Ecology and Environment Management

Introduction to Ecology and Environment Science

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Contents:

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INTRODUCTION TO ECOLOGY AND ENVIRONMENT SCIENCE

The field of ecology is as old as the time that has elapsed since the appearance of first life form on earth. Early man before the start of agriculture lived and depended entirely on hunting and gathering food. He was a successful practicing ecologist at that time and utilized his environmental information to hunt for food, trap animals, find edible vegetation and locate shelter to survive hardships such as rains, thunderstorms and lightening imposed by nature. Pre- agricultural man was only *one species* in the biotic community which was neither strongest nor hardiest but it had the distinct advantage of being the most intelligent of all the species that existed even at that time. An increased knowledge of the importance of the environmental conditions led to the evolution of religious rituals, worship of Gods of weather, rain dances and seasonal festivals. Palaeontological evidences from the different parts of the world indicate continuous migrations of some social groups and tribes in search of food and to escape unfavourable temperature or harsh effects of other natural calamities. It was in fact very important for mankind to have an intelligent knowledge of the complex environment and understand "nature" for its survival, failing which its fate would have been will be like that of Dinosaurs which could not stand the natural pressures to survive.

The significance of studying ecology can be understood from the story of sheep ranchers who once thought that their young sheep were robbed by coyotes so they started slaughtering coyotes .This lead to rapid increase in the population of small rodents, rabbit and field mice causing a great destruction of the grasses. Then they stopped killing the coyotes and started poisoning the rodents which were then reduced to a very small number and became insufficient to support coyote populations as a result they started feeding now on young sheep. This shows that if the sheep ranchers had known about **ecological balance** in nature and the importance of every individual animal in the natural food chain they would not have created problem for themselves.

Therefore, to live in harmony with nature and its the environment, the study of ecology and environment science is of utmost importance. *Ecology is the scientific study of the relationship of energy and energy flows in relation to the organism and their survival in the environment*. The *environment* includes both the physical and biological conditions under which an organism lives. *Relationship* is the interactions of one species with the physical conditions as well as with the members of all other species co-existing with it.

Development of ecology:

The term ecology is derived from a Greek word *"Oecologie"* where *" oikos"* meaning 'household" and "*logy"* meaning the "study of". Literally ecology is the study of organisms at home. In other words it is the study of the organisms and their place to live. This term was explained for the first time by a German Biologist Earnst Haeckel in 1869 although, it was given by Reiter in 1868. Charles Elton a modern ecologist defined ecology as the study of animals and plants in relation to their habit and habitat According to him it is a scientific study of natural history. An American plant ecologist Frederick Clement considered ecology to be the science of the community.

It is difficult to trace the beginning of ecology. The roots of ecology lie in natural history which is as old as humans. Outbreak of animal plague led Egyptians and Babylonians to believe in super natural powers controlling the populations. The writings of Aristotle, Hippocrates and other philosophers do indicate about their appreciation, understanding and

knowledge of the subject of ecology. Aristotle wrote in his *Historia Animalium* that when the populations of mice could not be controlled by the natural predators like foxes and ferrets only heavy rains could bring down their population in substantial number.

Graunt (1662) known as father of demography quantitatively studied the natality, mortality, age ratio and sex ratio in human population. Anton van Leeuwanhoek a pioneer microscopist also pioneered the study of "food chains" and critical balance in population regulation. He studied the reproductive rates of several arthropods and calculated that a single pair of carrion flies could produce 746,496 flies with in three months. He was perhaps the first one to calculate theoretical rates of population increase for the animal species. The natural control of human and other populations was also described by Buffon in his book *Natural History* published in 1756. Buffon introduced a term called *environmental induction*, which states that "animals and plants developed adaptations which enabled them to favourably respond to changes in their environmental conditions." He also discussed that the enhanced fertility of every species is checked partly by the diseases and partly by the scarcity of food. He explained this by quoting the example of incidence of plague epidemic and population of field mice which was controlled by these factors and not by the rains as proposed by Aristotle.

