Environment: The term environment has been derived from the *French* word "*Environ*" which means *surroundings*, in which the organisms live and thus it is the sum of all biotic (living-plants & animals) and abiotic factors (non living - water, air, soil etc) that surround and potentially influence an organism. The definition of environment was given by *Eugine P. Odum in 1971*.

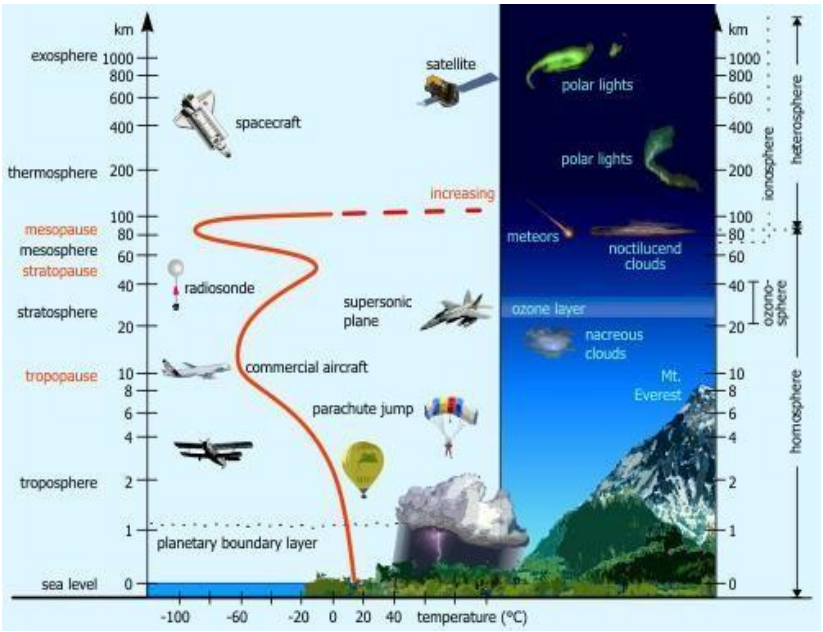
The environment for any living organism has *never been constant or static*. It has always been changing sometimes slowly and sometime rapidly or drastically. These changes in environment may be benefit or harm the living organisms living in it. Those species on earth could not cope up with the changing environment will vanishing.

The knowledge of environment and its various aspects will help in the prevention of exploitation of natural resources, atmospheric pollution and catastrophe (disaster). Importance of Environment Science swept across with United Nations *celebrating 5th June as World Environment day*. *World Earth day* is celebrating on *April 22nd*.

Components of Environment: The environment as a whole includes the *lithosphere, hydrosphere, atmosphere and biosphere*. These environment components have different physical, chemical and biological characteristics and they interact with each other and maintain a dynamic balance for sustainability. Through the natural cycles, the components are continuously transformed into various forms to support life. This balance of the environment is totally disturbed by the increasing human activities that decrease the quantity and quality of its components.

ATMOSPHERE: The earth is enveloped by a gaseous layer called atmosphere. It reaches over 560km from the surface of the earth. It is primarily composed of Nitrogen (78%), oxygen (21%), argon (0.93%), carbon-di-oxide (0.033%) and water vapour (0.04%). The other gases present are neon, helium, krypton, xenon, ozone and ammonia. Life on earth is supported by the atmosphere, solar energy and earth's magnetic field. The atmosphere absorbs the energy from the sun, recycles water and other chemicals and works with electrical and magnetic forces to provide a moderate climate. The atmosphere also protects us from the sun's ultra violet radiations.

Structure of atmosphere



Structure of atmosphere: There are five different layers within the atmosphere which can be distinguished on the basis of temperature and other related phenomena. These are troposphere, stratosphere, mesosphere, thermosphere and the exosphere.

Troposphere: The lowest layer of the atmosphere which lies closest to the earth's surface. It is about 8-10km thick near the Polar regions and about 18-20km thick near the equator. Troposphere is the most important zone for organisms because it is composed mainly of nitrogen, oxygen, argon and carbon dioxide and also it is a turbulent (violent) zone of strong air movement and all the climatic & weather change (cloud formation) takes place in this region. In troposphere, water vapour and dust occurs in extremely variable concentration. The concentration of water vapour in the troposphere may ranges from 0 to more than 4% and its abundance depends upon altitude and temperature. This layer shows gradual decrease in temperature with height at the rate of about 6.5^0 C per km and may decreases upto 60^0 C in the upper levels of troposphere. The upper layer of the troposphere which gradually merges with the stratosphere is called *tropopause*.

Stratosphere: The stratosphere is found above the tropopause and extends upto a height of 50km above the surface of the earth. This zone of atmosphere has no clouds and dust. The only cloud found in the stratosphere is very thin and wispy (fine), made up of tiny ice crystals. Many jet aircrafts fly in the stratosphere because it is very stable. In this region the temperature increases from a minimum of about -60^0 C to a maximum of about 5^0C. The increase is due to the presence of Ozone which absorbs ultra-violet radiation of sun. Ozone acts as a protective shield for life and earth from injurious effects of the sun's ultraviolet rays. The ozone layer is mainly found in the lower portion of the stratosphere, from approximately 20 to 30 km above the earth's surface. The principal chemical species in the stratosphere are N_2, O_2, O_3 and some water vapour and these are chemically active because of their interaction with ultraviolet solar radiation. The uppermost level of stratosphere is called stratopause.

Mesosphere: The mesosphere lies above the stratopause, which extends upto a height of 80km above the earth surface and is the coldest region of the atmosphere. In this layer, once again, temperature starts decreasing with the increase in altitude and reaches upto -100^0 C at the height of 80km. That's the reason mesosphere is the coldest region in the atmosphere. The principal chemical species in the mesosphere are N_2, O_2 and NO. The upper limit of mesosphere is called mesopause.

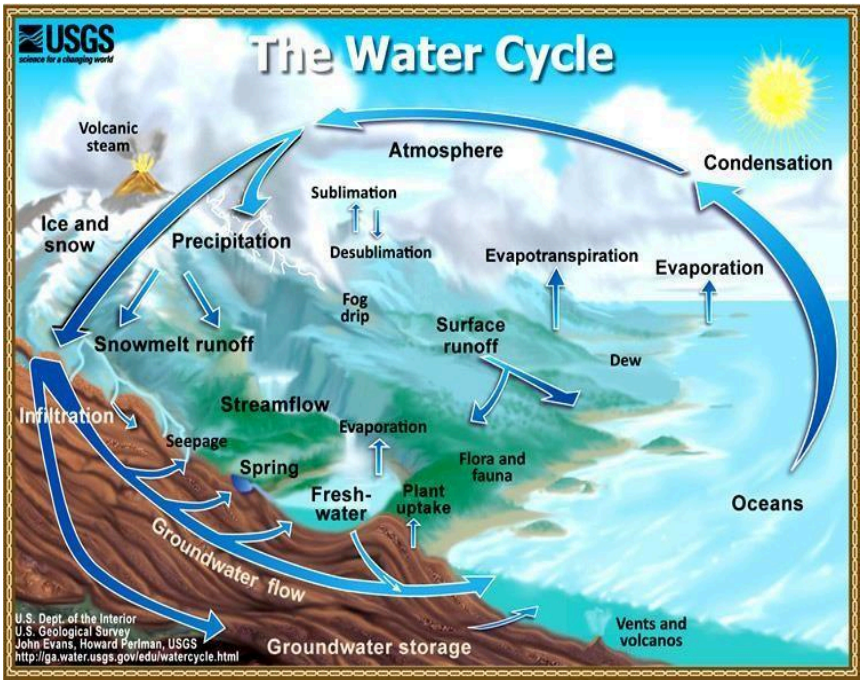
Thermosphere: Above the mesopause is the thermosphere which extends upto 500km above the earth surface and is characterized by steady temperature increase with height from the mesopause. The thermosphere is a layer with auroras (natural light display in the sky, predominantly seen in the high latitude (Arctic (***aurora borealis*** (or the **northern lights**) and Antarctic) regions ***aurora australis*** (or the **southern lights**)) and it is also where the space shuttle orbits. In thermosphere, most of the gaseous components such as O_2, O and NO are ionized under the influence of radiant energy and so, contains electrically charged particles (O^+, NO^+ etc.) known as ions, and hence, it is known as ***ionosphere***. These particles reflect radio waves back to the earth surface and enable us to have wireless communications.

