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UNIT -4 : GEOGRAPHY OF ENVIRONMENT

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SECTION – 1: UNIT AT A GLANCE

SUB UNIT-1 : ECOSYSTEM & ECOLOGY

abiotic components: land, air, water, soils and energy are abiotic or physical components of environment.

biome: the large natural ecosystem comprised of abiotic and biotic components wherein all the biota have minimum common characteristics, and more or less uniform environmental conditions, is called biome.

biotic components : plants, animals and micro-organisms alltogether are called biotic components of biospheric ecosystem.

climatic climax : the climax vegetation developed in any habitat due to climatic factors is called climatic climax.

climax vegetation: the vegetation community developed at the end of serai stages of biotic succession in a habitat is called climax vegetation.

consumers : all organisms including man, who derive their food from biotic matter produced by autotroph green plants, are called consumers.

decomposers : those micro-organisms are called decomposers who decompose dead plants, animals

and other biotic matter, and derive their food from decomposed matter.

ecocline : means a broad transition between two different ecosystems of mainly plant communities.In an

ecocline represents a gradient along which biotic communities mainly plant communities and biotic

fact,conditions change.

ecosystem : an ecosystem is defined as a fundamental functional unit occupying spatial dimension of 'earth

space ship' characterized by total assemblage of biotic community and abiotic components and the mutual interactions within a given time unit.

gradient analysis : the study of ecocline representing the changing conditions across the boundary of natural ecosystem is called gradient analysis.

producers : the green plants in natural ; ecosystems are called primary producers or simply producers because they produce food energy through photosynthesis.

Autecology : is the study of relationships of individual species to its environment.

Biomass : refers to the quantity or weight of living organisms (plants, animals and micro-organisms) per unit area and is represented in terms of dry weight.

Biome : The most extensive ecosystem uqit comprising all plants, animals and soils, wherein all biota have minimum common characteristics, is called biome which is characterized by more or less uniform environmental conditions.

Deep ecology: is a term of environmentalism that advocates radical measures to protect the environment irrespective of their impacts on human welfare because man and nature are two faces of same coin so both

should be given equal importance and thus it is based on ecocentric view point.

Ecocline : is ecological or vegetation gradent along which there is gradual change of vegetation of different ecosystems according to changing environmental conditions.

Ecological niche : is defined as 'the functional role and position (micro-habitat) of species in its ecosystem, including what resources it uses, how and when it uses the resources, and how it interacts with other species' (W.P. and M.A. Cunnigham, 2003).

Ecological productivity : refers to the rate of growth of organic matter per unit time and per unit area in anatural ecosystem.

Ecosystem : is a functional unit comprising abiotic and biotic and energy components wherein these components are very closely and intimately related.

Gross primary production : is the total amount of energy produced by the autotroph primary producer green plants at trophic level one.

Holozoic : animals get their food through their mouths such as large mammals like cows, elephants, deers etc.

Homeostatic mechanism: is inbuilt self-regulating mechanism in natural ecosystems through which any change in the ecosystem is counterbalanced by responses of the systems to the change and ultimately the ecosystem stability is restored.

Law of competitive exclusion : states that 'no two species will occupy the same niche and compete for exactly 'the same resources in the same habitat for very long' (Cunnigham and Cunnigham, 2003).

Net primary production: represents the amount of energy or organic matter fixed or stored at trophic level one.The net primary production excludes the amount of energy which is lost through respiration by the autotroph green plants. Thus net primary production is gross primary production minus the energy lost through respiration at trophic level one.

Parasites: are those organisms which depend on other living organisms for their food.

Saprophytes: are those organisms which depend on organic compounds in solution derived from dead plants and animals.

Shallow ecology : is a term of environmentalism based on anthropocentric view point. It pleads for control of resource depletion and pollution in the interest of only humans. It believes that man and nature are different and man is superior to nature.

Synecology : is the study of complex interrelationships of groups of organisms known as biological community because organisms (plants, animals, and micro-organisms) affect each other in reciprocal manner and interact with the habitat or natural environment.

Ecological pyramids : The pyramids of number of species, total biomass and energy availability at each trophic level in a food chain are called ecological pyramids.

Energy pyramid : represents total amount of energy used at each trophic level per unit area per unit time.

Food chain: food chain is the sequence of energy transfer from the lower trophic levels to the higher trophic levels.

Gross primary production: is the total amount of energy produced by the autotrophic primary producer green plants at trophic level one.

Net primary production: represents the amount of energy or organic matter fixed or stored at trophic level one. Net primary production is thus gross primary production minus (-) the energy lost through respiration.

Trophic level : The point in a food chain where food energy is transferred from one group ot organisms to the other group is called trophic level.

Biogeochemical cycles : The circulation and movement of soluble inorganic matter (nutrients) derived from sedimentary and atmospheric phases and reservoirs through organic phase of various biotic components and finally their return to inorganic phase is collectively called biogeochemical cycle.

Carbon cycle : The circulation of carbon in the biosphere through the storages and pathways of gaseous phase, liquid phase (dissolved carbon dioxide in water), and solid phase (carbone stored in the sediments including coal and organic matter) is called carbon cycle.

Nitrogen cycle: The circulation of nitrogen through a Cyclic pathway of (a) transfer of atmospheric nitrogen,

(b)mineralization. nitrification of nitrogen from soils to plants and animals, and (c) denitrification and return of

nitrogen to the atmosphere is called nitrogen cycle.

Oxygen cycle: involves the input of oxygen in the atmospheric storage pool from the photosynthesis of marine and terrestrial autotrophic plants and from volcanic eruptions, and the loss of oxygen from the atmospheric storage pool through respiration of marine and terrestrial organisms and mineral oxidation, burning of wood, grasses and firest fire, combustion of fossil fuels.

biodiversity : Simply means variety of living species of organisms of both plants and animals in an ecosystem having certain specific environmental conditions.

biodiversity hotspots : are defined as those areas which have rich biological communities including plants and animals wherein endemic species predominate.

SUB UNIT-2 : GLOBAL WARMING

The most significant global environmental problem faced by the world community is related to global environmental changes (GEC) consequent upon global warming resulting from a host of causal factors mainly anthropogenic factors such as changes in atmospheric chemistry, ozone depletion, emission of greenhouse gases at alarming increasing rate, urbanization, land use changes mainly deforestation etc. The probable net result of global warming and changes in atmospheric chemistry through air pollution and other natural sources would be climatic changes at local, regional and global levels including both short-term and long-term changes in weather and climate.

SUB UNIT- 3 : KYOTO PROTOCOL

A summit to reduce global warming was held from December 1 to 10, 1997 in Kyoto city of Japan and an agreement to this effect was also signed. This summit was attended by the representatives of 149 countries. This agreement is popularly known as Kyoto Protocol or Kyoto Thermal Treaty. The following are the main items of this historic agreement.

Section - 2 : Key Words

BASIC KEY STATEMENTS: Ecosystem (4.1.A.1) Biotic Component (4.1.A.IV) Abiotic component (4.1.A.IV) Ecosystem Productivity (4.1.A.VI) Mangrove (4.1.C.IV) Trophic Level (4.1.E.IV) Food Chain (4.1.E.IV) Food Web (4.1.E.IV) Ecological Pyramid (4.1.E.V) Energy Flow (4.1.E.VI) Global warming (4.2.1) Environmental Degradation (4.2.2) Water pollution (4.2.3) Soil pollution(4.2.4) Air pollution (4.2.5)

STANDARD KEY STATEMENTS: Ecocline (4.1.A.III) Stability of Ecosystem (4.1.A.VII) Biodiversity (4.1.C.I) Biodiversity Hotspots (4.1.C.II) Biosphere Reserve (4.1.C.III) Biogeochemical cycle (4.1.F.I) Carbon cycle (4.1.F.II) Oxygen cycle (4.1.F.III) Nitrogen cycle (4.1.F.IV) Biome (4.1.H.I) Erath Summit (4.3.2) Kyoto Protocol (4.3.4) Climate Agreement (4.3.5) Gaia Hypothesis (4.3.6)

ADVANCE KEY STATEMENTS: Ecology (4.1.B.I) Habitat (4.1.B.I) Autecology (4.1.B.I) Synecology (4.1.B.I) Ecological Niche (4.1.B.V) Deep Ecology (4.1.B.VI) Shallow Ecology (4.1.B.VI) Australian Region (4.1.D.I) Cape Region (4.1.D.I) Antarctic Region (4.1.D.I) Palaeotropical Region (4.1.D.1) Neotropical Region (4.1.D.I)Boreal Region (4.1.D.I) Oriental Region (4.1.D.III) Ethiopian Region (4.1.D.III) Sustainable Development (4.3.7)

Section-3: Key Facts and Figures

SUB UNIT-1

ECOSYSTEM & ECOLOGY

4.1.A.I ECOSYSTEM : MEANING AND DEFINITIONS

The term 'ecosystem' was first used by A.G. Tansley in 1935 who defined ecosystem as 'a particular category of physical systems, consisting of organisms and inorganic components in a relatively stable equilibrium, open and of various sizes and kinds'. According to Tansley the ecosystem is comprised of two major parts viz. biome (the whole complex of plants and animals of a particular spatial unit) and habitat (physical environment) and thus 'all parts of such an ecosystem-organic and inorganic, biome and habitat-may be regarded as interacting factors which, in a mature ecosystem, are in approximate equilibrium, it is through their interactions that the whole system is maintained' (A.G. Tansley, 1935). **F.R. Fosberg** (1963) has defined ecosystem as 'a functioning, interacting system composed of one or more living organisms and their effective environment, both physical and biological'.

According to R.L. Lindeman (1942) the term ecosystem applies to 'any system composed of physical-chemical-biological processes, within a space-time unit of any magnitude'. In E.P.

Odum's view (1971) 'living organisms and their non-living (abiotic) environment are inseparably interrelated and interact upon each other. Any unit that includes all of the organisms (i.e. the Community) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycle (i.e. exchange of materials between living and non-living parts) within the system is an ecological system or ecosystem'.

According to **A.N. Strahler and A.H.Strahler (1976)**, 'the total assemblage of components interacting with group of organisms is known as ecological system or more simply, an ecosystem. Ecosystems have inputs of matter and energy, used to build biological structure (the biomass), to produce and to maintain necessary internal energy levels. Matter and energy are also exported from an ecosystem. An ecosystem tends to achieve a balance of the various processes and activities within it'.

Based on the contents of above definitions of ecosystem provided by various scientists it may be pointed out that 'ecosystems are therefore unities of organisms connected to one another and to their environment' (P.A. Furley and W.W. Newey. I983), 'and fhe ecosystem is thus the sum or all natural organisms and Substances within an area, and it can be viewed as a basic example of an open system in physical geography' (C.C Park, 1980). Stressing the importance of ecosystem C.C Park further says that ‘ecosystems are regarded by many ecologists to be the basic units of ecology because they are complex, interdependent and highly organised systems, and because they are the basic building blocks of the biosphere’.

‘In a more lucid style and simple term an ecosystem may be defined as a fundamental functional unit occupying spatial dimension of ‘earth space ship’ characterised by total assemblage of biotic community and abiotic components and their mutual interactions within a given time unit’. **(Savindra Singh, 1991)**

4.1.A.II Properties of Ecosystems

The ecosystems are characterized by the following basic properties :

- Ecosystem of any given space-time unit represents the sum of all living organisms and physical environment.
- It is composed of three basic components viz. energy, biotic (biome) and abiotic (habitat) components.
- It occupies certain well defined area on the earth-spaceship (spatial dimension).
- It is viewed in terms of time-unit (temporal dimension).
- There are complex sets of interactions between biotic and abiotc components (including energy component) on the one hand and between and among the organisms on the other hand.
- It is an open system which is characterised by continuous input and output of matter and energy.
- It tends to be in relatively stable equilibrium unless there is disturbance in one or more controlling factors (limiting factors).
- It is powered by energy of various sorts but the solar energy is the most significant.
- It is a functional unit wherein the biotic components (plants, animals including man and micro-organisms) and abiotic (physical environment) components (including energy component) are intimately related to each other through a series of large-scale cyclic mechanisms viz. energy flow, water cycle, bio-geochemical cycle, mineral cycle, sediment cycle etc.
- Ecosystem has its own productivity which is the process of building organic matter based on the availability and amount of energy passing through the ecosystem. The productivity refers to the rate of growth of organic matter in an aeralunitper time-unit.

- Ecosystem has scale dimension i.e. it varies in spatial coverage. It may be as small as a cowshed, a tree or even a part of a tree having certain micro-organisms. The largest unit is the whole biosphere.
- There are different sequences of ecosystem development. The sequence of ecosystem development in term of a particular suite of physical and chemical conditions is called as ‘sere’. A ‘sere’ represents the development of a series of sequential successions starting from primary succession and culminating into the last succession in a sere as ‘climax’ or ‘climatic climax’ which is the most stable situation of an ecosystem. Thus, the study of ecosystem development may help in environmental planning from ecological point of view.
- Ecosystems are natural resource systems.
- Ecosystem concept is monistic in that environment (abiotic component), man, animals, plants and micro-organisms (biotic components) are put together in a single framework so that it becomes easy to study the patterns of interactions among these components.
- It is structured and well organized system.

4.1.A.III TYPES OF ECOSYSTEMS

Ecosystems may be identified and classified on various bases, with different purposes and objectives as outlined below :

(I) On the basis of habitats : The habitats exhibit physical environmental conditions of a particular spatial unit of the biosphere. These physical conditions determine the nature and characteristics of biotic communities and therefore there are spatial variations in the biotic communities. Based on this premise the world ecosystems are divided into two major categories viz. (A) terrestrial ecosystems, and (B) aquatic ecosystems. There are further variations in the terrestrial ecosystems in terms of physical conditions and their responses to biotic communities. Therefore, the terrestrial ecosystems are further divided into sub categories of (i) upland or mountain ecosystems, (ii) lowland ecosystems, (iii) warm desert ecosystems, and (iv) cold desert ecosystems. These subecosystems may be further divided into descending orders depending on specific purposes and objectives of studies. (B) The aquatic ecosystems are subdivided into two broad categories (i) freshwater (on continents) ecosystems, and (ii) marine ecosystems. Fresh water ecosystems (Bi) are further divided into (Bia) river ecosystems, (Bib) lake ecosystems, (Bic) pond and tank ecosystems, (Bid) marsh and hog ecosystems while (B11) marine ecosystems are divided into (Biia) open ocean ecosystems, (Biib) coastal estuarine ecosystem. (Biiic) coral reef ecosystem, or can be alternatively divided into (Biia) ocean surface ecosystems, and (Biib) ocean bottom ecosystems.

(2) On the basis of ecoclines : Ecocline means a broad transition between two different ecosystems of mainly plant communities. Infact an ecocline represents gradient along which biotic communities mainly plant community and abiotic conditions change. The study of ecocline representing the changing conditions, across an ecosystem boundary is known as 'gradient analysis' which implies the plotting of variations of plant community in particular direction and the analysis thereof and division of world ecosystem (M.J. Bradshaw, 1979). Based on above considerations R.C. Whittaker (1970) has drawn four profile diagrams of four ecoclines on a major world scale viz. (A) from Applachians to southern Texas (USA) on the basis of increasing aridity, (B) from equatorial rainforest to desert area, on the basis of increasing aridity, (C) from ground surface to higher altitudes of the Andes on the basis of increasing altitude, and (D) from tropical rainforest to tundra on the basis of decreasing temperature. Thus on the basis of above gradient profiles and associated ecoclines the following types of ecosystems in the aforesaid four situations may be identified :

(A) From mountains with relatively more moisture to the areas of increasing aridity

(a) mesophytic forest ecosystem, (b) oak-hickory forest ecosystem, (c) oak woodland ecosystem

(d) prairie ecosystem, (e) dry grassland ecosystem, and (d) desert ecosystem.

