UNIT 4

Energy & Environment

Q.1. Elaborate the statement "Multidisciplinary nature of Environmental science".

Ans. Most of the major challenges in the environmental sciences (and management) require multidisciplinary solutions. The "environment" may be conceptualized in biological, chemical, physical, or social scientific terms, and important research endeavors arise from all these fields. New training, new organization, and new funding are needed to bring together multidisciplinary teams that can undertake research aimed at understanding the following:

- How natural systems work.
- How human activities and other influences perturb these systems.
- What causes these perturbations
- How changes in one system affect other systems and human well-being.
- How the knowledge needed to make well-informed choices about means of transforming or restoring environmental systems can be developed.

Natural systems—ecosystems; oceans; drainage basins, including agricultural systems; the atmosphere; and so on—are not divided along disciplinary lines; understanding any one of them requires expertise that cuts across several disciplines. For example, oceanic circulation patterns influence and are influenced by atmospheric circulation patterns, rainfall patterns, the topography of the ocean floor, temperature, and the chemistry of water, among other factors. Terrestrial ecosystems are affected by land use, land cover, and the climate system, as well as by the chemistry and biology of their constituent environments; while species within ecosystems are affected by physical-chemical inputs, population genetics, and interactions with other species, including humans. And because so many physical, chemical, and biological processes are strongly affected by and affect human activities, understanding those activities, including the development and use of technology, is integral to the environmental sciences. Thus environmental sciences include branches of social sciences and engineering just as they include branches of biological and physical sciences. For the environmental sciences to build the knowledge base they need, these disparate fields need to cooperate and collaborate.

Q.2. What is Environment? How can you say it constitutes a "life supporting system?"

Ans. The natural environment encompasses all living and non-living things occurring naturally on Earth or some region thereof. It is an environment that encompasses the interaction of all living species. The concept of the *natural environment* can be distinguished by components:

- Complete ecological units that function as natural systems without massive human intervention, including all vegetation, microorganisms, soil, rocks, atmosphere, and natural phenomena that occur within their boundaries.
- Universal natural resources and physical phenomena that lack clear-cut boundaries, such as air, water, and climate, as well as energy, radiation, electric charge, and magnetism, not originating from human activity.

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The atmosphere of the Earth serves as a key factor in sustaining the planetary ecosystem. The thin layer of gases that envelops the Earth is held in place by the planet's gravity. Dry air consists of 78% nitrogen, 21% oxygen, 1% argon and other inert gases, such as carbon dioxide. The remaining gases are often referred to as trace gases, among which are the greenhouse gases such as water vapour, carbon dioxide, methane, nitrous oxide, and ozone. Filtered air includes trace amounts of many other chemical compounds. Air also contains a variable amount of water vapor and suspensions of water droplets and ice crystals seen as clouds. Many natural substances may be present in tiny amounts in an unfiltered air sample, including dust, pollen and spores, sea spray, volcanic ash, and meteoroids. Various industrial pollutants also may be present, such as chlorine (elementary or in compounds), fluorine compounds, elemental mercury, and sulphur compounds such as sulphur dioxide [SO_2].

The ozone layer of the Earth's atmosphere plays an important role in depleting the amount of ultraviolet (UV) radiation that reaches the surface. As DNA is readily damaged by UV light, this serves to protect life at the surface. The atmosphere also retains heat during the night, thereby reducing the daily temperature extremes.

Evidence suggest that life on Earth has existed for about 3.7 billion years. All known life forms share fundamental molecular mechanisms. In biology, the science of living organisms, "life" is the condition which distinguishes active organisms from inorganic matter, including the capacity for growth, functional activity and the continual change preceding death. A diverse array of living organisms (life forms) can be found in the biosphere on Earth, and properties common to these organisms—plants, animals, fungi, protists, archaea, and bacteria—are a carbon- and water-based cellular form with complex organization and heritable genetic information. Living organisms undergo metabolism, maintain homeostasis, possess a capacity to grow, respond to stimuli, reproduce and, through natural selection, adapt to their environment in successive generations.

Q.3. Briefly describe the need of public awareness about the environment.

Ans. To know and understand what is good and what is better, and at the same time commit a wrongdoing, is socially more injurious than committing a wrongdoing in ignorance. Therefore, building, in a society, a new system of values with the aim of creating environmental public awareness, should include systematic training activities aimed at increasing the basic knowledge of ecology and environmental protection, and, at the same time, heightening the sensitivity of individuals to nature.

Environmental public awareness comes from a result of general knowledge, specialist knowledge of a particular problem and also sensitivity to, and a sense of, responsibility for the environment.

Environmental public awareness is shaped throughout the whole life of particular people living in a given local community, performing specific work and having definite personal characteristics which have a deciding effect on their sense of responsibility and ability to emotionally perceive the environment as having value in itself. The knowledge acquired during school education and then systematically improved in adulthood, is an essential factor in heightening the environmental awareness of an individual and, at the same time, an indispensable condition for the development of a pro-ecological lifestyle.

Q.4. What is environmental impact assessment? Discuss its importance in planning and implementation of engineering projects.

Ans. Environmental impact assessment is the formal process used to predict the environmental consequences (positive or negative) of a plan, policy, program, or project prior to the decision to move forward with the proposed action. Formal impact assessments may be governed by rules of administrative

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procedure regarding public participation and documentation of decision making, and may be subject to judicial review. An impact assessment may propose measures to adjust impacts to acceptable levels or to investigate new technological solutions.

The purpose of the assessment is to ensure that decision makers consider the environmental impacts when deciding whether or not to proceed with a project. The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made." EIAs are unique in that they do not require adherence to a predetermined environmental outcome, but rather they require decision makers to account for environmental values in their decisions and to justify those decisions in light of detailed environmental studies and public comments on the potential environmental impacts.

Importance of EIA: Biodiversity is relevant to all types of impact assessment and should be addressed at all levels, from environmental impact assessment carried out for individual projects (EIA) to the strategic environmental assessment of policies, plans and programmes (SEA). Its values should be addressed in social impact assessment; health impact assessment may need to consider the role of biodiversity in disease transmission or biological control. Finally, biodiversity provides commodities for international trade that may be the subject of study in trade impact assessment (sometimes referred to as sustainability impact assessment).

EIA procedures should refer to other relevant national, regional and international legislation, regulations, guidelines and other policy documents such as the national biodiversity strategy and action plan (NBSAP) documents, the CBD and biodiversity-related conventions and agreements, including, in particular, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); the CMS and related agreements; the Convention on Wetlands (Ramsar, Iran, 1971); the Convention on Environmental Impact Assessment in a Transboundary Context; the United Nations Convention on the Law of the Sea; the European Union directives on environmental impact assessment; and the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources.

