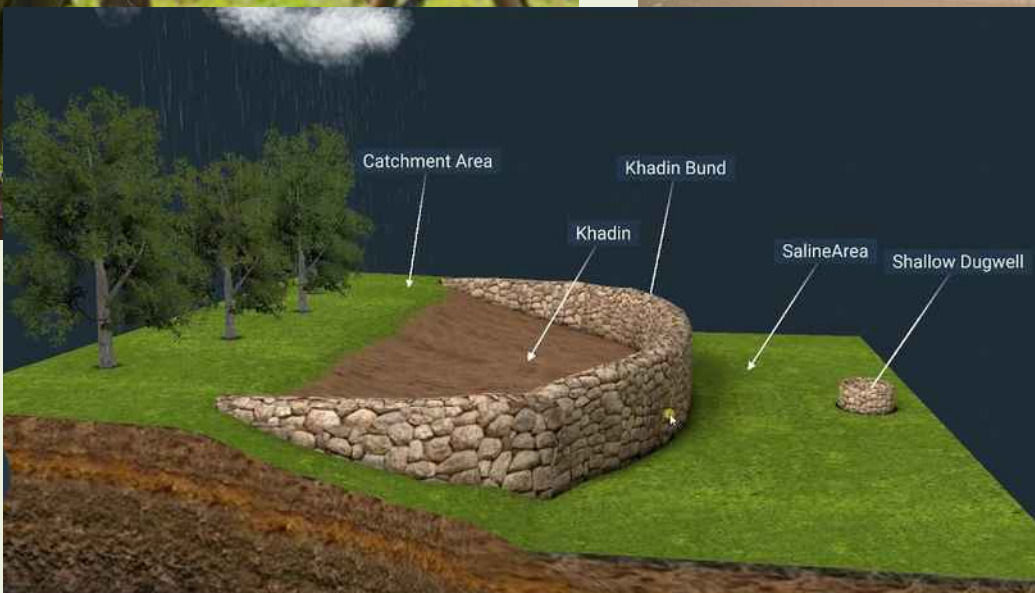
- Residential and commercial lighting
- Transportation means including automobiles and public transport for moving from residence to workplace
- Modern life-style using a large number of electrical gadgets in everyday life
- Industrial plants using a big proportion of energy.
- A large amount of waste generation which has to be disposed off properly using energy based techniques
- Control and prevention of air and water pollution which need energy dependent technologies

# Water Conservation

- Decreasing run-off losses
- Reducing evaporation losses
- Storing water in soil
- Reducing irrigation losses
- Re-use of water
- Preventing wastage of water
- Increasing block pricing



# Rainwater Harvesting



Khadin  
Johad  
Tanka

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# Rainwater Harvesting



Modern Rainwater Harvesting



# Rainwater Harvesting

## ■ Objectives of Rain Water Harvesting:

- Rain water harvesting fulfill the demand of water in domestic, industrial, and agricultural sectors.
- It helps to raise the water table by recharging ground water.
- It helps in minimizing ground water pollution.
- The proper harvesting of rain water reduces soil erosion, flooding and run off. It reduces the incidence of floods.

## ■ Techniques of Rainwater Harvesting

- This can be done by constructing special structures like dug wells, percolation pits, lagoons, check dams, tanks, etc.
- Broadly there are two ways of harvesting rainwater:
  - (i) Surface runoff harvesting
  - (ii) Roof top rainwater harvesting

# Watershed Management



- A watershed is an area of land that drains to a common location. A watershed can vary in size, they can represent the area draining to a small stream to the entire area draining to an ocean

# Watershed Management

## Benefits of Watershed Management

- Ensure ecological balance
- Stabilize income even under unfavorable weather conditions.
- Minimize the risks of drought, landslides floods, and help to reduce erosion and sediment production.
  - Proper utilization of marginal or waste lands through alternate land use systems
  - Maximize productivity per unit area, per unit time and per unit of water.
  - Scope for beneficial developmental activities like domestic water supply, irrigation, hydropower generation, etc.
  - Develop rural areas in the region with clear plans for improving the economy of the region



A photograph of a lush green forest. In the upper left, a waterfall cascades over rocks. The middle section is filled with dense, vibrant green foliage, including many large, round leaves. At the bottom, a stream flows over dark, mossy rocks. The entire image is framed by a dark green border.

# LAND RESOURCE

Dr. Prasenjit Adak

# Land as a resource

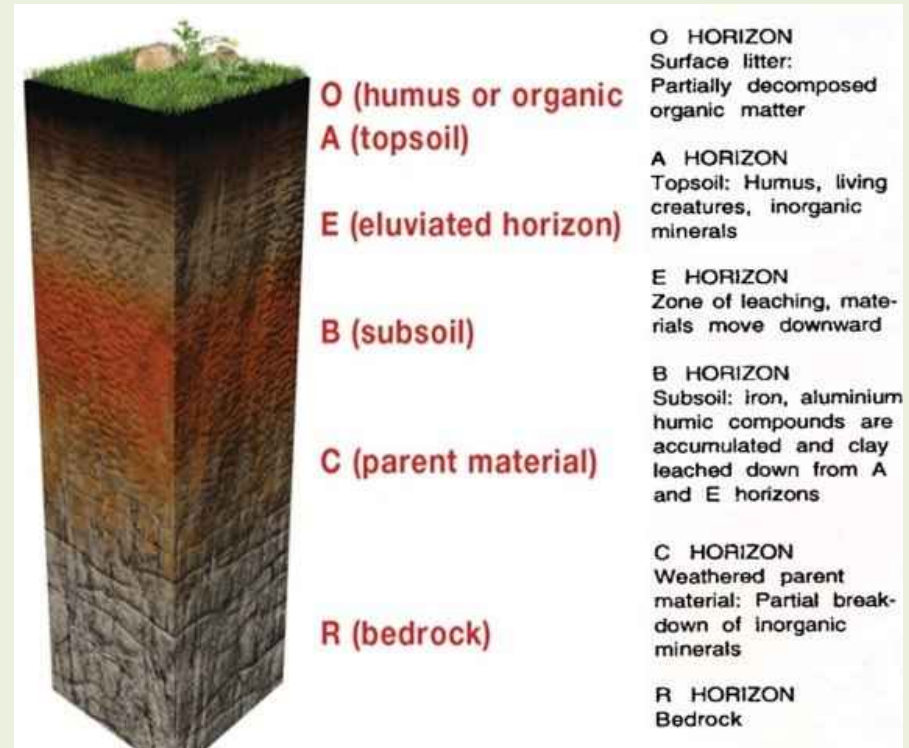
- The study of soils in their natural environment is called “pedology”.
- Land is a renewable but **limited** resource
- **Problems related to land resource**
  - Reaching the carrying capacity
  - Population density
  - Improper land-use planning
  - Saltwater intrusion
  - Land degradation
  - Soil erosion