Exosphere: The region above the thermosphere is called exosphere which extends upto 32,190 km from the earth and gradually merges with the outer space. Exosphere has very high temperature due to solar radiation.

HYDROSPHERE: The hydrosphere is often called 'water sphere' as it includes all the earth's water that is found in oceans, seas, streams, rivers, glaciers, lakes, reservoirs, polar ice caps, ground water and air. Approximately, oceans cover about 71% of the earth's total area and hold more than 97% of the earth's water supply. Remaining amount of earth's water supply are distributed as follows,

Earth's water supply	*Percentage*
oceans	97.25
Ice caps and glaciers	2.05
Ground water	0.68
Lakes	0.01
Soil moisture	0.005
Atmosphere	0.001
Streams and rivers	0.0001
Biosphere	0.00004

Hydrological cycle: Water occurs in the atmosphere, hydrosphere and lithosphere in three different states as solid, liquid and gas. It is continuously changing from one state to other and also from one sphere to the other. These changes take place all the time due to its continuous movement in the earth. The endless circulation of water between the atmosphere, hydrosphere and lithosphere is called hydrological cycle. The driving force for the circulation is provided by the sun. Thermal energy and gravitation are the two motive forces of hydrological cycle. Heat causes evaporation, the condensation of water vapour and other processes. Terrestrial gravitation is the force that makes the rain drops to fall and river water to flow. These two forces often act together.



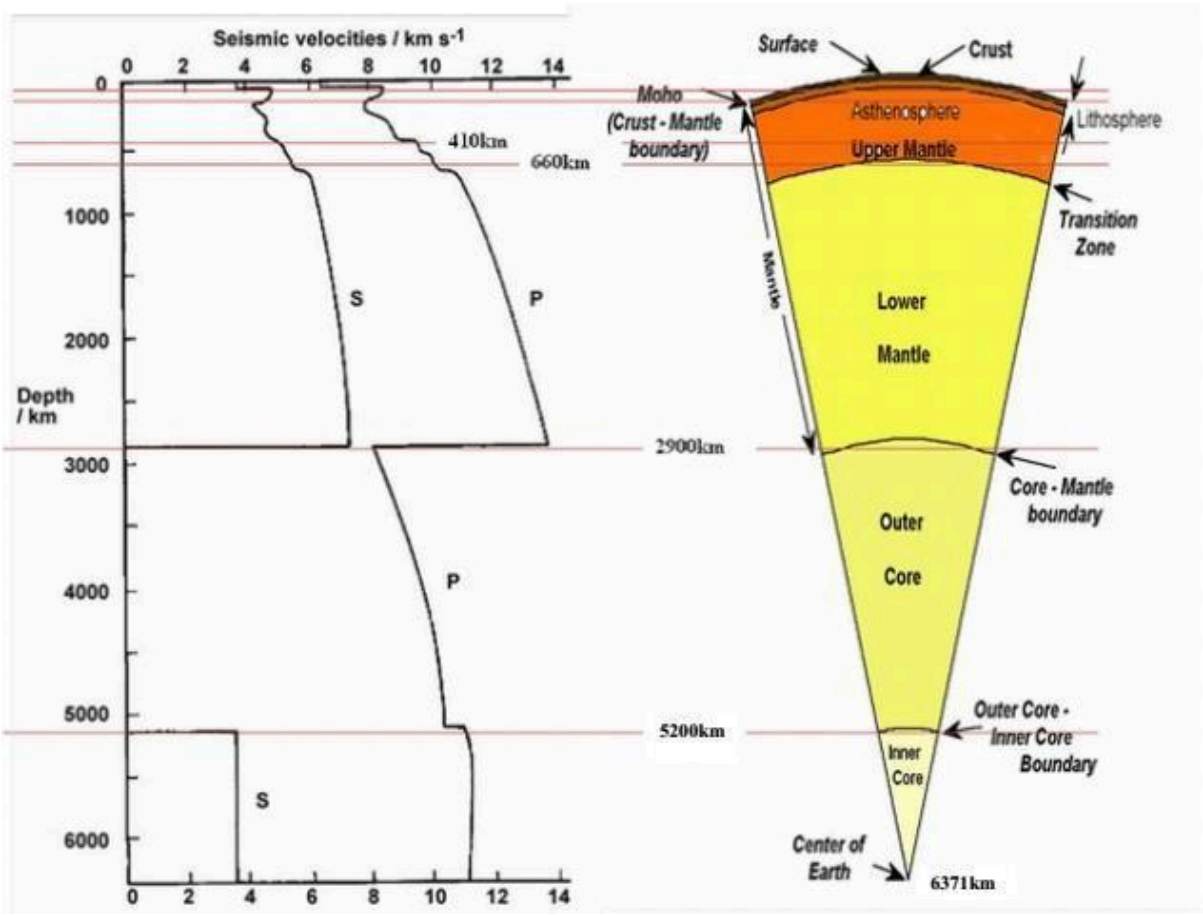
Hydrological cycle has no beginning or end, as water evaporates from ocean or land and becomes a part of the atmosphere. The evaporated moisture is lifted and carried into the atmosphere. Finally it gets precipitated after condensation and comes down as rainfall or snowfall. The precipitated water may be intercepted by the

plants or transpired by plants. A part of the water will infiltrate into the ground. The infiltrating water reaches the groundwater body, and also moves towards the oceans as base flow.

LITHOSPHERE: The outer solid portion of the earth existing above the asthenosphere (partially molten plastic layer) is called the lithosphere. The lithosphere includes the crust and part of the upper mantle. The shape of the earth is spheroid, and it is bulged in the equatorial regions and flattened at the Polar Regions. The earth's radius is about 6,371km. The difference between the equatorial and polar Radius of the earth is 21km.

Internal structure of earth:

Earth is made of three distinct layers namely, Crust, Mantle and Core. Seismological evidences tell us that the Earth has a layered structure. Seismic waves generated by earthquakes travel through the Earth with velocities that depend on the type of wave and the physical properties of the material through which the waves travel. P waves can travel through both solid as well as liquid medium but, the velocity is higher in solid compare to liquid medium. Whereas S waves can travel only through solid medium and its velocity is always lower compare to P waves.



Crust: The thin, outermost, brittle layer of the earth is called crust. It comprises of continental and oceanic crust. The continental crust is about 35km thick and granitic in nature, while the oceanic crust is about 10km thick and basaltic in nature. The boundary surface that separates the earth's crust from the subjacent mantle is known as Mohorovicic discontinuity.

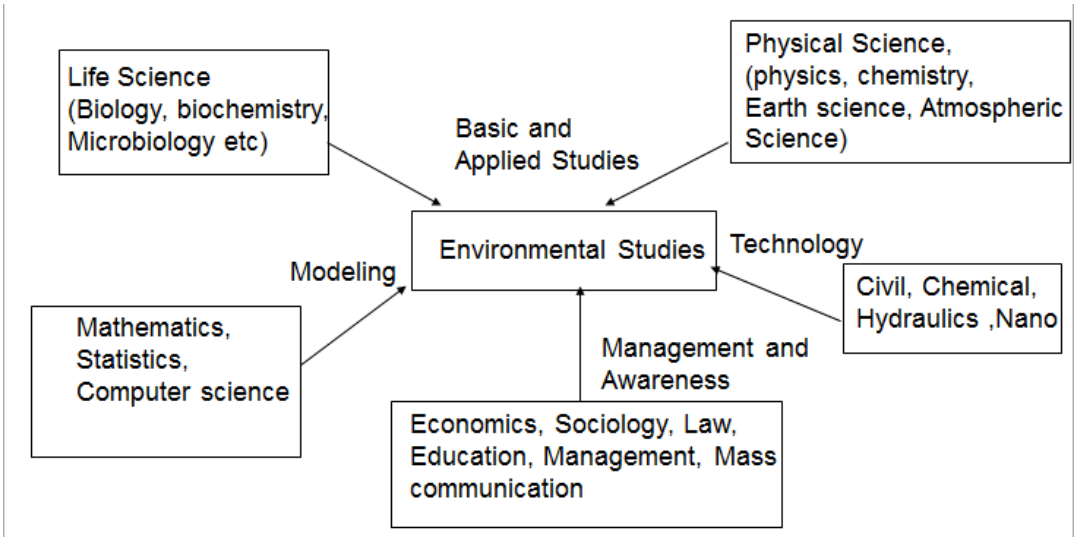
Mantle: Mantle is located beneath the earth's crust and extends upto 2900km. It has been divided into two layers namely, upper mantle and lower mantle. The boundary between these two layers is at about 700km depth. The average composition of the upper mantle is peridotitic in nature. This zone provides lave for volcanic eruptions. At a depth of 100-350km, a partially molten plastic layer is located, is called asthenosphere, over which the plates of the lithosphere slide. The entire mantle constitutes about 84% of the earth by volume. The boundary surface that separates the lower mantle from the subjacent outer core is known as Weichert-Gutenberg discontinuity lies at a depth of 2900km.