Q.5. What is the scope of environmental studies? Discuss the role of women education in environment protection.

Ans. The scope of environmental studies is vast and wide. Sky is its limit and ocean is its depth. What is not covered in environmental studies shall take years and years yet to think as how to cover. Studies reveal that during the past, few decades there has been fundamental change in the attitude of man towards environment. There was a time when environment meant only sanitation and health.

Today, the environment is conceived in its totality and a holistic approach is designed while planning a better quality of life stressing upon sustainable development.

Who will not agree with this fact that human activities have been changing with greater speed and velocity. Our number population-wise is increasing fast. In India the populations were only 34.7 crores in 1951 and today, are more than 100 crores.

This is the story of human population. What about animals and other organisms. Are they same? No not at all. On account of this reason human activities have been drastically changing the ecological balance of practically every component of the environment.

(i) Environmental studies Teaches us deforestation and forest conservation: Increasing population, along with widespread poverty, has generated pressure on our natural resources. Of the

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329 m ha. of the total land area in the country, it is estimated that about 174 m. ha. Is degraded, this consists of agricultural as well as non-agricultural lands and forest resources.

(ii) Environmental Studies teach us Diversified Ecologies: Conservation ecology deal with the application of ecological principles to the proper management of resources leading to sustained yields of useful resources to human welfare. Resource ecology deals with the renewable and non-renewable resources and their judicious management.

Pollution ecology deals with problems associated with the movements of pollutants in the environment, environmental deterioration and the maintenance of its cleanliness. System ecology deals with the analysis and modeling of ecological systems. Radiation ecology is concerned with radio-active substances, radiation and the environment. Paleoecology deals with organisms and their environment in the geological past.

Role of women Education in Environment protection: Women plays a vital role in the protection of our environment because women are the one who raises a child and teaches them about the minor and major things. If a women is environment friendly and is aware about the adverse effects of the environment, she can easily transfer the knowledge and the habits to the children's which will be able to protect the environment in the future. Hence, women education plays the most important role in environment protection.

Q.6. What are the basic components of our ecosystem?

Ans. Basic components of Ecosystem:

Abiotic Components: The abiotic components of an ecosystem are all of the nonliving elements. They include the water, the air, the temperature and the rocks and minerals that make up the soil. Abiotic components of an ecosystem might include how much rain falls on it, whether it is fresh water or salt water, how much sun it gets or how often it freezes and thaws. The biotic components of the ecosystem both live on and interact with the abiotic components.

Producers at the Base: Producers are the living organisms in the ecosystem that take in energy from sunlight and use it to transform carbon dioxide and oxygen into sugars. Plants, algae and photosynthetic bacteria are all examples of producers. Producers form the base of the food web and are generally the largest group in the ecosystem by weight, or biomass. They also act as an interface with the abiotic components of the ecosystem during nutrient cycles as they incorporate inorganic carbon and nitrogen from the atmosphere.

Consumers in the Chain: Consumers are living organisms in the ecosystem that get their energy from consuming other organisms. Conceptually, consumers are further subdivided by what they eat: Herbivores eat producers, carnivores eat other animals and omnivores eat both. Along with producers and decomposers, consumers are part of what is known as food chains and webs, where energy and nutrient transfer can be mapped out. Consumers can only harvest about 10 percent of the energy contained in what they eat, so there tends to be less biomass at each stage as you move up the food chain.

Decomposers and Nutrient Cycling: Decomposers are the living component of the ecosystem that breaks down waste material and dead organisms. Examples of decomposers include earthworms, dung beetles and many species of fungi and bacteria. They perform a vital recycling function, returning nutrients incorporated into dead organisms to the soil where plants can take them up again. In this process they also harvest the last of the sunlight energy initially absorbed by producers. Decomposers represent the final step in many of the cyclical ecosystem processes.

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Q.7. Explain the following:

(i) Species Diversity (ii) Genetic Diversity (iii) Ecosystem Diversity

Ans. (i) Species Diversity: In all shape and size (tiny organisms to huge one): includes bacteria, protozoan, fungi, flowering plants, ants, beetles, butterflies, birds, reptiles and large animals.

Each species is a group of organisms with unique characteristics. An individual of a species can reproduce successfully, creating a viable offspring, only with another member of the same species. Still learning how many species exist and how they relate to each other and to their physical environment. Cannot predict the precise ripple effects that the loss of one species will have on others and on ecosystems.

(ii) Genetic Diversity: Every individual inherits genes from its parents and passes on to the next generation. Biodiversity is more than the variety of species. Genetic diversity everywhere (songs, feather colors, taste and texture). Genetic variation is extremely important to the survival of species. Genetic variability, responsible for these different traits, interact with local environmental conditions to determine the extent to which populations can adapt to environmental changes and survive exposure to new diseases.

Isolated populations in small patches of habitat cut off from the surrounding environment tend to have less genetic variation than populations in large, intact ecosystems. Therefore, those isolated populations are more susceptible to extinction.

(iii) Ecosystem Diversity: Populations and non-living environmental components- such as water or minerals surrounding them interact dynamically to form an ecosystem. It includes: predators consuming prey, pollinators selecting flowers and species responding to physical processes such as heavy rain. Plant and Animal communities make up many kinds of ecosystems (forest, wetlands, rangelands, mountains, deserts, terrestrial ecosystems). Species are not evenly distributed

Q.8. Explain the structure and function of an Ecosystem in detail.

Ans. Each ecosystem has two main components:

1. Abiotic 2. Biotic

1. Abiotic Components: The non living factors or the physical environment prevailing in an ecosystem form the abiotic components. They have a strong influence on the structure, distribution, behaviour and inter-relationship of organisms.

Abiotic components are mainly of two types:

(a) Climatic Factors: Which include rain, temperature, light, wind, humidity etc.

(b) Edaphic Factors: Which include soil, pH, topography minerals etc.

The functions of important factors in abiotic components are given below: Soils are much more complex than simple sediments. They contain a mixture of weathered rock fragments, highly altered soil mineral particles, organic mat-ter, and living organisms. Soils provide nutrients, water, a home, and a struc-tural growing medium for organisms. The vegetation found growing on top of a soil is closely linked to this component of an ecosystem through nutrient cycling.

The atmosphere provides organisms found within ecosystems with carbon di-oxide for photosynthesis and oxygen for respiration. The processes of evapora-tion, transpiration and precipitation cycle water between the atmosphere and the Earth's surface.

