

The Study of Environmental Science from Local, National & Global Point of View

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Abstract - Environment is defined as the natural world in which people, animals and plants live. The term Environment is derived from French terms 'virer (to turn) or 'in/viron' meaning to encircle; and denotes the interaction between natural surroundings and organisms including human beings. Thus, environment is the surroundings in which living and non-living things live, interact, grow and perish. Environmental Science promotes communication among government, business and industry, academia, and non-governmental organisations who are instrumental in the solution of environmental issues such as climate change, biodiversity, environmental pollution and wastes, renewable and non-renewable natural resources, sustainability, and the interactions among these issues. Environmental science is a multidisciplinary academic field that combines physical, biological and information sciences to the environmental study. The social science fields that are incorporated into environmental science include geography, economics, and political science. Components of Environmental Science include Atmospheric Sciences, Environmental Chemistry, Forestry and Agricultural Sciences, Geosciences, Oceanography and Marine Sciences.

keywords - Environmental Science



1. Environmental Science

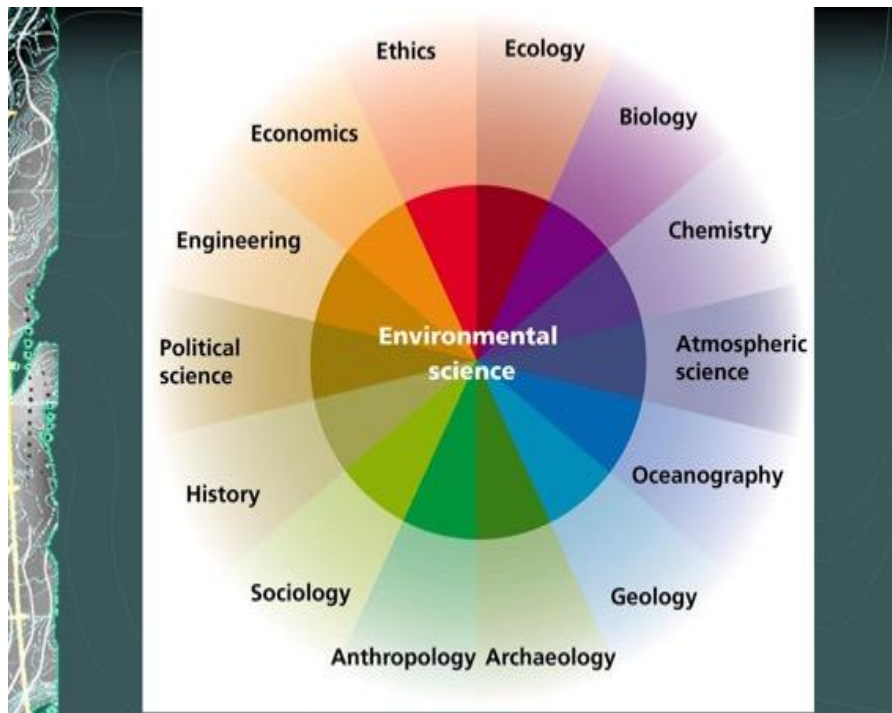
Environment as we all know is very precious gift from the mother nature. The survival of the human race depends mainly on the sustainability of the resources.

Need for Environmental studies (Environmental protection starts by creating awareness)

- It is very important for every person for self-fulfilment and social development.
- It helps to understand different food chains and ecological balance in nature.
- It helps to understand and appreciate how the environment is used for making a living and for promoting a material culture.
- It helps in appreciating and enjoying nature and society.
- It generates concern for the changing environment in a systematic manner for the future as well as immediate welfare of mankind.
- It directs attention towards population explosion, exhaustion of natural resources and pollution of environment and throws light on solutions.

2. Goals of Environmental Education

"To develop a world population that is aware of and concerned about environment as a whole and the problems associated with it, and committed to work individually as well as collectively towards solutions of current problems and prevention of future problems"



3. Primary objectives: (SPEAK Awareness)

Skill: Acquire skills for identifying and solving environmental problems.

Participation: To provide an opportunity to be actively involved at all levels in working towards the solution of environmental problems.

Evaluation ability: Develop the ability to evaluate environmental measures and education programmes in terms of ecological, economic, social and aesthetic factors.

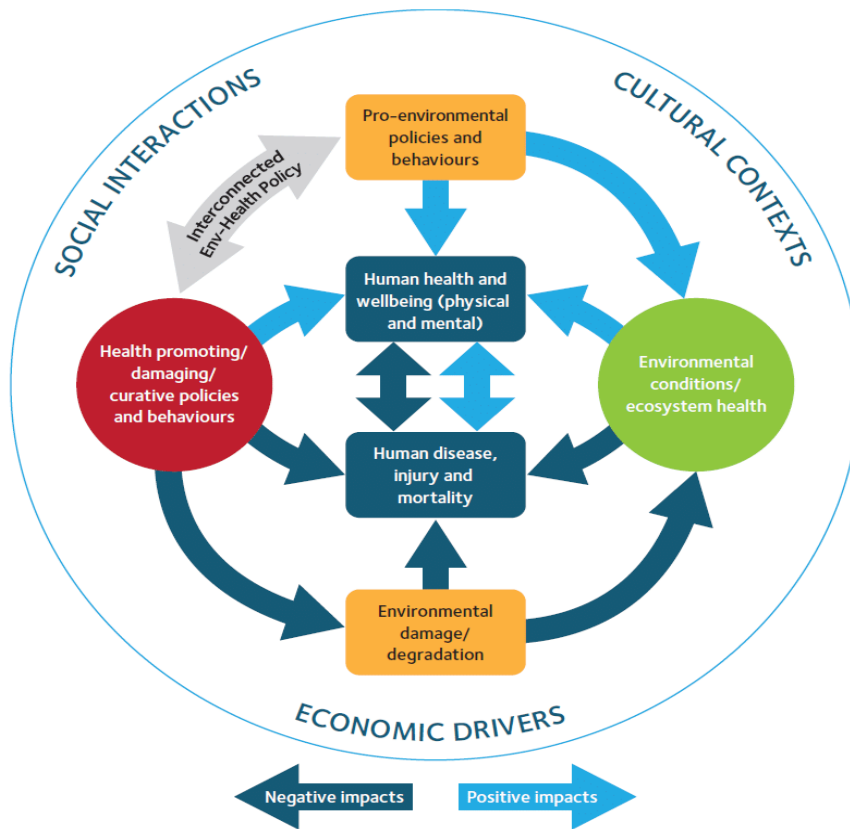
Attitude: Acquire a set of values and feelings of concern; motivation for active participation to improve and protect environment.

Knowledge: Gain a variety of experiences and acquire a basic understanding of the environment and its associated problems.

Awareness: Acquire an awareness of the environment as a whole and its allied problems and sensitivity.

4. Guiding Principles of Environmental Science

- To consider the environment in its totality (natural, artificial, moral, cultural etc.)
- To consider a continuous life process (pre-school to degree, formal, non-formal)
- To be inter-disciplinary in approach
- To emphasise active participation in the prevention and control of environmental problems
- To examine the major environmental issues from local, national and global point of view
- To focus on current potential environmental situations
- To consider environmental aspects in plans for growth and development
- To emphasise the complexity of environmental problems and the need to develop critical thinking and problem solving skills
- To promote the value and necessity of local national and global cooperation in the prevention and control of environmental problems
- To utilise diverse approaches for teaching and learning about environment
- To help learners discover the symptoms of real causes of environmental problems
- To relate environmental sensitivity, knowledge, problem solving and value clarification at every level
- To enable learners to have a role in planning their learning experiences and provide an opportunity for making decisions and accepting their consequences



Man-Environment relationships

- Period of hunting and food gathering
- Period of animal domestication and pastoralism
- Period of plant domestication and agriculture
- Period of Science, technology and industrialization

1. Period of hunting and food gathering

Related to primitive man

- Man was part of natural environment
- He was concerned with food (fruits) and shelter (caves, on trees)
- He had a friendly relationship with environment

Started hunting animal for food

- First exploitation of natural resources
- Had very less impact on environment (low population)