# Soil

- Soil is a dynamic natural body capable of supporting a vegetative cover. It is composed largely of weathered rocks, water, oxygen and organic materials.
- Soil formation
  - Processes
    - Physical weathering
    - Chemical weathering
    - Biological weathering
  - Factors
    - Parent material
    - Living organisms
    - Climate
    - Topography
    - Time

# Soil

## ■ Soil profile



# Soil

- **Functions of soil**
  - Facilitates nutrient cycle
  - Food and other biomass production
  - Stores water and regulates water supply
  - Regulates the emission of trace gases
  - Filter ground water
  - Degrades pollutants
  - Biological habitat
  - Source of clay
  - Platform for man-made structures: buildings, highways

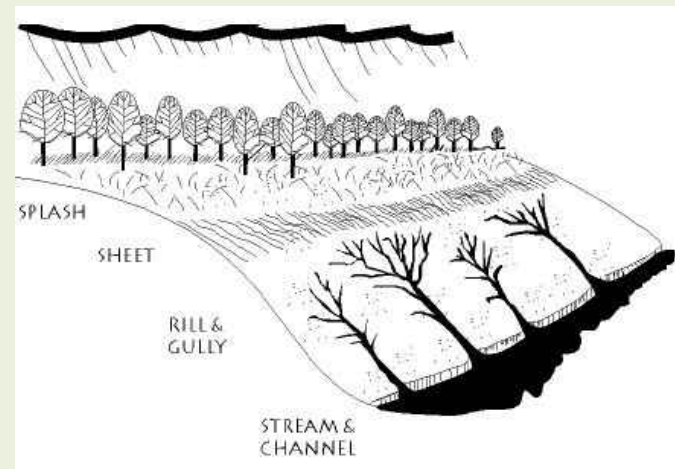
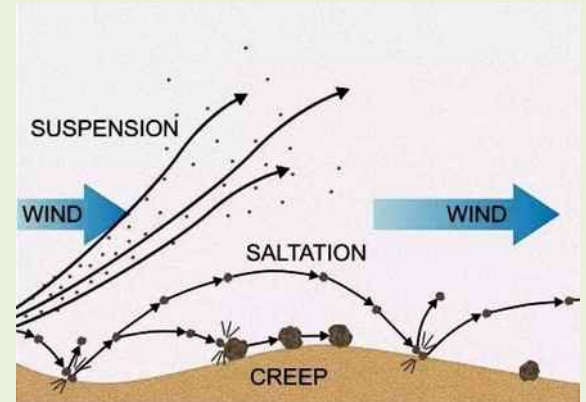


# Land Degradation

- **Causes**
  - **Natural causes**
    - Heavy rainfall
    - High speed winds
    - Natural disasters: earthquake, landslide, flood, draught
    - Expansion of desert
  - **Anthropogenic causes**
    - Mining
    - Urbanization
    - Deforestation
    - Overgrazing
    - Water logging
    - Construction of dams
    - Extensive use of fertilizers
    - Dumping of industrial and municipal wastes

# Soil Erosion

- Types
  - Normal erosion or geologic erosion
  - Accelerated or Anthropogenic erosion
- Causes
  - Climatic agents
    - Water induced erosion
      - Splash erosion
      - Sheet erosion
      - Rill erosion
      - Gully erosion
      - Slip erosion
      - Stream bank erosion
    - Wind induced erosion
      - Suspension
      - Saltation
      - Surface creep
  - Biotic agents



# Soil Erosion

## ■ Effects

- Decreased productivity of land
- Desertification of land
- Deposition of soil in water bodies
- Reduction of agricultural land in river banks

# Soil Erosion

- Control
  - Conservational till farming
  - Stubble mulching
  - Contour farming
  - contour bunding
  - Construction of check dams
  - Terracing
  - Strip cropping
  - Alley cropping (Agro-forestry)
  - Wind breaks



# Desertification

- **Types**
  - Moderate (10 – 25%)
  - Severe (25 – 50%)
  - Very severe (more than 50%)



# Desertification

- **Causes**
  - **Natural causes**
    - Very low rain fall
    - Excessive evaporation
    - Vast difference in diurnal temperature
    - High salinity
  - **Anthropogenic causes**
    - Deforestation
    - Overgrazing
    - Conversion of pasture into arable land
    - Excessive use of fertilizer

# Desertification

- **Effects**

- Rapid soil erosion
- Poor soil quality
- Unfavorable climate
- Low water table, salty and hard water
- Economic and human cost

# Desertification

- **Control**

- Large scale plantation
- Sustainable agricultural practices
- Development of pasture land and controlling overgrazing
- Development of water catchment
- Rainwater harvesting



# **WATER RESOURCE**

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# Properties of water and its effects

- It has the **highest specific heat**, due to which it warms up and cools down very slowly without causing shocks of temperature jerks to the aquatic life.
- It has a **high latent heat of vaporization**. Hence, it takes a huge amount of energy for getting vaporized. That's why it produces a cooling effect as it evaporates.
- It is an **excellent solvent** for several nutrients. Thus, it can serve as a very good carrier of nutrients, including oxygen, which are essential for life. But, it can also easily **dissolve various pollutants** and become a **carrier of pathogenic microorganisms**.
- Due to **high surface tension** and cohesion it can easily rise through great heights through the trunk.
- It has an anomalous **expansion behaviour**. It is because of this property that even in extreme cold, the lakes freeze only on the surface. Being lighter the ice keeps floating, whereas the bottom waters remain at a higher temperature and therefore, can sustain aquatic organisms even in extreme cold.