Solar radiation is used in ecosystems to heat the atmosphere and to evapo-rate and transpire water into the atmosphere. Sunlight is also necessary for photosynthesis. Photosynthesis provides the energy for plant growth and me-tabolism, and the organic food for other forms of life.

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Most living tissue is composed of a very high percentage of water, up to and even exceeding 90%. The protoplasm of a very few cells can survive if their water content drops below 10%, and most are killed if it is less than 30-50%.

Water is the medium by which mineral nutrients enter and are trans-located in plants. It is also necessary for the maintenance of leaf turgidity and is required for photosynthetic chemical reactions. Plants and animals receive their water from the Earth's surface and soil. The original source of this water is precipita-tion from the atmosphere.

2. Biotic Components: The living organisms including plants, animals and micro-organisms (Bacteria and Fungi) that are present in an ecosystem form the biotic components.

On the basis of their role in the ecosystem the biotic components can be classi-fied into three main groups:

(A) Producers (B) Consumers (C) Decomposers or Reducers

Q.9. What do you understand by Ecological Pyramid or Food Pyramid?

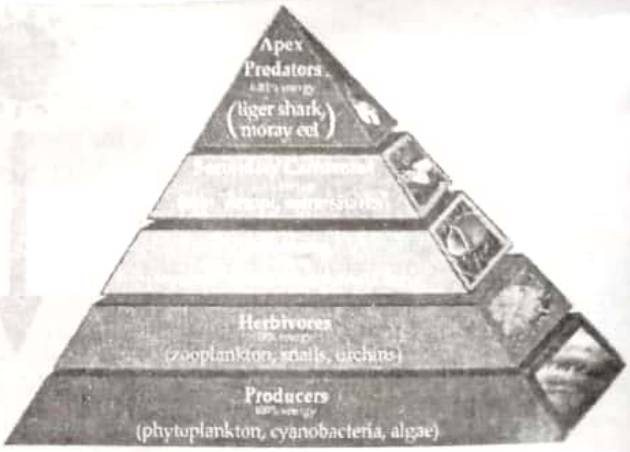
Ans. An ecological pyramid (also trophic pyramid, energy pyramid, or sometimes food pyramid) is a graphical representation designed to show the biomass or bio productivity at each trophic level in a given ecosystem.

Biomass is the amount of living or organic matter present in an organism. *Biomass pyramids* show how much biomass is present in the organisms at each trophic level, while *productivity pyramids* show the production or turnover in biomass.

Ecological pyramids begin with producers on the bottom (such as plants) and proceed through the various trophic levels (such as herbivores that eat plants, then carnivores that eat herbivores, then carnivores that eat those carnivores, and so on). The highest level is the top of the food chain.

An *ecological pyramid of biomass* shows the relationship between biomass and trophic level by quantifying the biomass present at each trophic level of an ecological community at a particular time. It is a graphical representation of biomass (total amount of living or organic matter in an ecosystem) present in unit area in different tropic levels. Typical units are grams per meter^2, or calories per meter^2. The pyramid of biomass may be "inverted". For example, in a pond ecosystem, the standing crop of phytoplankton, the major producers, at any given point will be lower than the mass of the heterotrophs, such as fish and insects. This is explained as the phytoplankton reproduce very quickly, but have much shorter individual lives.

Pyramid of Energy: When production is considered in terms of energy, the pyramid indicates not only the amount of energy flow at each level, but more important, the actual role the various organisms play in the transfer of energy. An energy pyramid illustrates how much energy is needed as it flows upwards to support the next trophic level.



The pyramid is constructed according to the rate at which food material (in the form of energy) passes through the food chain. Some organisms may have a small

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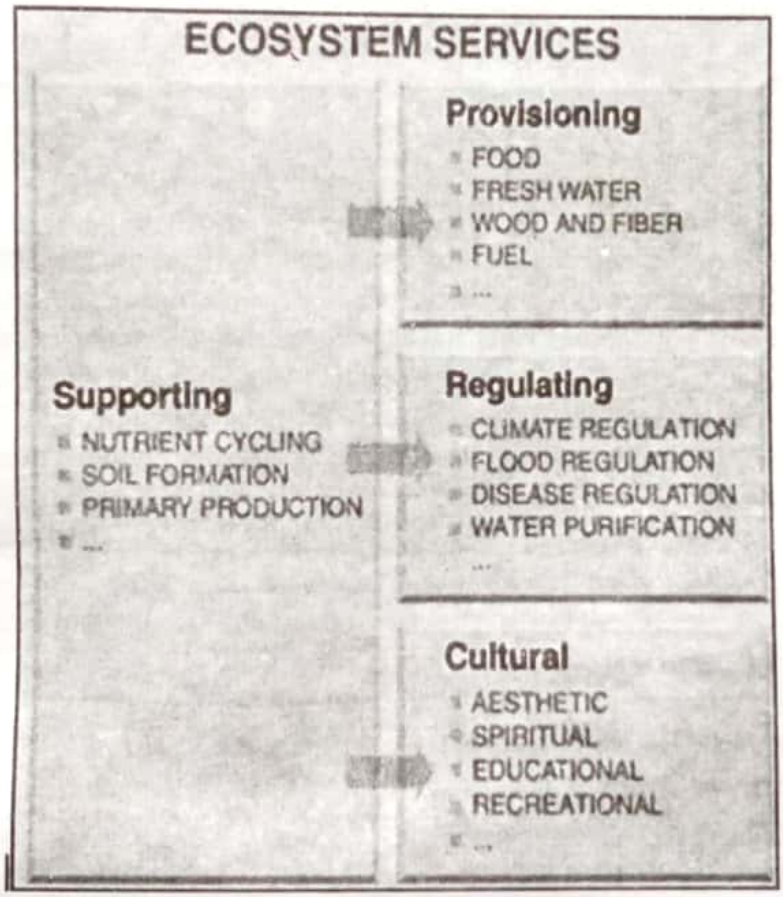
biomass, but the total energy they assimilate and pass on, may be considerably greater than that of organisms with a much larger biomass.

Energy pyramids are always slopping because less energy is transferred from each level than was paid into it. In cases such as in open water communities the producers have less bulk than consumers but the energy they store and pass on must be greater than that of the next level.

Q.10. Enumerate the services provided by a health ecosystem.

Ans. An ecosystem (also called as environment) is a natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the non-living physical (abiotic) factors of the environment. Ecosystem services are the benefits that people obtain from ecosystems. Ecosystem services are indispensable to the wellbeing of all people, everywhere in the world. They include provisioning, regulating, and cultural services that directly affect people, and supporting services needed to maintain the other services. From the availability of adequate food and water, to disease regulation of vectors, pests, and pathogens, human health and well-being depends on these services and conditions from the natural environment.