(B) From the areas of high moisture (equatorial areas) to the areas of lowest moisture (desert) : (a) tropical rainforest ecosystem, (b) evergreen seasonal-deciduous forest ecosystem, (c) thorn forest ecosystem, and (a) desert scrub ecosystem.

(C) from lower to higher altitudes (in the Andean area of S. America) :

(a) tropical rainforest ecosystem, (b) lower montane rainforest ecosystem, (c) montane rainforest ecosystem, (d) montane thicket ecosystem, (e) elfine woodland ecosystem, and (f) paramos ecosystem.

(D) From equatorial hot and moist areas to cold tundra :

(a) Tropical forest ecosystem, (b)sub- tropical forest ecosystem, (C) temperate deciduous forest ecosystem, (d) temperate mixed forest ecosystem, (e) boreal forest ecosystem, and (f) tundra ecosystem.

(3) On the basis of spatial scales ecosystems are divided into different types of various orders on the basis of spatial dimensions required for specific purposes. The largest ecosystem is the whole biosphere which is subdivided into two major types: (A) continental ecosystem, and (B) oceanic or marine ecosystems. The spatial scales may be brought down from a continent to a single biotic life (plant or animal).

(4) On the basis of uses E.P. Odum (1959) has divided the world ecosystems on the basis of use of harvest methods and net primary production into two broad categories viz. (A) cultivated ecosystems, and (B) non-cultivated or natural ecosystems. Cultivated ecosystems may be further subdivided into several categories on the basis of cultivation of dominant crops, e.g. wheat field ecosystem, rice field ecosystem, sugarcane field ecosystem, fodder field ecosystem etc. Similarly, non-cultivated ecosystems can be subdivided into forest ecosystem, tall grass ecosystem, short grass ecosystem, desert ecosystem, seeweeds ecosystem etc.

(5**) On the basis of source and level of energy :** ecosystems can be classified on the basis of source, type and amount of energy available in the ecosystem on the basic premise that the main driving force of the ecosystems for their functioning is energy. E.P. Odum (1975) has classified the ecosystems into four categories on this basis.

(A) Unsubsidized natural solar-powered ecosystems are those which are driven by solar energy only wherein incoming solar radiation is used to fix chemical energy. Open oceans, upland forest, wide and deep lakes may be cited typical examples of such ecosystems. The annual energy flow ranges between 1000- 10,000 Kcal/in^2/yr (kilocalories per square meter per year) whereas estimated average energy is about 2000 Kcal/m2/yr.

(b) Natural-subsidized solar-powered ecosystems represent tidal estuaries, lowland forests, coral reefs etc. Natural processes like tides, waves, surface runoff, wind etc. supplement solar energy input because these processes bring additional organic matter and bio- geochemical cycleshelpin recycling of nutrients in the aforesaid ecosystems and thus solar energy is augmented to produce organic matter through primary producers (phtotroph and chemotroph plants) so much so that these ecosystems become the most productive natural ecosystems. The annual energy flow in such ecosystems ranges between 10,000-50,000 Kcal/ m^2/year and average estimated energy flow is 20,00 Kcal/m^2/year.

(C) Man-subsidized solar powered ecosystems are those where additional energy is supplemented by human activities (e.g. farming). In other words, man applies additional energy in the form of fertilizers both natural and chemical, machines, irrigational water etc. to make the land more productive. Thus he produces more food and fiber crops (food and fibre producing ecosystems) in a simple farming system. In a highly mechanised farming ecosystems, man increases the productivity through the use of chemical fertilizers, pesticides and herbicides (fossil energy to provide additional energy to crops, to kill insects and unwanted plants so that maximum energy is utilized by field crops), irrigational water (which augments the cycling and recycling of nutrients so that these are made available to desired plants), and by developing new hybrid high yielding varieties of seeds so- that the relatively low amount of solar energy and can make maximum use of solar energy to prepare food plants remain dwarf and require through photosynthesis and thus can yield more production. The use of machines like tractors, hoes etc. also helps in augmenting the natural processes of bio-geochemical cycles (these agricultural implements make the soil horizons very friable after ploughing and thus organic matter is easily distributed in the soils for easy uptake by plants). The examples of such ecosystems are simple crop and fibre farming systems and highly advanced mechanised farming systems (agriculture) and some forms of aquaculture (fish farming, shellfish cultivation etc.). The annual energy flow is from 10,000 to 50,000 Kcl/m^2/year and estimated average annual quantity being 20,000 Kcl/m^2/year.

(D) Fuel-powered ecosystems are represented by urban and industrial areas where fuel energy fully replaces solar energy. The fuel energy is derived through fossil fuels like coal and petroleum which are obtained from underground quite away from the centres of utilization. Besides, energy is also supplied through hydroelectricity, nuclear power and wood coal. These ecosystems are basically wealth generating systems. These ecosystems also generate pollutants and thus are potential sources of environmental pollution in cities and towns, suburban areas, industrial areas as well as the rural atmospheric environment of even very distant places. These fuel-powered urban- industrial ecosystems though generate material wealth of the economy of the society but these depend for life support (oxygen supply and food supply) fully on solar-powered natural ecosystems, nature-subsidized solar-powered ecosystem and man-subsidized solar-powered ecosystems. The annual flow of energy ranges between 100,000 to 3,000,000 Kcal/m^2/year, the estimated average being 2,00,0000 Kcal/m^2/year. Thus these ecosystems are powered by largest amount of energy which comes from non-solar sources.

4.1.A.IV COMPONENTS OF ECOSYSTEM

There are three major components of ecosystems : **energy component, abiotic or physical component** and **biotic component.** The abiotic component comprises land and soils, water, air and sunlight. Besides, some organic substances (carbohydrates, protein, fat and liquid substances) and biogenic substances (carbon, nitrogen, hydrogen, phosphorous, calcium and potassium in large quantity andiron,manganese, magnesium, zinc, cobalt in small quantity) arc required to sustain lilc of different biotic communities. Components of the ecosystems have been discussed in detail in the next chapter (Chapter 6).

The biotic components represent plants, animals and micro-organisms. Biotic components are classified into two broad categories on the basis of functions : (i) autotrophic component comprises those plants which produce their food themselves through photosynthesis and chemosynthesis. Thus they become (a) photographs (which prepare food through photosynthesis by using solar radiation) and (b) chemotrophs (which prepare food through chemosynthesis from inorganic substances by oxidation). Autotrophs are the primary producers of the ecosystem, (ii) Heterotrophic components comprise those organisms which depend on autotrophs or primary producers (plants). Besides, some heterotrophic organisms decompose and rearrange the organic substances.On the basis of feeding or getting food heterotrophs are divided into 3 sub-types : (a) saprophytes (depending on organic compounds in solutions derived from dead plants and animals), (b) parasites (depending on living organisms), and (c) holozonic (get food through their mouths, example-large animals including man).

The elements of ecosystem are divided into 4 categories on the basis of functions :

- abiotic elements include abiotic and dead biotic compounds of any site or habitat,
- producers (green plants (autotrophs) which act as intermediataries between biotic and abiotic kingdoms),
- consumers are primarily animals including man and they obtain their food from organic substances produced by autotrophs or primary producers, and
- decomposers are micro-organisms which decompose dead plants and animals and organic substances. During this process they receive their food as well as they rearrange organic substances so that these become easily available to primary producers

4.1.A.V FUNCTIONING OF ECOSYSTEM

The functioning of an ecosystem depends on the pattern of energy flow because all aspects of living components of an ecosystem depend on energy flow which also helps in the distribution and circulation of organic and inorganic matter within the ecosystem. While the energy flow follows unidirectional path, the circulation of matter follows cyclic paths. These aspects of energy flow and circulations of matter will be discussed in detail in the 8th and 9th chapters respectively. Here, only a brief discussion is presented so as to have a general idea of the functioning of ecosystem.

The energy pattern and flow are governed by first and second laws of thermodynamics. The first law states that in any system of constant mass, energy is neither created nor destroyed but it can be transformed from one type to another type (example, electrical energy can be converted into mechanical energy). In terms of ecosystem energy inflow or energy input into the system will be balanced by energy outflow from the system. The second law of thermodynamics states that when work is done, energy isdissipated and the work is done when one form of energy is transformed into another form. In the context of ecosystem there is dissipation of energy from each transfer point (trophic level) and thus the dissipated or lost energy is not again available to the ecosystem,

Solar radiation is the basic input of energy entering the ecosystem. The radiant solar energy is received by the green plants. Most of the received solar energy is converted into heat energy and is lost from the ecosystem to the atmosphere through plant communities. Only a small proportion of radiant solar energy is used by plants to make food through the process of photosynthesis. Thus green plants transform a part of solar energy into food energy or chemical energy which is used by the green plants to develop their tissues and thus is stored in the primary producers or autographs at the bottom of trophic levels.

The chemical energy stored at trophic level one becomes the source of energy to the herbivorous animals at trophic level two of the food chain. Some portion of energy is lost from trophic level one through respiration and some portion is transferred to plant-eating animals (herbivores) at trophic level two.

The transfer of energy from trophic level one (green plants) to trophic level two (herbivores) is performed through the intake of organic tissues (which contain potential chemical energy) of green plants by the herebivores. Thus the chemical energy consumed by herbivores helps in the building of their own tissues and is stored at trophic level two and becomes the source of energy for carnivores at trophic level three.

A substantial portion of chemical energy is released by carnivores at trophic level three through respiration because more energy is required for the work to be done by carnivores at trophic level three (building of tissues, growing, movement for grazing, catching prey, reproduction of their offsprings etc.).

Some portion of potential chemical energy is transferred from trophic level three to trophic level four or top trophic level represented by omnivores (those animals which eat both plants and animals, man is the most important example of omnivores). The animals at trophic level four mainly man also take energy from trophic levels one and two. Again some portion of energy is released by omnivores through respiration.

The remaining stored chemical energy in the plants and animals is transferred to decomposers when they (plants and animals) become dead. The decomposers release substantial amount of energy through respiration to the atmosphere.

It may be pointed out that at each trophic level the available potential chemical energy to be transferred to the next higher trophic level decreases as more energy is released through respiration to the atmosphere from each trophic level. Respiration means chemical breakdown of food in the body and thus respiration releases hem vs Inch is transfviied to the atmosphere.

Based on above statement it may be summarised that apart from the energy released to the atmosphere through respiration, the remaining energy 'is transferred in successive consumer stages known as trophic (literally nourishment) levels from autotrophs to heterotrops (meaning that they derive their nourishment from others). Ultimately all the energy is passed on the detrivores, or decomposer organisms' (P.A. Furley and W.W. Newey, 1983).

The circulation of elements or matter or nutrients (organic and inorganic both) is made possible through energy flow. In other words, energy flow is the main driving force of nutrient circulation in the various biotic components of the ecosystem. The organic and inorganic substances are moved reversibly in the biosphere, atmosphere, hydrosphere and lithosphere through various closed system of cycles in such a way that total mass of these substances remains almost the same and are always available to biotic communities. Tn other words, the materials that make up the biosphere are distributed and redistributed by means of an infinite series of cyclic pathways motored by the continuous input of energy' (P.A. Furely and W.W. Newey, 1983).

The materials or nutrients involved in the circulation within an ecosystem are grouped into three categories viz. (i) macro-elements (which are required in large quantity by plants, e.g. oxygen, carbon and hydrogen), (ii) minor or micro-elements (which are required by plants in relatively large amounts, e.g. nitrogen, phosphorous, potassium, calcium, magnesium and sulphur) and (iii) trace elements (plants require very small amounts of about 100 elements, important being iron, zinc, manganese and cobalt).

Besides these inorganic chemical elements, there are organic materials as well which comprise (i) decomposed parts of either alive or dead plants and animals, and (ii) waste materials released by animals. A few of the chemical elements act as organic catalysts or enzymes because they help chemical reactions but seldom undergo chemical change themselves. Such chemical elements are hydrogen, oxygen and nitrogen which belong to gaseous phase (that is they are found in the atmosphere in gaseous state—atmospheric reservoir or pool) and phosphate, calcium or sulphur which belong to sedimentary phase (that is they are found in weathered rocks and soils-sedimentary reservoirs or pool).

Thus these elements, derived from atmospheric and sedimentary reservoirs, are pooled into soils from where these are taken by plants in solution form through the process of root osmosis. The plants then convert these elements into such forms which are easily used in the development of plant tissues and plant growth by biochemical processes (generally photosynthesis). Thus the nutrients driven by energy flow pass into various components of biotic communities through the process known as 'biogeochemical cycles'. In a generalised form the biogeochemical cycles include the uptake of nutrients or inorganic elements by the plants through their roots in solution from the soils where these inorganic elements, derived from sedimentary phase, are stored. The nutrients are transported to various trophic levels through energy flow. Here the nutrients become organic matter and are stored in the biotic reservoirs of organic phase.

The organic elements of plants and animals are released in a variety of ways i.e.

- decomposition of leaf falls from the plants, dead plants and animals by decomposers and their conversion into soluble inorganic from,
- burning of vegetation by lightning, accidental forest fire or deliberate action of man. The portions of organic matter on burning are released to the atmosphere and these again fall down, under the impact of precipitation, on the ground and become soluble inorganic form of element to join soil storage, while some portions in the form of ashes are decomposed by bacterial activity and join soil storage,
- The waste materials released by animals are decomposed by bacteria and find their way in soluble inorganic form to soil storage.

Thus, biogeochemical cycles involve the movement and circulation of soluble inorganic substances (nutrients) derived from sedimentary and atmospheric phases of inorganic substances (the two basic components of inorganic phase) through biotic phase and finally their return to inorganic state. The study of biogeochemical cycles may be approached on two scales : (i) the cycling of all the elements together or (ii) cycling of individual elements e.g. carbon cycle, oxygen cycle, nitrogen cycle, phosphorous cycle, sulphur cycle etc. Besides, hydrological cycle and mineral cycles are also included in the broader biogeochemical cycles

4.1.A.VI ECOSYSTEM PRODUCTIVITY

The productivity of ecosystem refers to the rate of growth of energy or organic matter per unit time by autotrophs at trophic level one through the process of photosynthesis with the help of solar energy. In other words, ecosystem productivity represents the total amount of energy (organic matter) fixed or stored by the autotrophs per unit time and per unit area in the ecosystem. The production of organic matter or energy by autotrophos is known as primary production and the green plants involved in the production activity are called primary producers.

The ecosystem productivity depends on two factors e.g. (i) the availability of the amount of solar radiation to the primary producers at trophic level one, and (ii) the efficiency of the plants to convert solar energy into chemical energy which is used by the green plants to build up their tissues.

Primary production is measured in two ways : (i) gross primary production (GPP) is the total amount of energy produced by the autotrophs at trophic level one, and' (ii) net primary production (NPP) represents the amount of energy or organic matter fixed or stored at trophic level one. Thus net primary production excludes the amount of energy which is lost through respiration by the autographs. Net primary production is, thus, gross primary production minus the energy lost through respiration. Net primary production represents the usable amount of energy at trophic level one, which is available to higher trophic levels. The ecosystem productivity, whether gross or net, is generally measured in gram/m^{2}day or year.