# Importance of water

- Water is the basic component of every living cell.
- Water is one of the input required for agriculture.
- Industries consume water for cooling, heating and other processes.
- Electricity generation
- Waterways are used for inland transport.
- Water may be used for obtaining common salt.
- Water provides habitat to aquatic flora and fauna.

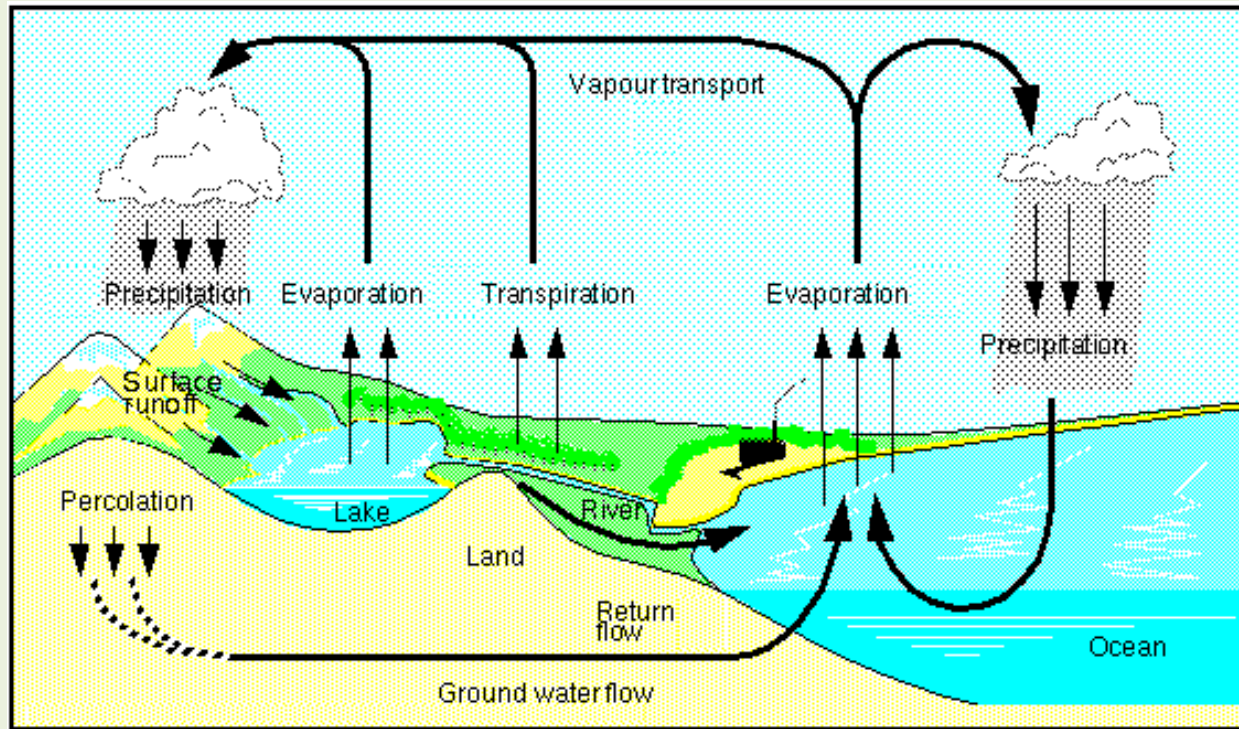
# Water usage

- Agriculture – 70%, Municipal – 11%, Industrial – 19%
- Average requirement is 20 – 40 liter per head per day (Twice of the usage 50 years ago)
- About 30% of fresh water is used by US (4% of world population) where, middle east (5% of world population use 1% of fresh water).
- More than 1 billion people don't have fresh water supply.
- Presently 31 countries facing water scarcity.
- By 2025, 48 countries will face water shortage (including India).
- By 2050, 4 billion people will suffer water shortage.

# Conflict over water

- Tigris and Euphrates conflict (Turkey – Syria – Iraq)
- Nile conflict (Egypt – Ethiopia – Sudan)
- Jordon river conflict (Israel - Lebanon – Jordon – Palestine)
- Aral sea conflict (Kazakhstan – Uzbekistan – Tajikistan – Turkmenistan)
- Indus water treaty (Jhelum – Chenab: Pakistan, Satluj, Ravi, Beas: India)
- Kaveri dispute
  - Origins in brahmagiri hill (Karnataka)
  - Then enters Tamil Nadu
  - First agreement in 1892
  - Mettur dam was built in 1970 – Tamil Nadu raised objection
  - 1991 a tribunal is formed – Karnatake opposed
- Satluj-Yamuna Link (SYL) canal dispute (Punjab – Haryana)