The causal links between environmental change and human health are complex because they are often indirect, displaced in space and time, and dependent on a number of modifying forces. Human health ultimately depends upon ecosystem products and services (such as availability of fresh water, food and fuel sources) which are requisite for good human health and productive livelihoods.

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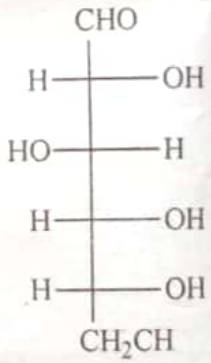
Q.11. Name the functional and metabolically similar group of organisms that are must for a long term survival of an ecosystem. Also give an account of their role and functions in an ecosystem.

Ans. Amino acids and proteins: Proteins are made of amino acids arranged in a linear chain joined together by peptide bonds. Many proteins are enzymes that catalyze the chemical reactions in metabolism. Other proteins have structural or mechanical functions, such as those that form the cytoskeleton, a system of scaffolding that maintains the cell shape. Proteins are also important in cell signaling, immune responses, cell adhesion, active transport across membranes, and the cell cycle. Amino acids also contribute to cellular energy metabolism by providing a carbon source for entry into the citric acid cycle (tricarboxylic acid cycle), especially when a primary source of energy, such as glucose, is scarce, or when cells undergo metabolic stress.

Lipids: Lipids are the most diverse group of biochemicals. Their main structural uses are as part of biological membranes both internal and external, such as the cell membrane, or as a source of energy. Lipids are usually defined as hydrophobic or amphipathic biological molecules but will dissolve in organic solvents such as benzene or chloroform. The fats are a large group of compounds that contain fatty acids and glycerol; a glycerol molecule attached to three fatty acid esters is called a triacylglyceride. Several variations on this basic structure exist, including alternate backbones such as sphingosine in the sphingolipids, and hydrophilic groups such as phosphate as in phospholipids. Steroids such as cholesterol are another major class of lipids.

Carbohydrates:

Glucose can exist in both a straight-chain and ring form.



Carbohydrates are aldehydes or ketones, with many hydroxyl groups attached, that can exist as straight chains or rings. Carbohydrates are the most abundant biological molecules, and fill numerous roles, such as the storage and transport of energy (starch, glycogen) and structural components (cellulose in plants, chitin in animals). The basic carbohydrate units are called monosaccharides and include galactose, fructose, and most importantly glucose. Monosaccharides can be linked together to form polysaccharides in almost limitless ways.

Nucleotides: The two nucleic acids, DNA and RNA are polymers of nucleotides, each nucleotide composed of a phosphate group, a ribose sugar group, and a nitrogenous base. Nucleic acids are critical for the storage and use of genetic information, and its interpretation through the processes of transcription and protein biosynthesis. This information is protected by DNA repair mechanisms and propagated through DNA replication. Many viruses have an RNA genome, for example HIV, which uses reverse transcription to create a DNA template from its viral RNA genome. RNA in ribozymes such as spliceosomes and ribosomes is similar to enzymes as it can catalyze chemical reactions.

Q.12. What do you understand by Natural Ecosystem? Explain in brief.

Ans. Natural ecosystem is a community of living and non-living organisms, where each component interacts together as a unit through biological, physical and chemical processes. The distinctiveness of natural ecosystems is that they are purely natural and their formations are not in any way influenced by human activity.

The reason for pointing this out is because ecosystem is an intricate term and as such, it also encompasses artificial ecosystems – influenced by human activity, which necessitates the need to

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differentiate the two. The components enabling the interactions that make up the natural ecosystems include soil, plants, sunlight, air, water, microorganisms and animals. The sizes and characteristics of ecosystems also vary and are thus categorized according to the notable variations.

Q.13. What are the different types of natural ecosystems?

Ans. Here is a list of the various types of natural ecosystems.

1. **Tropical Rainforest Ecosystems:** The tropical rainforests are found near the equator, between the tropics. These are the regions that experience very high annual rainfall and are characterized with high average temperatures. The areas also have high humidity that is lower in the dry season compared to the wet seasons.

   The tropical rainforest areas have extreme biodiversity and boost some of the most unique plant and animal species in the planet. Due to their location near the equator, they offer favorable conditions for survival. However, the soils in tropical rainforest ecosystems are poor in nutrients as they are not stored for very long in the soil.

2. **Taiga Ecosystem:** Taiga ecosystems are also referred to as the boreal forests or snow forests. These ecosystems constitute the world's largest land ecosystems making up 29% of the world's forest cover. They are found throughout the high northern latitudes with considerable regional variations. Particularly, they are Subarctic-subalpine, needle-leaved forests. The Taiga ecosystems experiences extreme winters and short summers. Taiga soils are thin and poor in nutrients due to the cold which hinders the development of the soils.

3. **Temperate Forest Ecosystem:** The temperate forest ecosystems primarily include the temperate coniferous forests, which are evergreen and the temperate deciduous forests – the trees that lose their leaves each year. These natural ecosystems are mainly found between the tropics and in the Polar Regions. Their trees are wide leafed, large and tall. The major trees in these forests are the maple, oak, redwood, ash, birch, pine and beech. The areas have less undergrowth. The temperate rainforest experience moderate rainfall and dense humidity with mild winters.

4. **Tundra Ecosystem:** Tundra ecosystems are found in the Arctic and Antarctic – the Polar Regions. The vegetation in Tundra ecosystems is composed of dwarf shrubs, sedges and grass, mosses and lichens. The subsoil is permanently frozen, which makes it impossible for trees to grow in the region. The tundra is covered in marches, lakes and streams during the warm summers.

   Since the Tundra ecosystems are very cold, the biodiversity is low with few plant species and land mammals adapted to the prevailing environmental conditions. Polar bears are example of the land mammals adapted to the Tundra regions. There are also numerous bird species migrating through these regions each year.

5. **Shrubland Ecosystem:** Shrubland ecosystems are as well-known as scrubland since they are dominated by low shrubs. The ecosystem occurs as a result of a transitional plant community between regions or may also occur after a disturbance of a forest because of natural or wildfires. Other interacting factors leading to the formation of shrublands include nutrient-poor soils, aridity or drought.

   Since these conditions are highly common in temperate, semi-arid, and continental climate areas, shrublands existence are predominant in these areas. Heath is a good example of shrubland found on free-draining infertile acidic soils in humid and sub-humid areas. The moorland, another example, is mostly found on the mountain regions and its species is suitable for its unique microclimate.