Biomass refers to the quantity or weight of living materials (animals, plants etc.) per unit area and is represented in terms of dry weight. Plant and animal biomass may be measured and represented separately. R.H. Wittaker and G.M. Woodwell have measured the net primary productivity and biomass of plants of the major natural ecosystems and of the whole earth's surface. Mean net primary productivity for the whole earth is 320 dry grams/m^2/year whereas the mean values for the tropical rainforest, swamps and marshes and estuaries are 2000 dry grams/m^2/year in each case. Very low net primary productivity is of extreme desert, rock and ice (3 dry grams/m^2/year), desert scrub (70 dry grams/m^2/year), open ocean (125 dry grams/m^2/year) and Tundra and Alphine ecosystem (140 dry grams/m^2/year).

Since the primary productivity of a natural ecosystem largely depends on the amount of solar radiation, there is positive correlation between primary productivity and solar radiation. Since there is marked decrease in solar radiation received at the earth's surface from equator towards the poles, primary productivity also, on an average (besides a few intermediate zones of exception), decreases markedly towards the poles. This results in spatial variations in primary productivity at regional and local scales. At a very large scale the primary productivity of the terrestrial ecosystems is far more than the marine ecosystems. E.P. Odum (1959) has identified three levels of productivity at world scale as follows :

(i) the regions of high ecological productivity represented by shallow water areas, moist forest (tropical and temperate), alluvial plains and regions of intensive farming;

(ii) the regions of low ecological productivity represented by arctic snow-covered wastelands, deserts and deep ocean areas, and

(iii) regions of intermediate ecological productivity e.g. grasslands, shallow lakes and farmlands except intensively cultivated areas See chapter 8 for detailed discussion on trophic levels and food chains.

4.1.A.VII STABILITY OF ECOSYSTEM

The stability of ecosystem refers to the balance between production and consumption of each element in the ecosystem. In other words, ecosystem stability means balance between input and output of energy and normal functioning of different biogeochemical cycles and stable condition of concentration of all elements. T.D. Brock (1967) has defined steady-state condition mature ecosystem as 'a time-independent condition in which production and consumption of each element in the system are exactly balanced, the concentration of all elements within the system remaining constant, even though there is continual change' (Brock, 1967).

Ecosystem or ecological stability is viewed in different ways as follows :

1. No-Oscillation stability : Stability is viewed as constancy of species numbers within a natural ecosystem or the constancy of individual numbers of a species within a population.
Such stability has been termed by M.I.Dunbar (1973) as 'no-oscillation stability'.

2. Stability resilience : stability of a natural ecosystem is viewed in terms of system's capacity to withstand changes brought in the system by external factors and to maintain or return to its original state after external change. Such stability has been termed by H.A. Regier andE.B. Cowell (1972) as 'stability resistance'.

3. Resilience stability : Stability has been interpreted by A.R. Hill (1975) as a resilience of system to adjust to stresses brought in the ecosystem. This is called as 'resilience stability'.

4. Elastic stability : Elastic stability refers to the establishment of stability in a natural ecosystem after large-scale disturbances or perturbations.

5. **Cyclic-stability :** Cyclical stability **refers** to the adjustment of a system to regular external changes. There is no unprecedented disturbance or perturbation.

The natural, 'normal' or 'uneventful' ecosystem attains its steady state or equilibrium condition through homeostatic mechanisms. There is inbuilt self-regulating mecmanism in a natural ecosystem through which any change in the ecosystem is counterbalanced by rsponses of the system to the change and ultimately ecosystem or ecological stability is restored. For example, if there is sudden change in the ecosystem (due to any external factor) like rapid increase or decrease in the population of a species and if this change is regulated and the population returns to its normal position through self regulating mechanisms within the' system and the system returns to stability, these self regulating mechanisms are called as homeostatic mechanisms. This may be further explained with an example. If the population of insects in a specific area increases significantly beyond optimum level due to favourable climate, the food supply falls short of the demand of increased insect population. With the result there is competition among the insects for food and many insects die of starvation and thus the insect population is brought back to its original size and stability is restored.

Diversity/ Stability Theory

The 'diversity/stability theory' of ecosystem or ecological stability states that ecosystem diversity and complexity enhance the stability of population in a given system. This has been illustrated in a variety of ways by different scientists e.g. (i) according to C.S. Elton (1958) increase in the diversity of food webs promotes ecosystem stability because increased food web diversity increases the resilience of the system to outside invasions of exotic organisms and reduces the fluctuation in the population within a given ecosystem.

(ii) Following R.H. MacArthur (1955) the ecosystem stability increases with increase of number of links in the food web because a large number of interacting feeding links provide alternative channels for energy flow and thus is generated a wide variety of adjustments of the population to environmental changes and stresses within the ecosystem.

(iii) E.P. Odum has related high species diversity of a mature ecosystem representing a 'climax community' to more stability of a natural ecosystem because as the community succession operates, the homeostasis increases due to more protection available to the members of the community against external environmental change.

Equilibrium-Non-Equilibrium Theory

There are two models of the nature of ecosystem equilibrium. The equilibrium model states that an ecosystem always tends towards stability. Whenever the community of an ecosystem is disturbed due to external environmental change, it quickly returns to original state whereas the non-equilibrium model original state whereas the non-equilibrium model states that ecosystem stability is rarely attained because di sturbances caused by frequent external environmental change do not allow to develop ordered state of species assemblages in an ecosystem.

4.1.A.VIII ECOSYSTEM INSTABILITY

Ecosystem instability refers to that state when an ecosystem is unable to adjust with environmental changes. This so happens when the changes are continuous and enormous and these changes exceed the resilience or capacity of the ecosystem. For example, rapid rate of mass felling of trees in a forest ecosystem seldom allows regeneration of forest community because exposed surface due to deforestation is subjected to intense weathering and erosion and nutrients are washed out by surface run-off. Himalayan forest ecosystem is a typical example of ecosystem instability because mass deforestation and subsequent grazing have resulted into complete removal of forests at certain localities.

The factors responsible for ecosystem stability or instability should always be viewed in terms of ecosystem resilience. If the environmental changes exceed the ecosystem resilience, ecosystem instability is caused but when the ecosystem resilience is such that it can withstand the environmental changes, ecosystem stability is maintained. The environmental changes which are responsible for ecosystem instability are both natural ones (climatic change, for example) or man-induced.

Man causes instability in the natural ecosystem by :

- destroying completely or partly the natural vegetation or original animal species or by replacing them by other vegetation or animal species;
- introducing exotic plants or animals or both to any area where such biotic communities were not present previously;
- altering or modifying one or more components of physical environment (such as land use changes);
- introducing foreign chemical substances through the use of chemical fertilizers, pesticides and herbicides;
- increasing or decreasing the original I proportion of atmospheric gas i.e. by changing the atmospheric chemistry e.g. emission of greenhouse gases and ozone depletion;
- manipulation of environmental processes etc.

4.1.B.I ECOLOGY : MEANING AND DEFINITIONS

Ecology, in a very simple term, is a science that studies the interdependent, mutually reactive and interconnected relationships between the organisms ana their physical environment on the one hand and among the organisms on the other hand. Though the term **'ecology'** (oekologie or oecologie) was first coined and used by the German biologist, Ernst Haeckel in 1869, a few conceptual terms were already proposed to reveal relationships between organisms and their environment. For example, French zoologist, Isodore Geoffroy St. Hilaire used the term 'ethology' in 1859, for the study of the relations of the organisms within the family and society in the aggregate and in the community.

4.1.B.II AIMS AND SCOPE OF ECOLOGY

The major themes and areas of ecological studies at ecosystem level (based on the basic tenet that ecosystem is a fundamental ecological unit) include the holistic view of the characteristics of the following :

- abiotic (physical) and biotic components which form an ecosystem,
- the functioning of ecosystem through energy flow and bio-geochemical cycles involving the cycling and recycling of organic and inorganic substances through various components of ecosystem,
- photosynthesis, food chains and food webs, ecological pyramids, ecosystem productivity, limiting factors of productivity,
- ecological stability,
- evolution of plant and animal species, extinction of species, contemporary evolution, successional development of plant communities, spatial distribution of plants and animals and biome types,
- ecological variations at global and regional scales,
- man-induced ecological changes, environmental controls of ecological variations, ecological resources,
- ecological imbalance and environmental degradation and pollution and remedial measures thereof,
- resource management, and ecological basis of environmental management.

The most significant thrust area of vital interest is the study of man-environment relationships specially the impacts of man on environment which adversely affect the environmental and ecological processes causing environmental degradation and ecological imbalance and the formulation of ecologically sound environmental planning and management.

The concept of ecology now has been extended from single phenomenon (plant ecology, animal ecology) to set of phenomena occupying a definite space in the biosphere at a definite time interval e.g. forest ecology, grassland ecology, lake ecology, river ecology, agricultural ecology, industrial ecology, rural ecology, urban ecology, population ecology, social ecology etc. The main sub-fields of ecology are outlined in the following next subsection.

4.1.B.III SUB-DIVISIONS OF ECOLOGY

The field and the scope of ecology have changed during various phases of methodological development of the subject and therefore major sub-divisions of ecology should be determined according to different approaches which include taxonomic affinities, habitat, levels of organisation and modern social and economic situations at global and regional levels.

1. Sub-division Based on Taxonomic Affinities

In the beginning, ecology was exclusively associated with biological sciences-botany and zoology and thus plants (botany) and animals (zoology) were studied separately. This approach led to the division of ecology into (i) plant ecology and (ii) animal ecology. Each division was further sub-divided into micro-divisions based on specialized studies of individual components e.g. plant ecology into oak ecology, pine ecology etc. and *animal ecology* into insect ecology, bacterial ecology, fish ecology etc. It may be pointed out that these two groups of biota are so inseparable and interrelated that it is not advisable to isolate one individual from the groups of organisms for the ecological study of single species and therefore this subdivision is not acceptable at present on the ground that there is complex interrelationships and interdependencies of all types of organisms with their habitats (physical environment).

2. Sub-divisions on the Basis of Habitat

The basic tenet of the division of ecology on the basis of habitat is that there are variations in habitats in terms of their physical characteristics (e.g. topography, soils, insolation and temperature, water, minerals, weather and climate etc.) and therefore there are definite effects of a particular habitat on the organisms and general characteristics of biotic communities vary from one habitat to the other. This approach of ecological study led to the development of 'habitat ecology'. The habitat ecology is further sub-divided on the basis of habitats and their relationships with the organisms inhabiting a particular habitat into forest ecology, grassland ecology, fresh water ecology, estuarine ecology, island ecology, marine ecology, coral reef ecology etc.

3. Sub-division on the Basis of Levels of Organization:

The third approach to ecological studies is to study either individual organisms or groups of organisms of a particular ecosystem. In other words, ecological studies may be accomplished at two levels viz.

- **study of ecological relationships between the species, and**
- ecological relationships within the ecosystem involving all the organisms present therein.

This approach led to the development of (i) autecology, and (ii) synecology.

Autecology is the study of relationships of individual species to its environment. Thus it is apparent that autecological approach rests on individual species as fundamental units of study wherein various aspects of species Iike geographical distribution, morphological and taxonomic position, life cycle and succession and ecological factors which affect different stages of growth and development of species are studied.

Synecology is the study of complex interrelationships of groups of organisms known as biological community because organisms (plants, animals and micro-organisms) affect each other in reciprocal manner and interact with the habitat or natural environment. Thus the fundamental unit of study is biological community rather than individual organisms.

Further, synecology is subdivided into 'population ecology' (the study of interactions of individuals 'population' of single species with each other), 'community ecology' (the study of interrelationships and interdependencies of groups of individuals of different species- plants and animals together), 'biome ecology' (the study of interactions and interrelationships of more than one biological communities in different stages of succession under similar climiatic condition of the area concerned) and 'ecosystem ecology' (the study of interactions and interrelationships of all organisms among themselves and with their environment). Thus the fundamental unit of study is an ecosystem area having both biotic and abiotic (physical) components. It is ecosystem ecology which forms the basis of studies in environmental geography.

4.1.B.IV Summary of Ecological Principles

The ecological principles may be summarised as follows :

> natural ecosystem is a fundamental unit of ecological study.

> at the largest scale the whole of biosphere becomes an ecosystem, the biotic and abiotic components of which are intimately related.

> 'sustained life on the earth is a characteristic of ecosystem'.

> 'nothing actually disappears when we throw it away' because all the materials are rearranged and cycled and recycled through a series of cyclic pathways (geobiochemical cycles) in the natural ecosystem.

> the natural resources are finite and are public property.

> 'nature has spent millions of years to refine a stable ecosystem.'

> the physical, chemical and biological processes follow the principle of uniformitarianism.

> all living organisms and physical environments are interdependent and mutually interactive.

> ecosystem functions through the input of mainly solar energy.

> there is unidirectional flow' of energy through various trophic levels in natural ecosystem.

> as the distance between the organisms of a given trophic level in a natural ecosystem and the initial source of energy (trophic level one of the green plants) increases the probability of the organisms to depend exclusively on the preceding trophic level for energy decreases.

> the relative loss of energy due to respiration increases with higher trophic levels.

> the chemical (inorgnaic) and organic substances are circulated among the various components of the biosphere through a series of closed system of cycles collect! vely known as geobiochemical cycles.

> the ecosystem productivity antj ecological production depend on (i) the availability of the amount of solar energy to the primary producers (autotrophic green plants) at trophic level one, and (ii) the efficiency of plants to convert solar energy into chemical (food) energy.

- there is marked positive correlation between solar radiation and primary ecological productivity.
- the natural ecosystem attains its stability through homeostatic mechanism.
- increase in the diversity of food webs promotes ecosystem stability and ecological balance.
- ecosystem instability and ecological imbalance result when an ecosystem becomes unable to adjust with environmental changes, whether natural or anthropogenic.
- evolution of species represents the inherently dynamic nature of ecosystem, wherein there is gradual speciation by the process of 'natural selection' and 'adaptation' (Darwin) but there is also spontaneous and abrupt evolution of species through the process of 'mutation' (De-Vries).
- 'reproductive isolation' is another aspect of evolution of morphologically differentiated populations of species.
- there is successional development of vegetation community through the phases of nudation, migration, ecesis, reaction and stabilization.
- the vegetation community developed at the end of succession becomes 'climax vegetation' or 'dimax community' or 'climatic climx'.
- besides community succession, the ecosystem also undergoes the process of successional changes.
- the ultimate goal of ecological study is to conserve and preserve ecological resources by maintaining the ecological diversity (biodiversity) and richness, and ecosystem stability.

4.1.B.V ECOLOGICAL NICHE

Meaning and Definition

The concept of 'ecological niche' was first introduced by J. Grinel in 1917 but it was developed by Charles Elton in the year 1927. G.E. Hutchinson proposed more biophysical definition of ecological niche. The term of ecological niche has been used in different contexts by the ecologists such as ecological niche as a particular function played by a specific species in a given ecosystem (role of species); as a habitat, of specific species in a given ecosystem representing total environmental condition (habitat factor) or as a distributional pattern of species in ecosystem (community role) etc.

It may be mentioned that in a natural ecosystem there are several species of plant and animal communities and species of each community play different roles in getting food and thus each community is confined to a certain locality. Such locality having ideal environmental conditions which are suitable for the survival of specific species is called niche. The species of a given niche may not survive in other niches. It is also important to note that there are numerous niches in a given natural ecosystem.