In 1798 Malthus a famous demographer stated in his "Essay on Population" the mathematical aspects of population that any population growth is geometrical (1,2,4,8,16 ……..) whereas the food grows at an arithmetical progression rate (1,2,3,4…….) leading to a stress in the human population. Doubleday did not accept Malthus concept of check on population growth by limited resource and proposed his *True Law of Population* in 1841. He stated that whenever survival of a species is threatened, nature makes a corresponding effort to preserve it by increasing fertility of its members. Human populations which were undernourished had the highest fertility, whereas those that were well fed had lowest fertility. High mineral contents of food reduce rate of reproduction. According to him wealthy countries have less populations than the poor ones. Pierre-Francois Verhulst (1838) derived an equation describing a sigmoidal shaped growth curve. This 'S' shaped curve he called as logistic growth curve and is the most popular concept in modern population ecology. Even with all these studies the initial philosophical idea of Plato's time that there is a harmony in nature was still alive as *providential ecology*. The concept that the natural systems are stable and in equilibrium with their environment unless otherwise disturbed by human beings was well known.

Recognition of communities of living organisms in nature is very old but the understanding about the importance of these relationships among these organisms is quite recent. Edward Forbes (1844) described the distribution of animals in British coastal waters and Mediterranean sea. He explained the different life zones at different depths in oceans and each zone exhibiting its own species types. Karl Mobius in 1877 described oyster –bed community and coined a term *biocoenosis* for it. Later in 1877 S. A. Forbes studied lakes and proposed another term as *Microcosm* for it. He described lake as an organic complex with in which any disturbance to just one species influences the entire system. He also believed that there is a steady balance in nature, which holds each species with in natural limits with time, although each species tries to increase its number. H.C. Coweles a plant ecologist described the plant succession on sand dunes for the first time.

Applied sciences like agriculture, fisheries and medicine have also contributed to the development of the subject of ecology. Introduction of predators to control plant pest are in practice for along time. For example mynas bird was introduced from India to the island of Mauritius to control red locust in 1762 (biological controls).

In 1890, interest in *epidemiology(* field of study of epidemics) was created due to the spread of malaria. Pioneering work of Robert Ross describe the mathematical terms for the propagation of malaria and his models are still being used in modern ecology to predict the spread of the disease. The prime need of all life forms is food and the subject of p*roduction ecology* that deals with the study of harvestable yields of plants and animals is known since early eighteenth century. Richard Bradley recognized the fundamental similarities in plant and animal production and proposed a conceptual framework of *monetary investment versus profit which forms* an important component of applied ecology. A road from natural history, pure science to applied science, the study of ecology has blossomed with an increasing understanding of the ecosphere supported by the earth.

Relationship of ecology with other disciplines

Ecology is one of the *basic division* of biology like morphology, physiology, genetics, molecular biology, developmental biology and evolution. A basic division of biology is one which is concerned with the fundamentals common to all life. Biology can also be divided into its taxonomic divisions which deal with the specific kind of organisms. Bacteriology, Botany and Zoology are the broad taxonomic groups. Entomology, protozoology, ornithology and phycology etc are more organism specific divisions. At each taxonomic level, all the various parameters mentioned above can be studied e.g. one studies plant ecology, animal ecology or more specifically bird or insect ecology. Evolution and ecology are inseparable. All organisms are the phenotypic representations of their genotype under a given set of environmental conditions. The present is related to the past (evolution) and the future is related to the present for all forms of life (adaptations). The modern biotechnologist therefore has to understand the all the environmental conditions for rearing, reproducing through cloning or artificial insemination.

Ecology is also very closely and intimately related to the other branches of sciences as well as sociology and economics. The modern ecologists have to be well versed with physics, chemistry and mathematics to understand the various models and equations at population or community levels. A sociologist can only complete his study if he has clearly understood about human population growth patterns and the changes in social conditions around at various places and various times.

Ecology and economics have many things in common. Just as economics deals with household resource management, ecology deals with the economics (management) of resources of nature. The interactions of the organisms with the environment and among themselves are based more on the principles and concepts.

As a pure science, it is concerned with understanding the balance and turnover of matter and energy. *Ecology deals with actions, reactions and co-actions(interactions) as shown in Fig. 1*

Action = Habitat -- Organism

Reaction = Organism –Physical Factors

Co-action =Organism – Organism

INTER AND INTRA-SPECIFIC INTERACTIONS

(Predation, Competition etc.)

NATURAL CALAMITIES

(Tsunamis, Cyclones etc.)