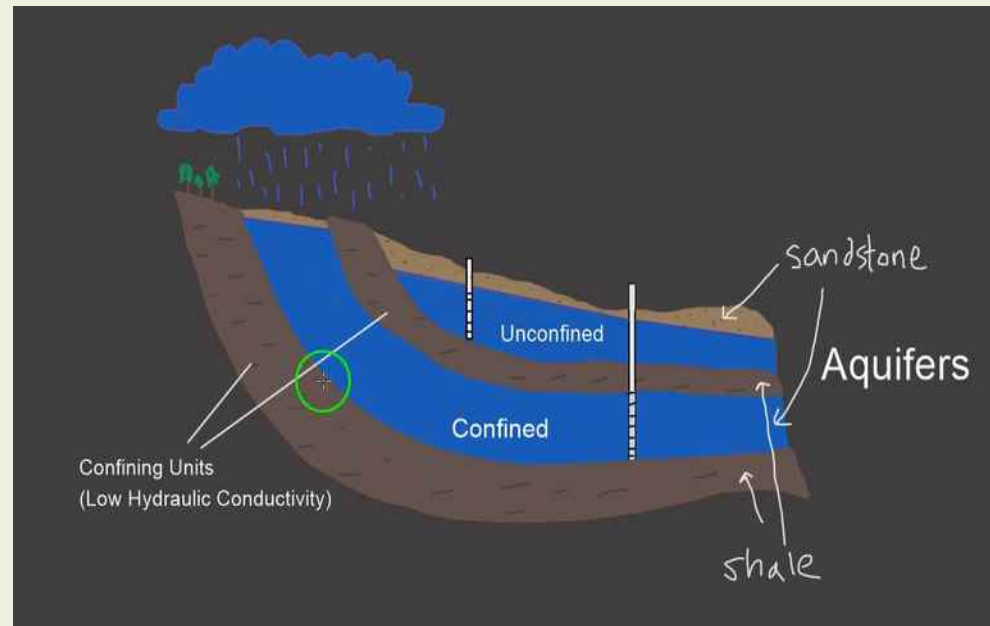
# Water cycle



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# Source of water

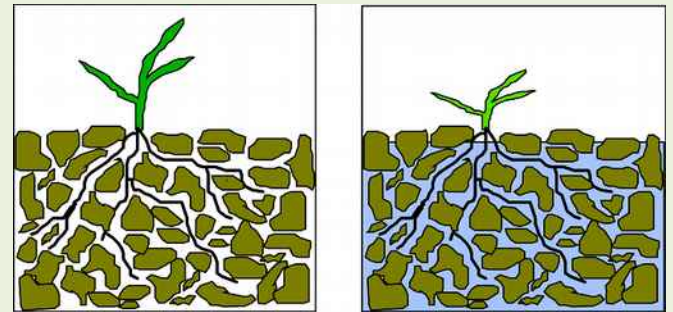
- Surface water
  - Rainfall, snow
- Ground water
  - Confined aquifer
  - Unconfined aquifer





# Over exploitation of ground water

- Ground subsidence
- Lowering water table
- Reduced surface water flow
- Increased power consumption
- Water logging
- Ground water pollution



# Water calamities (Flood)

- **Types**

- Flash flood: Heavy rainfall, dam failure, river obstruction
- River flood: Precipitation over large catchment area, melting of snow
- Coastal flood: Hurricanes, tropical cyclone, tsunami

- **Causes**

- **Upslope factors**
  - Melting of snow
  - Intense rainfall
  - Time of concentration
- **Downslope factors**
  - Dams and reservoirs
  - Tides
  - Natural events: Tsunami, Storm



# Water calamities (Flood)

- **Effects**

- Negative effects: Loss of life and property, damage to crops, damage to power transmission, water-borne diseases, difficulty in health facilities, decline in tourism
- Positive effects: Distribution of nutrients, relocation of fishes

# Water calamities (Drought)

- **Types**
  - Meteorological drought: Less rainfall
  - Hydrological drought: Low stream flow
  - Agricultural drought: Low soil moisture
- **Causes**
  - Dry season
  - Climate change
  - Erosion and human activity



# Water calamities (Drought)

- **Effects**
  - Decrease in crop growth
  - Dust storm
  - Famine and mal nutrition
  - Habitat change
  - Mass migration
  - Reduced electricity
  - Wild fire

# Dams

- Benefits

- Electricity generation
- Employment
- Irrigation water supply
- Drinking water supply
- Reduction in famine
- Flood control





# Dams

## ■ Problems

- Displacement of tribal people
- Loss of forest
- Changes in aquatic environment
- Waterlogging near reservoir
- Breeding of vectors
- Microclimatic changes
- Reduced water flow
- Flash flood
- Salt water intrusion
- Sediment carrying nutrients get deposited in reservoir.
- Outbreak of vector-borne diseases like malaria,

A long-exposure photograph of a waterfall in a dense forest. The water is blurred into white streaks as it falls over a rocky ledge. The surrounding vegetation is thick and green, with many hanging mosses and ferns. The bottom of the image shows a calm stream flowing over dark rocks.

# FOREST RESOURCE

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# Forest

- A forest , a biotic community with predominance of trees is an important Renewable natural resource.



# Forest

- Forest: Land covered with more than 10% tree canopy
- Types of forest
  - Very dense – above 70%
  - Moderately dense – 41 – 70%
  - Open forest – 10 – 40%
- 33% should be forest
- 22% in India
- Annual growth: 1990 to 2000 – 0.22%, 2000 – 2010 – 0.46%
- Fuel wood consumption – 5 times more than sustainable
- 80% rural and 48% urban people use fuel wood

# Functions of forests

- **Commercial use**
  - Timber, pulpwood
  - Raw materials: oil, bamboo, cotton, jute, rubber, gum, fibers etc.
  - Edible products: Fruits, condiments, spices, Beverages, fodder
  - Manure, fuel wood
  - Medicines
  - Minerals
  - Employment opportunity
  - Recreation: Tourism

# Functions of forests

- **Environmental functions**
  - Regulation of hydrological cycles
  - Produces oxygen
  - Soil conservation
  - Pollutants moderators
  - Driving energy flow and nutrient cycle
  - Wild life habitat
  - Reducing Greenhouse gas