Core: Core is located beneath the lower mantle at a depth of 2900km. It is divided into two distinct layers namely, outer core and inner core. The outer core is liquid in nature and extends upto 5200km. The inner core extends from about 5200km to the earth's centre i.e. 6371km. The inner core is solid in nature. Both the inner and outer core are believed to be consists of iron and nickel. The Ingleman discontinuity separates the outer core from the inner core at a depth of 5200km.

BIOSPHERE: The biosphere is the thin shell of organic matter on the surface of earth comprising of all living organisms, including man. Life evolved on earth during its early history between 4.5 and 3.8 billion years ago and the biosphere readily distinguishes our planet from all others in the solar system. The chemical reactions of life (e.g. photosynthesis, respiration, carbonate precipitation, etc.) have also imparted a strong signal on the chemical composition of the atmosphere, transforming the atmosphere from the reducing conditions to an oxidizing environment with free oxygen. The biosphere is responsible for the grand scale recycling of matter on earth. The life sustaining resources (air, water and food) are withdrawn from the biosphere and cycled through the biosphere only. The waste products in gaseous, liquid and solid forms too are discharged into the biosphere.

ENVIRONMENTAL SCIENCE:

Environmental science deals with the study of chemical species existing in various segments of the environment, their sources, pathways, reactions and their consequences on the activities of human beings and other living organisms. It is multidisciplinary in nature involving physics, chemistry, earth science, ecology, climatology, engineering, psychology, law and economics etc. The multidisciplinary nature of environmental science is illustrated in following diagram



Scope and importance:

- Environmental science gives a valid, generalizable knowledge about the environment and impact of human activities on environment.
- It gives best ideas and solution to deal environmental problems successfully through proper environmental management strategies, policies and applications of advanced scientific technologies i.e. application of Geographic Information System and remote sensing, environmental modeling, environmental impact assessment and ecofriendly technologies.
- Environmental science integrates the natural sciences, social sciences and humanities with environmental ethics, environmental law, environmental economics and environmental planning.
- It also gives knowledge for the persons involved in resource planning and management.
- All the nations of the world are undertaking any developmental activities keeping in mind its environmental impact.
- Sustainable development can be achieved through acquiring knowledge on environmental science
- Environmental science covers the man's relationship with the natural as well as social and non-living environment.
- The knowledge of environment and its various aspects will help in the prevention of exploitation of natural resources, atmospheric pollution and catastrophe.
- Environmental science had a wide application in the field of research and development (include research & development of pollution control technology, clean fuel development, sustainable agricultural practice etc.), green advocacy (increase emphasis on implementation of various acts and laws related to pollution, wildlife, forest conservation and protection) and green marketing (more emphasis on consumer good which are more eco-friendly, food products without contamination of pesticides, insecticides, Increase use of products with ECO marks).
- Environmental science have become more significant for the following reasons

  Environmental issues being of international importance: Environmental issues such as global warming, ozone layer depletion, biodiversity loss, marine pollution etc., have global implication.

  Problems cropped in the wake of development: Rapid development in the selected area leads to Urbanization, Industrial Growth, Transportation Systems, Agriculture and Housing etc which in turn leads to environmental pollution

  Rapid increase in pollution: Rapid growth of human population resulted in tremendous increase in the demand of resources such as food resources, energy resources ultimately leading to the environmental degradation.
- Importance of environmental science swept across with United Nations celebrating world's environment day on June 5th.

ECOSYSTEM: The living organisms of a habitat (*physical and chemical factors of the place where the organisms live*) and their surrounding environment, which interacts with each other and function together as a single natural unit is called as an ecosystem. The ecosystem is an open system. It receives energy from an outside source (the sun), as an input, fixes and utilities the energy and ultimately dissipates the heat into space as output. The term ecosystem was proposed by a British ecologist A.G. Tansley in the year 1953.

Ecosystems are classified into two major categories as aquatic and terrestrial.
Aquatic: *Freshwater ecosystem* - Pond ecosystem, Lake Ecosystem and river ecosystem
Marine water ecosystem - Ocean ecosystem
and E*stuarine ecosystem* - *Estuarine*
Terrestrial: Forest ecosystem, grassland ecosystem, desert ecosystem etc.

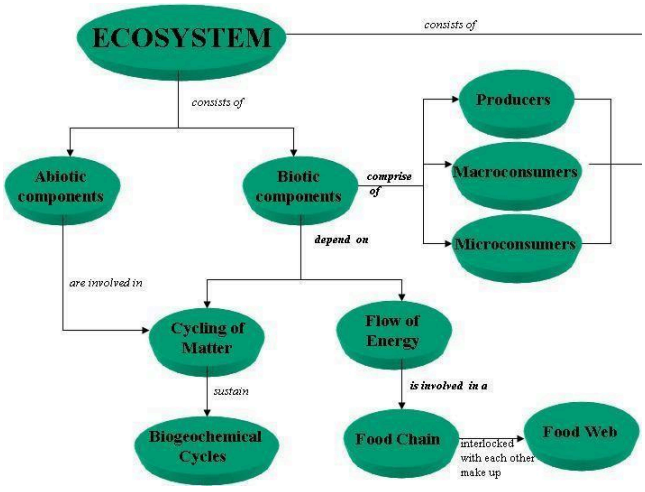
Components or structure of ecosystem: The components of ecosystem are classified into biotic components and abiotic components.

Biotic components: Biotic components include all living organisms and their products. Thus, this group includes all animals, plants, bacteria, fungi and their waste products like fallen leaves, branches, faeces and urine. Biotic components are classified into four categories as producers, consumers, transformers and decomposers.

Producers: The producers are the autotrophic (auto= self, troph=nourishing) organisms. They are capable of synthesizing food from non-living inorganic compounds. They include green plants and certain photosynthetic or chemosynthetic bacteria. They possess a green pigment called chlorophyll. The chlorophyll pigment transducts solar energy. Such autotrophs are called as photo-autotrophs (eg. plants). There is another group which uses energy generated by an oxidation-reduction process. They are called as chemoautotrophs (eg: Micro organisms and sulphur bacteria).

The producers are called energy transducer because they convert the solar energy into chemical energy, with the help of organic and inorganic substances like

Organic substances: - Protein, carbohydrates, lipids, humic substances etc.
Inorganic substances: - water, carbon-di-oxide etc.



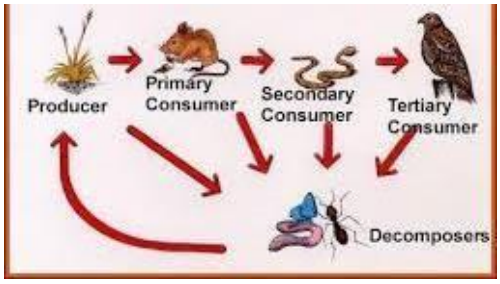
Consumers: Consumers consume the food materials prepared by the producers (autotrophs). So, consumers are heterotrophic organisms. Animals belong to this category. Depending upon the food habits, consumers are of a few types like

Primary consumers: An organism that feed upon the producers is called primary consumers or Herbivores (plant eaters). Eg. Elephant, cattle, horse etc.

Secondary consumer: Secondary consumers are those which predate on primary consumers. Carnivores (flesh eaters): Eg. Tiger, lion etc. Omnivores (Biophages) – Eat plant and flesh.