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6. **Lentic Ecosystems:** These are the still water ecosystems. Lakes and the seas are good examples, but they can range from ponds to lagoons to vast oceans. These ecosystems have three regions. They include the open water zone, deep bottom regions not exposed to light, and the bottom and shore regions each with different conditions. Therefore, they host species specifically adapted to live in the regions, forming layers of different ecosystems.
7. **Desert Ecosystem:** Desert ecosystems are typically cold in the night and very hot during the day. They receive little to no rainfall annually. Deserts cover up to one fifth of the earth's surface and lie in temperate zones as well. Owing to their extreme weather conditions, only a few animals live in the deserts.

   A good example is the camel which is capable of storing sufficient water and withstands the heat. Many other desert animals are nocturnal, spending most of their time underground during the day.
8. **Coral Ecosystem:** The diverse underwater marine ecosystems in existence across the world's oceans in both deep and shallow waters constitute the coral reef ecosystems. They cover about one percent of the total ocean floor. Coral reefs are the "big cities of the sea" also often referred to as the "rainforests of the sea".

Q.14. Explain the Agricultural system with the help of a diagram.

Ans. Agriculture can be regarded as a system with inputs that have physical, cultural, economi and behavioural elements. In areas where farming is less developed, physical factors are usually more important, but as human inputs increase, these physical controls become less significant. This system model can be applied to all types of farming, regardless of scale or location. It is the variations in the inputs which are responsible for the different types and patterns of agriculture around the world (Fig.) The leads to classifications of agriculture in which contrasts between the different types of faring are clear.

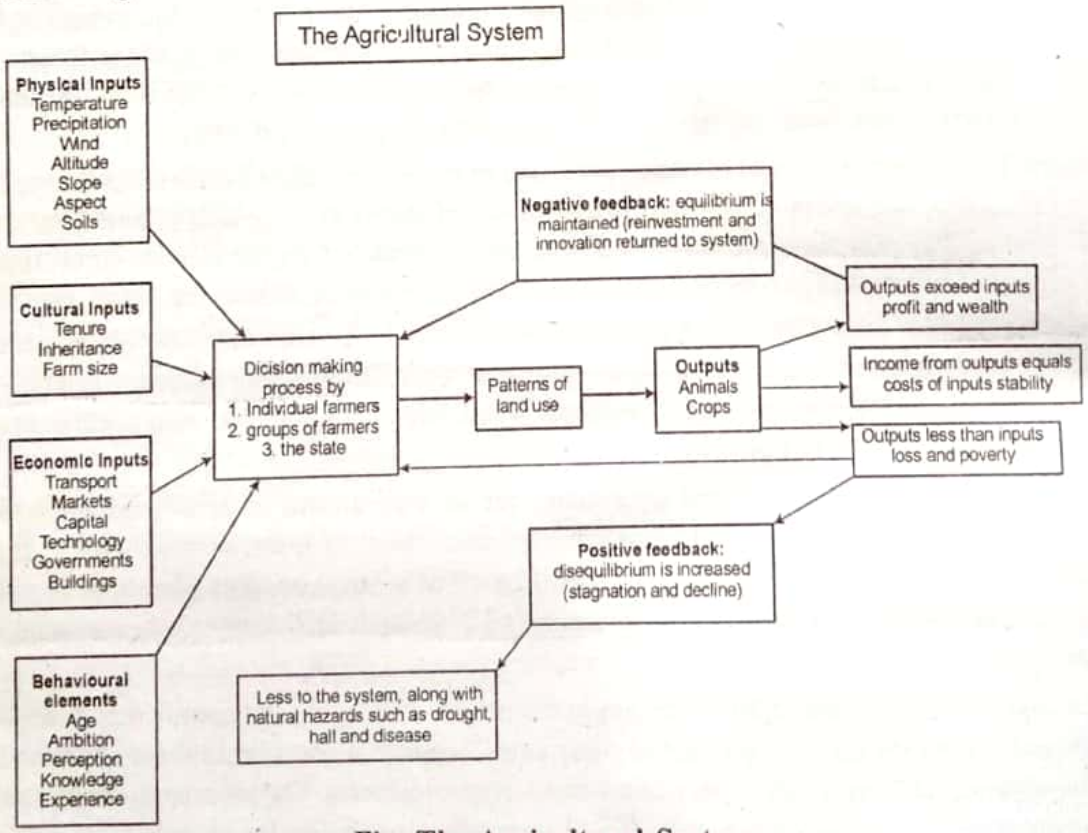

Fig. The Agricultural System

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Q.15. What do you mean by subsistence agriculture? Explain.

Ans. Subsistence agriculture occurs when a plot of land produces only enough food to feed the family working it or the local community (group, tribe etc.), pay taxes and sometimes leave a little surplus for barter or to sell in better years.

- The main priority is self-sufficiency, which is achieved by growing a wide range of crops wherever possible.
- Improvements to the system are held back by a lack of capital to provide fertilisers, pesticides and other farming technology.
- Animals are kept, although where land is limited it is generally too valuable to allow grazing or growth of fodder crops.
- Where the climate is too extreme to support permanent settled agriculture, farmers become pastoral nomads, moving in search of food for their animals.
- Depending on their location, animals provide milk, meat and blood for consumption; wool and skins for shelter and clothing; dung for fuel; bones for utensils and weapons; and mounts for transport.
- Other examples of subsistence farming are shifting cultivation, which is practised in parts of the Amazon basin and in south east Asia, and **wet rice agriculture**, also in south east Asia and the Indian sub-continent.

Q.16. What do you mean by Industrial Ecology? Explain.

Ans. Industrial ecology (IE) is the study of material and energy flows through industrial systems. The global industrial economy can be modelled as a network of industrial processes that extract resources from the Earth and transform those resources into commodities which can be bought and sold to meet the needs of humanity. Industrial ecology seeks to quantify the material flows and document the industrial processes that make modern society function. Industrial ecologists are often concerned with the impacts that industrial activities have on the environment, with use of the planet's supply of natural resources, and with problems of waste disposal. Industrial ecology is a young but growing multidisciplinary field of research which combines aspects of engineering, economics, sociology, toxicology and the natural sciences.

Industrial ecology has been defined as a "systems-based, multidisciplinary discourse that seeks to understand emergent behavior of complex integrated human/natural systems". The field approaches issues of sustainability by examining problems from multiple perspectives, usually involving aspects of sociology, the environment, economy and technology. The name comes from the idea that the analogy of natural systems should be used as an aid in understanding how to design sustainable industrial systems.

Q.17. Discuss the principal of Industrial Ecology in brief.