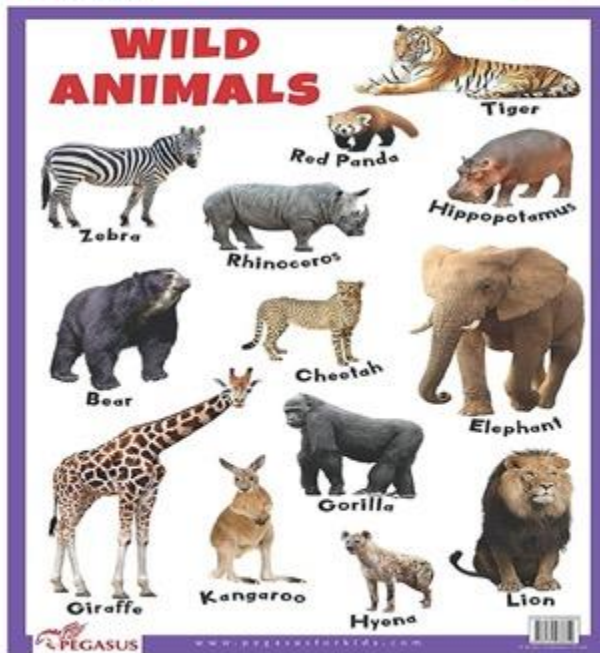
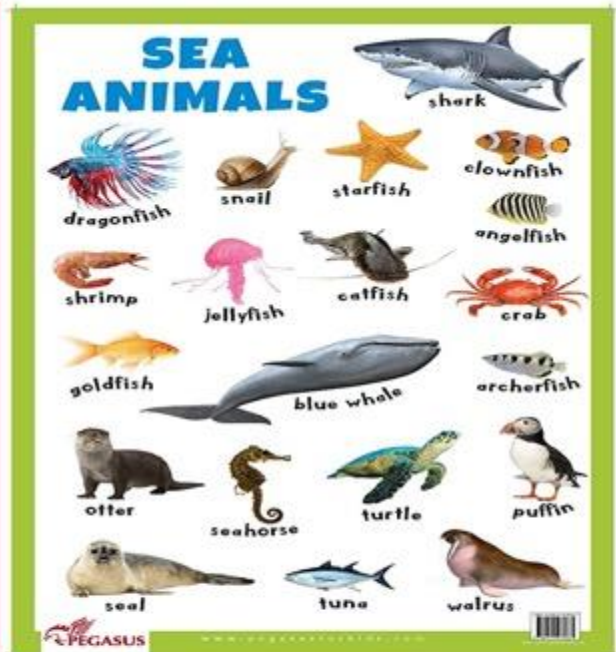
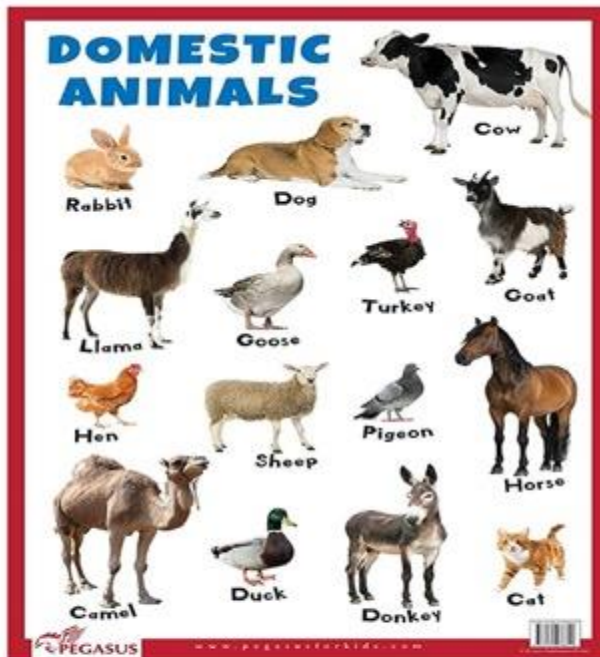
Discovery of fire, invention of tools

- Continued exploitation of natural resources
- Careless mistakes led to forest fires, destruction of forests
- Fire was the first major ecological tool used by human beings to change the environment for their own Benefit

2. Period of animal domestication and pastoralism

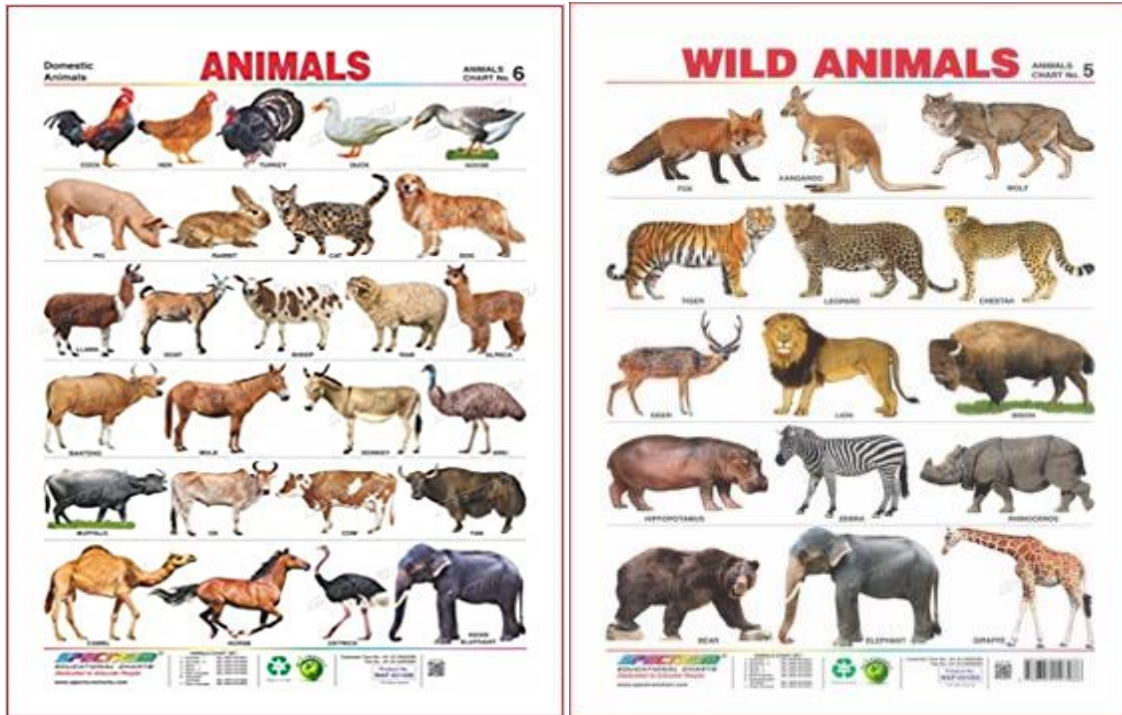
Started domesticating animal for meat and milk

- Created habitat for these animals
- This led to destruction of forest
- This also led to the first community life among people
- Domesticated animal population increased



Pastoralism is the branch of agriculture concerned with the raising of domesticated animals.

- This led to meaningful exploitation of environment resources.
- Still not much damage is done on the environment



3. Period of plant domestication and agriculture

- Started domesticating plant for food
- Nomad life style changed to settled life style
- Started cultivating crops
- This led to the earliest river valley civilisation
- This changed the friendly and cordial relationship
- Gradual increase of human population
- More forest were cleared for agricultural land
- Man developed cultural environment, built house, school, temple, road etc.
- This continued until Industrial revolution

4. Period of Science, technology and industrialisation

- Industrial revolution started around 1860
- Emergence of science, development of efficient technology
- Initiated hostile relationship with environment
- Birth of technological man
- Indiscriminate exploitation of natural resources led to present ecological problems

5. Four Components of Environment

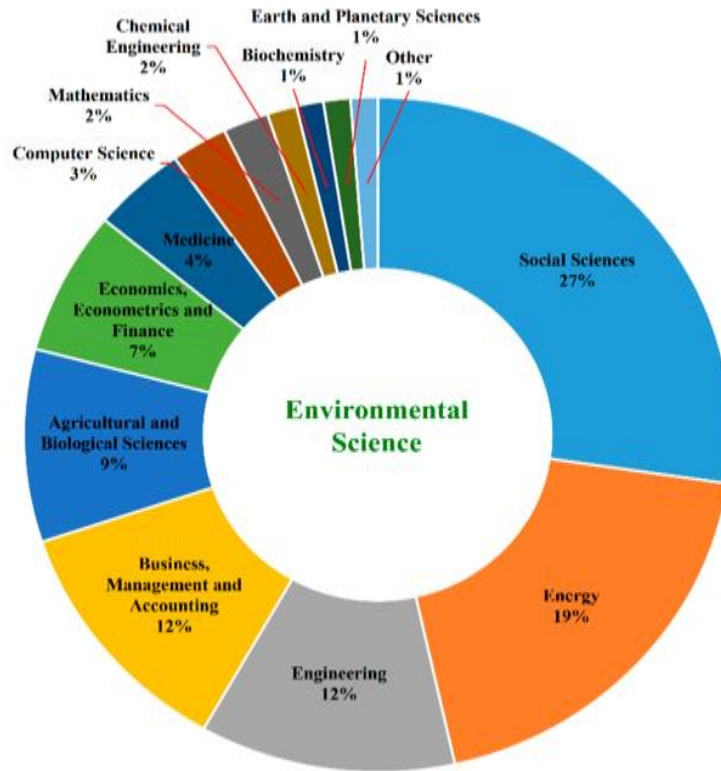
The four major components of environment include lithosphere, hydrosphere, atmosphere and biosphere, corresponding to rocks, water, air and life respectively.