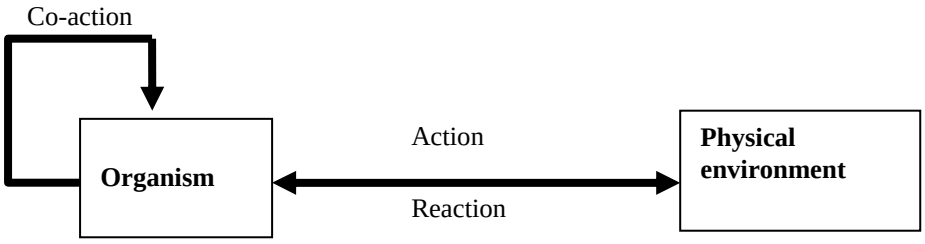


Figure 1: Showing action, reaction and co- action between the environment and organism

To an ecologist, nature means both the physical environment and the living organisms. The physical environment comprises of *lithosphere, hydrosphere* and *atmosphere***.** Physical environments affect the living systems from the moleular level in a cell to the entire Biosphere.

Levels of Organization

Each step of independent interaction between the living and nonliving is called a level of organization.

The interactions between the living and nonliving can be studied at all these levels of organization starting from the molecular level of genes to a biological community and the whole ecosphere.

- *Molecule*
- *Genes*
- *Cell*
- *Organ*
- *Organism*
- *Population*
- *Community*

At each level of organization, there is a direct interaction of the physical system that is matter and energy . The living system and the physical system together make a Biosystem.

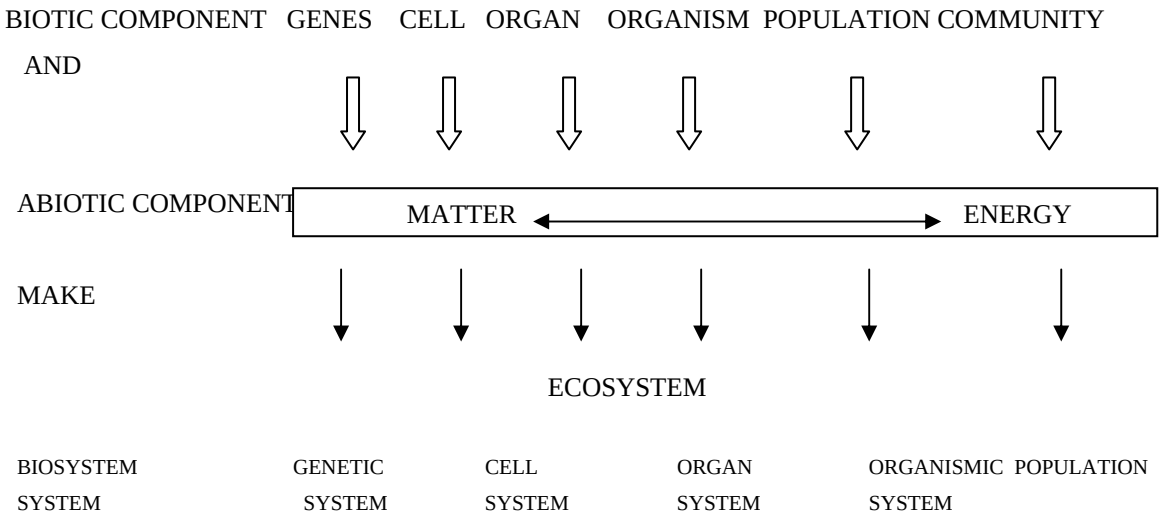


Figure 2: Relationship between abiotic, biotic and biosystem.

As is clear from the above figure that the biotic components at all levels of organization when integrated with the abiotic components constitute a *Biosystem* unit which is functionally independent under a given set of conditions.

In the above hierarchy, a Genetisist studies the genetic system, a Cell Biologist the cell system and an Ecologist the interactions starting from the level of an organism to the ecosystem.

An *organism* is a phenotypic representation of the genotype that is directly influenced by the surrounding environment. All other similar organisms, belonging to the same species, living at one place at any given time make a *population.* A population is a unit for the transfer of energy through an ecosystem. For example all the sunfishes in a pond, white oak trees in a forest or all the people in a country. A population has always a specific place for its living in sizeable number which is known as its habitat. The habitat of sunfish is pond and a lion a forest. *Species* is a very frequently used term in ecology and evolution. *It is defined as a group of organisms which can interbreed and successfully produce offsprings.* These organisms may be separated in space and time into smaller groups called populations. All populations of the different species occupying a particular area at a given time make a *biological community. A biological community along with its nonliving environment of energy and matter is called an ecosystem.* And a*n ecosystem is a functionally independent unit to study in ecology.* It can range in size from a puddle of water to a stream or a patch of wood to entire forest or even the entire ecosphere. Ecosystems can be natural or modified by human activities like croplands, farms, ponds and dam reservoirs. *The entire earth's ecosystems together make up the ecosphere.*