Thus, ecological niche may be defined as 'the functional role and position (micro-habitat) of species in its ecosystem, including what resources it uses, how and when it uses the resources, and how it interacts with other species'. W.P. and M.A. Cunnigham, 2003

Characteristies of Ecological Niche

SJ. McNaughton and L.L. Wolf (1970) have outlined the following characteristic features of ecological niche :

- The number of species in a niche of a natural ecosystem becomes large with high abundance of resources and vice versa.
- With the increase in the number of species of a community the average width of niche of species within that community decreases (and hence availability of resources also decreases).
- Dominant species occupy extensive and broader ecological niche in comparison to less dominant species because they are specialists as they have adapted themselves to a particular niche having single dimension of environmental variation.
- More species may be added to the ecosystem by 'compression of existing niches'.
- If the sites (habitats or locations) are most equitable having equitable distribution of ' resources, the dominance of a particular species becomes minimum.

Quoted by C.C. Park, 1980

Factors

According to S.A. Whittaker, and R.B. Root (1973) ecological niche are affected by 3 types of variables e.g. inter-ecological niche are affected by 3 types of variables e.g.,(l) inter- community variables or habitat variables, (2) intra-community variables or niche varibles, and (3) population response variables.

1) Habitat variables include physical factors such as relief (elevation), slope, soil moisture, soil fertility etc. The community gradient (species variations as determined by physical factors) as determined by physical environmental factors are also important factors which determine the nature of a particular ecological niche.

2) Niche variables include height of the location above ground surface, relationship to intracommunity pattern (food habit, food chain etc.), seasonal and diurnal time, number and size of prey, and ratio between number of animals and plant food etc.

3) Population response variables include population density (of both plants and animals), coverage of species, frequency of feeding, success of reproduction, fitness of animals etc.

(In C.C. Park, 1980)

4.1.B.VI DEEP ECOLOGY VS. SHALLOW ECOLOGY

1. Deep Ecology

- The term deep ecology is related to environmentalism or is considered as a movement or a concept that pleads radical measures to protect the natural environment irrespective of their effects on human welfare.
- Deep ecology considers humans no more significant than other species (of plants and animals). In other words, all life whether humans or plants and animals, have equal importance on our planet earth.
- In fact, deep ecology brings to focus the fact that nature and man are two faces of the same coin and thus removes the illusion that nature and man are different.
- The term 'deep ecology' was first coined and introduced by Norwagian activist and philosopher Arnies Naess in the year 1972.
- The central theme of deep ecology is that we are part of the earth rather than apart, and separate from it.
- Arnie Naess advocated to have close relationships between different areas, bringing together personal and social change, science and spirituality, economics and ecology.
- Deep ecology, thus, is an ecocentric philosophy or view point of radical environmental movement that considers humans as equal to other organisms within the global ecosystem. The word 'deep' is used because it asks deeper questions about the place of human life, who we are. In fact, the term 'deep' applies to 'deepness of change' and 'deepness of questioning' but it does not necessitate an 'ecocentric view', so W. Fox (1990) suggested the abandonment of the term 'deep ecology' in favour of 'ecocentric'.

- Arnie also introduced the following terms in 1972 into environmental literature :
  (a) deep ecology movement
  (b) ecosophy

He defined 'ecosophy' as a philosophy of ecological harmony or equilibrium in the global natural ecosystem/environmental system.

Principles of Deep Ecology

1) Humans and non-humans (all life forms including plants and animals and physical environment) on the earth have intrinsic value.
2) The richness and diversity of life forms are values in themselves.
3) Humans are not above nature and therefore they should not overexploit natural resources and reduce this richness.

4) Flourishing of human life and culture together with non-human life on this earth requires substantial decrease in human population to maintain ecological equilibrium.
5) Presently, the interference of humanbeing with non-living world has become excessive and hence it should be minimised.
6) Present-day technology being non ecofriendly must be drastically changed.
7) There should be idealogical change regarding standard of life of the western idealogy and culture. The high quality of life should replace the thinking of high standard of life.

2. Shallow Ecology

- The term 'shallow' is used for those approaches which are concerned primarily with natural resource degradation and pollution. In fact the philosophy of shallow ecology is more 'anthropocentric' as it seeks to save the earth but only for humans. It seeks to preserve wilderness areas for the recreation and pleasure of humans. The shallow ecology wants us to save the natural environment and the ecosystems only if they are useful and valuable for human society.
- Shallow ecology believes that nature and humans are different and man is superior to the nature.Thus,no amount of efforts of environmentalism can prevent distruction of natural environment if the present-day thinking and culture that the world belongs to it by right as man is empowered to exploit the natural resources in his interest, is not changed.
- Arnie Naess also argued that the 'shallow ecology movement' is oriented only to light against pollution and resource depletion inorder to safeguard that health of people in the developed western world.

It may be concluded that 'deep ecology' is 'ccocentric' and considers humans and non- humans on equal footing and considers natural environment in holistic manner and pleads for the safeguard, conservation and preservation of all plan! and animal species because they have their intrinsic value. On the other hand, 'shallow ecology' advocates for protection of natural resources and control of pollution in the intrests of only humans. Thus, shallow ecology is such environmentalism movement which is based on 'anthropocentric' view point. But deep ecology environmentalism movement advocates for both, the raising and maintenance of quality of human life as well as safeguarding the natural ecosystem and maintaining ecologica lequilibrium.

BIODIVERSITY, BIOSPHERE RESERVE AND WILDLIFE CONSERVATION

BIODIVERSITY

The comprehensive study of biodiversity is very important for the conservation and increase of biodiversity of a nation because the status of biodiversity determines the health and wealth of the nations. The study of biodiversity includes the following aspects :

- meaning and concepts of biodiversity,
- types of biodiversity,
- benefits of biodiversity,
- causes of the loss of biodiversity, and
- conservation of biodiversity.

4.1.C.I Biodiversity : Meaning and Definitions

Biodiversity simply means variety of living species of organisms of both plant and animal communities in an ecosystem having certain specific environmental conditions and larger spatial scale, such as tropical rainforest ecosystem, savanna ecosystem, temperate grassland ecosystem etc. Here, ecosystem is taken at biome level. The term biodiversity was first coined and used by Walter G. Rosen in the year 1986. In fact, the term biodiversity is the contraction of the term biological diversity which was used by Thomas E. Lovejoy of the USA (a biologist) in the year 1980. The concept was popularized worldover by E.O. Wilson.

4.1.C.II Biodiversity Hotspots

The term ‘biodiversity hotspots’ was first coined and used by Norman Myers, a British ecologist, in the year 1998. He defined biodiversity hotspots as those areas which have rich biological communities including plants, animals and microorganisms wherein endemic species predominate. He identified 10 such very rich biodiversity areas i.e. biodiversity hotspots in the tropical rainforest biomes. Now, 34biodiveristy hotspot areas have been identified in the world. Jt may be mentioned that endemic species are those species of plants and animals including micro-organisms which are found in a specific area only and are not found in other areas. Only those rich biodiversity areas are disignated biodiversity hotspots which have atleast 1,500 species of endemic vascular plants and have lost 70 percent of their original habitats. In all, about 34 hot-spots of rich biodiversity have been identified in the world of which 3 hot-spots are found in india e.g. (1) Western Ghats, (2) North-Eastern India, and (3) Himalayas.

4.1.C.III Biosphere Reserves

India has also made biosphere reserves of terrestrial and coastal ecosystems within the framework of UNESCO's Man and Biosphere (MAB) programme with the goals of (1) conservation of biodiversity, (2) promoting research and training, and (3) monitoring and providing models for sustainable development. It is apparent that the biosphere reserves have to play 3 roles, namely (1) conservation role, (2) logistic role, and (3) development role.

In all 13° biosphere reserves have been identified and notified (table 24.5) by the Ministry of Environment and Forests (MEF) of Govt, of India, of which 4 have been recognized and approved by the International Coordinating Council (ICC) of MAB Programme of the UNESCO, such as (1) Nilgiri (2000), (2) Gulf of Mannar (2001), (3) Sundarbans (2001), and (4) Nanda Devi (2004).

Table 24.5 : Biosphere reserves in India

Sl. No.	**Name of the site**	**Location**
1.	NILGIRI	WESTERN GHAT
2.	NANDA DEVI	WEST HIMALAYA
3	NOKREK	MEGHALAYA
4.	MANAS	ASSAM
5.	SUNDERBANS	WEST BENGAL
6.	GULF OF MANNAR	TAMIL NADU
7.	GREATNICOBAR	ANDAMAN AND NICOBER ISLAND
8.	SIMLIPAL	ORISSA
9.	DIBRUSAIKHOWA	ASSAM
10.	DEHANG DEBANG	ARUNACHAL PRADESH
11.	PACHMARHI	MADHYA PRADESH

12.	KANCHANJUNGA	SIKKIM
13.	AGASTHYAMALAI	KERALA
14.	ACHANAKMAR AMARKANTAK	CHHATTISGARH
15.	GREAT RANN OF KUTCH	GUJARAT
16.	COLD DESERT	HIMACHAL PRADESH
17.	SESACHALAM HILLS	ANDHRA PRADESH
18.	PANA	MADHYA PRADESH

4.1.C.IV Wetlands, Mangroves and Corals

The Ramsar Convention has defined 'wetlands' as given below :

'Wetlands as areas of marsh fen, peatland or water, whether artificial or natural, permanent or temporary, with the water static or flowing, brackish or salt, including marine areas, depth of which does not exceed 6 meters such as mangroves, corals, estuaries, creeks, bays, sea grasses and lakes etc.'

The wetlands, managroves, and corals are of great ecological and economic significance but these are under severe threats of destruction and disappearance due to increasing human activities. Thus, the government launched a scheme of conservation and management of these fragile ecosystems in the year 1987. In all 24 wetlands, 33 mangroves, and 4 coral ecosystems have been identified for their conservation and management.

4.1.C.V Table 24.6 : National Parks in India

SI. No.	Narnje-	Area (km^2)	Date of establishment	District	State/
1	Kasu Brahmananda Reedy	1.42	1994	Hyderabad	Andhra Pradesh
2	Maha veer Harina Vanasthali	14.59	1994	Hyderabad	Andhra Pradesh
3	Mrugavani	3.60	1994	Hyderabad	Andhra Pradesh
4	Sri Venkateswara	353.62	1989	Chittor & Cuddapah	Andhra Pradesh
5	Mouling	483.00	1986	Upper Siang	Arunachal Pradesh
6	Naldapha	1,985.23	1983	Changlang	Arunachal Pradesh
7	Dibru-Saikhowa	340.00	1999	Tinsukia & Dibrugarh	Assam
8	Kaziranga	471.71	1974	Golaghat & Nagaon	Assam
9	Manas	500.00	1990	Barpeta & Bongaigaon	Assam
10	Nameri	200.00	1998	Sonitpur	Assam
11	Orang	78.80	1999	Darrang & Sonitpur	Assam
12	Valmiki	335.65	1989	Pashchim Champaran	Bihar
13	Indravati	1,258.37	1981	Dantewada	Chhattishgarh
14	Kangerghati	200.00	1982	Ranker	Chhattishgarh
15	Sanjay	1,471.13	1981	Surguja, Koria	Chhattishgarh
16	Mollem	107.00	1978	North Goa	Goa
17	Bansda	23.99	1979	Valsad	Gujarat
18	Gir	258.71	1975	Junagadh	Gujarat
19	Marine (Gulf of Kachchh)	162.89	1980	Jamnagar	Gujarat
20	Blackbuck	34.08	1976	Bhavnagar	Gujarat
21	Kalesar	46.82	2003	Yamuna Nagar	Haryana
22	Sultanpur	1.43	1989	Gurgaon	Haryana
23	Great Himalayan	754.40	1984	Kullu	Himachal Pradesh
24	Pin Valley	675.00	1987	Lahul & Spiti	Himachal Pradesh
25	City Forest (Salim Ali)	9.07	1992	Srinagar	Jammu & Kashmir
26	Dachigam	141.00	1981	Srinagar	Jammu &
27	Hemis	4,100.00	1981	Ladakh	Jammu &
28	Kistwar	400.00	1981	Doda	Jammu &

29	Betla	231.67	1986	Palamau	Jharkhand
30	Anshi	250.00	1987	Uttar Kannada	Karnataka
31	Bandipur	874.20	1974	Chamarajanagar	Karnataka
32	Bannerghatta	104.27	1974	Bangalore	Karnataka
33	Kudremukh	600.32	1987	Chikmagalur & Dakshin Kannada	Karnataka
34	Nagarahole (Rajiv Gandhi)	643.39	1983	Mysore & Kodagu	Karnataka
35	Anamudi	7.5	2003		Kerala
36	Eravikulam	97.00	1978	Idukki	Kerala
37	Mathikettan Shola	12.82	2003	Idukki	Kerala
38	Pambadum Shola	1.318	2003	—	Kerala
39	Peri y ar	350.00	1982	Idukki	Kerala
40	Silent Valley	89.52	1984	Palakhad	Kerala
41	Bandhavgarh	448.85	1982	Umaria & Jabalpur	Madhya Pradesh
42	Fossil	0.27	1983	Mandla	Madhya Pradesh
43	Kanha	940.00	1955	Mandla & Balaghat	Madhya Pradesh
44	Madhav	375.22	1959	Shivpuri	Madhya Pradesh
45	Panna	542.67	1973	Panna & Chhaiarpur	Madhya Pradesh
46	Pench (Priyadarshini)	292.85	1975	Seoni &	Madhya Pradesh
47	Sanjay	466.88	1981	Sidhi	Madhya
48	Satpura	585.17	1981	Hoshangabad	Pradesh
49	Van Vihar	4.45	1979	Bhopal	Madhya
50	Gugamal	361.28	1987	Amravati	Maharashtra
51	Nawegaon	133.88	1975	Bhandara & Gondia	Maharashtra
52	Pench	257.26	1975	Nagpur	Maharashtra
53	Sanjay Gandhi (Bori villi)	86.96	1983	Thane & Mumbai-Suburban	Maharashtra
54	Tadoba	116.55	1955	Chandrapur	Maharashtra
55	Keibul-Lamjao	40.00	1977	Bishnupur	Manipur
56	Balphakram	220.00	1986	South Garo Hills	Meghalaya
57	Nokrek	47.48	1986	East, West & South Garo Hills	Meghalaya
58	Murlen	200.00	1991	Champhai	Mizoram
59	Phawngpui Blue Mountain	50.00	1997	Chhimtuipui (E)	Mizoram
60	Intanki	202.02	1993	Dimapur	Nagaland
61	Bhitarkanika	145.00	1988	Kendrapara	Orissa
62	Simlipal	845.70	1986	Mayurbhanj	Orissa
63	Darrah	265.8	2003	Kota	Rajasthan
64	Desert	3,162.00	1980	Barmer & Jaisalmer	Rajasthan
65	Keoladeo Ghana	28.73	1981	Bharatpur	Rajasthan
66	Ranthambore	392.00	1980	Sawai Madhopur	Rajasthan
67	Sariska	273.80	1992	Al war	Rajasthan
68	Khangchendzong	1,784.00	1977	North & West	Sikkim
69	Guindy	2.82	1976	Chennai	Tamil Nadu
70	Gulf of Mannar Marine	6.23	1980	Ramanathpuram & Tuticorin	Tamil Nadu
71	Indira Gandhi (Annamalai)	117.10	1989	Coimbator	Tamil Nadu
72	Mudumaiai	103.24	1990	Nilgiris	Tamil Nadu