Ans. One of the central principles of Industrial Ecology is the view that societal and technological systems are bounded within the biosphere, and do not exist outside it. Ecology is used as a *metaphor* due to the observation that natural systems reuse materials and have a largely closed loop cycling of nutrients. Industrial Ecology approaches problems with the hypothesis that by using similar principles as *natural systems, industrial systems* can be improved to reduce their impact on the natural environment as well. The table shows the general metaphor.

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Biosphere	Technosphere
• Environment	• Market
• Organism	• Company
• Natural Product	• Industrial Product
• Natural Selection	• Competition
• Ecosystem	• Eco-Industrial Park
• Ecological Niche	• Market Niche
• Anabolism / Catabolism	• Manufacturing / Waste Management
• Mutation and Selection	• Design for Environment
• Succession	• Economic Growth
• Adaptation	• Innovation
• Food Web	• Product Life Cycle

Moreover, *life cycle thinking* is also a very important principle in industrial ecology. It implies that all environmental impacts caused by a product, system, or project during its life cycle are taken into account. In this context life cycle includes

- Raw material extraction
- Material processing
- Manufacture
- Use
- Maintenance
- Disposal

Q.18. Briefly explain about Environmental pollution and types of pollution.

Ans. One of the greatest problems that the world is facing today is that of environmental pollution, increasing with every passing year and causing grave and irreparable damage to the earth. Environmental pollution consists of five basic types of pollution, namely, air, water, soil, noise and light.

Air pollution is by far the most harmful form of pollution in our environment. Air pollution is cause by the injurious smoke emitted by cars, buses, trucks, trains, and factories, namely sulphur dioxide, carbon monoxide and nitrogen oxides. Even smoke from burning leaves and cigarettes are harmful to the environment causing a lot of damage to man and the atmosphere. Evidence of increasing air pollution is seen in lung cancer, asthma, allergies, and various breathing problems along with severe and irreparable damage to flora and fauna. Even the most natural phenomenon of migratory birds has been hampered, with severe air pollution preventing them from reaching their seasonal metropolitan destinations of centuries.

Chlorofluorocarbons (CFC), released from refrigerators, air-conditioners, deodorants and insect repellents cause severe damage to the Earth's environment. This gas has slowly damaged the atmosphere and depleted the ozone layer leading to global warming.

Water pollution caused industrial waste products released into lakes, rivers, and other water bodies, has made marine life no longer hospitable. Humans pollute water with large scale disposal of garbage, flowers, ashes and other household waste. In many rural areas one can still find people bathing and cooking in the same water, making it incredibly filthy. Acid rain further adds to water pollution in the

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water. In addition to these, thermal pollution and the depletion of dissolved oxygen aggravate the already worsened condition of the water bodies. Water pollution can also indirectly occur as an offshoot of soil pollution – through surface runoff and leaching to groundwater.

Noise pollution, soil pollution and light pollution too are the damaging the environment at an alarming rate. Noise pollution include aircraft noise, noise of cars, buses, and trucks, vehicle horns, loudspeakers, and industry noise, as well as high-intensity sonar effects which are extremely harmful for the environment.

Requirements of non-polluted environment:

1. Strict regulation against environment polluting industries and bodies
2. Plantation of trees on a larger scale
3. Minimal usage of motor vehicles and use of environment friendly fuel like biogas
4. Less use of chemicals in industries and switching to organic products

Q.19. Enumerate major categories of pollution of environment. What are their general fate?

Ans. The major forms of pollution are listed below along with the particular contaminant relevant to each of them:

- **Air pollution:** The release of chemicals and particulates into the atmosphere. Common gaseous pollutants include carbon monoxide, sulfur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides produced by industry and motor vehicles. Photochemical ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight. Particulate matter, or fine dust is characterized by their micrometre size PM_{10} to $PM_{2.5}$.
- **Light pollution:** Includes light trespass, over-illumination and astronomical interference.
- **Littering:** The criminal throwing of inappropriate man-made objects, unremoved, onto public and private properties.
- **Noise pollution:** Which encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar.
- **Soil contamination:** Occurs when chemicals are released by spill or underground leakage. Among the most significant soil contaminants are hydrocarbons, heavy metals, MTBE, herbicides, pesticides and chlorinated hydrocarbons.
- **Radioactive contamination,** resulting from 20th century activities in atomic physics, such as nuclear power generation and nuclear weapons research, manufacture and deployment.
- **Thermal pollution,** is a temperature change in natural water bodies caused by human influence, such as use of water as coolant in a power plant.
- **Visual pollution,** which can refer to the presence of overhead power lines, motorway billboards, scarred landforms (as from strip mining), open storage of trash, municipal solid waste or space debris.
- **Water pollution,** by the discharge of wastewater from commercial and industrial waste (intentionally or through spills) into surface waters; discharges of untreated domestic sewage, and chemical contaminants, such as chlorine, from treated sewage; release of waste and contaminants into surface runoff flowing to surface waters (including urban runoff and agricultural runoff, which may contain chemical fertilizers and pesticides); waste disposal and leaching into groundwater; eutrophication and littering.

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Q.20. Explain Air Pollution. Also differentiate between Line source and Point source in relation to air pollution.

Ans. Air pollution is the introduction of particulates, biological molecules, or other harmful materials into the Earth's atmosphere, possibly causing disease, death to humans, damage to other living organisms such as food crops, or the natural or built environment.

The atmosphere is a complex natural gaseous system that is essential to support life on planet Earth. Stratospheric ozone depletion due to air pollution has long been recognized as a threat to human health as well as to the Earth's ecosystems.

Difference between Line source and Point source:

A **line source** is a source of air, noise, water contamination or electromagnetic radiation that emanates from a linear (one-dimensional) geometry. The most prominent linear sources are roadway air pollution, aircraft air emissions, roadway noise, certain types of water pollution sources that emanate over a range of river extent rather than from a discrete point, elongated light tubes, certain dose models in medical physics and electromagnetic antennas.

A **point source of pollution** is a single identifiable source of air, water, thermal, noise or light pollution. A point source has negligible extent, distinguishing it from other pollution source geometries. The sources are called *point sources* because in mathematical modeling, they can be approximated as a mathematical point to simplify analysis. Pollution point sources are identical to other physics, engineering, optics, and chemistry point sources and include:

- Water pollution from an oil refinery wastewater discharge outlet
- Noise pollution from a jet engine
- Disruptive seismic vibration from a localized seismic study
- Light pollution from an intrusive street light
- Thermal pollution from an industrial process outfall
- Radio emissions from an interference-producing electrical device

Types of air pollution sources which have finite extent are line sources, area sources and volume sources. Air pollution sources are also often categorized as either stationary or mobile.