From figure 2, it is clear that the entire spectrum is continuous one right from the genes to the ecosystem because of the interrelations and interdependence for survival at each level. Genes have to be within a cell, a cell in an organ and an organ as an integral component of an individual for it to be a self perpetuating unit. An individual organism can not survive for long duration without its population and a community without the supply of nutrients and flow of energy through the ecosystem. Secondly a continuous horizontal bar also indicates

all the individual levels of organization are equally important. Each level of organization has its own attributes. Some of them become more complex as we move from left to right and some become more simple e.g. a rise in temperature of the surrounding will kill an isolated cell faster than an individual organism or a population. The higher levels are more complex and stable than the lower ones but the knowledge about them is still very limited and we need to explore many more virgin fields in ecology in the interest of longer and better survival of the *Homo sapiens sapiens*

Earth's life –support system

Air, water and land in a definite proportion on the surface of our planet earth constitute the life support systems. They include the atmosphere, hydrosphere and lithosphere respectively of the earth.

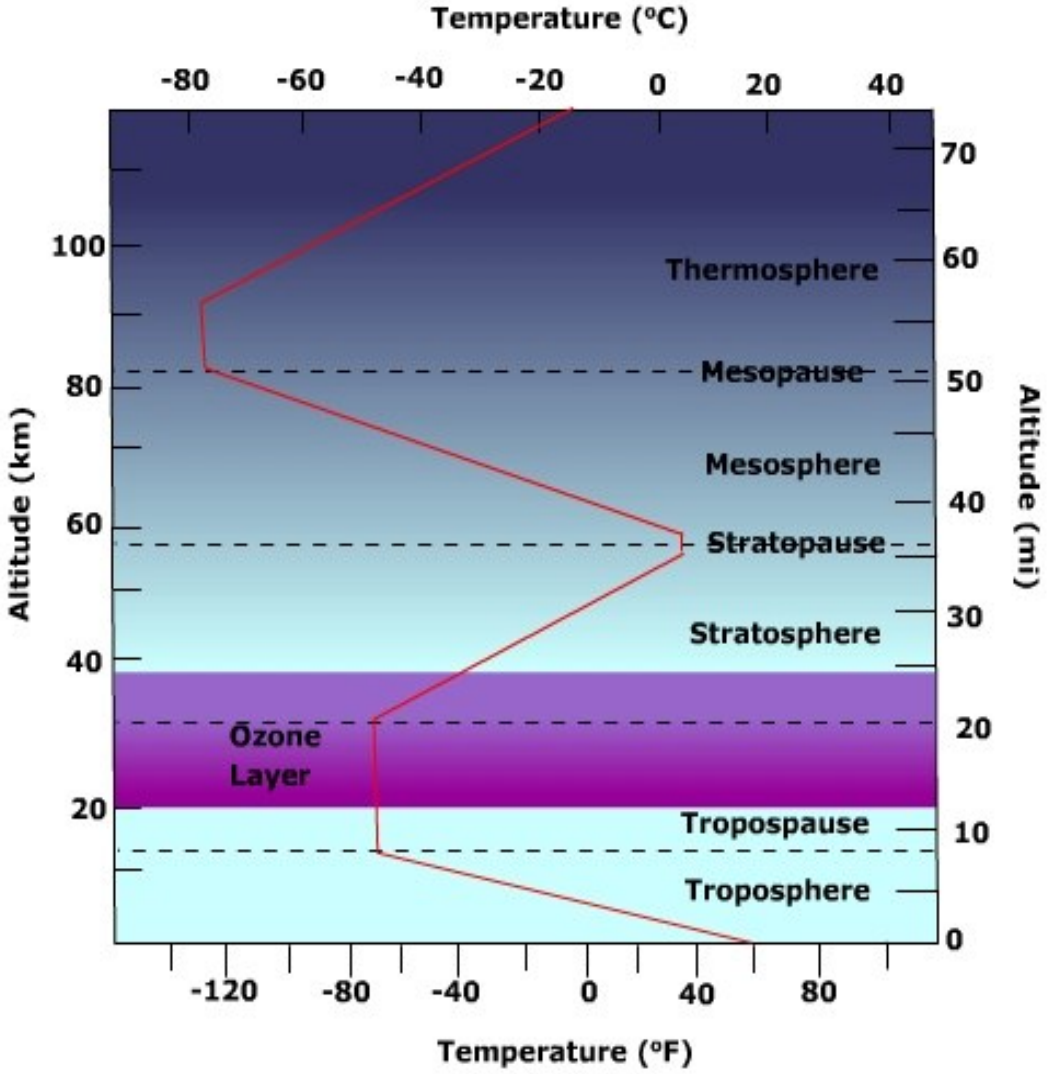
.The atmosphere

It is an insulating blanket of a mixture of gases around the earth supported by its gravitational force. The mixture of gases is called *air*.