Tertiary consumers: Tertiary consumers are the predators of predators. They are mostly larger animals.

Decomposers: They are also called microconsumers. They depend on dead organic matter for their food. They are chiefly micro organisms like bacteria and fungi. They break the complex organic matter found in plant and animal bodies, and release simple substances. These substances will be used by autotrophs once again. Thus decomposers are the '*recyclers of the biosphere'*. Some invertebrate animals like protozoa and earthworms use dead organic matter for their food. They are called as secondary decomposers.



Abiotic components: The abiotic components are the non-living components of the ecosystem. They include air, water, soil and the basic elements and components of the environment. They are of three categories.

1. *Climatic and physical factors*: Light, rainfall, wind, soil, temperature, pressure, humidity, evaporation, geomorphic condition etc.
2. Inorganic substances: water, oxygen, carbon, nitrogen, sulphur, phosphorous etc.
3. Organic substances: Proteins, carbohydrates, lipids, humic substances etc.

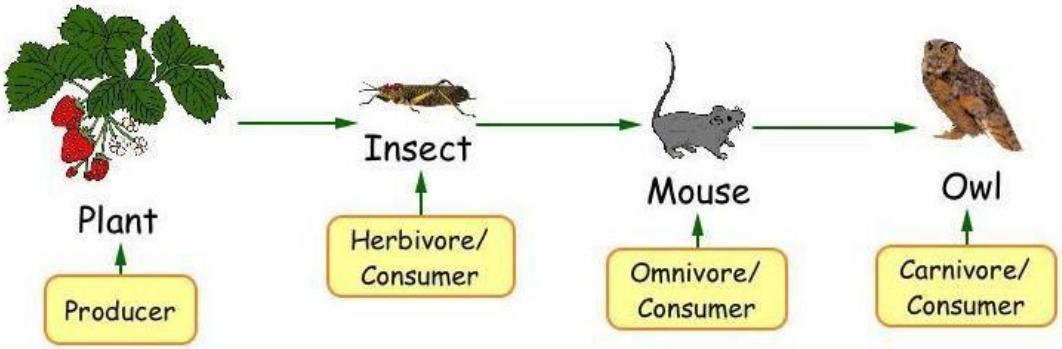
The inorganic substances (nitrates, carbonates, phosphates etc.) occur either freely or in the form of compounds dissolved in water and soil. Some of them are recycled by microorganisms on the dead bodies of plants and animals.

Balanced ecosystem: The stable ecosystem represents a dynamic balance among numerous factors of biotic potential and environmental resistance. Altering any one factor will after the balance and may put the system into a state of change. The factors responsible for balanced ecosystem are

a. Balance between predators and prey,
b. Balance between vegetation, herbivores and carnivores,
c. Balance between competing species and balanced with biotic factors.

Food chain: Food chain is a chain of organisms of any natural community in which the food energy is transformed by repeated eating and being eaten.

General example: Plants ⟶ Herbivores ⟶ Primary carnivores ⟶ Secondary carnivores.



Each successive level of nourishment as represented by the links of the food chain is known as *trophic level.* The producers of an ecosystem form the first trophic level, the herbivores form the second trophic level and the carnivores form the third trophic level, the carnivores which consume third level carnivores form the fourth trophic level, and so on. All food chain begin at the producer level and all end at the decomposer levels.

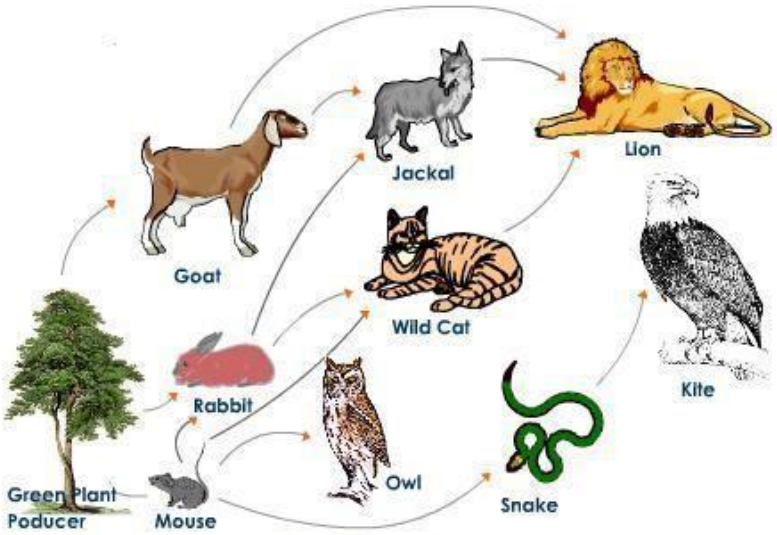
The number of steps (trophic levels) involved in a food chain is limited to 4 or 5. At each step in a food chain, a large portion of the potential energy is lost as heat. This indicates that shorter the food chain, greater will be the available food energy.

Types of food chains:

Food chains are of three types

1. Predator food chain (grazing food chain): Starts from a plant base and goes from smaller to larger animals.
   Eg: Grass ⟶ Grasshopper ⟶ Lizard ⟶ Hawk
2. Parasitic food chain: Starts from larger to smaller organisms.
3. Saprophytic food chain (detritus food chain): Starts from dead matter to micro-organisms. These food chains do not directly depend on the autotrophs and solar influx.
   Eg: Dead organic matter ⟶ Detritivores ⟶ $CO_2 + H_2O$

Food web: Food chains are not isolated or discrete sequences. They are interconnected with one another. This interlocking pattern is called as the food web. A food web represents different alternate food chains which are interconnected by a characteristic pattern. It means the complicated pattern of consumption.

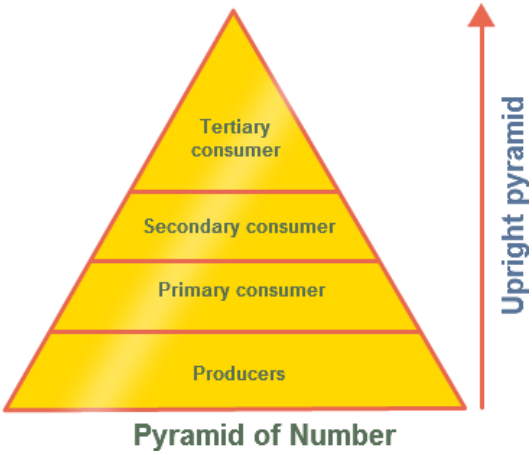


Food Web in a Forest

Ecological pyramids: The biotic components of an ecosystem are producers, consumers, decomposers etc. these are interconnected entities in the functioning of ecosystems. They have definite relationships with reference of their number, biomass, and energy. The animals at the base of a food chain are relatively larger or abundant while those at the end are a few. This relationship can be shown graphically by means of pyramids called as ecological pyramids. Ecological pyramids are of three types.

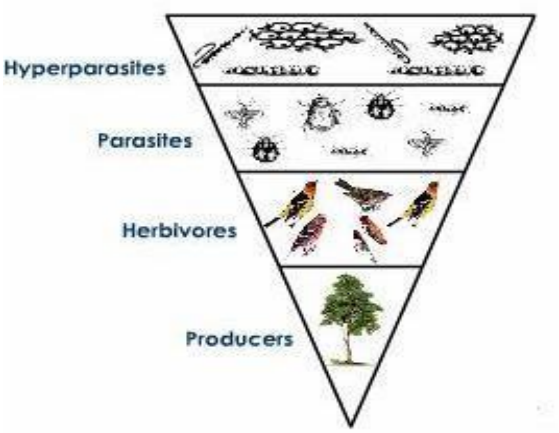
1. **Pyramid of numbers:** The pyramid of number is the graphical representation of the number of individuals in various trophic levels of food chain per unit area at any given time. The shape of the pyramid of number may be upright or inverted.

In grass land ecosystem the number of grasshoppers are usually less than the number of grass, number of frogs less than the number of grasshoppers and finally the number of top carnivores is the least in the series of organisms forming a food chain. In other words the number of organisms gradually shows a decrease in number, making the pyramid upright in shape.