Lithosphere is the outermost layer of earth called crust, which is made of different minerals. Its depth can reach up to 100 kilometers and is found on both land (terrestrial crust) and oceans (oceanic crust). The main component of lithosphere is earth's tectonic plates.

Hydrosphere comprises of all forms of water bodies on earth including oceans, seas, rivers, lakes, ponds, streams etc. It covers 70% of earth's surface. 97.5% of water found on Earth is in the oceans in the form of salt water. Only 2.5 % of water on Earth is freshwater. Out of this, 30.8% is available as groundwater and 68.9% is in frozen forms as in glaciers. Amount of 0.3% is available in rivers, reservoirs and lakes and is easily accessible to man.

Atmosphere is gaseous layer enveloping the Earth. The atmosphere with oxygen in abundance is unique to Earth and sustains life. It mainly comprises 78.08% nitrogen, 20.95% oxygen, 0.93% argon, 0.038% carbon dioxide, and traces of hydrogen, helium, and noble gases. The amount of water vapour present is variable.

Biosphere refers to all the regions on Earth where life exists. The ecosystems that support life could be in soil, air, water or land. The term Biosphere was coined by Geologist Edward Suess who used this term for place on Earth where life can be found. Biosphere refers to the sum total of all living matter, the biomass or biota. It extends from the polar ice caps to the equator, with each region harboring some life form suitable to the conditions there.



Environmental science is an interdisciplinary subject. It draws from a whole gamut of subjects like geography, geology, biology, chemistry, physics, botany, zoology, genetics, sociology, rural development, urban planning, policy development, politics, cultural studies, economics, ethics, law, education, health, communication and philosophy. It is a science that will address the biggest challenges encountering the planet in this millennium. It studies the complex interaction of human with nature and provides guidelines for the way forward.

6. Impact of Man on Environment

Direct or intentional impact (preplanned , man is aware of consequences)

- Land use changes - Clearing of forests, burning of land, felling of trees, changes in cropping pattern
- Construction and excavation - Construction of dams, diversion of rivers, construction of roads, bridges, urbanisation
- Agricultural practices - Mechanisation of agriculture, use of chemical fertiliser, pesticide etc.
- Weather modification programme - Cloud seeding to induce precipitation, dispersal and clearing of clouds, fogs
- Nuclear programme - Use of nuclear energy for constructive and destructive purposes

Example of Construction of dams, diversion of rivers: Three Gorges Dam was built on Yellow river, China. The Chinese government regards the project as a historic engineering, social and economic success



Direct or intentional impact (preplanned , man is aware of consequences): Human impact on the environment is also called as **anthropogenic** impact on the environment includes impacts on biophysical environments, biodiversity and other resources. Many are noticeable quickly but have impact over longer period of time. We can reverse the impact by taking appropriate actions like Afforestation, change of form farming practices

Indirect or unintentional impact (industrial development for economic growth)

- Many are not noticeable quickly but have impact over longer period of time.
- These are non-reversible.
- Affect the natural system in a detrimental way.
- Examples include pollution and environmental degradation

7. Ecology

“The study of the relation of organisms or groups of organisms to their environment” Or “The science of the interrelations between living organisms and their environment” Or “The totality or patterns of relations between organisms and their environment”

Subdivisions of Ecology

1. Taxonomic features

- Plant ecology
- Animal Ecology
- Avian ecology, Insect ecology, Bacterial ecology, Fungal ecology,
- Behavioural ecology, Mycorhyza ecology

2. Habitat

Study of ecology based on the basis of the habitats and their interactions and the subsequent effects upon the organisms.

3. Organisation level

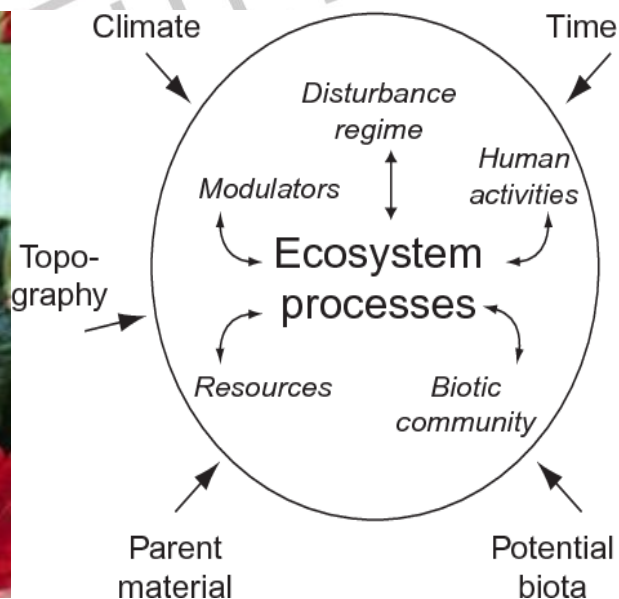
- Autecology: The study of the individual organisms
- Synecology: The study of groups of organisms which are associated together as a unit

Types of Synecology

- Populations ecology: Deals with study of individuals belonging to a species. Related to Population Size, growth rate, death rate, survival rate immigration, and emigration etc.
- Community ecology: Study of groups of individuals belonging to different species of plants as well as animals.
- Biome Ecology: Study of interactions among different communities of a particular area.
- Ecosystem ecology: Deals with circulation of energy and nutrients among biotic and abiotic components of ecosystems.

Concept of Ecosystem

- The system resulting from the integration of all living and non-living factors of the environment.
- Based on interactions and exchange of materials
- Communities in a given area interact with physical environment. This flow of energy leads to trophic structure, biotic diversity and material cycle
- It is an overall integration of a whole mosaic of interacting organisms and their environment
- Ecosystem is the highest level of ecological integration which is energy-based and this
- functional unit is capable of energy transformation, accumulation and circulation



Types of Ecosystem

- Natural Ecosystems: Self operating under natural conditions; no interference by man
- Terrestrial ecosystems e.g. forests, grassland

- Aquatic ecosystems
- Freshwater ecosystem
- Lotic – Running water e.g. river, stream, spring etc.
- Lentic – Standing water e. g. lake, pond, well swamp etc.
- Marine ecosystems e.g. ocean, sea etc.
- Artificial Ecosystems: Managed and maintained by man. E.g. cropland

Different Aspects of Ecosystem

1. Structural (architectural) aspect

- The composition of biological community including species, numbers, biomass, life history etc.
- The quantity and distribution of non-living materials like nutrients, water etc.
- The conditions of existence such as temperature, light etc.

2. Functional (working process) aspect

- The rate of energy flow
- The rate of material (nutrient) cycles
- Biological regulation including both regulation of organisms by environment (photoperiodism) and regulation of environment by the organism (nitrogen fixing organism)

Abiotic (non-living) components

- Includes inorganic substances (C, N, O, P, S etc.), inorganic chemicals (chlorophyll), organic materials (proteins, carbohydrates, lipids etc.)
- They are present either in biomass or in the environment

Biotic (living) components

- These are the trophic (nutritional) structure of ecosystem (trophic –feeding)
- Based on nutritional relationship they are distinguished

Autotrophic or self-nourishing components

- Use light energy to make food from simple inorganic substances (H₂O, CO₂)
- Photosynthesis, Known as producers
- Eg. Green plants, algae, photosynthetic bacteria

Heterotrophic or other-nourishing components

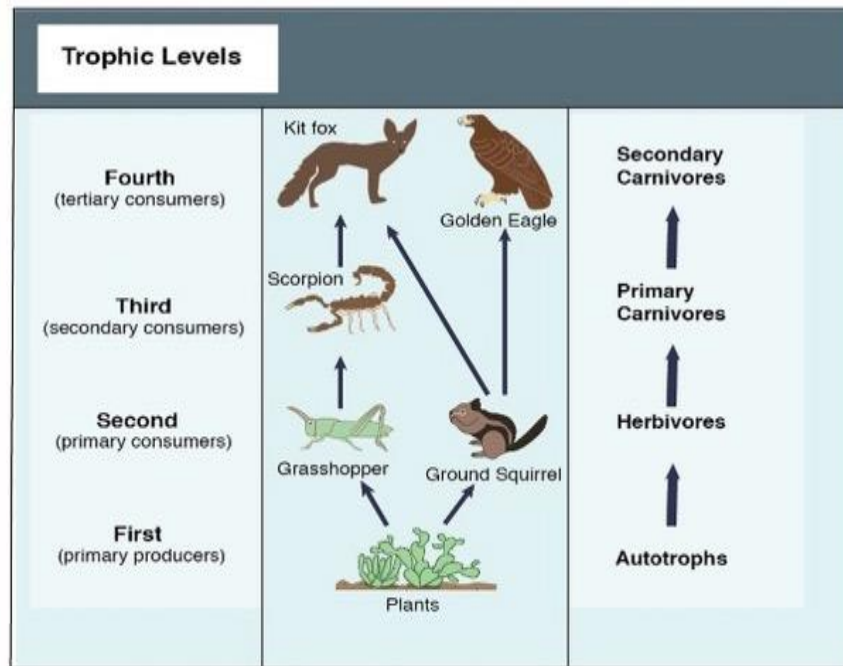
- Utilize rearrange and decompose the complex materials produced by the autotrophs, known as consumers
- Eg. Fungi, animals, humans