73	Mukurthi	78.46	1990	Nilgiris	Tamil Nadu
74	Corbett	520.82	1936	Nainital & Garhwal (Pauri)	Uttarakhand
75	Gangotri	1,552.00	1989	Uttarkashi	Uttarakhand
76	Govt nd	472.08	1990	Uttarkashi	Uttarakhand
77	Nanda Devi	630.00	1982	Chamoli	Uttarakhand
78 79	Vaalley of Flowers	87.50	1982	Chamoli	Uttarakhandd
80	Dudhwa	490.00	1977	Lakhimpur Kheri	Uttar
81	Buxa	117.10.	1992	Jalpaiguri	West
82	Gorumara	79.45	1994	Jalpaiguri	West
83	Neora Valley	88.00	1986	Darjeeling	West Bengal
84	Singhalila	78.60	1986	Darjeeling	West
85	Sunderbans	1,330.10	1984	North & South 24-	West Bengal
86	Mukurthi NP	78	2001	Tamil Nadu	
87	Clouded Leopard NP	5	2003	Tripura	
88	Chandoli NP	317	2004	Maharashtra	
89	Darrah NP	—	2004	Rajasthan	
90	Onkareshwar	293	2004	Madhya Pradesh	
91	Rajiv Gandhi NP (Rameswaram)	2.4	2005	Karnataka	
92	Mukundara Hills	200	2006	Rajasthan	
93	Bison (Rajbari) NP	31	2007	Tripura	
94	Papikonda NP	1063	2008	Andhra Pradesh	
95	Inderkilla NP	104	2010	H.P.	
96	Shimbalbora NP	28	2010	H.P.	
97	Khirganga NP	710	2010	H.P.	
98	Balphakram NP	220	2013	Meghalaya	

UnionTerritories

99	Campbell Bay	429.00	1992	Andaman	Andman & Nicobar
100	Galathea	110.00	1992	Andman	Andaman & Nicobar
101	Mahatama Gandhi Marine	281.50	1983	Andman	Andman & Nicobar
102	Middle Button Island	0.64	1979	Andaman	Andaman & Nicobar
103	Mount Harriett	46.62	1979	Andaman	Andaman & Nicobar
104	North Button Island	0.44	1979	Andaman	Andaman & Nicobar
105	Rani Jhansi Marine	256.14	1996	Andaman	Andman & Nicobar
106	Saddle Peak	32.54	1979	Andaman	Andaman & Nicobar
107	South Button Islands	0.03	1977	Andaman	Andaman &

Nicobar Islands

4.1.C.VI Tiger Reserves and Project Tiger

A national scheme known as 'Project Tiger has been launched in the country since 1973 by the Govt, of India with the following objectives :

- to ensure viable population of tiger in India through proper protection and management of tiger population,
- to ensure complete protection to tiger species in a few specially selected tiger reserves for scientific, ecological, economic, aesthetic, cultural and biological values and importance,
- to preserve the habitats and tigers therein as natural heritage for education and sight seeing, etc.

4.1.C.VII Project Elephant

The Govt. of India launched a scheme to protect the wild elephant population known as 'Project Elephant' on the line of 'Project Tiger' in the year 1992. The scheme has been implemented in 12 states of the country.

PLANT SYSTEM

4.1.D.I DISTRIBUTION OF TERRESTRIAL (LAND) PLANTS

The land plant species of the world are grouped into 6 major floristic kingdoms on the basis of their worldwide distribution (fig.10.4) as given below:

(1) **Australian Region**

The floristic kingdom includes the plants of whole Australia which is characterized by typical plant species e.g. eucalyptus.

(2) **Cape Region**

The floral kingdom has developed in the southern tip of Africa wherein the plants having bulbs and tubers have developed and these represent the typical plant species of this floral kingdom.

(3) **Antarctic Region**

This kingdom includes a narrow strip in the north of Antarctica which runs from Patagonia and southern Chile of South America to New Zealand. The most important representative plant of this zone is nothofagus which is also known as southern beech.

(4) **Palaeotropical Region**

This kingdom includes most of Africa, South West Asia, South Asia, South East Asia and southern and middle portions of China This floral kingdom is further divided into 3 sub-kingdoms e.g. (i) African sub-kingdom, (ii) Indo-Malaysian sub-kingdom, and (iii) Polynesian sub-kingdom.

(5) **Neotropical Region**

This region includes the whole of South America except southern Chile and Patagonia.

(6) **Boreal Region**

This floral kingdom includes the whole of North America except middle America, Greenland, entire Europe, northern Asia and Arctic region.

4.1.D.II DISTRIBUTION OF AQUATIC PLANTS

The habitats of plants are divided into two major types e.g. (i) land habitats, and (ii) aquatic or water habitats. Aquatic habitats are further divided into two sub-types e.g. (i) marine habitats, and (ii) fresh-water habitats which are further divided into two sub-types e.g. (a) mobile fresh water habitats (e.g. rivers), and (b) static freshwater habitats (e.g. lakes, tanks, reservoirs, ponds etc.).

ANIMAL KINGDOM

4.1.D.III WORLD DISTRIBUTION OF LAND ANIMALS

A.R. Wallace attempted the classification of world animals into faunal regions in 1876. Since then a number of attempts have been made to divide the world animals into fanual regions by several scientists e.g. P.J. Darlington (1957), S.C Kendleigh (1961), W.George (1962), De Latin (1976), W.T. Neil and M.D.F. Udavardv (1969), De Laubenfels (1970), J.Illies (1974) etc. but still the division of world animals into fanul regiosns as presented by A.R. Wallace is the most convincing and acceptable among all the subsequent divisioins. Normally, the world is divided into the following 6 major faunal regions.

1) Palaearctic region,

2) Nearctic region,

3) Oriental region,

4) Ethiopian region, and

5) Australian region.

1.Palaearctic Region

Palaearctic region includes Europe and midle and north Asia which represent 28 chordata families.

2. **Nearctic Region**

Nearctic region consists of the geographical territories of North America and Greenland.

3. **Oriential Region**

The oriental region includes the geographical areas of mainly south and south-east Asia.

4. **Ethiopian Region**

The Ethiopion region incorporates substantial areas of the world of Africa south of Sahara and far off south western Arabia which is separated from the African region by Red Sea.

5. **Australian Region**

The Australion region includes Australia, New Zealand and islands between S.E. Asia and Australia (such as New Guinea, Soloman, Samoa etc.).

6. **Neoarctic Region**

The neoarctic region includes the whole of South America which is characterized by tropical environment.

ECOLOGICAL PRODUCTION AND ENERGY FLOW IN THE ECOSYSTEM

4.1.E.I

As described in this chapter the biosphere is the largest ecosystem. There is input of matter and energy in the ecosystem to build biological structure, to reproduce and to maintain necessary internal energy level so that the ecosystems may function properly. There is also export, of matter and energy from the ecosystems. When there is balance between the input of matter and energy and output (exit) of matter and energy, the ecosystems tend to be in equilibrium state. All organisms in the biosphere are like machines because they use energy to work and convert one form of energy into another form of energy. The energy pattern and flow are governed by the first and the second laws of thermodynamics.

First Law:

Jhe first law of thermodynamics is known as the conservation of energy which states that in any system of constant mass, energy is neither created nor destroyed but it can be transformed from one type to another type (example, electrical energy can be converted into mechanical energy). In terms of ecosystem, energy inflow or energy input into the system will be balanced by energy outflow from the system.

Second Law:

The Second law of thermodynamics states that when work is done, energy is dissipated and the work is done when one form of energy is transformed into another form.

4.1.E.II SOURCES OF ENERGY

The sun is the most important source energy for the proper functioning of the ecosystem because the solar radiation is converted by green plants into food or chemical energy which is used by plants themselves, animals and man. Only 170 x 10^{19} Joules (which is only 0.2% of The total energy entering the earth's atmosphere) are stored in the biomass (the total mass of the living plant tissues). Thus it is obvious that the flora of the biosphere utilize only 0.2% of the total energy present in the light (solar radiation) of the right wavelength (suitable for photosynthesis by green plants).

4.1.E.III ECOLOGICAL PRODUCTION

Plant and animal biomass may be measured and represented separately. R.II. Whitaker and G.M., Woodwell (1971) have measured the net primary productivity, world net primary production and biomass of plants of major natural ecosystems of the whole earth's surface. Mean net primary productivity for the whole earth is 320 dry grams/m^2/year whereas the mean values for the tropical rainforest, swamps and marshes and estuaries are 2000 dry grams/m^2/year in each case. Very low net primary productivity is of extreme desert, rock and ice (3 dry grams/m^2/ year), desert scrub (70 dry gram m^2/year), open ocean (125 dry grams/m^2/year)and Tundra and Alpine ecosystems (140 dry grams/m^2/year) Table 8.1 presents the generalized picture "of net primary production and plant biomass of the major natural ecosystems.

4.1.E.IV TROPHIC LEVELS, FOOD CHAINS AND FOOD WEBS

As stated earlier, green plants are very important biotic component of the biospheric ecosystem because these green plants manufacture their own food which becomes source of food energy for all types of organisms in the biosphere. Plants manufacture their food with the help of carbon dioxide, inorganic salt (phosphorous and nitrates), water and sunlight. Carbon dioxide is taken by plants from the atmosphere through their leaves during day time while inorganic salts and water are taken by plants from the soils through their roots by the process of root osmosis. The green pigment chlorophyll of plants traps solar radiation or sunlight. Now plants convert water and carbon dioxide into starch and sugar with the help of sunlight. The whole chain. of this process is called photosynthesis. Thus the green plants are called primary producersand the animals depending on primary producer plants (autotrophs) are called consumers (heterotrophs). Some animals exclusively depend on other animals for their food whereas some animals (e.g. man) depend on both, plants and animals for their food. The animals deriving their food exclusively from plants are called herbivores. Those animals, which take their food exclusively from animals, are called carnivores and the animals depeding on both, plants and animals, for their food are called omnivores (e.g.man).

Feeding (or transfer and assimilation of food energy) takes place in hierarchical order in the ecosystem through various levels. Thus the levels through which food energy passes from one group of organisms to the other group are called trophic levels. The chain of transformation and transfer of food energy in the ecosystem from one group of organisms to the other group through a series of steps or levels (trophic levels) is called food chain. In other words, the chain of transfer of food energy from one group of organisms to the other group in the biosphere (ecosystem) is called food chain and the point where food energy is transferred from one group of organisms to the other group is called trophic level. The concept of trophic level is based on the classic work of R.L. Lindman (1942) who pointed out "that living organisms can be grouped into a series of more or less discrete trophic levels with each level depending on preceding one for its energy (food) supply". On an average four trophic levels of a food chain are identified.

(1) **Trophic level 1** : The base of the food chain is formed by autotrophic primary producer organisms which include green plants. This base of the food chain is called trophic level 1 where green plants produce their food through the process of photosynthesis with the help of sunlight, water, carbon dioxide and inorganic salts and they consume the produced energy to build their tissues and bodies. The trophic level 1 is also the source of food for all other organisms of the food chain. All the green plants are the members of trophic level 1.

(2) **Trophic level 2:** The organisms, who do not produce their food themselves but depend on primary producers (of trophic level 1) for their food, are included in trophic level 2. These organisms are animals and are called primary consumers. They are basically grazers like sheep, cows, rabbits, goats, deers etc. These animals are also called herbivores. The trophic level where food energy is transferred from primary producers to primary consumers is called trophic level 2

(3) Trophic level 3 : The animals, who depend on animals mainly herbivorous animals for their food, are included in this trophic level. These animals are called carnivores and secondary consumers because they depend on the primary consumer animals of herbivorous group of trophic level 2. Carnivores include (I) land animals-lions. hawks, beers, leopard, eagles etc,; (II) animals living in the soils-bacteria which decompose dead herbivorous animals; (III) aquatic animals-herring. The trophic level where energy is transferred from primary consumers to secondary consumers is called trophic level 3

(4) Trophic level 4 : Those animals are included in this trophic level which take their food either directly or indirectly from all the three lower trophic levels. Man is the most important member of this trophic level because he derives food and fuel from the green plants, connected overlapping food chains. This happens when greater number of species feed on many kinds of prey. Such complicated food chain is commodities from second and third trophic levels. Such animals (as man) are called omnivores. Decomposers also deri ve their energy from all the trophic levels .

A food chain is in fact the sequence of energy transfer from the lower trophic levels to the upper or higher trophic levels. A simple linear food chain may be illustrated by the following example

1. Plants (primary producers)—herbivorous animals (primary consumers)—carnivorous animals (secondary consumers or primary carnivores)—carnivores/omnivores (secondary carnivores).
2. Grass (primary producer) is eaten by—sheep (herebivores, primary consumer)—>sheep is eaten by—»wolves (carnivores, secondary consumer or primary carnivore).
3. Grass—insects—»frogs—>snake—hawk—> leopard.

When the feeding relationships in a natural ecosystem become more complicated, the food chain does not remain simple and linear rather it is also complicated by several inter-called food web. For example, there are various pathways of transfer of energy between diatoms (primary producer ip marine ecosystem) and adult herring e.g. (i) herring feeds on arrow worms which feed on barracle larva which feeds on diatoms; (ii) herring feeds on sea butterfly which feeds on pseudo calanus, acortia, temora, calanus, all of which feed on diatoms, and so on.

4.1.E.V ECOLOGICAL PYRAMIDS

If we look into the nature and pathways of transfer of energy through different trophic stages (levels) and total biomass at each trophic level we find certain common characteristics e.g. (i) the number of species tends to decline successively from the base of the trophic level (trophic level l) to the of the trophic level. (ii) The total biomass tends to decrease progressively from the base of the trophic level through successive higher trophic levels to the top. (iii) The energy availability at each successive higher trophic level decreases. Thus, it is obvious that the number of species, the total biomass and energy availability decrease with successive higher trophic levels in the food chain in such a way that the shape becomes like a pyramid. This is called ecological pyramid. There are three types of ecological pyramids e.g. (i) the pyramids of numbers, (ii) biomass pyramid, and (iii) energy pyramid.

1. Number Pyramids

Number pyramids include only the number of species and not their sizes (whether the organisms have larger bodies or smaller ones). C. Elton (1927) has pointed out that "the animals at the base of a food chain are relatively abundant, whilst those at the end are relatively few in number, and there is a progressive decrease in between the two extremes".

2. Biomass Pyramid

Pyramids of biomass include the biomass (total weight of organic matter) of each trophic level instead of number of species as is done in the case of pyramid of numbers. Thus the total weight of whole organic matter (biomass) at each trophic level represents the standing crop at a single point in time. This enables the pyramid to assume its natural shape i.e. broad base and thin appex. Biomass pyramid does not give any idea of the rate of ecological/ecosystem production.

3. Energy Pyramids

C. Elton (1927) suggested to construct a pyramid of energy to have an idea of ecological productivity. The energy pyramid is constructed, thus, on the basis of total amount of energy used at each trophic level per unit area per unit time.

4.1.E.VI ENERGY FLOW

Solar radiation is the basic input of energy which enters the ecosystem. This solar energy passes through the hierarchy of trophic levels in a food chain and food web and ultimately becomes output from the ecosystem as energy is lost through respiration from each trophic level. Biosynthesis is the process of the formation of organic tissue which represents the transformation of solar or light energy into chemical or food energy. Biodergradation is the process of breakdown and decomposition of organic matter and thus this process refers to the release of nutrients and food (chemical) energy in the form of heat. The energy flow (transfer of organic molecules) in the ecosystem is unidirectional and is non-cyclic (is not available again for reuse).

The radiant solar energy or light (of the sun) energy is trapped by green plants (primary producers or autotrophs) and is used to prepare food (chemical organic matter) through the process of photosynthesis. Thus autotrophic (or phototrophic) green plants transform a part of solar energy into food or chemical energy which is used by the green plants (primary producers at trophic level 1) to develop their tissues and thus it is stored in the primary producers or autotrophs at the bottom of trophic levels (i.e. trophic level 1).