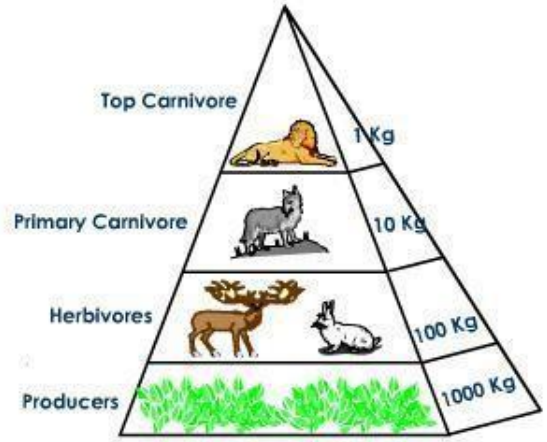
Pyramid of Number

In parasites food chain a single plant may support the growth of many herbivores. In its turn, each herbivore may provide nutrition to several parasites, which support many hyper parasites. In other words the number of organisms gradually shows an increase, making the pyramid inverted in shape.

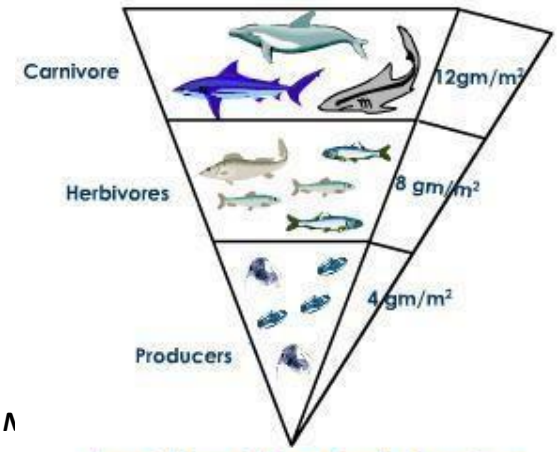


2. **Pyramid of biomass:** The living weight or biomass of the members of the food chain present at any one time form the pyramid of biomass. The shape of the pyramid of biomass may be upright or inverted.

In grassland and forest there is generally a gradual decrease in biomass of organisms at successive levels from the producers to the top carnivores. In this way, the pyramids are upright. However, in a pond the producers are small organisms, their biomass is least, and this value gradually shows an increase towards the apex of the pyramid and the pyramids are made inverted in shape.

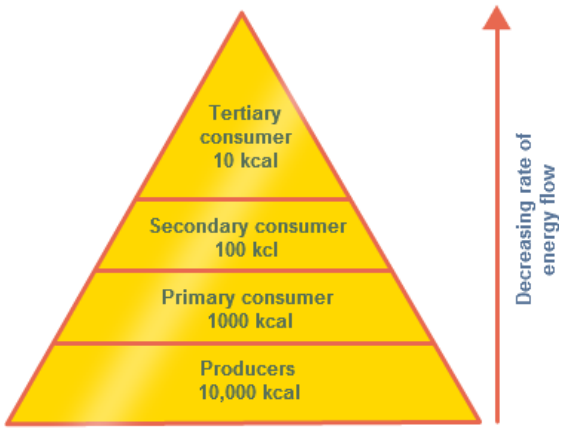


Upright Pyramid of biomass in a Terrestrial Ecosystem



Inverted Pyramid in an Aquatic Ecosystem

3. **Pyramid of energy:** The pyramid of energy represents the total amount of energy utilized by different tropic level organism of an ecosystem in unit area at a given time. The pyramid of energy is always upright in shape.

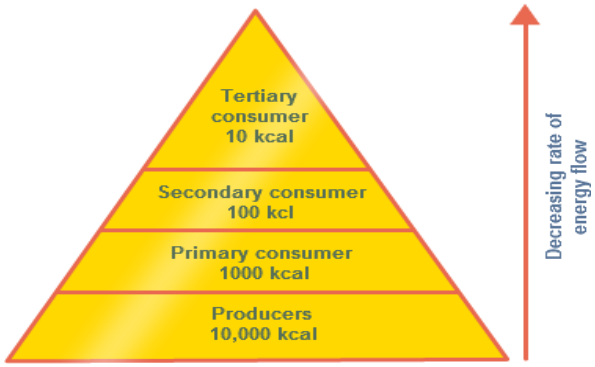


Pyramid of Energy

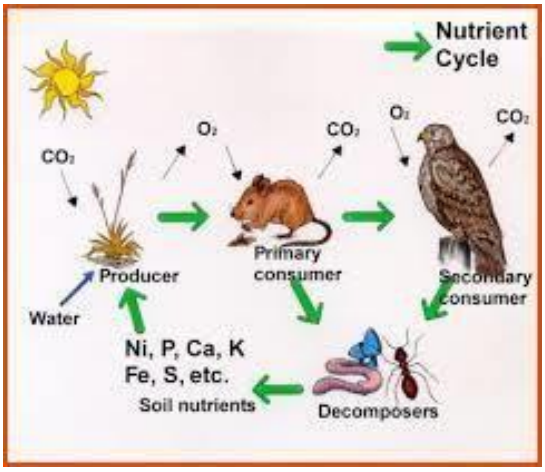
Energy flow in ecosystem: The study of energy transfer b/w different trophic levels in an ecosystem is known as bioenergetics. In an ecosystem the flow of energy is unidirectional and there is a successive reduction in the energy flow at successive trophic levels. The transfer of various forms of energy in an ecosystem is governed by laws of thermodynamics.

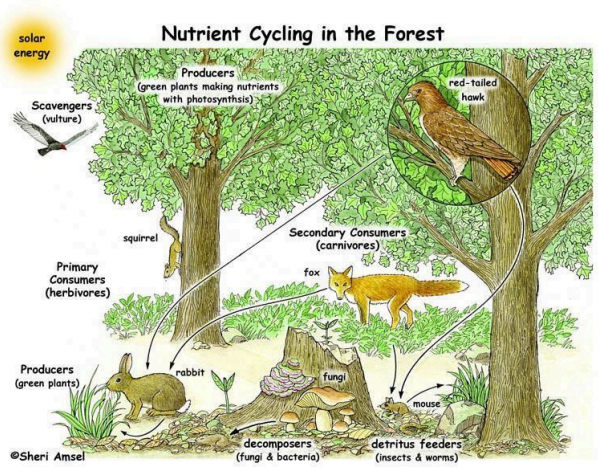
The first law of thermodynamics also known as the law of conservation of energy states that 'energy may be transformed from one form to another but it is never be created nor be destroyed. Thus solar energy/radiant energy falling on the autotrophic plants is transformed into chemical energy by the process of photosynthesis which is stored in plants and then used up during metabolism.

The second law states that when work is done, energy is dissipated and the work is done when one form of energy is dissipated into another form. This means that non-random energy (mechanical, chemical, radiant) cannot be converted into random form (heat energy) without some degradation. This is the reason why during transfer from one trophic level to another some part of energy is lost to the surroundings according to '10% law of energy transfer'. This states that during transfer of energy from one trophic level to another in a food chain 90% of the energy is lost to the surroundings and only 10% is transferred to next trophic level. This 90% is responsible for raising the energy content of the surroundings.



Nutrient cycling: It is the movement of chemical elements from the environment into living organisms and from them back into the environment, as the organisms live, grows, dies and decomposes. Autotrophic plants obtain a number of inorganic nutrients from the environment, which become a component of organic matter. From autotrophs, nutrients go to other living constituents, and again to the environment with the help of decomposers. In this way, nutrients circulate between non-living and living organisms.





BIODIVERSITY:

WHAT IS BIODIVERSITY? – Biodiversity is the variety of plant and animal life in the world or in a particular habitat. Biodiversity is measured by two major components: **species richness**, and **species evenness**.

Species richness: It is the measure of the number of species found in a community.

Species evenness: Species evenness is a measure of the relative abundance of the different species making up the richness of an area.

The sample forest A has 4 tigers, 5 deer and 6 rabbits and sample forest B has 1 tiger, 6 deer and 8 rabbits. Both samples have the same richness (3 species – species richness) and the same total number of individuals (15). However, the sample forest A has more evenness than the sample forest B.

Low evenness indicates that a few species dominate the site.

How Many Species are there on Earth and How Many in India?