Macro Consumers (Phagotrophs)

- They feed on other organic and particulate organic matter
- Herbivores (feed on plants) Primary consumer
- Carnivores or predators (feed on other animals) secondary
- Omnivores (feed on plants and animals) tertiary consumer

Micro Consumers (Saprotrophs)

- They are microscopic organisms
- Bacteria, actinomycetes, fungi
- Breakdown complex compounds of dead or living protoplasm
- Absorb some of the decomposed / breakdown products
- Release inorganic nutrient in to environment



Functional Territory of Nature

- Trophic level: The trophic structure of an ecosystem is one kind of producer-consumer arrangement where each step or level is known as trophic level
- Standing crop: The amount of living material in different trophic levels or in a component of population is known as standing crops
- Expressed as “number of organisms per unit area”
- Biomass i.e. organism mass in unit area, Measured as living weight, ash-free dry weight, carbon weight calories

Ecological pyramids: An ecological pyramid (also trophic pyramid or energy pyramid) is a graphical representation designed to show the biomass or biomass productivity at each trophic level in a given ecosystem.

Pyramids of numbers: Depicts number of individual organisms at each trophic level

Pyramids of Biomass: Showing the total dry weight, calorific value or other measure of the total living material

Pyramids of Energy: Depicts the rate of energy flow and/or productivity at successive trophic levels

Productivity Concept of Ecosystems

Productivity of an ecosystem is defined as “the rate at which radiant energy is stored by photosynthetic and chemosynthetic activity of producer organisms in the form of organic substances that can be used as food materials”



The amount of organic matter accumulated in any unit time is called productivity. The different types of Productivity are

1. **Primary Productivity**
2. **Secondary Productivity**
3. **Net Productivity**

1. **Primary Productivity** - “The rate at which radiant energy is stored by photosynthetic and chemosynthetic activity of producer “e.g. green plants, phytoplankton
2. **Secondary Productivity** - The rates of energy storage at consumer levels” It is dynamic i.e. keeps moving from one organism to another; Consumers assimilate and not produce (Odum)

3. **Net Productivity**

- “The rate of storage of organic matter not used by the heterotrophs (consumers) during the unit period of time”
- It is the rate of increase of biomass of the primary producers which has been left over by the consumers
- It is expressed as production of C g/m²/day.
- Is also called as net community productivity

The different types of Primary Productivity are

1. Gross Primary Productivity

The total rate of photosynthesis including the organic matter used up in metabolism for a particular period of time (total photosynthesis or total assimilation)

Measured as chlorophyll content (chl/g dry weight /unit area or photosynthetic number (amount of CO₂ fixed /g chl/hr)

2. Net Primary Productivity

The rate of storage of organic matter in excess of metabolic utilisation by the autotrophs during the period of measurement (apparent photosynthesis or net assimilation)

Net = Gross photosynthesis – Respiration (metabolism), death etc.

Food chains: “The transfer of food energy from the producer through a series of organisms herbivores, carnivores, decomposers with repeated eating and being eaten “is called food chain.

In grassland ecosystem this food chain consists of relationships between the producers, herbivores (primary consumers), first level carnivore (secondary consumers), second level carnivore (tertiary consumers) etc.



Food chains are mainly of two types

1. Grazing food chain
2. Detritus food chain

Grazing Food Chain: Grazing food chain starts with green plant base, goes to grazing herbivores (organism that eat plants and their predators) and finally to the carnivores (flesh eaters). It also depends on capture of energy by the autotrophs and the movement of captured energy to herbivores

Detritus Food Chain: This food chain starts from dead organic matter and then goes on to detritus-feeding organisms (detritivores) and their predators. They are less dependent of solar energy.

- Detritus consumers are mixed groups with respect to trophic level
- Grazing insects
- Saprotrophs (fungi, bacteria, protozoa)
- Coprophagy (coprophagy is the consumption of feces) (crab, coped, insect)

Detritus feeders obtain some energy from plants, mostly from microorganism (secondarily), some through carnivores (tertiary)

Population is a group of individuals of a particular species, sharing the common genepool and

occupying a particular area at a specific time. There are two types of populations in ecology

- Monospecific population (individuals of one species)
- Mixed or polyspecific population (individuals of more than one species)

Populations ecology may be analysed as

- Population characteristics
- Population dynamics
- Population regulation
- Population characteristics

A Populations has the following characteristics

- Size and density
- Natality (birth rate)
- Mortality (death rate)
- Age distribution
- Dispersion
- Life tables

Land Resources

Nature and importance of soil: Soil is defined as an uncemented aggregate of mineral grains and decayed organic matter with liquid and gas, occupying the void spaces between the soil particles.

Importance of soil

- It is required for plant growth
- Erosion leads to environmental degradation (control it)
- It is the source of sediment
- It acts as filter for ground water
- It serves as the bearing material for roads, pipelines etc. and act as a construction material for mud-built houses

Beneficial impact to man

- He gets all nutrient indirectly (by eating plants)
- It is a resource (for plant growth) and environmental medium

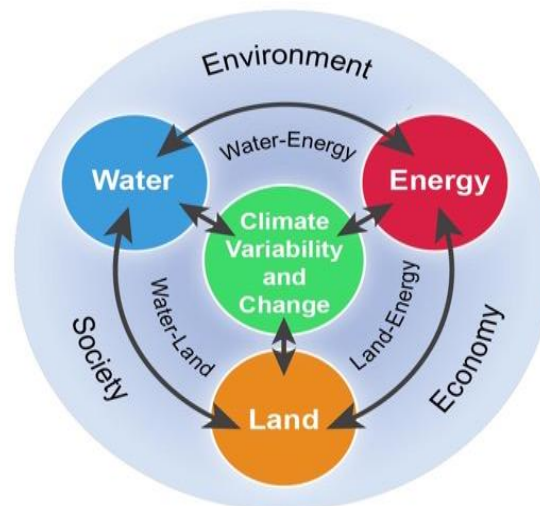
What are the impacts of man on soil

- Beneficial impact (by man)
- Drainage, Fertilisation (use of fertiliser), Irrigation
- Adverse impact (by man)
- Soil erosion, Loss of soil fertility, Salination, Desertification, Pollution

Formation of soil: Formed *in situ* from rocks or sediments or they may be deposited after transport. The principal factors that govern the formation and properties of the soil

- Climate - Temperature, rainfall, wind
- Nature of the parent material - Mineral content, relative portion of sand, silt and clay
- The geomorphic setting, slope and drainage - Grain size of the soil
- Time - Longer period of weathering, the greater the extent of soil formation

Energy, Water, Land, and Climate Interactions



1. Organism

- Affects/influences the soil fertility
- During weathering process, a variety of secondary mineral develop from primary mineral.
- Weathering is most intense in humid tropics
- Rapidity of weathering (Na, Ca, Mg) > (Fe, Al)
- Dissolution
- Mineral goes into solution completely, no precipitation (congruent dissolution)
- All or some of the ions released by weathering precipitates to form new compounds (incongruent dissolution)

Basic requirement for Wasteland development

1. Skills and training

- Horticulture and forest nurseries as revenue source
- Horticultural development
- Tusser silk production
- Bee-keeping
- Fodder production and processing
- Wood-based crafts

2. Forestry

- Survey and preparation of plantation sites
- Selection of suitable species
- Plantation programme planning
- Working out section wise plantation schedule and actual plantation operation
- Protection of reforested area with volunteers

3. Health Education

- Dissemination of basic knowledge about human anatomy, body functions, diseases
- Education about public sanitation and personal hygiene
- Ante natal and child care
- Propagation of home remedies
- Dental care based on traditional medicine

4. Nutrition Education

- Dissemination of information about the nutritional needs of the human body
- Informing people about nutritional value of food
- Ensuring adequate milk consumption by expectant and nursing mothers, children

5. Animal husbandry (agricultural practice of breeding and raising livestock)

- Promoting ecologically sound and economically beneficial livestock policy
- Genetic upgradation of cattle, goat, sheep so as to bring switch over from grazing economy to stall-fed economy
- Usage of modern technology to accelerate upgradation of livestock