Particulate matter: Particulate matter (PM) is an air pollution term for a mixture of solid particles and liquid droplets found in the air. The pollutant comes in a variety of sizes and can be composed of many types of materials and chemicals. Particles that are small enough to be inhaled have the potential to cause health effects. Of particular concern is a class of particles known as fine particulate matter or PM2.5 that gets deep into the lung.

Controlling PM Emissions: Efforts by EPA, other organizations, and the general public have successfully reduced ambient levels of PM in the United States. Between 2000, when monitoring began, and 2007, average national levels of PM2.5 declined by 11%. Similarly, national levels of PM10 declined by 28% between 1990 and 2007. However, these declines were regionally uneven; some areas experienced bigger declines while others actually experienced increases in PM levels during this period.

Revisions to the Clean Air Act in 1990 required each state to develop a State Implementation Plan (SIP) describing how it will reach and maintain the national standards. These SIPs vary by state, but generally include local monitoring of PM levels, strategies to reduce PM emissions, and steps to evaluate these strategies. Individual actions that can also make a difference include recycling, using energy-efficient products and appliances, planting deciduous trees, and driving less.

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Q.21. What is an Air pollutant? Explain primary and secondary air pollutants.

Ans. An air pollutant is a substance in the air that can have adverse effects on humans and the ecosystem. The substance can be solid particles, liquid droplets, or gases. A pollutant can be of natural origin or man-made. Pollutants are classified as primary or secondary. Primary pollutants are usually produced from a process, such as ash from a volcanic eruption. Other examples include carbon monoxide gas from motor vehicle exhaust, or the sulfur dioxide released from factories. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. Ground level ozone is a prominent example of a secondary pollutant. Some pollutants may be both primary and secondary: they are both emitted directly and formed from other primary pollutants.

Major primary pollutants produced by human activity include:

1. Sulphur oxides
2. Nitrogen oxides
3. Carbon monoxide
4. Volatile organic compounds

Secondary pollutants include:

- Particulates created from gaseous primary pollutants and compounds in photochemical smog. Smog is a kind of air pollution. Classic smog results from large amounts of coal burning in an area caused by a mixture of smoke and sulfur dioxide. Modern smog does not usually come from coal but from vehicular and industrial emissions that are acted on in the atmosphere by ultraviolet light from the sun to form secondary pollutants that also combine with the primary emissions to form photochemical smog.

Q.22. What are airborne diseases? Do they come under Air Pollution?

Ans. An **airborne disease** is any disease that is caused by pathogens and transmitted through the air. Such diseases include many that are of considerable importance both in human and veterinary medicine. The relevant pathogens may be viruses, bacteria, or fungi, and they may be spread through coughing, sneezing, raising of dust, spraying of liquids, or similar activities likely to generate aerosol particles or droplets. Strictly speaking airborne diseases do not include conditions caused simply by air pollution such as dusts and poisons, though their study and prevention may be related.

Airborne diseases include any that are caused by pathogens and transmitted through the air. Some are of great medical importance. The pathogens transmitted may be any kind of microbe, and they may be spread in aerosols, dust or liquids. The aerosols might be generated from sources of infection such as the bodily secretions of an infected animal or person, or biological wastes such as accumulate in lofts, caves, garbage and the like. Such infected aerosols may stay suspended in air currents long enough to travel for considerable distances, though the rate of infection decreases sharply with the distance between the source and the organism infected.

Airborne pathogens or allergens often cause inflammation in the nose, throat, sinuses and the lungs. This is caused by the inhalation of these pathogens that affect a person's respiratory system or even the rest of the body. Sinus congestion, coughing and sore throats are examples of inflammation of the upper respiratory air way due to these airborne agents. Air pollution plays a significant role in airborne diseases which is linked to asthma. Pollutants are said to influence lung function by increasing air way inflammation. Alongside pollutants, tobacco smoke increases the risk of attracting these diseases.

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Many common infections can spread by airborne transmission at least in some cases, including: Anthrax (inhalational), Chickenpox, Influenza, Measles, Smallpox,Cryptococcosis, and Tuberculosis.

No, Air borne diseases does not comes under diseases caused by air pollution. However, their prevention can be related.

Q.23. Define Water pollution in brief.

Ans. Water pollution is the contamination of water bodies, usually as a result of human activities. Water bodies include for example lakes, rivers, oceans, aquifers and groundwater. Water pollution results when contaminants are introduced into the natural environment. For example, releasing inadequately treated wastewater into natural water bodies can lead to degradation of aquatic ecosystems. In turn, this can lead to public health problems for people living downstream. They may use the same polluted river water for drinking or bathing or irrigation. Water pollution is the leading worldwide cause of death and disease, e.g. due to water-borne diseases.

Water pollution can be grouped into surface water pollution. Marine pollution and nutrient pollution are subsets of water pollution. Sources of water pollution are either point sources or non-point sources. Point sources have one identifiable cause of the pollution, such as a storm drain, wastewater treatment plant or stream. Non-point sources are more diffuse, such as agricultural runoff. Pollution is the result of the cumulative effect over time. All plants and organisms living in or being exposed to polluted water bodies can be impacted. The effects can damage individual species and impact the natural biological communities they are part of.

Q.24.What are the adverse effects of water pollution? How can it be controlled?

OR

Q. What are the problems which rises from water pollution? What are the control measures? Explain.

Ans. Adverse effects of water pollution: The effects of water pollution are varied and depend on what chemicals are dumped and in which locations.

Many water bodies near urban areas (cities and towns) are highly polluted. This is the result of both garbage dumped by individuals and dangerous chemicals legally or illegally dumped by manufacturing industries, health centers, schools and market places.

- **Death of aquatic (water) animals:** The main problem caused by water pollution is that it kills life that depends on these water bodies. Dead fish, crabs, birds and sea gulls, dolphins, and many other animals often wind up on beaches, killed by pollutants in their habitat (living environment).
- **Disruption of food-chains:** Pollution disrupts the natural food chain as well. Pollutants such as lead and cadmium are eaten by tiny animals. Later, these animals are consumed by fish and shellfish, and the food chain continues to be disrupted at all higher levels.

Diseases: Eventually, humans are affected by this process as well. People can get diseases such as hepatitis by eating seafood that has been poisoned. In many poor nations, there is always outbreak of cholera and diseases as a result of poor drinking water treatment from contaminated waters.

- **Destruction of ecosystems:** Ecosystems (the interaction of living things in a place, depending on each other for life) can be severely changed or destroyed by water pollution. Many areas are now being affected by careless human pollution, and this pollution is coming back to hurt humans in many ways.