# Over-exploitation of forests (Deforestation)

## ■ Causes

- Extensive wood cutting and logging
- Deforestation due to road construction
- Clearing forest for agriculture
- Overgrazing
- Mining activities
- Big hydropower projects
- Forest fire

# Over-exploitation of forests (Deforestation)

- **Effects**
  - Threatens the existence of wildlife species
  - Biodiversity is lost
  - Hydrological cycle gets affected
  - Soil erosion and loss of soil fertility
  - Siltation of river and lakes
  - May lead to landside
  - Global warming
  - Flood
  - Loss of revenue
  - Socio-economic problems: Relocation, threat to culture and tradition

# Over-exploitation of forests (Deforestation)

- **Control**
  - Mining activities should be prohibited in protected forests
  - Cutting of trees should follow massive plantation
  - Environmental laws and legal provisions must be strictly followed
  - Social forestry, agro-forestry, recreational forestry, extension forestry
  - Public awareness
  - Participation in forest conservation programs

# Control of deforestation

- **Control**
  - **Reforestation**
    - Reforestation is the reestablishment of forest cover, either naturally or artificially in a deforested area.
  - **Afforestation**
    - Afforestation is the establishment of a forest or stand of trees in an area where there was no forest.



A photograph of a lush green forest with a waterfall and a stream. The waterfall is on the left, cascading over rocks. The stream flows from the waterfall towards the right. The forest is dense with green foliage and moss. The overall scene is serene and natural.

# ENERGY RESOURCE

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# Energy resource

- What is energy – capacity to do work
- Source of energy
- India (2017)
  - Coal – 76.5%
  - Large hydro plant – 9.9%
  - Small hydro plant – 0.6%
  - Wind – 3.7%
  - Solar – 1%
  - Biomass – 1.1%
  - Nuclear – 3.1%



# Renewable and non-renewable energy

- **Non-renewable**

- Sources: Coal, oil, natural gas, nuclear energy
- Problems
  - Leakage during transportation – water pollution
  - Accidental fire – air pollution
  - Refinery waste – solid waste, salt, grease, cleaning of oil tankers
  - Vehicular emission

- **Renewable**

- Solar energy, wind energy, hydro-power, Tidal energy, Ocean thermal energy, Geo thermal energy, biomass energy, biogas, biofuel, hydrogen fuel

# Non-renewable resources

- Coal

- Types of coal

- Anthracite: The highest rank of coal. It is a hard, brittle, and black lustrous coal, often referred to as hard coal, containing a high percentage of fixed carbon and a low percentage of volatile matter.
    - Bituminous: Bituminous coal is a middle rank coal between subbituminous and anthracite. Bituminous usually has a high heating (Btu) value and is the most common type of coal used in electricity generation in the United States. Bituminous coal appears shiny and smooth when you first see it, but look closer and you may see it has layers.
    - Subbituminous: Subbituminous coal is black in color and dull (not shiny), and has a higher heating value than lignite.
    - Lignite: Lignite coal, aka brown coal, is the lowest grade coal with the least concentration of carbon.
    - Also, there is peat. Peat is not actually coal, but rather the precursor to coal. Peat is a soft organic material consisting of partly decayed plant and, in some cases, deposited mineral matter. When peat is placed under high pressure and heat, it becomes coal.

# Non-renewable resources

## ■ Petroleum

- Organization of Petroleum Exporting Countries (OPEC) consists of 13 countries and having 67% of world's petroleum reserve.
- Petroleum is a complex mixture of alkane hydrocarbons.
- It is purified and refined by the process of fractional distillation.
- Petroleum is a cleaner fuel as compared to coal.
- Petroleum products
  - Petroleum gas, kerosene, petrol, diesel, lubricating oil, paraffin, wax, asphalt, plastic etc.
- Liquefied Petroleum Gas: mainly composed of butane, other being propane and ethane.