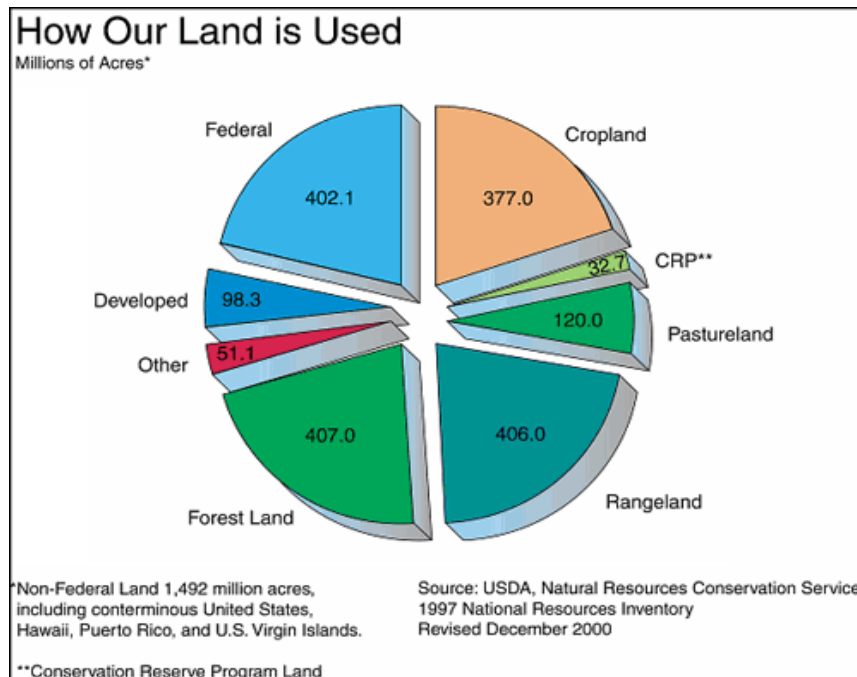
6. Conservation

- Educating the formers about all the aspects of nature conservation
- Promoting economical use of water

7. Agricultural extension

- Evolution of scientific land use pattern
- Identification of rotation cropping patterns for micro-ecosystem
- Experiments in genetic engineering by a carefully selected avant-garde group of local formers

Govt. of India had created the **Department of Wasteland Development** during July, 1992 under the Ministry of Rural Development, which has been subsequently reorganized and renamed as **Department of Land Resources**, with a broader mandate.



Desertification: Desertification refers to loss of productivity of the land. Desertification is the persistent degradation of dryland ecosystems due to human activities and variations in climate.

- Moderate loss (25 %)
- Severe (25 - 50 %)
- Very severe (> 50 %)
- End result is creation of desert where there had once been thriving agriculture

Major desert zones

- The desert basins that run from northwestern Mexico to the southwestern USA.
- The Atacama desert in the southwestern South America.
- The great desert belt running from the Sahara in Africa. through the deserts of Iran, USSR, Pakistan, India, Mongolia and China.
- The Kalahari desert in southwestern Africa.
- Most of the continent of Australia.

Reasons for desertification

- Over cultivation
- Deforestation
- Overgrazing
- Unskilled irrigation

Increase of population also compounds the issue

The Dust Bowl, or the Dirty Thirties, was a period of severe dust storms causing major ecological and agricultural damage to American and Canadian prairie lands in the 1930s. The phenomenon was caused by **severe drought** combined with farming

methods that did not include crop rotation, fallow fields, cover crops, soil terracing and wind-breaking trees to prevent wind erosion.

Area susceptible to desertification

- Range lands (grazing for livestock) 80 % affected by desertification
- Croplands watered by rain 60 % affected by desertification
- Cropland watered by irrigation 30 % affected by desertification

Effects of desertification: Survival depends on success of few crops or the sale of few animals

- Productivity of the land falls
- Living conditions worsen
- Crops fail
- Water source dry up
- Animals die
- Fuel-wood become scarce
- The only solution is migration

Water Resources

Ocean covers 71 % of Earth's surface. Water is found in Glaciers, ice caps, lakes, streams, soils, underground reservoirs and in the bodies of all living organisms.

- Ice melts in water
- A considerable amount of energy is consumed when ice melts (80 cal) and evolved when it boils (540 cal)
- Water is an excellent solvent for many different kinds of substances and is therefore called an universal solvent
- We use water in home, industry, agriculture etc.
- These use differ with respect to quality and quantity of the water.
- We use all available sources – inland water, groundwater, ocean water
- We pollute it, purify it, reuse it over and over again
- H₂O is the molecular formula of water
- It has a bent shape
- The H-O-H bond angle is 104.5 °.
- Due to this H₂O has dipole.
- H₂O molecules are bonded to each other through H-bonding.

Properties of Water

How does ice remain in the solid state at 0 °C?

The strong H-bonding between the water molecules result in association of molecules and thus molecular weight and hence melting point, increases. This keeps ice in the solid state up to 0 °C.

What makes ice float on water?

When crystal structure of ice breaks, the liberated molecules become associated with each other so strongly that they pack together more closely than in ice crystal itself. As a consequence, ice becomes less dense than water and floats on it. If it did not happen, a body of water would freeze from the bottom upwards instead of from top downwards, and aquatic life, as we know, would not exist. When water vaporizes and becomes steam, the molecules are completely dissociated from each other. i.e. All H-bonds between the water molecules is broken. This requires about 7 times as much energy as it does to melt ice. When these processes are reversed the energy flow also is reversed.



Hydrological cycle: The sequence of events involving the transfer of water from the atmosphere to the landmasses and oceans and its return to the atmosphere is called hydrological cycle.

Evaporation: It is the change of state of a liquid into vapour at a temperature below the boiling point of that liquid. It takes place from the surface of all water bodies in hydrosphere.

Condensation: The water vapour raises and gets cooled to form drops of water around the dust particles present in air. This is how clouds are formed.

Transpiration: The physiological process by which water is lost in the form of water vapour, from the green aerial parts of the plants.

Precipitation: It is a general term for all forms of atmospheric moisture which descend on to earth in the form of rain, snow, hail and sleet.

Run-off: It is the flow back of the precipitation to the oceans through streams. It consists wholly or partly of water contributed by overland flow (surface run-off) and by groundwater flow (base flow). Hydrological cycle is fuelled by the solar and planetary forces.

Sources and causes of groundwater Pollution

1. Municipal Source

a) Sewer Leakage

- Leakage of sewage into ground water from old sewers
- It introduces high concentration of COD, BOD, NO₃, bacteria
- Sewage leak from industrial area increases toxic concentration of As, Cu, Fe, Pb, Hg

b) Liquid Waste

- Domestic use, industries or storm run-off produces wastewater
- Generally treated wastewater is discharged into surface waters
- When there is a considerable stress on the aquifer this wastewater introduces bacteria, virus, inorganic or organic chemicals, heavy metals
- Chlorination of wastewater can also produce additional pollutants

c) Solid Waste (Why does land disposal of solid waste create groundwater pollution?)

- Leachates from landfill can pollute groundwater if water moves through the fill material
- When landfill receives high rain fall or when the groundwater occurs in an unconfined shallow water table conditions increase pollution
- Pollutants include BOD, COD, Fe, Mn, Cl, NO₃
- Hardness, alkalinity, total dissolved solids (TDS) increases CO₂, CH₄, NH₃, H₂S may reach groundwater through rainwater or seepage water

2. Industrial Sources

- The major uses of water in industrial plants are for cooling, sanitation, manufacturing and processing
- Groundwater pollution occurs when the industrial waste water is discharged into pits, ponds.
- This leads to water migration to water table. Some times deep injection of hazardous waste into saline water below fresh water aquifer also leads to pollution.
- The groundwater can be polluted from leakage of underground storage tanks and pipe (mainly fuels or chemical storage, radioactive waste)
- Mining activity (coal, phosphate, uranium, iron, copper, zinc)

How do industries contribute to the degradation of groundwater?

- Solid materials that are stockpiled near industrial plants cause leaching of toxic materials due to precipitation into the soil.
- Some times solid wastes are dumped besides the river banks. When they are washed into the river (rainfall) it may cause pollution.

Brine is saline waste water produced during production of oil, gas. Industries inject brine deep into oil/gas formations that is below the fresh water aquifer. When the oil wells are abandoned or unplugged they allow saline to mix with aquifer (pollution).

3. Agricultural sources

- Irrigation increases salinity of return water 3-10 times than the applied water. This occur due to addition of salts (fertiliser)
- Fertilisers and pesticides leach through soil and pollute water table

4. Miscellaneous sources

- Spills, surface discharges, septic tanks, saline water intrusion
- Connate water can contaminate aquifer due to over pumping of groundwater

5. Connate water

- The water trapped in the geological formations during sedimentation and remains out of contact with the atmosphere for a long time (millions of years)
- This type of water is found in oil fields and is saline
- Purifying process of Polluted groundwater

What are the different sources of wastewater?