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Control measures: Never throw rubbish away anyhow. Always look for the correct waste bin. If there is none around, please take it home and put it in your trash can. This includes places like the beach, riverside and water bodies.

- Use water wisely. Do not keep the tap running when not in use. Also, you can reduce the amount of water you use in washing and bathing. If we all do this, we can significantly prevent water shortages and reduce the amount of dirty water that needs treatment.
- Do not throw chemicals, oils, paints and medicines down the sink drain, or the toilet. In many cities, your local environment office can help with the disposal of medicines and chemicals. Check with your local authorities if there is a chemical disposal plan for local residents.
- Buy more environmentally safe cleaning liquids for use at home and other public places. They are less dangerous to the environment.
- If you use chemicals and pesticides for your gardens and farms, be mindful not to overuse pesticides and fertilizers. This will reduce runoffs of the chemical into nearby water sources. Start looking at options of composting and using organic manure instead.

Q.25. What are waterborne diseases? How are they caused?

Ans. Waterborne diseases are caused by pathogenic microorganisms that most commonly are transmitted in contaminated fresh water. Infection commonly results during bathing, washing, drinking, in the preparation of food, or the consumption of food thus infected. Various forms of waterborne diarrheal disease probably are the most prominent examples, and affect mainly children in developing countries; according to the World Health Organization, such disease account for an estimated 4.1% of the total DALY global burden of disease, and cause about 1.8 million human deaths annually. The World Health Organization estimates that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene.

Q.26. What are the salient features of Water (Prevention and Control of Pollution) Act, 1974?

Ans. Salient features of the Water (Prevention and Control of Pollution) Act, 1974.

- Water (Prevention and Control of Pollution) Act, 1974 is an appropriate step for the management of water pollution; the maintenance or restoration of wholesomeness of water; the establishment, with a view to carrying out the purposes aforementioned, of Boards for the prevention and control of water pollution; conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.
- The Act deals with a particular type of pollution and presents an integrated approach to tackle the problem. It is an important legislative measure which has been enacted to implement the decision taken in the United Nation's Conference on Human Environment held in June 1972 at Stockholm.
- The Water (Prevention and Control of Pollution) Act, 1974 has 64 Sections and has been divided into eight chapters relating to i) Preliminary, ii) Central and State Boards for the Prevention and Control of Water Pollution, iii) Joint Boards, iv) Powers and Functions of Boards, v) Prevention and Control of Water Pollution, vi) Funds, Accounts and Audit, vii) Penalties and Procedures, and viii) Miscellaneous.

Q.27. What is Land Pollution? Also explain about Soil contamination.

Ans. Land pollution is the deterioration (destruction) of the earth's land surfaces, often directly or indirectly as a result of man's activities and their misuse of land resources.

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It occurs when waste is not disposed of properly, or can occur when humans throw chemicals onto the soil in the form of pesticides, insecticides and fertilizers during agricultural practices. Exploitation of minerals (mining activities) has also contributed to the destruction of the earth's surface.

It is important to understand that land pollution is not just littering, although it is a part of the issue. Land pollution is a way bigger issue. It is more of an industrial issue, involving big oil refineries, industries that manufacture chemicals, herbicides, pesticides and fertilizers used in farming. It also involves illegal dumping of waste in landfills and so on.

Human actions have also caused many large areas of land to lose or reduce their capacity to support life forms and ecosystems. This is known as land degradation. Note that land degradation can result from many factors, and land pollution is only one of them.

- **Soil Contamination**: Soil contamination, degradation and pollution mean different things even though we often use these terms to mean one thing. Here is the difference:
- **Soil pollution** is when humans introduce harmful objects, chemicals or substances, directly or indirectly into the soil in a way that causes harm to other living things or destroys soil or water ecosystems. Soil pollution is often considered as a hidden danger, because it is a kind of pollution that is not easily visible to the eye, although its effects can be catastrophic.
- **Soil contamination** is when the concentration of chemicals, nutrients or elements in the soil becomes more than it normally or naturally is, as a result of human action. If this contamination goes on to harm living organisms, we can call it pollution.
- **Soil degradation** is when the soil loses its value (in terms of nutrients, chemical make-up etc) as a result of over-farming, over-grazing or erosion. For example, if a bush fire wipes out the vegetation on a piece of land thereby exposing the soils, and nutrients in the soil get dissolved by rainwater run-off, the ability of the soil to support plant life is reduced. We can call this soil degradation.

Q.28. What are the major causes of Deforestation? Discuss its consequences.

Ans. Deforestation is the permanent destruction of indigenous forests and woodlands. The term does not include the removal of industrial forests such as plantations of gums or pines. Deforestation has resulted in the reduction of indigenous forests to four-fifths of their pre-agricultural area. Indigenous forests now cover 21% of the earth's land surface

Deforestation is brought about by the following:

- Conversion of forests and woodlands to agricultural land to feed growing numbers of people;
- Development of cash crops and cattle ranching, both of which earn money for tropical countries
- Commercial logging (which supplies the world market with woods such as meranti, teak, mahogany and ebony) destroys trees as well as opening up forests for agriculture;
- Felling of trees for firewood and building material; the heavy lopping of foliage for fodder; and heavy browsing of saplings by domestic animals like goats.

To compound the problem, the poor soils of the humid tropics do not support agriculture for long. Thus people are often forced to move on and clear more forests in order to maintain production.

Consequences of Deforestation

(a) The carbon cycle. Forests act as a major carbon store because carbon dioxide (CO_2) is taken up from the atmosphere and used to produce the carbohydrates, fats, and proteins that make up the

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tree. When forests are cleared, and the trees are either burnt or rot, this carbon is released as CO_2. This leads to an increase in the atmospheric CO_2 concentration. CO_2 is the major contributor to the greenhouse effect. It is estimated that deforestation contributes one-third of all CO_2 releases caused by people.

(b) The water cycle. Trees draw ground water up through their roots and release it into the atmosphere (transpiration). In Amazonia over half of all the water circulating through the region's ecosystem remains within the plants. With removal of part of the forest, the region cannot hold as much water. The effect of this could be a drier climate.

- *Soil erosion* With the loss of a protective cover of vegetation more soil is lost.
- *Silting of water courses, lakes and dams* This occurs as a result of soil erosion.
- *Extinction of species* which depend on the forest for survival. Forests contain more than half of all species on our planet - as the habitat of these species is destroyed, so the number of species declines.
- *Desertification* The causes of desertification are complex, but deforestation is one of the contributing factors.

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