The chemical energy stored at trophic level 1 becomes the source of energy either directly or indirectly to all of the animals at different trophic levels in a food chain in a natural ecosystem. Some portion of energy is lost through respiration from trophic level 1 and some portion of chemical energy is transferred to plant-eating animals (herbivores) al trophic level 2. Some portion of plants tails down without being consumed by herbivores of trophic level 2 on the ground surface and is ultimately consumed by detri vores or decomposers and thus some energy is also transferred from trophic level 1 to the decomposers living in the soils. It may be pointed out that the transfer of energy from trophic level 1 (green plants, primary producers or autotrophs) is performed through the intake of organic tissues (which contain potential chemical energy) of green plants by the herbivorous animals (when a cow grazes grasses, chemical energy stored in grasses is transferred to the cow).

Thus the chemical energy consumed by herbivorous animals (derived from trophic level 1 through food intake) helps in the building of their own tissues at trophic level 2 and thus the energy is stored in them. This stored energy in the bodies of herbivores now becomes the source of energy for carnivorous animals (secondary consumers) at trophic levle 3. A substantial portion of chemical energy is lost through respiration from herbivores at trophic level 2 because the animals have to consume energy for their movement for getting food from green plants. In other words, energy is required for the work to be done and when work is done energy is dissipated and the work is done when one form of energy is transformed into another form (second law of thermodynamics). Some portion of potential chemical energy is transferred to carnivorous animals at trophic level 3 through intake of food from herbivores. Some portion of energy is released by herbivores as wastes (e.g. dung, urine etc.) which are decomposed by detrivores or decomposers. Still some portions of herbivores, when dead, are broken down and decomposed by decomposers.

A substantial portion of potential chemical energy stored in the bodies of carnivores is lost through respiration from trophic level 3 because the carnivorous animals have to run for greater distances to catch their preys. A portion of chemical energy is transferred to trophic level 4 or tophic level represented by ominivores (those animals which eat both plants and animals, man is the most important example of omnivores). The animals at trophic level 4, mainly man, also take energy from trophic levels 1 and 2. Again some portion of energy is released through respiration from trophic level 4 by omnivores. The omnivores, after their death, are decomposed by the decomposers.

Thus it is obvious from the above discussion that there are three-way pathways of flow of energy in the natural ecosystem as follows :

(i) transfer of chemical energy from each trophic level to the next higher trophic level (i .e. from trophic level 1 to 2, from 2 to 3 and from 3 to 4) and direct transfer of chemical energy from trophic levels 1 and 2 to trophic level 4 (top trophic level);

(ii) transfer of chemical energy from dead organisms of each trophic level to decomposers, and

(iii) loss of energy in the form of heat through respiration from each trophic level and from decomposers. The whole amount of heat energy released from different organisms through respiration is lost to the atmosphere and thus is not again available to the organisms for reuse. It is thus evident that the energy flow in the ecosystem is unidirectional and non-cyclic.

The first law of thermodynamics, “that in any system of constant mass, energy is neither created nor destroyed but it can be transformed from one type to another type, the energy inflow or input in a system is balanced by energy outflow or output”, holds good in the mechanism of energy flow in the ecosystem as elaborated above. Light energy (solar radiation) is transformed into chemical energy (food energy) by autotrophic green plants through the process of photosynthesis. The chemical energy is released as heat energy through respiration by the organisms at different trophic levels. R.L.Lindeman (1942) has formulated the following five principles regarding the relationships betwen different trophic levels and energy flow in a natural ecosystem.

Principle I: As the distance between the organisms of a given trophic level and the initial source of energy (trophic level 1) increases, the probability of the organisms to depend exclusively on the preceding trophic level for energy decreases. In other words, the organisms at trophic levels 3 and 4 do not depend for their energy only on trophic levels 2 and 3 respectively rather they receive energy from more than one- source (trophic level) which means that organisms at trophic level 3 and beyond tend to be 'generalists’ rather than ’specialists' in terms of their feeding habit. food and therefore more energy is lost due to respiration.

Principle III : Species at progressively higher trophic levels appear to be progressively more efficient in using their available food supply, because increased activity predators increases their chances of encountering suitable prey species, and in general predators are less specific than their prey in food preferences’.

Principle IV : 'Higher trophic levels tend to be less discrete than the lower ones' because the organisms at progressively higher trophic levels receive energy from more than one source (trophic level) and are 'generalists' in their feeding habit and they are more efficient in using their available food supply.

Principle V : 'Food chains tend to be reasonably short. Four vertical links is a common maximum' because loss of energy is progressively higher for higher trophic levels and species at higher levels ten to be less discrete.

CIRCULATION OF MATTER IN THE ECOSYSTEM

4.1.F.I BIOGEOCHEMICAL CYCLES

Biogeochemical cycles may also be termed as geobiochemical cycles because the necessary nutrients are provided by the soils and the roots of phototrophic green plants take the nutrients in solution form through the process of root osmosis from the soils. The biologists prefer to use the term biogeochemical cycles because plants play active role in the cyclic pathways of nutrients.

'A biogeochemical cycle is the cycling of chemical clement' through the earth's atmosphere, oceans and sediments as it is affected by the geological and biological cycles. It can be described as a series of compartments or storage reservoirs, and pathways between these reservoirs' (D.B. Botkin and E.A. Keller, 1982). P.A. Furley and W.W. Newey (1983) have defined biogeochemical cycles as 'large scale cycles, involving inorganic substances which pass through a biotic phase and then return to an inorganic state'.

The elements derived from the atmospheric and sedimentary reservoirs are pooled into soils. The inorganic elements stored in sedimentary phase are made available to soil pool or reservoir due to weathering and erosion of rocks. The inorganic elements of the atmospehric phase are brought to the soils under the impact of precipitation. The inorganic elements or nutrients pooled in the soil reservoir are teken up by plants in solution form through the process of root osmosis. The plants then convert these inorganic elements into such forms which are easily used in the development of plant tissues and plant growth by biochemical processes (generally photosynthesis). Thus the nutrients driven by energy flow pass into various components of biotic communities through the process known as biogeochemical cycles.

4.1.F.II CARBON CYCLE

The carbon which moves in the biosphere through various parthways has three phases of its storage and movement e.g. (i) gaseous phase in which carbon is present as gas (CO_2) in the atmosphere, (ii) liquid phase which includes dissolved carbon dioxide in water, and (iii) solid phase which includes carbon stored in the sediments, fossil fuels and organic matter. 'The movement of carbon in solid and liquid forms and as carbon dioxide (gaseous form) is of particular interest as it makes up around 50 percent of organic matter by dry weight, and its movemetns within the biosphere are closely bound up with the flow of energy' (P.A. Furley and W.W. Newey, 1982).

4.1.F.III OXYGEN CYCLE

Oxygen plays a significant role in the biosphere and is very essential element for the living organisms because it supports life and arises from it. The circulation of oxygen also helps in the cycling of other elements in the biosphere. Oxygen is chemically very active because it combines with majority of the elements in the biosphere. It generally forms about 70 percent atoms in living matter and plays a very important role in the formation of carbohydrates, fats and proteins. It is required for respiration process by the animals including man and for photosynthesis by the plants. The oxygen cycle in the biosphere is very much complicated because of its various chemical forms e.g. molecular oxygen (O_2), water (H_2O), carbon dioxide (CO_2), different inorganic compounds as oxides (iron oxides-Fe_2O_3), carbonates (calcium carbonate-$CaCO_3$) etc.

4.1.F.IV NITROGEN CYCLE

'Nitrogen moves through the biosphere in a gaseous cycle in which the atmosphere, containing 78 percent nitrogen by volume, is a vast storage pool available to organisms' (A.N. Strahler and A.H. Strahler, 1976). Nitrogen is very important for all life forms in the biosphere because it is an essential part of amino acids which make up proteins. Nitrogen generally exists in seven forms in the atmosphere e.g. molecular nitrogen (N_2), oxides of nitrogen (e.g. N_2 0 = nitrous oxide, NO = nitric oxide and NO_2 = nitrogen peroxide) and hydrogen- nitrogen compounds (e.g. NH = amino, NH_3 = ammonia and HNO_2 = nitrous acids). Though nitrogen constitutes the largest proportion of atmospheric gases by volume, but li ving organisms cannot use nitrogen directly rather they obtain nitrogen in the form of ammonium salts and nitrate through their roots from the soils. Animals get nitrogen from the plants by eating them. The nitrogen cycle involves the conversion of atmospheric nitrogen into different usable compounds (which become usable for living organisms) under the process of nitrogen fixation; transfer of nitrogen to the plants through their roots from the soils and liberation of nitrogen as gas through the process of denitrification and final return of nitrogen as gas to the atmospheric storage pool of nitrogen.

MAN AND ENVIRONMENTAL PROCESSES

4.1.G.I MAN'S IMPACTS ON ENVIRONMENTAL PROCESSES

The external or exogenetic environmental processes originate from the atmosphere and are basically related to solar energy which affects the basic elements of atmospheric processes. Fluvial, glacial, periglacial and aeolian processes are controlled by solar energy. The efficiency of environmental processes is determined by the potential energy of the lithospheric reliefs. Man, by affecting solar radiation and thus the heat energy, may affect the processes of precipitation and air circulation which in turn would affect the environmental processes. Weather modifications and climatic change affected by man change and transform the very nature of environmental processes.

MAN AND COASTAL PROCESSES

The direct modifications of coastal processes by man include the following :

- disruption of wave motion and weakening of energy of coast-bound waves by injecting air bubble curtains,
- attempts to deflect or resist the effects of sea waves and currently constructing sea walls, groynes (groins), break-waters (masonry walls to break sea waves),
- trapping or import of sediments to replenish beaches, and
- plantation of trees to stabilise beaches and coastal dunes.

Sedimentological Characteristics

Man's activities also affect sedimentological characteristics of coastal environment as follows :

- There is additional supply of waste materials coming out of quarrying in the coastal zones. These materials are reworked and dispersed by sea waves and thus these materials are deposited in certain localities and new beaches are formed (example-progradation of beach ridge plain on the east coast of Jutland, Denmark, due to dumping of waste materials coming out from chalk quarry).

- Artificial replenishment of eroded beaches due to alteration^)f sediment supply caused by construction of breakwaters.
- Conversely, destabilised coastal dunes can be stabilised by planting trees, shrubs and grasses (example, Landes region, S.W. France, Culbin area on Scottish coast etc.).

MAN AND SUBSURFACE PROCESSES

Man changes subsurface conditions in a number of ways such as :

(1) introduction of additional artificial superincumbent load through :

(i) construction of big dams, and

(ii) impounding of huge volume of water in big reservoirs.

(2) injection of used and waste water through injection wells into the ground.

(3) supply of water through irrigation in the agricultural farms.

(4) withdrawal of water and mineral oil from the ground.

(5) underground mining.

BIOMES

4.1.H.I BIOME : MEANING AND CONCEPT

According to I.G. Simmons (1982) 'the most extensive ecosystem unit which it is convenient to designate is called biome'. Though a biome is studied in terms of its plant and animal communities but it also conforms with a definite distributional patterns of soils and climate. 'Thus the biomes of the world are major world-scale regions which integrate a number of factors into an intuitively recognisable whole-deserts, forests, savannas, oceans etc.' (I.G. Simmons, 1982). 'Although the biome includes the total assemblage of plant and animal life interacting within the life layer, the green plants dominate the biome physically because of their enormous biomass, as compared with that of other organisms. 'The plant geographers concentrate on the characteristic life-form of the green plants within the biome....the life-forms are principally trees, shrubs, lianas, and herbs but other life forms are important in certain biomes' (A.N. Strahler and A.H. Strahler, 1976).

4.1.H.II BIOME TYPES

World biomes are divided variously on different bases like climate, vegetation, soil-water condition, heat, growth form of plants, Basically world-biomes are divided into the following two board categories on the basis of the nature of the habitats:

(1) land biomes, and

(2) aquatic biomes.

Land Biomes

1. On the Basis of Climate and Vegetation

Though there is variation in the evolutionary stages of plants and animals over lands and in aquatic environments but on an average there is close relationship between the world distributional patterns of plants and animals and the present climatic types of the world. Thus based on relationships between the distributional patterns of plants and animals and world climates the world biomes have been divided into the following 3 board categories:

(1) Tundra biome,

(2) Temperate biome, and

(3) Tropical biome.

Since the vegetation is the most dominant component of the biomes and the vegetation and climates are very intimately related and hence the world is divided into different biome types on the basis of major world climates and vegetation types.

Aquatic Biomes

Aquatic biomes are divided into 3 major categories and 8 sub-types as follows:

(A) Warm water biome

(1) continental shelf biome

(2) open sea biome

(B) Cold water biome

(3) upwelling water biome

(4) continental shelf biome

(5) open ocean biome

(C) Fresh water biome

(6) riverine biome (river biome)

(7) lacustrine biome (lake biome)

(8) pond biome

PREVIOUS YEAR QUESTIONS

SUB UNIT-1

JULY-2018,

PAPER-II

Sub Unit:-1

1. Given below are the two statements, one labelled as Assertion (A) and the other labelled as Reason (R). Select your answer from the code given below :

Assertion (A) : Energy flow shifts from production to respiration in the entrophic stage, with oxygen demand exceeding oxygen availability.

Reason (R) : Stratospheric ozone layer depletion causes skin diseases.

Code :

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).

(2) Both (A) and (R) are true but (R) is not the correct explanation of (A).

(3) (A) is true but (R) is false.

(4) (A) is false but (R) is true.

2. Which one of the following groups of natural elements in living matters make up more than 99% of Earth's biomass ? (1)H, O, C (2) N, Ca, K (3) H, Ca, N (4) S, H, Na

3. Match the List - I with List - II and select the correct answer from the code given below :

List - I (Process)	List - II (Process) (Outcome)
(a) Decomposition	(i) CO_2
(b) Transpiration	(ii) O_2
(c) Respiration	(iii) CH_4
(d) Photosynthesis	(iv) Water vapour

Code :

	(a)	(b)	(c)	(d)
(1)	(i)	(iv)	(ii)	(iii)
(2)	(iv)	(iii)	(i)	(ii)
(3)	(iii)	(iv)	(i)	(ii)
(4)	(iii)	(iv)	(ii)	(i)

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	27	B	4.1.E.VI
2.	28	A	4.1.E.V
3.	19	C	4.1.E.IV

NOVEMBER-2017,PAPER-II

1. Which one of the following terms is appropriate for the mixing zone of two biomes ?
(1) Environment (2) Ecology (3) Ecosound (4) Ecotones

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	15	D	4.1.A.III

NOVEMBER-2017,PAPER-III

1. Which one of the following terms is appropriate for plants that endure seasonal climatic fluctuations from year to year ?

(1) Perennials (2) Annuals (3) Seasonal (4) Bi-annuals

2. Given below are two statements, one labelled as Assertion (A) and the other labelled as Reason (R). Select your answer from the code given below :

Assertion (A) : The regional boundaries of biomes are some-what arbitrary.

Reason (R) : All kinds of major biomes are existing both in ocean and land.

Code :

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).

(2) Both (A) and (R) are true, but (R) is not a correct explanation of (A).

(3) (A) is true, but (R) is false.

(4) (A) is false, but (R) is true.