Domestic wastes: These comprises of wastes from sinks, toilets, washing machines etc. They contains solids, organic matter, ammonia, some metals and large numbers of faecal bacteria.

Industrial wastes: These comprises of metals, toxic organic compounds and acids. They are produced from washing, processing and cooling. The wastes may be present as suspension or solution form.

Surface drainage: These comprises of metals, bacteria, organic solids. It comes from runoff from impermeable areas like pavements, roads, car parking etc. The flow is a reflection of the precipitation.

Agricultural waste water: These comprises of animal waste, bacteria, nutrients, organic matter, fertilisers, pesticides. It happens where there is intensive farming.

Leachates: These comprises of effluents that contains organic matter, metal, pesticide etc. It originates from solid waste of domestic, industrial or agriculture use.

What is sewerage system?

It is waste water collection system usually constructed to collect domestic wastewater, industrial wastewater and surface drainage.

What are the important hydraulic properties that should be considered before construction of sewerage system?

- Adequate scouring so that solids do not accumulate in sewer
- Short retention time, especially in hot climates, to avoid formation of septic conditions
- Adequate capacity to avoid the system discharging during the peak flows

What are the operating facets to be considered for operating sewerage system?

Health of the worker: Poisonous gases (H_2S , HCN) may be generated in the sewer, organic solvents and petroleum products may produce toxic or explosive vapours.

Damage to the fabric of the sewer: Strong acid or alkalis may corrode the sewer, solids may be deposited or some substance may react with the mortar. These may lead to sewer collapse.

Damage to treatment plant: Toxic substance discharged into a sewer may interfere with the operation of a wastewater treatment plant.

Damage to receiving water: Toxic substances that pass unchanged through a treatment plant or directly to a receiving water may cause damage to flora and fauna.

Treatment: Wastewater treatment rarely produces any by products of any value. CH_4 is exception. The design of the system is primarily concerned with lower cost. Segregation rather than destruction is another aspect.

How is polluted ground water purified?

Pollution can be reduced or removed in concentration with time and increase in the distance travelled. The self purification process consists of

- Microbial decomposition
- Chemical precipitation and co-precipitation
- Sorption
- Exchange of gases
- Mechanical filtration
- Dilution
- Radioactive decay

Flow Movement of Groundwater

1. **Porous aquifer**
 - Composed of sand and gravel
 - Groundwater flows in small interstices
 - The velocity of the flow is 1 m/day to few m/day
2. **Fissured rocks**
 - Groundwater movement restricted to fissures and cracks
 - The velocity of the flow is 0.3 m/day to 26 m/day

1. Microbial decomposition (How micro-organisms purify ground water?)

Biochemical degradation of organic and inorganic pollutants are carried out by microorganisms.

When the pollution level increases, the degradation process also increases due to availability of more nutrients to micro-organisms. The motile and immotile organisms form microbial slimes on the surface of the ground particles. Now the bacteria and virus that accompany the waste can not survive. The bacteria is also removed by silt and clay.

2. Chemical precipitation and co-precipitation

- No free dissolved oxygen zone is called “reduction zone”
- Eh is an indication of oxidation reduction states of systems
- It is a measure of the tendency of a system to undergo change (oxidation/reduction)
- It is measured in volts or mV
- When Eh is +ve strong oxidising conditions exist
- Reduction zone with negative Eh is favourable for eliminating heavy metal ions
- Downstream from the reduction zone are transition and oxidation zones
- Here hydroxides of Fe and Mn are precipitated
- Cu, Pb, Zn, As, W, V, F and PO₄ are co-precipitated

3. Sorption

- Sorption serve as a major mechanism for reducing groundwater pollution, clay, metallic oxides, hydroxides, organic matter serve as sorption material
- Most pollutants can be sorped under favourable conditions (except Cl, NO₃, SO₄)
- Sorption depends on type of pollutant, physical and chemical properties of solution and the subsurface material

4. Exchange of gases

- Gaseous exchange influence groundwater pollution
- The decomposition of pollutants in groundwater is significantly influenced by the supply of O₂ from the soil, air and sewage water
- Volatile pollutants and decomposition products like CH₄, CO₂, H₂S, N₂ will escape into the soil air and to the atmosphere thus removing considerable amount of contaminants
- Poorly permeable strata above the aquifer (clay and silt) reduce the O₂ supply. This disturbs the escape of gaseous pollutants and the decomposition products

5. Mechanical filtration and Dilution

- Suspended particles can be removed by filtration
- Filtration can remove Fe, Mn particulates, precipitate from chemical reactions
- Filtration can also remove suspended bacteria and virus present in ground water
- When fresh water or seepage water mixes with polluted groundwater, dilution of pollution takes place
- It depends on the rate of recharge of water and its physical/chemical properties
- Dilution is the most important process for pollutants

6. Radioactive decay

- Radioactive decay will have a decontaminating effect when short-lived radioisotope are decayed by long stay of contaminated water in the aquifer as a result of retarding factors such as slow groundwater velocities and long flow distances.
- It is important to know the hydrogeological criteria before selecting sites for disposal of waste materials
- There should be large distance between water table and soil surface
- There should be good sorption capacity, presence of clay and silt, low groundwater velocity

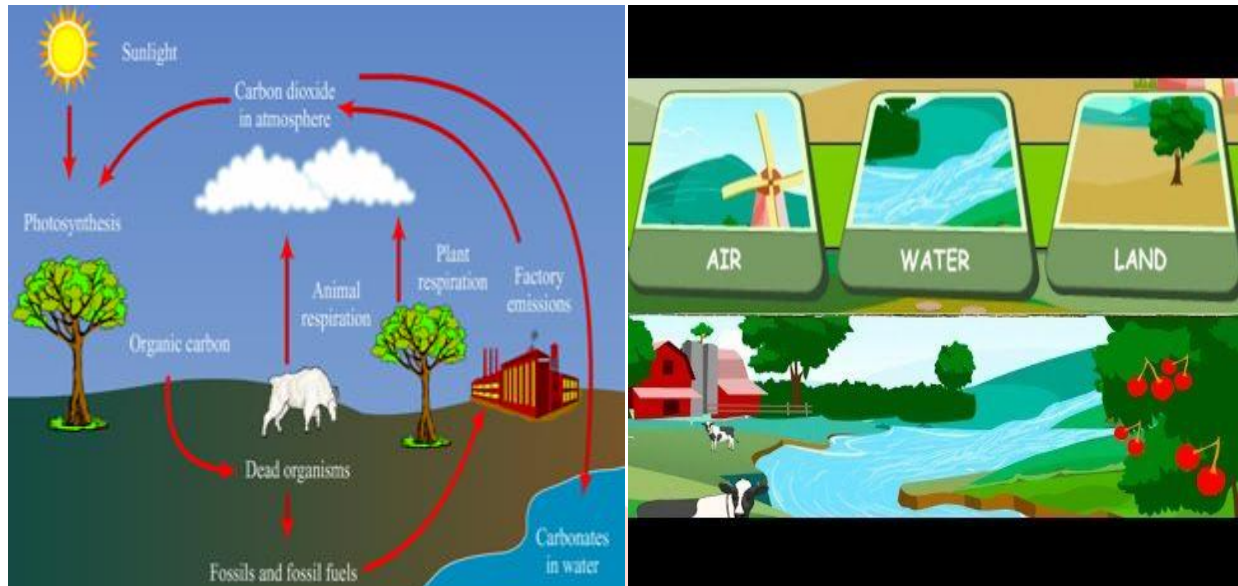
Pollution of the oceans

- Domestic sewage constitutes largest amount of waste (18,240 MLD)
- The waste are converted using large amount of O₂ from sea
- This leads to loss of O₂ in sea water and sea flora and fauna are affected greatly
- Discharge of industrial waste pollutes sea water
- The quantity of industrial mass generated by industries are 0.67 X 10⁹ m³
- Many small and medium industries discharge untreated effluents
- The industrial effluents contain metals like Hg, Cd, Pb, As etc.
- Oil spills damage the ocean water to a large extent
- Immediately after the spill oil spread on the sea surface (depends on wind speed)
- Lighter fraction evaporates within 24 hr (40%)
- Solar UV radiation removes another 10%
- Heavier fraction broken down by oil degrading bacteria
- Oil oxidised by dissolved O₂ in sea water at a rate of 1 mg oil per 3 mg of O₂
- Barely 1% of spilled oil get dispersed, suspended or dissolved in water

Air Resources

Origin of Atmosphere

- Early aquatic organisms started producing organic matter through photosynthesis
- O₂ was liberated. It saturated the water then started filling atmosphere
- O₂ was toxic to some primitive organism hence they perished
- Other species started using O₂ for getting energy through respiration
- N₂ evolved from the Earth's interior



How was the ozone layer above the Earth's surface formed?