Structure of atmosphere

The troposphere which is the inner layer of the atmosphere, extends up to 17 Km. (11 miles) above the mean sea level. This contains most of the planet's air (nearly 80 to 85 %). The composition of tropospheric air is - nitrogen (78%), oxygen (20.94%), carbon dioxide (0.03%), Argon (0.93 %) and many other trace gases. It shows a decrease in temperature with an increase in altitude at a rate of 6.5^{o} C per kilometer. The atmospheric pressure also reduces with an increase in altitude due to reduction in the weight of overlying air. When one climbs up the mountains one can feel this effect. *Tropopause* separates the troposphere from *stratosphere* which is the next higher layer extending from 17 to 48 km. Ozone present in the lower layer of the stratosphere forms distinct *ozonosphere* that protects the earth from the harmful UV radiations of the sun. This absorption of UV radiatons results in an increase in stratospheric temperature. Above the stratosphere is *mesosphere* upto an altitude of 80 to 90 Km. There is a decrease in temperature in this layer of the atmosphere. It burns the meteroids entering the earth's surface by the collision with the gas particles. This causes an increase in the concentration of its iron and other metals in this layer. Mesosphere along with the stratosphere make the middle layer of the atmosphere. Beyond the mesosphere is *thermosphere* which extends upto 500 -600 km above the surface of the earth . The increase in temperature in this layer is due to the absorption of solar radiations. The temperature in it may rise as high as 1727^{0} C. It consists of very little of light gases such as oxygen, helium and hydrogen in their atomic form. **Exosphere** is beyond thermosphere and it merges with

interplanetary gases or space. Exosphere contains mainly helium and hydrogen at very low



density.

Figure 3: The various layers of the atmosphere showing the temperature changes.

***The atmosphere does many other things also to support life on earth*.**

- It is a reservoir of oxygen and carbon dioxide required by animals and plants.
- The heat trap provided by appropriate quantities of atmospheric carbon dioxide and water vapours have created the conditions for greening the earth. On Mars where carbon dioxide is too little in the atmosphere it is completely frozen and Venus where it is too much is like a dry furnace, so no life can exist on both of them.
- It helps in the recycling of water and other nutrients
- Birds and other animals can fly only because of the presence of atmospheric air.
- Sound can not travel without the atmospheric air
- Weathers on earth are due to atmosphere.
- It burns meteoroids that enter into it from the outer space (that would otherwise bombard the surface of the earth) .

- The atmosphere regulates the fluctuations in day and night temperature which would be very high without it.

The hydrosphere

Hydrosphere is a discontinuous shell of water at the surface of the earth. It comprises oceans with their connecting rivers, streams, ground water, water vapours, snow and ice. Oceans covers nearly 71 % of the surface therefore, earth is also sometimes called the **watery planet.** Water is essential to all forms of life and it is believed that life originated in water. The living cells contain a high percentage of water to perform life processes.

The lithosphere

A thin layer of earth's crust and mantle make the **lithosphere**. This is the source of minerals, nutrients and both the renewable and nonrenewable sources of energy. Life exists only within a thin layer on and around the earth called the Biosphere which is comparable to the peel of an orange.

Life sustaining systems on earth

1. *Sun as the source of energy:* Sun's light and heat energy help in photosynthesis by plants and warming of the planet earth. All the living organisms are dependent for their food directly or indirectly on the plants
2. *Unidirectional flow of energy*: Solar energy reaching the surface of the earth enters into all the living systems (food chains) and low quality energy is dispersed into the air or water and eventually back into the space.
3. *Recycling of matter*: Earth is a closed system for the exchange of matter from the space. Therefore, all the nutrients already present on the earth should be recycled again and again for the life to continue perpetually.
4. *Gravity of earth:* This allows the earth to hold the atmosphere and causes the downward movement of chemicals in the mineral cycle. It gives weight to the objects on earth.