3. Match List - I with the List - II and select the correct answer from the code given below :

List - I (Zoogeographic regions)	List - II (Country)
(a) Orientel	(i) Brazil
(b) Nearctic	(ii) Sumatra
(c) Neotropical	(iii) Netherland
(d) Palaearctic	(iv) USA

Code :

	(a)	(b)	(c)	(d)
(1)	(iii)	(i)	(iv)	(ii)
(2)	(iii)	(iv)	(ii)	(i)
(3)	(ii)	(iv)	(i)	(iii)
(4)	(iv)	(ii)	(i)	(iii)

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	21	B	Plant That endure seasonal climatic fluctuation from year to year called is annual.
2.	22	C	4.1.H.II
3.	23	C	4.1.D.III

JUN-2014,PAPER-III

1. Given below are two statements, onelabelled as Assertion (A) and the other labelled as Reason R). Select your answer from the codes given below :

   Assertion (A) : The growth of grass and other vegetative cover is limited to selvas.
   Reason (R) : The separate crowns of trees coalesce and form a thick anopy above the forest floor.
   Codes :
   (A) Both (A) andü (R) are true and ü (R) is correct explanation of (A).
   (B) Both (A) andü (R) are true, but (R) is not correct explanation of(A).
   (C) (A) is true but (R) is false.
   (D) (R) is ture but, (A) is false

2. Xerophytes can tolerate and stand against :
   (A) High temperature
   (B) Severe Cold
   (C) Humidity
   (D) The drought Conditions

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	17	A	
2.	20	D	The drought conditions is suitable for Xerophytes.

JAN-2017,PAPER-III

1. Which one of the following was first to put forward the concept of 'life form' among plants in 1934 ?

(1) A.S. Moffat (2) R.H. Whittaker
(3) Christen Raunkiaer (4) E.O. Box

2. The transition zone between two ecosystems is called

(1) Biotope (2) Ecotone
(3) Biome (4) Habitat

3. Which one of the following is located in the Bastar region ?

(1) Dandeli wildlife Sanctuary (2) Rajaji National Park
(3) Bandhavgarh National Park (4) Indravati National Park

Answer with Reference Table

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	17	C	The concept of 'life form 'among plant in 1934 put Christen Raunkiaer.
2.	23	B	4.1.A.III
3.	59	D	4.1.C.V

JULY-2014,PAPER-II

1. Vast numbers of herbivorous animals and carnivorous such as lions, Jackals and hyenas are found in
   (A) Equatorial rainforest
   (B) Taiga
   (C) Campos of Brazil
   (D) Savannas of Africa

2. Match List – I with List – II and select the correct answer from the codes given below :

List – I	**List – II**
a Green Plants	i. Decomposer
b. Animal Parasites	ii. Primary consumer
c. Plant Parasites	iii. Secondary Consumer
d. Fungi	iv. Producer

Codes :

	a	b	c	d
(A)	iv	iii	ii	i
(B)	ii	i	iv	iii
(C)	iii	ii	i	iv
(D)	i	ii	iv	iii

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	14	A	4.1.E.IV
2.	15	A	4.1.E.IV

DECEMBER-2014,PAPER-III

1. Which one of the following marine ecosystems has the highest primary production ?

(A) Open seas (B) Tidal estuaries
(C) Continental shelves (D) Algae beds and reefs

2. Hekistothermal plants are found in

(A) Mediterranean climate (B) Hot desert
(C) Equatorial climate (D) Cold desert

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	22	D	4.1.E.III, 4.1.E.IV
2.	23	D	4.1.D.I

JULY-2016,PAPER-II

1. The concept of ecological pyramid was first given by whom ?

(1) E.P. Odum (2) A.G. Tansley
(3) Charles Elton (4) Juday

2. The Milankovitch cycle refers to
(1) Hydrological cycle
(2) Nitrogen cycle
(3) Phosphorus cycle
(4) Changes in the rotation and revolution of the earth which may trigger climate change

3. The term ‘Dendrochronology’ is used for which of the following ?
(1) To study the density of trees in a forest
(2) To study the growth of rings of trees annually
(3) To study the dendretic drainage system
(4) To study the antecedent drainage system

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	13	C	4.1.E.V
2.	14	D	4.1.F.I
3.	27	B	4.1.D.I

JULY-2016,PAPER-II

1. The pyramid of biomass is inverted in case of
   (1) Forest ecosystem (2) Grassland ecosystem
   (3) Marine ecosystem (4) Fresh water ecosystem

2. Which one of the following percentages India contributes to world's biodiversity ?
   (1) 2% (2) 4%
   (3) 6% (4) 8%

3. The endemic species of India are mainly found in
   (1) Eastern India (2) Central India
   (3) North-east India (4) North-west India

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	18	D	4.1.E.V
2.	19	D	4.1.C.I
3.	23	C	4.1.C.I,4.1.C.II,III

JUNE-2016,PAPER-III

1.After Rodgers and Panwar (1988) India is divided into how many bio-geographical zones ?
(1) 5 (2) 10
(3) 15 (4) 20

2. Which one of the following counties has more than one hotspots in biodiversity ?
(1) Philippines (2) India
(3) New Caledonia (4) Madagascar

3. Match List-I with List-II and select the correct answer using codes given below.

List – I Taxon)	**List – II (Number of species threatened at the global scale)**
I. Birds	A. 169
II. Corals and sponges	B. 713
III. Reptiles	C. 1029
IV. Fish	D. 154

Codes :

	I	II	III	IV
(1)	C	D	A	B
(2)	C	D	B	A
(3)	D	C	B	A
(4)	C	B	A	D

4 The widest continental shelves are associated with which part of the world ?

(1) Indian Peninsula (Eastern Coast)
(2) Siberia
(3) North America (Western Coast)
(4) South America (Eastern Coast).

5. The ratio between Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)
should always be

(1) Equal to one (2) Less than one
(3) More than one (4) Both (2) and (3)

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	18	B	4.1.C.III
2.	19	B	4.1.C.II
3.	20	D	4.1.C.I,II
4.	21	D	4.1.C.III, 4.1.D.I
5.	23	B	4.1.F.1

DECEMBER-2015GEOGRAPHY PAPER-III

1.Identify tke correct sequence of vegetation belts in an ascending order in mountain
nvironment from tke following:

(1) Submontane, Montane, Subalpine, Alpine

(2) Alpine, Subalpine, Montane, Submontane

(3) Montane, Submontane, Alpine, Subalpine

(4) Alpine, Montane, Subalpine, Submontane

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.		D	Himalayan vegetation

JANUARY-2017GEOGRAPHY PAPER-II

2. Tropical Evergreen Forests are found in the areas of rainfall ranging between
   (1) less than 100 cms
   (2) 100 – 200 cms
   (3) 200 – 300 cms
   (4) more than 300 cms

3 India has how many major bio-geographic regions ?

   (1) 7 (2) 8
   (3) 9 (4) 10

4. Which one of the following countries is devoid of Glossopteris flora ?
   (1) India (2) Australia
   (3) Norway (4) South Africa

5. Given below are two statements, one labelled as Assertion (A) and other labelled as Reason (R). Select your answer from the codes given below :
   Assertion (A) : In the altitudinal range between 3400 metre and 4500 metre in the Himalayas
   Alpine forest is found.
   Reason (R) : Alpine forest like no human interference.

   Codes :
   (1) Both (A) and (R) are true and (R) is the correct explanation of (A).
   (2) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
   (3) (A) is true, but (R) is false.
   (4) (A) is false, but (R) is true

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	12	B	
2.	13	D	4.1.C.III
3.	14	C	4.1.D.III
4.	15	C	

JUNE-2015 PAPER-III

1. The place where an organism or community of organisms lives is called :

   (1) Environment (2) Atmosphere (3) Habitat (4) Society

2. Photosynthesis is the process by which :

   (1) Radiant energy converted into chemical energy

   (2) Radiant energy converted into thermal energy

   (3)Radiant energy converted into bio-energy

   (4)Radiant energy converted into geo-thermal energy

3 .Vadose water' remain in between :

   (1) Crust and mantle (2) Mantle and core

   (3) Ground surface and water table (4) Ground surface and tropopause

4. Which one of the following is not a macro-nutrients to plants ?

   (1) Carbon (2) Iron (3) Nitrogen (4) Oxygen

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	21	C	4.1.B.III
2.	22	B	4.1.E.I, II
3.	23	C	
4.	24	D	4.1.E.IV

DECEMBER-2015 PAPER-II

1. Alpine vegetation from mean sea level is found at an altitude(metres) of:

(1) 2200 – 3200 (2) 3200 - 3700

(3) 3200 – 4200 (4) 4200 – 5200

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	14	B	Alpine vegetation found 3200-3700 metres altitude in Himalayan region

SUB UNIT-2: ENVIRONMENT AND ENVIRONTAL POLLUTION

4.2.1 GLOBAL WARMING

The most significant global environmental problem faced by the world community is related to global environmental changes (GEC) consequent upon global warming resulting from a host of causal factors mainly anthropogenic factors such as changes in atmospheric chemistry, ozone depletion, emission of greenhouse gases at alarming increasing rate, urbanization, land use changes mainly deforestation etc. The probable net result of global warming and changes in atmospheric chemistry through air pollution and other natural sources would be climatic changes at local, regional and global levels including both short-term and long-term changes in weather and climate.

It is thus, necessary to discus the evidences of global warming, trend of global warming, processes of global warming including ozone dpletion and emission of greenhouse gases, effects of global warming, air pollution leading to changes in atmospheric chemistry, and related environmental problems and international cooperations to tackle the problems of global warming and climatic changes.

ENVIRONMENTAL DEGRADATION

4.2.2 URBANIZATION AND ENVIRONMENTAL DEGRADATION

Increasing concentration of population in urban centres and origin and expansion of new urban centres due to industrial expansion and development are responsible for rapid rate of exploitation of natural resources and several types of environmental degradation and pollution in the developed and developing countries. The level of urbanization in the developed countries of the world has already reached its peak. The accumulation of wealth and availability of more economic and job opportunities in the urban centres have resulted into the concentration of population in the congested meteropolitan aras and thus the formation and growth of big slum areas.

Salient Features of World Urban Population (2014)

The following are the adverse impacts of urbanization on environment :

> In fact, increasing urbanization means phenomenal increase in the concentration of human population in limited space which results in the increase of buildings, roads and streets, sewage and storm drains, pucca surface area, vehicles (motor cars, trucks, buses, motor cycles, scooters etc.), number of factories, urban wastes, aerosols, smokes and dusts, sewage waters etc. which cause several environmental problems.

Urban centres when combined with industrial sectors become more hazardous from the standpoint of environmental degradation and pollution. Huge quantity of aerosols and gases is emitted from human 'volcanoes' and vehicles which form 'dust domes' over the cities. These 'dust domes' cause 'pollution domes' over the cities. The urban and industrial growth has resulted into rapid rate of deterioration of the quality of air because of heavy pollution of air through gases and areosols emitted from the vehicles, factories and household appliances.

> Industrial towns and cities often cause poisonous killer urban smog due to trapping of pollutants mainly smoke and sulphur dioxide spewed from the chimneys of the mills by stagnant air during inversion of temperature. Such poisonous smogs occur over only those cities and towns which have factories and mills. The examples of poisonous smogs of Donora, Pennsylvania, U.S.A. (October 26, 1948,43 percent of the population became ill while 20 persons died), of Meuse Valley, Belgium (December 1950, 63 deaths) and of London (1952, 4000 deaths) are sufficient enough to demonstrate the killer effects of urban smogs caused by urban and industrial pollution.Increasing incidence of dense fogs and smogs over the cities causes hurdles in the transport systems.

> Increasing urbanization also modifies the water budgets of surface water as well as groundwater. Increasing urbanization increases the frequency and dimension of floods of nearby streams because the convering of ground surface by pucca structure reduces infiltration of rain water and increases surface run-off. Moreover, the masonary storm drains quickly dispose off surface runoff of nearby streams. Urban centres also modify the local and region radiation and heat balance through the creation of heat island and pollution dome.

> Increasing urbanization increases pressure on groundwater resources for the supply of waer for domestic and industrial uses. Excessive withdrawal of groundwater rsults in the formation of large cavities below he ground surface. The development of such cavities causes the collapse of ground surface and thus inflicts great damage to human health and wealth.

Besides industrial wastes from industrial cities, huge quantity of urban solid wastes also creates environmental problems. It may be pointed out that greater attention is paid towards the production, storage, accumulation, transportaton, treatment and proper disposal of urban wastes in the developed coutnries but the problem of urban wastes in the developing countries is difficult one because (i) no proper attention is paid towards the storage, transportation, treatment and proper disposal of solid wastes, . (ii) the big cities of developing countries have grown out of unplanned old cities and towns and hence there are no facilities like wide road and streets for the operation of modern machines to clear the wastes, (iii) people do not care to stock the wastes at marked places etc. The quantity of urban solid wastes is rapidly increasing with urban expansion and growth in urban population.

4.2.3 WATER POLLUTION

Meaning and Definition

water pollution may be defined as 'alteration in physical, chemical and biological characteristics of water which may cause harmful effects on human and aquatic life.'

Sources of Water Pollutants

The substances which degrade the quality of water from its equilbrium state are called water pollutants which are generated from two basis :

(1) Natural sources of water pollutants, and

(2) Anthropogenic sources of water pollutants.

Types of Water Pollutants

Water pollutants may be divided into certain categories on different bases such as sources of pollutants, physical and chemical properties of water, and the nature of degradation.

(1) On the basis of sources of pollutants

(a) industrial pollutants

examples : industrial waste water, including several chemical pollutants such as chlorides, sulphides, carbonates, ammonical nitrogen, nitrites, nitrates, heavy metals such as mercury, lead, zinc, arsenic, baron etc., organic chemical compounds synthesized for industrial purposes, radioactive wastes etc.

(b) Agrilcultural pollutants

Example : chemical fertilizers, pesticides, insecticides and herbicides, and severalother synthetic chemical compounds, weeds and plant remains.

(c) Urban pollutants

Examples : various types of ions such as sulphate ion, nitrate ion (representing washout of air pollutants emitted from automobiles and other forms of combustion of fossil fuels), chlorine ion, and sodium ion (coming from deicing salts used to melt ice spread over roads and streets in cold countries),calcium ions and bicarbonate ions(from lime and chemical fertilizers used in the lawns and gardens within the cities),sulphate, nitrate and potassium ions, a host of chemical ions contained in urban sewage water, household sewage stored in the septic tanks, phosphate and nitrate ions, wastes of human and animals etc.

(d) Natural pollutants

Example : volcanic dusts, eroded and weathered sediments, debris caused by landslides, decayed and decomposed organic matter (both plants and animals).

(2)On the basis of physical and chemical properties

(a)physical pollutants

Example : colour, taste, turbidity, sediments, volcanic dust, oil and greese, dissolved and Suspended solids, total solids.

(b) chemical pollutants

Example : chlorides, sulphides, carbonates, ammonical nitrogen, nitrates, nitrites pesticides, Insecticides, heribicides, several other synthetic chemical compoundes.

(3) On the basis of degradability

(a) biodegradable pollutants

(b) non-biodegradable pollutants

Those pollutants which are broken down and decomposed by biological means such as decomposers/micro-organisms are called biodegradable or simply **degradable pollutants.** These pollutants are also called as organic pollutants. Nondegradable pollutants are those which cannot be degraded by biological means. Such pollutants are also called as inorganic pollutants. Examples of biodegradable or organic pollutants are leaf litters, sewage, garbages, plants and animal excreta etc. Non-degradable pollutants include all of the chemical pollutants and toxic solid substances.