- ✓ Between 1-2 billion years ago O₂ built up in the atmosphere
- ✓ Some O₂ molecules were split by UV radiation to single atoms
- ✓ They combined with O₂ to form O₃. Thus O₃ layer was formed
- ✓ It absorbs the harmful UV radiation coming from Sun
- ✓ Life form started from sea then moved to land
- ✓ The present composition of atmosphere is same as it was 500 million years ago
- ✓ Due to biological activities it is changing now

The physical parameter of the atmosphere vary with altitude. **Density** decreases with increasing altitude. **Pressure** drops as we go up. **Temperature** varies from -100 °C to 1200 °C. Atmosphere mass is very small compared to Earth's mass.

Structure of the Atmosphere

What is atmosphere?

- It is the multilayer gaseous envelope that surrounds Earth
- It gives all the gases necessary for sustenance of all life forms in biosphere
- It filters harmful UV rays by filtering
- It protects the Earth from becoming too hot

Troposphere

What is troposphere?

- It is the lower most layer of the atmosphere
- The average height is 11 km. (16 km near equator and 6 km over poles)
- 70 % of the total mass of atmosphere is in troposphere

What is temperature inversion?

- Generally as we go up in altitude temperature decreases in troposphere
- A temperature inversion is a condition in which the temperature of the atmosphere increases with altitude

Why is troposphere more turbulent region in the atmosphere?

- Air in the tropopause is non-uniform with respect to density and temperature

- Due to the global energy flow arising from the imbalances of heating and cooling rates between equator and poles turbulence arises

Stratosphere

- Stratosphere extends from tropopause to stratopause (11-50 km)
- Temperature increases with height

What is the importance of ozonosphere?

- The lower part of the stratosphere (15-30 km) is called ozonosphere.
- Here the concentration of O₃ is higher
- It acts as a protective shield for life on Earth from Sun's harmful UV radiation
- It supplies the heat source for partitioning stratosphere and troposphere
- Due to the slow mixing, the residence time of molecules in this region is long
- When pollutant is introduced here they pose long term global-hazard

Mesosphere, Thermosphere

Mesosphere extends between 50-80 km, temperature decreases with increasing height. The temperature inversion happens at mesopause (—ve to +ve lapse rate)

- In thermosphere temperature increases rapidly with increasing height
- Ionosphere: it extends up to 640 km. D, E, F1 and F2 are different layers. Since they reflect signals they play a vital role in radio-communication
- Exosphere: it is the upper most layer.

Agricultural Sources

- Ploughing up of agricultural field
- Use of agricultural chemicals eg. Pesticides
- Field refuse burning

Air pollutant source are grouped according to their number and spatial distribution

1. **Single or Point Source:** Point sources are large stationary sources of pollution. Eg. Industrial chimneys
2. **Multiple or Area Source:** When pollutants are released directly into the atmosphere from an entire area, without the help of any primary exhaust system
 - Stationary area eg. Residential area, parking lot, storage
 - Mobile area eg. Vehicle, ship, auto mobile

Energy Resources

- Energy is defined as the capacity to do work.
- Mechanical Energy: It is the energy possessed by a body by virtue of its position or configuration (potential energy).
- Kinetic Energy: It is the energy possessed by a body by virtue of its motion.
- Total mechanical energy = Potential energy and kinetic energy
- Other forms of energy are Heat, light, electrical, sound, chemical, plasma etc.

Principle of conservation of energy state: Energy can neither be created nor destroyed. It only changes from one form to another.

Major Types of Natural Resources

- Renewable Energy Resources: Mostly biological in nature - agriculture, animal forestry, solar, wind, water, geo-thermal, tidal, bio-fuel, hydro-electric etc.
- Non-renewable Energy Resources: These are physical resources like fossil fuels coal, petroleum, natural gas etc.,



Energy sources can be of two types.

- Conventional energy sources: They are in use for a longer period of time since 1700.
- Non-conventional energy sources: They are alternative sources of energy which are both renewable and pollution free.

Different conventional sources of energy

1. Biomass or dried fuel
 - Wood leaves, cow dung, dried twigs
 - Consumed for domestic purpose in rural areas, Less useful to industry
2. Fossil fuels
 - Coal, Oil, Natural gas

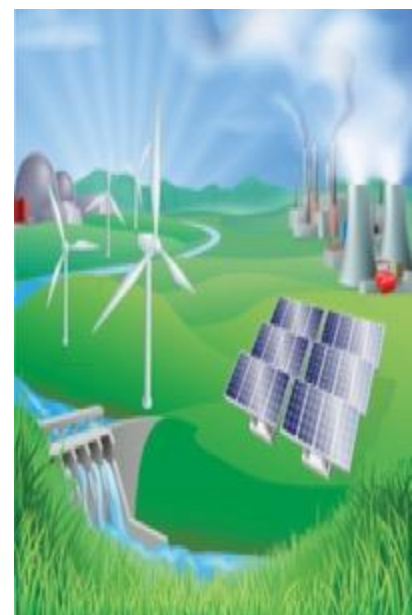
Conventional sources of energy Coal

- Present through out the world
- 2,730 X 106 Ton extracted per year
- Estimated mining 300-850 years

Natural gas

- CH₄ is major constituent
- Lower sulphur content
- Least polluting of all energy sources

ENERGY SOURCES



Oil

Has high energy content; major constituents Petrol, kerosene, diesel, naphtha

Nuclear Energy

Developed after World war II. It is a viable source of energy; It is a substitute for fossil fuel

Hydroelectric Energy

Obtained from water flow; most conventional renewable source of energy; Mechanical energy of down flowing water is harnessed to generate electricity

Conditions that favour generation of Hydroelectricity

- Uneven topography which leads to development of powerful water currents
- Perennial rivers and temperatures above the freezing point
- Presence of forest regulates rainfall and prevent soil erosion
- Availability of knowhow in technology and funds to meet capital requirement

Non- Conventional sources of energy: *The less polluting, environmentally clean sources of energy, which are socially relevant and can be used as alternatives to conventional source.*

Non conventional energy sources include Solar energy, wind energy, tidal energy, geothermal energy, biomass energy

The Sun be the solution to the world's energy problem**Solar energy**

- Sun provides continuous supply of energy that exceeds demand
- The solar radiation comprise of X-ray, gamma ray and UV rays
- Earth receives only a small portion of Sun's radiation
- The average value of solar radiation incident on Earth is 1.2 KW/m²
- About 0.3 KW/m² is reflected back by Earth
- Around 0.9 KW/m² is being utilized for photosynthesis and evaporation
- The remaining enormous amount of energy is available to life on Earth
- Amount of energy received from Sun each day is 600 times greater than the amount of energy produced each day by all the other sources taken together

Solar energy be utilised as an alternative to the conventional energy resources

- In a passive heating system, the solar energy is converted directly to heat for use at the site of collection
- In an active heating system, the solar energy is converted into heat, but the heat energy must be transferred from the region of collection to the place of use
- The solar energy may also be used to generate electricity which may be transmitted along normal wires or used to operate solar batteries

Photovoltaic system

- Electromagnetic radiation produces eclectic signal
- In photovoltaic effect an EMF is produced between two layers of different material as a result of irradiation
- Electricity produced can be used for lighting
- This energy is free of chemical and noise pollution
- First solar desalination plant installed in Haryana

Wind Energy**How can wind be used to generate electricity?**

- When wind has higher speed (5-10 m/s) it can be converted to electrical energy by attaching a wind-electric generator to the axle of the wind mill
- In California, USA 300 MW electricity is produced
- In India, Gujarat, Western Ghats have high wind density of 10 KW/m²/day
- Mandvi (3.3 mW), Kutch (1.1 mW), Tuticorin (550 kW), Puri (550 kW)

Tidal Energy

Tidal energy offers an alternative to the conventional sources of energy: The gravitational pull of the Sun and the Moon, along with the west to east rotation of the Earth causes tide. The greater the difference between high and low tides, the more is the energy that can be harvested.

OETC (ocean thermal energy conversion): It is the temperature difference existing between warm surface of sea water (29-30 °C) and the cold deep sea water (5-7 °C) which is available at a depth of 800-1000 m in tropical waters.

Wind wave Energy

- The incessant motion of the sea surface in the form of wind waves provides a source of energy this is more efficient than direct collection of energy from wind.
- A multi purpose wave regulator system in the form of long barrier constructed on Indian coast line helps in harnessing this energy.
- It also helps in agriculture, space for transportation of lighter and faster crafts and shore protection from sea erosion.