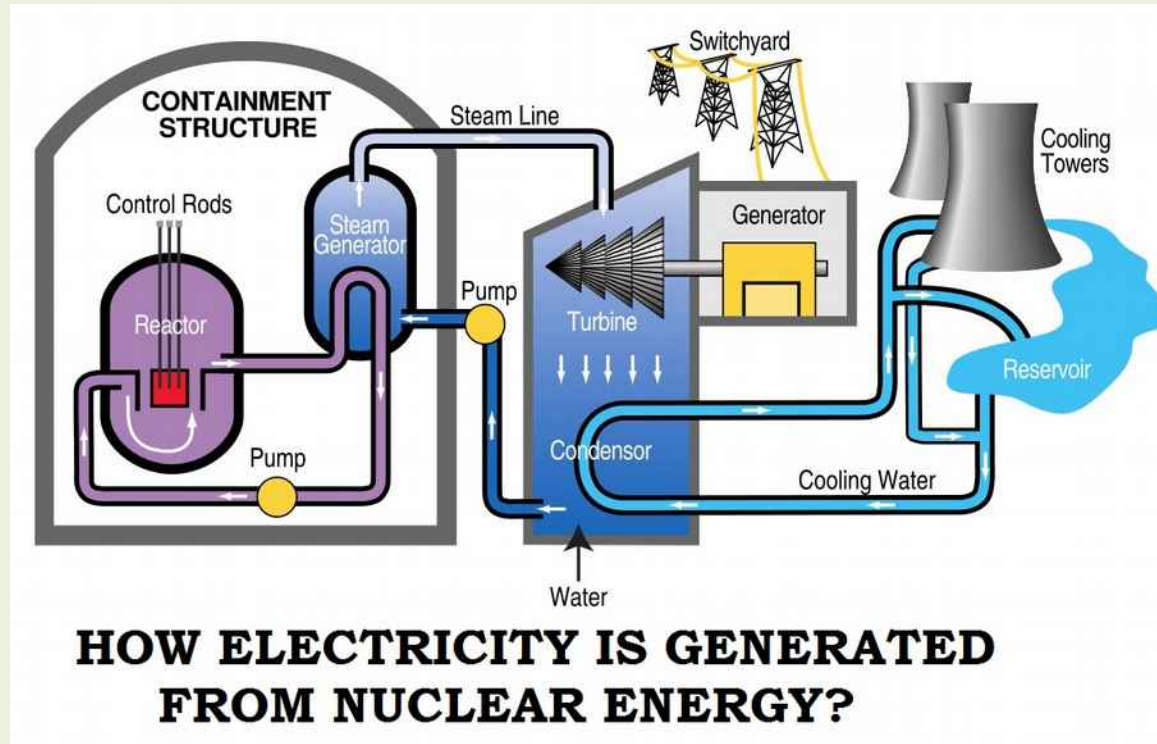
# Non-renewable resources

## ■ Natural gas

- Natural gas is the cleanest fossil fuel.
- composed of 95% methane, small amount of propane and ethane.
- It has been formed by decomposing remains of dead plants and animals.
- It has high calorific value (about 50 KJ/g)
- Compressed Natural Gas (CNG): It is used as an alternative to petrol and diesel in many cities including Delhi.
- Synthetic Natural Gas (SNG): It is a mixture of carbon monoxide and hydrogen. Low grade coal is first transformed into synthetic gas, then into methane by catalytic conversion.

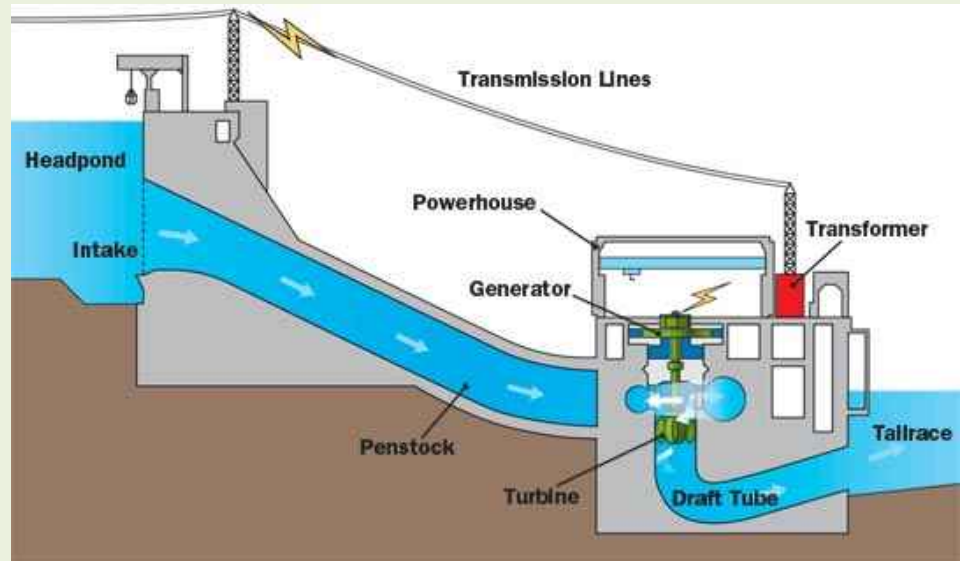
# Nuclear energy

- **Types of nuclear reactions**
  - Fission: Splitting of large nucleus into smaller nuclei.
  - Fusion: Joining of small nuclei into a large nucleus.
- **Elements used in nuclear energy production: Uranium, Thorium, Plutonium**
- **Advantages:**
  - Less fuel offers more energy.
  - The cost of nuclear fuel is only 20% of the cost of energy generated.
  - The production of electric energy is continuous (almost 90% of annual time).
- **Disadvantages:**
  - Risk of unexpected event or nuclear accidents.
  - Difficulty in the management of nuclear waste.
  - Nuclear plants have a limited life.



# Hydro-electric energy

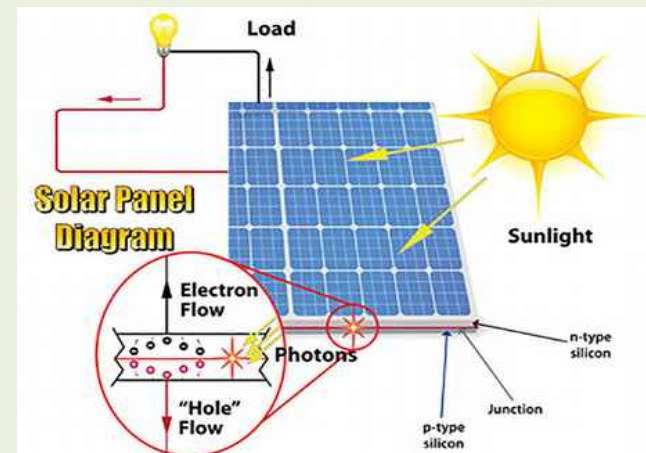
- The potential energy in the water stored in dams is converted into electrical energy by releasing the water flow and rotating the turbine
- **Advantages**
  - Low operating and maintenance cost
  - Non-polluting
  - Reliable
  - Flexible
  - Safe
- **Disadvantages**
  - High setup cost
  - Affects fish population
  - Limited reservoirs
  - Affected by draught
  - Probable seismic activity