The water pollution is assessed on the basis of certain parameters e.g. (i) physical, (ii) chemical, and (iii) biological parameters. Physical parameters used to ascertain the quality of water include temperature, colour, odour, turbidity, conductivity, density, suspended, dissolved and total solids while chemical parameters include nature and amount of soluble salt, hardness of water, acidity and alkalinity of water, dissolved oxyengen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), concentration of hydrogen ion (pH), amount of ammonia, nitrate and nitrites, amount of heavy metals, mercury, lead, chromium, chlorides, pesticides, insecticides, detergents,etc. Biologycal parameters are bacteria, coliform MPN, algae, viruses etc. Generally, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved oxygen (DO), and pH value are important indicators of water quality

Types of Water Pollution

Water pollution may be divided on the basis of sources and stroages of water into the following 4 categories :

1) Surface water (river water) pollution,
2) Lake water pollution,
3) Groundwater pollution, and
4) Sea water pollution

Water pollution may also be divided on the basis of sources of water pollution into the following 4 types:

1) Sewage water pollution,

2) Domestic waste water pollution,

3) Industrial waste water pollution, and

4) Solid waste water pollution.

Central Water Control Acts

(A) Before Independence

1. The North India Canal and Drainage Act, 1873
2. The Obstruction of Fairways (navigable channel) Act, 1881
3. The Indian Fisheries Act, 1897

(B) After Independence

4. The Damodar Valley Corporation (Prevention of Pollution of Water) Regulation Act, 1948

5. The River Boards Act, 1956

6. The Merchant (Amendment) Shipping Act, 1970

7. The water (Prevention and Control of Pollution) Act, 1974

8. The Water (Prevention and Contol of Pollution) Cess Act, 1977

9. The Water (Prevention and Control of Pollution) Cess Rules, 1978

10. The Coastal Regulation zone Notification, 1991, puts regulation on various activities, including construction. This notification offers protection to natural buffers, such as backwaters, estuaries, corals, mangroves, beaches and coastal dunes.

The government plans to clean the Ganga and the Yamuna under the Ganga Action Plan (GAP)

and the Yamuna Action Plan (YAP) would be discussed in Chapter 25 of this book.

4.2.4 LAND/SOILS POLLUTION

Here land simply means the surficial parts of lithosphere wherein soil is the most significant aspect of land surface for biological communities. This is why soils are termed as 'biological reservoirs' or 'biological factory'. Land degradation simply means loss of utility of land for plants and animals. Though some natural factors such as climatic changes (e.g. desertification and desert spread, conversion of warm land into cold land-icecovered surfaces etc.) volcanic eruption and lava flow, orogenesis etc. cause land degradation but anthropogenic factors are mostly responsible for land degradation and pollution world over. The following human activities degrade land surfaces :

- mining activities
- massive deforestation,
- overgrazing,
- global warming resulting into desert spread,
- major land use changes,
- heavy canal irrigation,
- construction and building activities,
- discharge of sewage or waste water from industrial and urban areas on to the land used for agricultural purposes,
- irrigation of agricultural fields with polluted water,
- soil pollution etc.

In fact, soil pollution is the major form of land degradation and pollution and hence it requires detailed discussion.

Soils are in fact the very heart of the life layer (the biosphere) because these represent a zone wherein plant nutrients are produced, held, maintained and are available to plants through their roots and to the micro-organisms which live in the soils. Soil is also very important environmental attribute for human society because :

- It is the basic medium for food and timber production.
- It is very exhaustible natural resource because it cannot be replaced if it is destroyed or lost through excessive soil erosion caused by anthropogenic activities and it is the base for the evolution and development of human civilization.
- It provides foundation for buildings and roads.

Sources of Soil Pollution

The sources or agents of soil pollution may be divided into the following 5 categories :

- (1) physical agents/sources,
- (2) biological agents/sources,
- (3) air-born sources,
- (4) biocides and chemical fertilizers, and
- (5) urban and industrial sources.

- **4.2.5 AIR POLLUTION**
- **1. MEANING AND DEFINITION**
- (1) *Air pollution is defined as limited to situation in which the outdoor ambient atmosphere contains materials in concentration, which are harmful to man and his surrounding environment.*
- **2. SOURCES AND TYPES OF AIR POLLUTION**
- Major sources of air pollution are divided into two broad categories :
- (1) **natural sources**
- (e.g. volcanic eruptions, deflation of sands and dusts, forest fires etc.)
- (2) **anthropogenic sources**
- (e.g. industries, urban centers, automobiles, aircrafts, agriculture, power plants etc.)

PREVIOUS YEAR QUESTIONS

JULY-2014,PAPER-II

Sub Unit:-2

1. The main source of carbonmonoxides,as air pollutants, is

(A) Thermal decomposition of fats
(B) Dye-making
(C) Blast furnaces
(D) Gasoline motor exhausts

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1	11	D	4.2.5

J-2016,PAPER-III

2. The clean water act in India was introduced in the year

(1) 1976 (2) 1977

(3) 1978 (4) 1979

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	17	B	4.2.3

PROGRAMMES AND POLICIES ON ENVIRONMENT

SUB UNIT-3

4.3.1 GLOBAL WARMING AND INTERNATIONAL CO-OPERATIONS

The international communities are well aware and are seized of the global environmental and ecological problems and various effeorts have been initiated to control global warming and halt probable climatic changes. There are several organizations, government agencies, intergovernmental agencies, non-government organizations (NGO) which have undertaken various action plans and projects to study the relationships between man and environment, interactions between man and nature, the environmental problems resulting therefrom and remedial measures therefor. It is heartening to note that now international cooperations are forthcoming for the amelioration of the environmental and ecological problems. Efforts are being made to control ozone depletion and greenhouse effects at global level. Several international conferences, seminars, symposia, workshops etc. for the maintenance of environmental quality, ecological balance, ecosystem stability and biodiversity have been attended by different countries, United Nations, voluntary non-government and government organizations and several agreements and declarations have been signed. The following are the important conferences, protocols, agreements and declarations.

- (1979) first World Climate Summit, 1979 in Geneva (Switzerland).
- (1980), Conference on Industrieis and Climate, 1980, in Vienna (Austria).
- (1985), Vienna Convention (Austria), 1985, for the protection and maintenance of ozone layer.
- (1987), Agreement on Montreal Protocol, Montreal, Canada, 1987 (September) for reduction of the production and consumption of ozone depleting chlorofluorocarbons (CFCs) in order to check the depletion of ozone layer. The Montreal Protocol on substances that deplete the ozone signed in September, 1987 at Montreal, Canada, by 35 developed countries of the world was the first concrete step in this regard. This was initiated by United Nations Environment Programme (UNEP). The following provisions were commonly agreed by the countries which signed the protocol.
  - (i) To freeze the production of CFCs at 1986 level by 1989.
  - (ii) To decrease the production of these synthetic chemical compounds by 20 per cent by the end of 1993.
  - (iii) To allow further 30 per cent cut in the production of these chemicals by 1998.
  - (iv) To freeze the production of halons at 1986 level starting from 1992.
  - (v) Thus, the total production of ozone depleting chemicals (mainly CFCs and halons) would be reduced by 50 percent by the beginning of 1999.

5. (1988) Toronto Summit, in Toronto city of Canada, for the reduction in the emission of carbon dioxide. The summit aimed at 20 per cent cut in the emission of carbon dioxide by 2005 AD but the developped countries backed out from the agreement on the pertext of non-availability of reliable data of emission of green house gases.

6. (1988), Constitution of Intergovernmental Panel on Climate Change (IPCC) for the study of climatic changes by United Nations Environment Programme (UNEP) and World Meteorological Organization (WMO) in 1988. This panel was assigned the main task, of presenting report on effects of greenhouse gases on the earth from time to time.

7. (1990), Second World Climate Summit was held in 1990 to search effective measures to check the emission of greenhouse gases and Intergovernmental Agreement Commitee was constituted.

8. (1992). The United Nations Conference on Environment and Development— UNCED, better known as First Earth Summit or Rio Summit, was organized in June, 1992 in Rio De Janeiro city of Brazil which was attended by 178 countries which signed the Climate Change Convention.

9. (1994).The signed climate change convention during ‘first earth summit’ was given practical shape which aimed at reduction in carbon emission and to stabilize the emission at 1990 level by 2000 AD but it could not be implemented in letter and spirit by the allotted time frame.

10. (1995), The first summit of the advocates of Climate Change Convention, better known as Berlin Summit, was held in June 1995 in Berlin city of Germany but no agreement could be arrived at for the fixing of amount of emission of carbon dioxide by different countries.

11. (1996), The second summit of the advocates of the Climate Change Convention was held in Vienna, city of Austria in July 1996 but this summit also proved unsuccessful as no agreement on the amount of emission of carbon dioxide could be struck.

12. (1997), United Nations Second Earth Summit, was organized in New York city of the U.S.A, from June 23 to 27, 1997 and was represented by the representatives of 170 countries and 70 heads of the government.This summit aime datthe evaluation of the implementation of Agenda 21 of the first earth summit organized in Rio De Janeiro in 1992.

13. (1997). The third summit of the advocates of the climate change was held from December 1 to 10,1998, in the Kyoto city of Japan. After prolonged discussion an agreement, known as Kyoto Agreement, to 5.2 per cent cut in the emission of carbon dioxide by the developed countries, was signed.

14. The 10th climate change meet known as Tenth Conference of Parties (CoP-10) of the United Nations Framework Convention on Climate Change (UNFCCC) was held from Dec. 6 to 17, 2004 in Buenos Aires (Argentina) to combat global warming and implement Kyoto Protocol but nothing substantial could be achieved as "political will for concerted global solutions (of global warming and climate change) has seriously waned’ (Down to Earth, Jan 15, 2005, p. 22).

Besides, the Stockholm Conference in 1972 (Sweden), Desertification Conference in 1972 in Nairobi (Kenya), Hague Declaration of March, 1989, Helsinki Declaration of May, 2, 1989 etc. are positive steps towards the maintenance of environmental quality. It may be mentioned that about 158 agreements, delcarations, protocols etc. have been signed upto 1997.

4.3.2 FIRST EARTH SUMMIT (RIO SUMMIT)

United Nations Conference on Environment and Development (UNCED), better known as Earth Summit or Simply Rio Summit was organized from June 3 to 14,1992, in Rio De Janeiro city of Brazil under the aegis of United Nations for the protection of the earth and its environment, maintenance of ecological balance and to enrich bodiversity. The conference was attended by the representatives of 178 developed and developing countries. The primary objectives of the conference were to arrive at commonly acceptable agreements and their implementation to tackle the problems of global warming, depletion of ozone layer and ozone hole, deforestation, biodiversity, weather and climate change, acid rain, sustainable development etc. The following were- five important agenda of the conference : (i) rise in global temperature (global warming), (2) forest protection, (3) biodiversity, (4) agenda 21, and (5) Rio declaration. Only two aspects of global warming and forest conservation of Rio Summit are being discussed here as only these two are directly concerned with global warming and climate change.

4.3.3 SECOND EARTH SUMMIT

The second earth summit was held from June 23 to 27, 1997 in New York city of the U.S.A, in order to evaluate the progress and implementation of proposals and Agenda 21 which were agreed during the First Earth Sumit organized in 1992 in Rio De Janerio city of Brazil. The second earth summit was attended by the representatives of 170 countries with 70 heads of government. This summit is also known as Plus-5 Summit because this summit was organized after 5 years from the first earth summit (Rio Summit) and the programmes and action plans (accepted during Rio Summit) were discussed and reviewed but ultimately no concrete and fruitful results could be achieved because no agreement could be made on any agenda.

4.3.4 KYOTO PROTOCOL

A summit to reduce global warming was held from December 1 to 10, 1997 in Kyoto city of Japan and an agreement to this effect was also signed. This summit was attended by the representatives of 149 countries. This agreement is popularly known as Kyoto Protocol or Kyoto Thermal Treaty. The following are the main items of this historic agreement.

4.3.5 PARIS CLIMATE AGREEMENT, 2015 COP 21, NOV. 30-DECEMBER-12, 2015

The following resolutions were adopted :

- Reaffirm the goal of limiting global temperature increase well below 2°C, while urging efforts to limit the increase to 1.5°C;
- Establish binding commitments by all parties to make "nationally determined contributions" (NDCs), and to pursue domestic measures aimed at achieving them;
- Commit all countries to report regularly on their emissions and "progress made in implementing and achieving "their NDCs, and to undergo international review;
- Commit all countries to submit new NDCs every five years, with the clear expectation that they will "represent a progression" beyond previous ones;
- Reaffirm the binding obligations of developed countries under the UNFCCC to support the efforts of developing countries, while for the first time encouraging voluntary contributions by developing countries too;
- Extend the current goal of mobilizing $100 billion a year in support by 2020 through 2025, with a new, higher goal to be set for the period after 2025;
- Extend a mechanism to address "loss and damage" resulting from climate change, which explicitly will not "involve or provide a basis for any liability or compensation";
- Require parties engaging in international emissions trading to avoid "double counting"; and
- Call for a new mechanism, similar to the Clean Development Mechanism under the Kyoto Protocol, enabling emission reductions in one country to be counted toward another country's NDC." Source: U.N. Climate Change Conference in Paris COP 21, Nov. 30 Dec. 12, 2015 .

4.3.6 Gaia Hypothesis

Gaia hypothesis, later on developed as Gaia theory, postulated by British biologist James Lovelock in early 1970s, after the name of Greek goddes, emphasizes the need to strike a balance between human needs and development on one hand, and the maintenance of environmental quality on the other hand as the hypothesis says that 'human needs must be weighed against maintaining critical natural processes'.

Originally, Lovestock and his associate Lynn Margulis postulated that 'life on earth actively Margulis postulated that 'life on earth actively keeps the surface conditions always favourable for whatever is the contemporary ensemble organisms'. That is 'life on earth, instead of adapting itself to the given climatic conditions as earlier believed, actually modified the conditions to suit its survival and further evolution' (Hindu, July, 2006).

4.3.7 Sustainable Development

Sustainable development denotes material growth of humans and improvement in life style with growing demands of ecological resources and maintenance of environmental quality and ecological balance.

G.H. Harlem (1987) has defined sustainble development as follows :

Sustainable development may be defined as an approach 'to meet the needs and aspirations of the present without compromising the ability to meet those of future.'

W.P. Cunnigham and M.A. Cunnigham (200) have defined sustainable development in the following manner :

'Sustainable development, then, means progress in human well-being that we can extend or prolong over many generations, rather than just a few years. To be truly enduring, the benefits of sustainable development must be available to all humans and not just to a priviledged group;.

The concept of sustainable development probably came in 1970 but it became known to wider section of society with the publication of 'Limit to Growth' by the Club of Rome. Soon the concept of sustainable development was preferred to 'Zero Growth' by general public.

Sustainable development concept is used in a variety of sense as follows :

PREVIOUS YEAR QUESTIONS

JULY-2018,PAPER-II

Sub Unit:-3

1.The U.N. Conference on Environment and Development held in Rio de Janeiro during June 3 - 14, 1992
was chaired by :

(1) George W. Bush (2) Maurice F. Strong
(3) Tony Blair (4) Rachel Carson

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
4.	30	B	4.3.2, 4.3.3

JUN-2014,PAPER-III

1. ‘Montreal Protocol’ is related to
   (A) Global Warming
   (B) Ozone Depletion
   (C) Air Pollution
   (D) Water Pollution

2. The objective of Kyoto Protocol was to reduce green house gas emission by :

   (A) An average of 10 percent below 1995 level by the year 2010
   (B) An average of 8 percent below 1998 level by the year 2012
   (C) An average of 20 percent below1997 level by the year 2009
   (D) An average of 5 percent below 1990 level by the year 2012

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	18	B	4.3.1
2.	19	A	4.3.4, 4.3.5