Geothermal Energy

The Earth’s core is very hot. When the hot material is close enough to the surface, they heat the ground water and form steam. Geysers and hot springs are the natural openings through which steam and hot water come up to the surface. In the areas where the steam is trapped underground, geothermal energy can be tapped by drilling wells to obtain steam. This steam can be used to provide power to electrical generators. Geothermal energy is the energy that is produced from beneath the earth. It is clean, sustainable and environment friendly. High temperatures are produced continuously inside the earth’s crust by the slow decay of radioactive particles. Hot rocks present below the earth heats up the water that produces steam. The steam is then captured that helps to move turbines. The rotating turbines then power the generators. Geothermal energy can be used by a residential unit or on a large scale by a industrial application. It was used during ancient times for bathing and space heating.

Biomass Energy

- Biomass is accumulation of organic materials produced by living things
- New plant growth, residues and wastes, herbaceous plants, fresh water algae, aquatic plants, agricultural and forest residues and wastes.

Biogas Energy

- About 22,425 X 10⁶ m³ of biogas can be produced from animal dung.
- The slurry can produce 206 X 10⁶ ton of organic manure. This can replace 1.4 X 10⁶ ton N, 1.3 X 10⁶ ton P₂O₅, 0.9 X 10⁶ ton K₂O. Around 15-26 X 10⁶ household can get biogas.



Energy Plantation: Some plants latex serve as a source of liquid HC. Denuded wasteland can grow shrubs and trees of high calorific value. They provide fuel wood, charcoal, fodder, power. Plants belonging to *Euphorbiaceae*, *Apocynaceae*, *Asclepiadaceae*, *Utricaceae* are energy plants.

Bagasse: Bagasse a waste of sugar mills, is a good source for energy generation. They produce 2,000 MW of surplus electricity. 40 % of that is being used by sugar mills for power and the remaining used for irrigation etc.

Hydel Energy

Hydel energy considered to be the cheapest source of eco-friendly energy generation in India. Also known as hydraulic power, hydropower is the energy or force of moving water. The movement of water as it flows downstream creates kinetic energy that can be converted into electricity. It is also used for irrigation and operation of varied machines including textile machines, water mills and saw mills.

Solar Energy

Solar power harvests the energy of the sun through using collector panels to create conditions that can then be turned into a kind of power. Large solar panel fields are often used in desert to gather enough power to charge small substations, and many homes use solar systems to provide for hot water, cooling and supplement their electricity. The issue with solar is that while there is plentiful amounts of sun available, only certain geographical ranges of the world get enough of the direct power of the sun for long enough to generate usable power from this source.



Hydrogen Energy

Hydrogen is available with water (H₂O) and is most common element available on earth. Water contains two-thirds of hydrogen and can be found in combination with other elements. Once it is separated, it can be used as a fuel for generating electricity. Hydrogen is a tremendous source of energy and can be used as a source of fuel to power ships, vehicles, homes, industries and rockets. It is completely renewable, can be produced on demand and does not leave any toxic emissions in the atmosphere.

Wave Energy

Wave energy is produced from the waves that are produced in the oceans. Wave energy is renewable, environment friendly and causes no harm to atmosphere. It can be harnessed along coastal regions of many countries and can help a country to reduce its dependance on foreign countries for fuel. Producing wave energy can damage marine ecosystem and can also be a source of disturbance to private and commercial vessels. It is highly dependent on wavelength and can also be a source of visual and noise pollution.

Hydroelectric Energy

What many people are not aware of is that most of the cities and towns in the world rely on hydropower, and have for the past century. Every time you see a major dam, it is providing hydropower to an electrical station somewhere. The power of the water is used to turn generators to produce the electricity that is then used. The problems faced with hydropower right now have to do with the aging of the dams. Many of them need major restoration work to remain functional and safe, and that costs enormous sums of money. The drain on the world's drinkable water supply is also causing issues as townships may wind up needing to consume the water that provides them power too.

Nuclear Power

While nuclear power remains a great subject of debate as to how safe it is to use, and whether or not it is really energy efficient when you take into account the waste it produces the fact is it remains one of the major renewable sources of energy available to the world. The energy is created through a specific nuclear reaction, which is then collected and used to power generators. While almost every country has nuclear generators, there are moratoriums on their use or construction as scientists try to resolve safety and disposal issues for waste.

Fossil Fuels (Coal, Oil and Natural Gas)

When most people talk about the different sources of energy they list natural gas, coal and oil as the options – these are all considered to be just one source of energy from fossil fuels. Fossil fuels provide the power for most of the world, primarily using coal and oil. Oil is converted into many products, the most used of which is gasoline. Natural gas is starting to become more common, but is used mostly for heating applications although there are more and more natural gas powered vehicles appearing on the streets. The issue with fossil fuels is twofold. The fossil fuel reserves are also limited, expecting to last only another 100 years given are basic rate of consumption. It isn't easy to determine which of these different sources of energy is best to use. All of them have their good and bad points. While advocates of each power type tout theirs as the best, the truth is that they are all flawed. What needs to happen is a concerted effort to change how we consume energy and to create a balance between which of these sources we draw from.

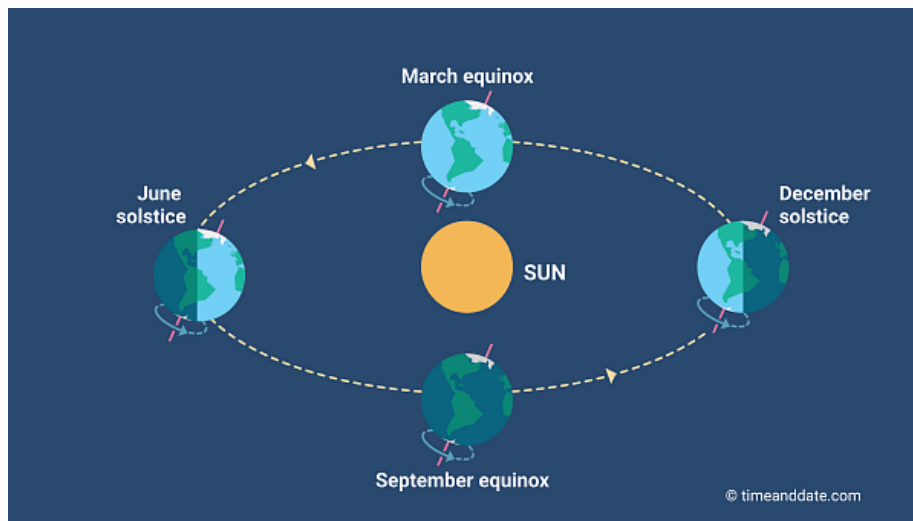
The Four Seasons

According to the meteorological definition, the seasons begin on the *first* day of the months that include the equinoxes and solstices:

1. Spring runs from March 1 to May 31;
2. Summer runs from June 1 to August 31;
3. Fall (autumn) runs from September 1 to November 30; and
4. Winter runs from December 1 to February 28 (February 29 in a leap year).



The beginning of each season marks the end of the last. Because the timings of the equinoxes and solstices change each year, the length of astronomical seasons within a year and between years also vary.



Conclusions and Recommendations

- In Ecology and Environment, ecological concepts and topics included are the following:
 - Natural resources and conservation
 - Population and the Environment
 - Biotic community
 - Ecosystem,
 - Pollution,. Waste management
 - Forest conservation and Management
 - Interaction between species
 - Green house effect
 - Ozone depletion
 - Global environmental change
 - Species interaction
- The scope of environmental studies is very wide and it deals with many areas like
 - Conservation of natural resources,
 - Ecological aspects,
 - Pollution of the surrounding natural resources,
 - Controlling the pollution,
 - Social issues connected to it, and
 - Impacts of human population on the environment.
- Sustainable use of resources necessarily includes the rational use of forest resources, to provide solutions for the local people who make their living by tapping and processing these resources.

- National efforts to develop this kind of model for the sustainable use of forests resources through appropriate technology and financial resources should be supported by the international community.
- Regardless of the economic activity, development is closely linked to use of the natural resource endowment.
- Productive rehabilitation of degraded ecosystems, technical and financial assistance to farmers, and the compatibilization of a nation's agricultural and environmental policies appears to be basic for ensuring viability of a sustainable development strategy for agriculture.
- Along with rational use of natural resources, viable regional development requires that priority be placed on human development.
- Policies that have been followed in designing development for the border regions clearly show an orientation toward eradication of poverty, even though it is difficult to attain in the short term.
- Physical planning and management can orient the land settlement process towards making efficient use of resources, setting standards to minimize potentially polluting activities, delimiting lands for multipurposes and uses, for protection or conservation, and for improving the infrastructure of the territory.
- In order to achieve a more satisfactory relationship between society and its environment, timely provision should be made for the changes that human activities and competition over use of resources

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