According to the IUCN (2004), the total number of plant and animal species described so far is slightly more than 1.5 million, but we have no clear idea of how many species are yet to be discovered and described. Some extreme estimates range from 20 to 50 million, but a more conservative and scientifically sound estimate made by Robert May places the global species diversity at about 7 million.

Although India has only 2.4 per cent of the world's land area, its share of the global species diversity is an impressive 8.1 per cent. That is what makes our country one of the 12 mega diversity countries of the world. Nearly 45,000 species of plants and twice as many of animals have been recorded from India.

Only 22 per cent of the total species have been recorded so far. Applying this proportion to India's diversity figures, we estimate that there are probably more than 1, 00,000 plant species and more than 3, 00, 000 animal species yet to be discovered and described.

- India has 23.39% of its geographical area under forest and tree cover.
- In terms of species richness, India ranks seventh in mammals, ninth in birds and fifth in reptiles.
- In terms of endemism of vertebrate groups, India's position is tenth in birds with 69 species, fifth in reptiles with 156 species and seventh in amphibians with 110 species.
- Endemism is the ecological state of a species being unique to a defined geographic location.
- Keystone species is a species whose addition to or loss from an ecosystem leads to major changes in the occurrence of at least one other species. All top predators (Tiger, Lion, Crocodile, Elephant) are considered as keystone species because they regulate all other animal population indirectly.

Global Biodiversity Gradient Biodiversity is not distributed evenly across the planet:
Biodiversity is not distributed evenly across the planet but shows a rather uneven distribution, certain ecosystems and regions contain far more species than others. Tropical rain forests, coral reefs, the deep sea, and large tropical lakes appear to be the most species rich ecosystems on the planet (WCMC 1992; Heywood 1995; Levin 2001). For most groups of terrestrial plants and animals, species diversity is lowest near the poles and increases toward the tropics, reaching its peak in tropical rain forests. These forests, occupying only 6 percent of the earth's land surface, are believed to contain more than half the species on earth.

Diversity at the level of community and ecosystem exists along 3 levels.

• It could be within-community diversity (alpha diversity),

• Between-communities diversity (beta diversity) or

• Diversity of the habitats over the total landscape or geographical area (gamma diversity).

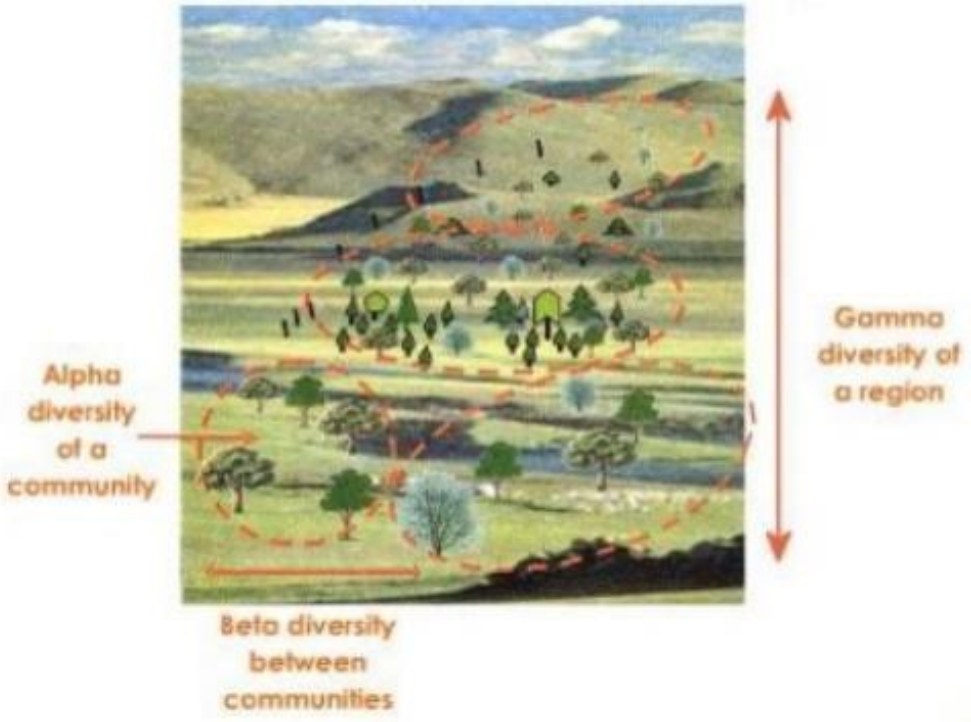
Alpha, Beta, and Gamma Diversity:

Whittaker (1972) described three terms for measuring biodiversity over spatial scales: alpha, beta, and gamma diversity.

• **Alpha Diversity** refers to the diversity within a particular area or ecosystem, and is usually expressed by the number of species (i.e., species richness) in that ecosystem.

• **Beta diversity:** a comparison of diversity between ecosystems, usually measured as the amount of species change between the ecosystems.

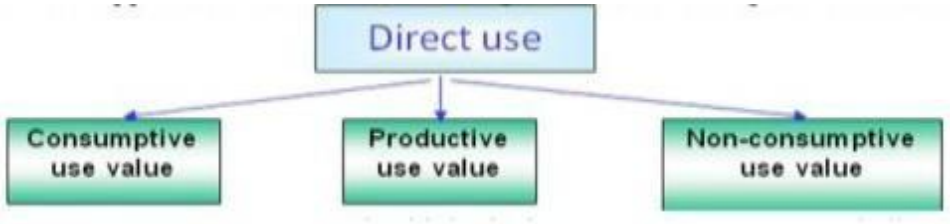
• **Gamma diversity:** a measure of the overall diversity within a large region. Geographic-scale species diversity according to Hunter (2002)



THE VALUES OF BIOLOGICAL DIVERSITY

- Human society depend on biological diversity for almost all the food supply, half of its medicines, much of its clothing and in some region virtually all of its fuel and building material and as well as, of course, an important part of its mental and spiritual welfare.

- Ecological services Biological diversity as a resource. The three main approaches used for determining the value of biological resources.



- Consumptive use value: The biological resources are consumed directly, without passing to the market. Assessing the value of nature's products - such as fire wood, fodder, game meat, etc.

- Productive use value: The resource comes through market or trading. Assessing the value of products that are commercially harvested, such as timber, fish, game meat sold in a market, ivory, and medicinal plants.

- Non-consumptive use value: The resources meant for the future potential uses of biodiversity (tourism, scientific research) and ecological balance. Indirect use - Ecological services

Benefits of biodiversity:

• ***Economical benefits:***

a) Food value – providing food to the human population on this earth for thousands of years. In the process of development of human civilization, man has unfolded many plant and animal life forms which are directly or indirectly helpful for him in solving his food problem. Due to the scientific advancement many new taxa have been discovered which are high yielding.

b) Commercial value –timber which is a major component of material used for providing shelter to man. Natural fibres like cotton and silk are still used for clothing by human population.

c) Medicinal value –Medicines, drugs and pharmaceuticals. Many plant genetic resources are used from derivation of basic drugs. These plant resources vary from actinomycetes and fungi to large trees. Traditional knowledge of indigenous people still keeps an edge over the scientific knowledge in this field. This benefit of biodiversity is still unexplored as the scientists could assess a small fraction of biodiversity for their potential for medicine and agriculture.

d) Aesthetic value – Man has always been fascinated by the natural beauty and nature has inspired him resulting in development of his moral and ethical values. This intrinsic value of plants and animals are independent of their economic and commercial value. Wonderful plants and animals of this planet not only reflect their aesthetic value but they can make us think of the creator. This opens doors for spiritually which envisages to live in harmony with the nature.

Ecological benefits/services (Indirect use value) – Biodiversity supplies the buffering capacity and stability to life on the planet by maintaining the interactive dynamics of the ecosystems of the world.

LOSS/THREATS TO BIODIVERSITY:

Growing human population - specific types of human actions that threatened biodiversity and ecosystems and causes to extinction of many species are:

- Over-hunting/over-exploitation
- Habitat loss/ degradation/fragmentation
- Deforestation
- Invasion of non-native species
- Pollution
- Climate change
- Cultural impacts

Over-exploitation: Humans have always depended on nature for food and shelter, but when ‘need’ turns to ‘greed’, it leads to over-exploitation of natural resources.