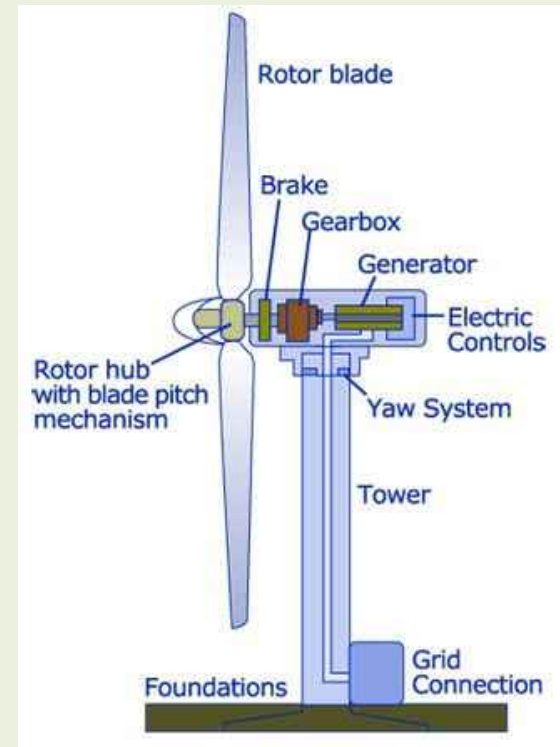
# Solar energy

- 1 hour solar energy can be used for 1 year
- Uses of solar energy
  - Solar heating of home (sunspace)
  - Solar water heating, solar cooker, solar furnace
  - Solar desalination system
- Photovoltaic energy: Silicon → PV cells → PV modules → PV array → solar panel
- Advantages
  - Easy to install
  - No pollution, no noise
  - Can be installed anywhere
- Disadvantages
  - Doesn't work when light is not available
  - Requires energy storage device
  - Low efficiency
  - Damage easily



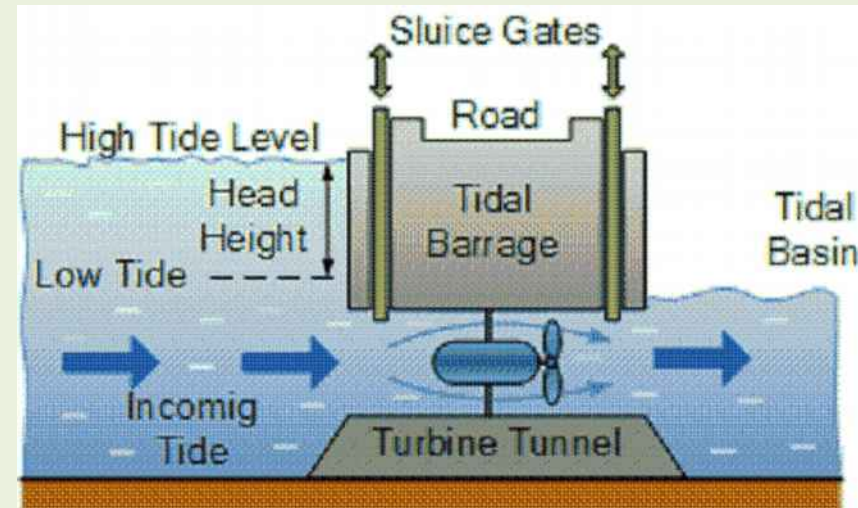
# Wind energy

- One of the earliest renewable energy – sail ships, windmills
- India is the 4<sup>th</sup> largest producer of wind energy (after China, US and Germany).
- Advantages
  - Unlimited, free, renewable resource
  - Low maintenance cost
  - No pollution
- Disadvantages
  - High setup cost
  - Birds and bats get killed
  - Noise and signal reception problem



# Tidal energy

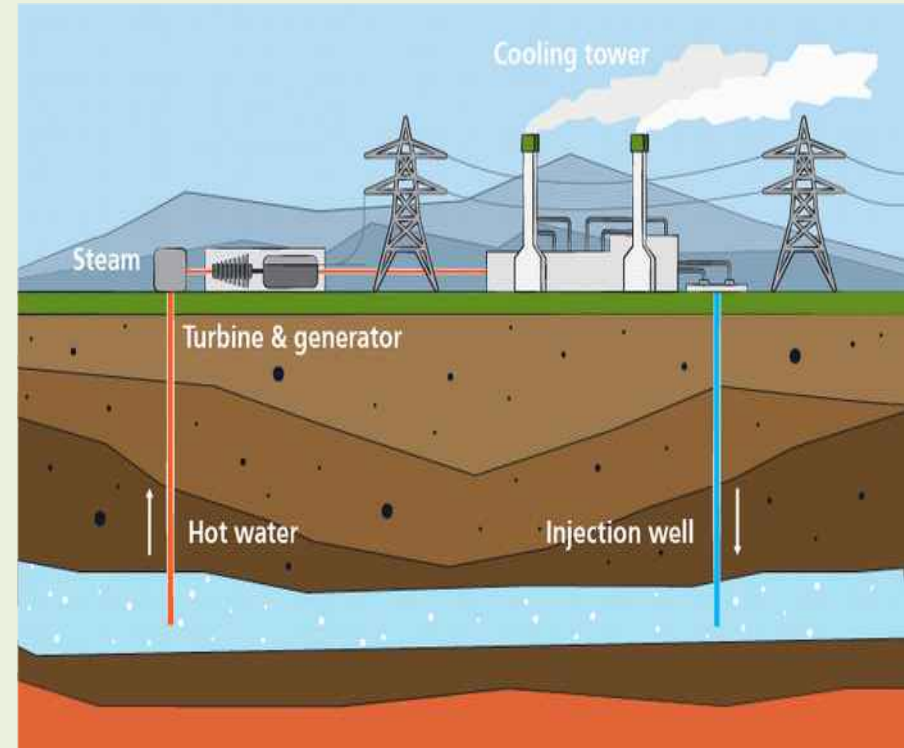
- Tidal power or tidal energy is a form of hydropower that converts the energy obtained from tides into electricity.
- **Advantages**
  - Tides are more predictable than the wind and the sun
  - Uses less area.
  - No emission of gaseous or particulate pollutants
  - longevity of equipment
- **Disadvantages**
  - Electro-magnetic emission affects the aquatic life.
  - High construction cost



- **Types**
  - Tidal stream generator
  - Tidal barrage
  - Dynamic tidal power
  - Tidal lagoon

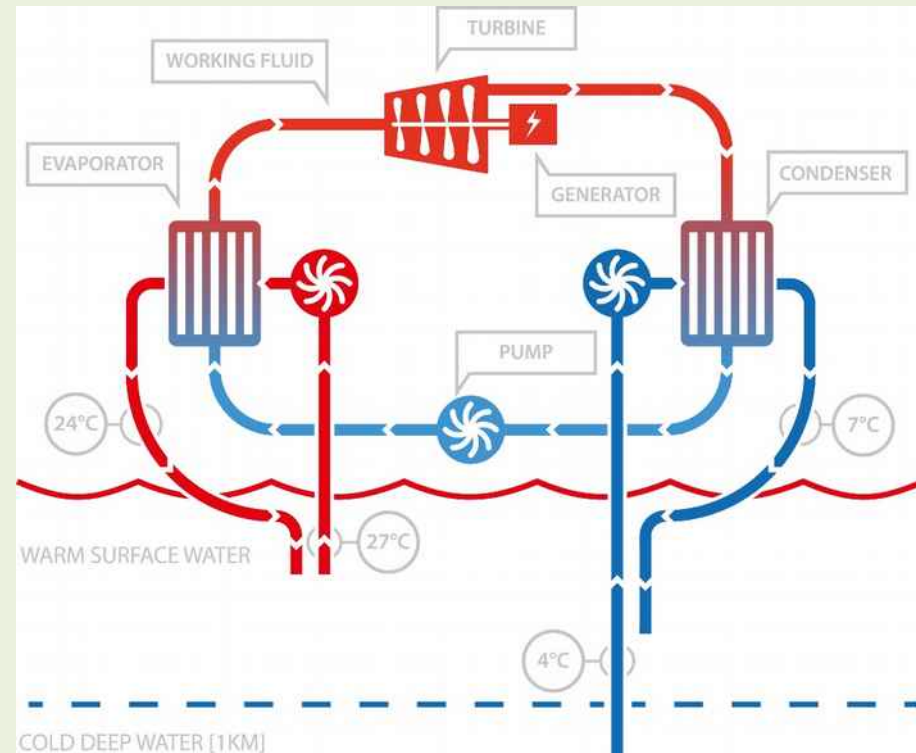
# Geo-thermal energy

- The energy harnessed from the hot rocks present inside the earth is called geothermal energy.
- Sometimes natural geysers or artificially drilled holes can be used to released the water vapour underneath the earth surface.
- **Advantages**
  - No pollutant emission
  - Reliable source of renewable energy
  - Less operating cost
  - Less maintenance cost
- **Disadvantages**
  - Possibility of emissions of  $H_2S$ ,  $CO_2$ ,  $CH_4$  during extraction
  - High Investment Costs



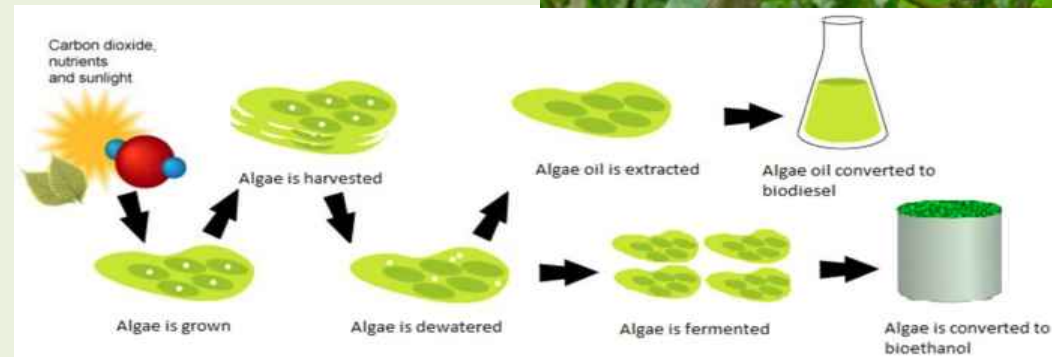
# Ocean-thermal energy

- The energy available due to the difference in temperature of water at the surface of tropical oceans and deeper levels is called ocean-thermal energy.
- A difference of at least 20° C is required
- The heat is used to vaporize ammonia and rotate the turbine using the vapour.
- **Advantages**
  - Continuous source of energy
  - No pollutant emission
  - Output shows very little seasonal variation
- **Disadvantages**
  - Capital investment is very high
  - High maintenance cost
  - Low efficiency
  - Pipes could damage coral reefs



# Biomass energy

- Log burning is a simple way use biomass energy
- Wood is the largest source of biomass energy. It can also be used in electricity production in wood-based power stations.
- Energy crop
  - An energy crop is a plant grown as a low-cost and low-maintenance harvest used to make biofuels, such as bioethanol, or combusted for its energy content to generate electricity or heat. Example: Jatropha, Sunflower etc.
- Energy trapped inside biomass
- Biofuels
  - Biodiesel
  - Biopetrol
  - Biogas
  - Bio-ethanol
  - Bio-methanol





# Energy recovery

- Getting energy by burning the waste
- Advantages
  - Reduced number of coal fired power plants
  - Reduced airborne particles
  - Improved air quality
  - Lower fuel bills on transport
  - Longer availability of crude oil
  - Reduction of waste volume (up to 90%)
  - Less requirement of landfill space
- Disadvantages
  - Release of toxic substances
  - Residual ash may contain heavy metal

# Refuse Derived Fuel (RDF)

- RDF consists largely of combustible components of such waste, as non recyclable plastics, paper cardboard, labels etc.
- These fractions are separated by different processing steps in order to produce a homogeneous material which can be used as substitute for fossil fuels