Habitat loss/degradation/fragmentation: It is an important cause of known extinctions. As deforestation proceeds in tropical forests, this promises to become the cause of mass extinctions caused by human activity. All species have specific food and habitat needs. The more specific these needs and localized the habitat, the greater the vulnerability of species to loss of habitat to agricultural land, livestock, roads and cities. In the future, the only species that survive are likely to be those whose habitats are highly protected, or whose habitat corresponds to the degraded state associated with human activity.

Alien species invasions: When alien species are introduced unintentionally or deliberately for whatever purpose, some of them turn invasive, and cause decline or extinction of indigenous species. E.g. environmental damage caused and threat posed to our native species by invasive weed species like carrot grass (Parthenium), Lantana and water hyacinth (Eicchornia). The recent illegal introduction of the African catfish Clarias gariepinus for aquaculture purposes is posing a threat to the indigenous catfishes in our rivers.

Pollution: Chemical contaminant certainly poses a further threat to species and ecosystems. While not commonly a cause of extinction, it likely can be for species whose range is extremely small, and threatened by contamination.

Climate changes: A changing global climate threatens species and ecosystems. The distribution of species (biogeography) is largely determined by climate, as is the distribution of ecosystems and plant vegetation zones (biomes) [GCI,11/8]. Climate change may simply shift these distributions but, for a number of reasons, plants and animals may not be able to adjust. The pace of climate change almost certainly will be more rapid than most plants are able to migrate. For these reasons, some species and ecosystems are likely to be eliminated by climate change. Agricultural production likely will show regional variation in gains and losses, depending upon crop and climate.

BIODIVERSITY CONSERVATION

Why Should We Conserve Biodiversity?

There are many reasons, some obvious and others not so obvious, but all equally important. They can be grouped into three categories: ***narrowly utilitarian, broadly utilitarian, and ethical***.

The narrowly utilitarian arguments for conserving biodiversity are obvious; humans derive countless direct economic benefits from nature food (cereals, pulses, fruits), firewood, fibre, construction material, industrial products (tannins, lubricants, dyes, resins, perfumes) and products of medicinal importance. More than 25 per cent of the drugs currently sold in the market worldwide are derived from plants and 25,000 species of plants contribute to the traditional medicines used by native peoples around the world. Nobody knows how many more medicinally useful plants there are in tropical rain forests waiting to be explored. With increasing resources put into ‘bioprospecting’ (exploring molecular, genetic and species-level diversity for products of economic importance), nations endowed with rich biodiversity can expect to reap enormous benefits.

The broadly utilitarian argument says that biodiversity plays a major role in many ecosystem services that nature provides. The fast dwindling Amazon forest is estimated to produce, through photosynthesis, 20 per cent of the total oxygen in the earth’s atmosphere. Can we put an economic value on this service by nature? You can get some idea by finding out how much your neighborhood hospital spends on a cylinder of oxygen. Pollination (without which plants cannot give us fruits or seeds) is another service, ecosystems provide through pollinators layer – bees, bumblebees, birds and bats. What will be the costs of accomplishing pollination without help from natural pollinators? There are other intangible benefits – that we derive from nature–the aesthetic pleasures of walking through thick woods, watching spring flowers in full bloom or waking up to a bulbul’s song in the morning. Can we put a price tag on such things?

The ethical argument for conserving biodiversity relates to what we owe to millions of plant, animal and microbe species with whom we share this planet. Philosophically or spiritually, we need to realize that every species has an intrinsic value, even if it may not be of current or any economic value to us. We have a moral

duty to care for their well-being and pass on our biological legacy in good order to future generations. Biodiversity knows no political boundaries and its conservation is therefore collective responsibilities of all nations.

How do we conserve Biodiversity?

In situ conservation - In India, ecologically unique and biodiversity-rich regions are legally protected as biosphere reserves, national parks and sanctuaries. India has also a history of religious and cultural traditions that emphasized protection of nature eg. Sacred groves.

Ex situ Conservation– In this approach, threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care and protective maintenance. Examples; zoological parks and botanical gardens, in vitro fertilisation, tissue culture propagation and cryopreservation of gametes.

Forests and wildlife Act:

The Forest (Conservation) Act, 1980 This Act was adopted to protect and conserve forests. The Act restricts the powers of the state in respect of de-reservation of forests and use of forestland for non-forest purposes (the term ?non-forest purpose? includes clearing any forestland for cultivation of cash crops, plantation crops, horticulture or any purpose other than re-afforestation).

The Wildlife (Protection) Act, 1972, Amendment 1991 The WPA (Wildlife Protection Act), 1972, provides for protection to listed species of flora and fauna and establishes a network of ecologically-important protected areas. The WPA empowers the central and state governments to declare any area a wildlife sanctuary, national park or closed area. There is a blanket ban on carrying out any industrial activity inside these protected areas. It provides for authorities to administer and implement the Act; regulate the hunting of wild animals; protect specified plants, sanctuaries, national parks and closed areas; restrict trade or commerce in wild animals or animal articles; and miscellaneous matters. The Act prohibits hunting of animals except with permission of authorized officer when an animal has become dangerous to human life or property or so disabled or diseased as to be beyond recovery (WWF-India, 1999). The near-total prohibition on hunting was made more effective by the Amendment Act of 1991.

National Parks Definition: An area dedicated by statute for all time, to conserve the scenery and natural and historical objects of national significance, to conserve wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations, with such modifications a local conditions may demand". (IBWL 1952).

Wildlife Sanctuary Definition: It is an area where killing and capturing of any species of birds or animals is prohibited except under orders of competent authority and whole boundaries and characteristics should be sacrosanct (free from outrage) as far as possible". (IBWL 1952) Aims of establishment of National Parks and Wildlife Sanctuary.

The sanctuaries and national parks (Protected areas) are established with the view to:-

1. Adequate representation of bio-geographic diversity.
2. Proper geographic distributions of PAs across prominent wilderness belts.

3. Setting-up new PAs rationalizing boundaries of existing ones so as to meet the imperative in the above 1 & 2.

4. Overcoming management deficiencies in PAs.

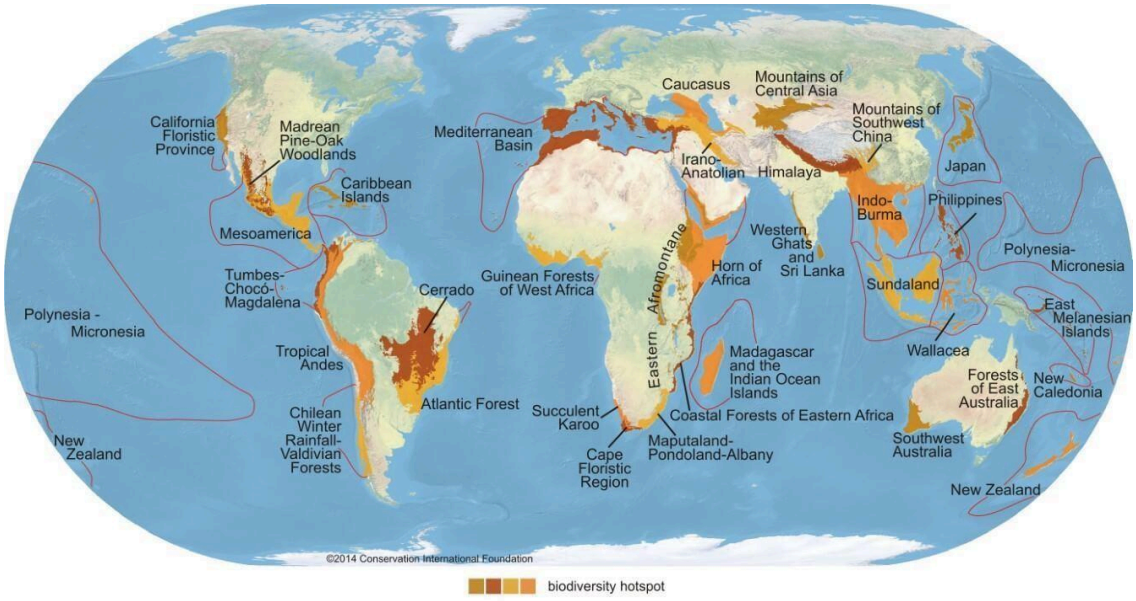
5. Promoting corridor values (conducive to movement of major mammals and long terms, long ranging gene- travel of all species of flora and fauna) through forests and multiple-use areas that lie between PAs in a given wilderness belt.

6. Establishing a monitoring mechanism to access the viability of network of PAs.

Hotspots of Biodiversity:

Biodiversity hotspots are regions with high species richness and a high degree of endemism. The British biologist Norman Myers coined the term "biodiversity hotspot" in 1988 as a biogeographic region characterized both by exceptional levels of plant endemism and by serious levels of habitat loss.

The earth's biodiversity is located in specific ecological regions. There are over a thousand major 'ecoregions" in the world. Of these, 200 are said to be richest, rarest and most distinctive natural areas. These areas are referred to as the 'Global 200'. It has been estimated that 50,000 endemic plants, which comprise 20% of global plant life, probably occur in only 18 'hot spots' in the world. Countries have a relatively large proportion of these biodiversity hotspots are referred as 'mega-diversity nations'.



Conservation International (conservation.org) defines 35 biodiversity hotspots — extraordinary places that harbor vast numbers of plant and animal species found nowhere else. All are heavily threatened by habitat loss and degradation, making their conservation crucial to protecting nature for the benefit of all life on Earth.

Biodiversity hotspots in India:

- Himalaya: Includes the entire Indian Himalayan region (and that falling in Pakistan, Tibet, Nepal, Bhutan, China and Myanmar). The Himalaya Hotspot is home to important populations of numerous large birds and mammals, including vultures, tigers, elephants, rhinos and wild water buffalo.

- Indo-Burma: Includes entire North-eastern India, except Assam and Andaman group of Islands (and Myanmar, Thailand, Vietnam, Laos, Cambodia and southern China). Indo-Burma holds remarkable endemism in freshwater turtle species, most of which are threatened with extinction, due to over-harvesting and extensive habitat loss.

- Western Ghats and Sri Lanka: Includes entire Western Ghats (and Sri Lanka). The forests of the Western Ghats and Sri Lanka have been dramatically impacted by the demands for timber and

agricultural land. The region also houses important populations of Asian Elephants, Indian Tigers, the Lion-tailed Macaque, Niligiri tahr, Indian Giant squirrel, etc.

- Sundalands: Includes Nicobar group of Islands (and Indonesia, Malaysia, Singapore, Brunei, Philippines). The spectacular flora and fauna of the Sundaland Hotspot are succumbing to the explosive growth of industrial forestry in these islands and to the international animal trade that claims tigers, monkeys, etc.

India's biodiversity:

India is exceptionally rich in biodiversity and is one of the twelve mega diversity centres of the world.

With 10 biogeographic zones and 25 biotic provinces, all major ecosystems are represented.

India is a land mass of nearly 33 lakh sq.km with a coastline of 7,616 km and 14 different types of climatic forests and the total forest coverage in India is about 6,50,000 sq.km.

India is the home land of 13,000 species of flowering plants, 20,000 species of fungi, 50,000 species of insects, 65,000 species of fauna including 2000 species of birds, 350 mammals and 420 of reptiles.

It covers nearly 7% of world's flora and 6.5% of world's fauna of which 33 % flora and 62% fauna are endemic.

India has over 30 National parks that constitute about 1% of the landmass and 441 sanctuaries that constitute 3.5% of the area.

India is a home of over 35,000 tigers and the umbrella of project tiger 23 specially demarcated project tiger reserves covering 33,000 sq.km representing different climatic forests are spread across the country.

India has a rich and varied heritage of biodiversity, encompassing a wide spectrum of habitats from tropical rainforests to alpine vegetation and from temperate forests to coastal wetlands.

India figured with two hotspots - the Western Ghats and the Eastern Himalayas - in an identification of 18 biodiversity hotspots carried out in the eighties.

Recently, Norman Myers and a team of scientists have brought out an updated list of 25 hotspots. In the revised classification, the 2 hotspots that extend into India are The Western Ghats/Sri Lanka and the Indo-Burma region (covering the Eastern Himalayas); and they are included amongst the top eight most important hotspots.

In addition, India has 26 recognised endemic centres that are home to nearly a third of all the flowering plants identified and described to date. Of the estimated 5–50 million species of the world's biota, only 1.7 million have been described to date, and the distribution is highly uneven.

About seven per cent of the world's total land area is home to half of the world's species, with the tropics alone accounting for 5 million.

India contributes significantly to this latitudinal biodiversity trend. With a mere 2.4% of the world's area, India accounts for 7.31% of the global faunal total with a faunal species count of 89,451 species.

Some salient features of India's biodiversity have been mentioned below.

- India has two major realms called the Palaearctic and the Indo-Malayan, and three biomass, namely the tropical humid forests, the tropical dry/deciduous forests, and the warm desert/semi-deserts
- India has ten biogeographic regions including the Trans-Himalayan, the Himalayan, the Indian desert, the semi-arid zone(s), the Western Ghats, the Deccan Peninsula, the Gangetic Plain, North-East India, and the islands and coasts.
- As on 2020, there are 911 properties under the World Heritage List, which cover 711 cultural sites, 180 natural sites and 27 mixed properties encompassing 152 countries, including India. India is one of the 12 centres of origin of cultivated plants.
- India's first two sites inscribed on the list at the Seventh Session of the World Heritage held in 1983 were the Agra Fort and the Ajanta Caves. Over the years, 27 more sites have been inscribed, the latest site inscribed in 2012 being the Western Ghats. Of these 29 sites, 23 are cultural sites and the other six are natural sites. A tentative list of further sites/properties submitted by India for recognition includes 33 sites.
- India has 17 biosphere reserves, and 19 Ramsar wetlands. Amongst the protected areas, India has 102 national parks and 490 sanctuaries covering an area of 1.53 lakh sq. km.
- The wildlife sanctuaries in India are home to around two thousand different species of birds, 3500 species of mammals, nearly 30000 different kinds of insects and more than 15000 varieties of plants.

Biosphere Reserves:

Biosphere reserve programme was launched by UNESCO in 1971 under its MAB (Man and Biosphere Programme). Biospheres are sites where protection is granted not only to the flora and fauna of the protected region, but also to the human communities who inhabit these regions, and their ways of life. Biosphere reserves are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Program to promote sustainable development based on local community efforts and sound science. Currently there are 580 sites across 114 countries. The Indian government has established 17 Biosphere Reserves of India. Seven of the seventeen biosphere reserves are a part of the World Network of Biosphere Reserves, based on the UNESCO Man and the Biosphere (MAB) Program list.

Biosphere reserves of India

S.No	Name of Biosphere Reserve	Location
1	Great Rann of Kutch	Gujarat
2	Nokrek	Meghalaya
3	Manas	Assam
4	Gulf of Mannar	Tamil Nadu
5	Sundarban	West Bengal
6	Nandadevi	Uttrakhand
7	Nilgiri	Tamil Nadu, Kerala and Karnataka
8	Dehang Debang	Assam
9	Panchmani	Madhya Pradesh
10	Amarkantak	Madhya Pradesh and Chattisgarh
11	Kanchenjunga	Sikkim
12	Agasthyamalai Biosphere Reserve	Kerala and Tamil Nadu
13	Great Nicobar Biosphere Reserve	Andaman and Nicobar
14	Dibru-Saikhowa	Assam
15	Cold Desert	Himachal Pradesh
16	Seshachalam Hills	Andhra Pradesh
17	Simplipal	Orissa

Some of the policies, which can be taken into account for biodiversity conservation, are:

- Identifying and monitoring the important components of biological diversity that needs to be conserved and used sustainably.
- Establishing protected areas to conserve biological diversity while promoting environmentally sound development around these areas.
- Respecting, preserving and maintaining traditional knowledge of the sustainable use of biological diversity with the involvement of indigenous peoples and local communities.
- Educating people and raising awareness about the importance of biological diversity and the need to conserve it.
- Promoting public participation, particularly when it comes to assessing the environmental impacts of development projects that threaten biological diversity and protecting the biodiversity hot spots from alien species.
- Biodiversity conservation is an important step towards a successful disaster management and if policies are implemented to protect it, then we can get one step closer in making a Disaster Free World.