Ecological principles

Even though the human civilization has so many revolutions but all other living objects abide by the rules of nature superimposed by the anthropogenic factors. Human beings can make some rules and try to follow them but the nature is very messy and has so many exceptions to all the rules. Therefore, in ecology there are principles with many exceptions and not the rules. According to Robert Leo Smith , the study of ecology primarily concentrates on its unit structure ecosystem and he proposed the principles of ecology. Some of them are as given below:

1. Ecosystem is the major ecological unit. It contains both biotic and abiotic factors through which nutrients are cycled and energy flows.
2. To permit these nutrient cycles and flow of energy the ecosystem must possess a number of interrelated structural components such as soil, water, nutrients, producers, consumers and decomposers.
3. The flow of energy and nutrient cycles are the functional components of the ecosystem.

4. The total amount of energy that flows through the natural ecosystems depends upon the amount fixed by producers (plants). The transfer of energy follows the laws of thermodynamics and as it is passed from one feeding level to another, a portion of it is lost. This limits the number of organisms at each feeding level as well as the total number of feeding levels.
5. The ecosystems change from simple and unstable towards complex and stable with time (Succession). Anthropogenic and natural exploitation (sudden environmental changes) may reduce the rate of change.
6. Populations are the main functional units in the ecosystem.
7. Species diversity is related to the physical environment. More complex ecosystems showing vertical stratification have greater biodiversity than the simple ones. For example a forest is more rich in fauna and flora than a grassland.
8. Moderate and predictable environment holds more number of species than harsh and unpredictable environment.
9. The ecosystems are historical : the present is related to the past and the future is related to present.

Human cultural changes and revolutions:

A brief history of human civilization tells us about the origin of all these factors leading to the habitat destruction and present crises. The planet earth is about 4.6 billion years, and the *Homo sapiens sapiens* have walked the earth for only about 90,000-176,000 years. They were wild nomadic and hunters in search of food for their survival until about 12000 years ago. In the initial stages hunting exploited their environment to a limited extent as the population size was very small. Use of advanced tools and fire to convert forests into grassland caused the extinction of quite a few animals even at that time e.g. saber -toothed tiger, giant sloth, cave bear ,mammoth and giant bison. . Three major cultural changes have occurred in the evolution of the human beings only in the past 12000 years .

i) The first is *agricultural revolution* which began about 10,000 to 12,000 years ago.

ii) The second *is industrial revolution* which is about 300 years old and

iii) Last is *information and globalization revolution* which started about 50 years from now. Agricultural revolution involved a gradual move from nomadic hunting and gathering groups to settled agricultural communities in which people domesticated wild animals and cultivated wild plants. For the sustainable cultivation early grower used the various techniques of **shifting cultivation,** mainly in the tropical forests regions. This practice involved the shifting of the plot of cultivation after it has been used for several years as it was depleted of the nutrients. The abandoned plot was left uncultivated for several years (10 to 30 years) so that the soil became replenished with nutrients and fertile again. As more and more advanced forms of agriculture were introduced along with some leaders (like kings) conquering the resourceful lands, together lead to the environmental degradation in some parts of the world. The next cultural shift began in England in 1700 and spreaded to United States in 1800. There was a rapid expansion in production, trade and distribution of material goods. The use of renewable and nonrenewable resources and production of machine made goods, drastically changed the life style of people. The human life span increased due to better food supply and its population started increasing rapidly. The development of more advanced technologies led to the rapid *information, communication and global r evolution.* This was primarily due to the

development of new technologies such as telephones , radio, television, computers, internet and data bases and remote sensing satellites. Presently we are living in this rapidly changing age. Now the question is, whether these changes are **good** or **bad** for the mankind ? A question which is difficult to answer but very important for the coming generations.

Subdivisions of ecology

According to Smith there are three different approaches to the study of ecology namely**,**

- **system ecology,**
- **theoretical ecology** and
- **evolutionary ecology**.

System ecology is concerned with analysis and understanding of structure and functions of the ecosystem using applied mathematics. It involves the construction of models that represent the real system for the purpose of experimentation. The model should mimic the real system at least over some restricted range.

Theoretical ecology involves modeling of mainly the populations a focusing mainly on areas like predation, competition, niche theory, diversity and stability of a community structure. It utilizes the theories and equations developed in pure mathematics

The evolutionary ecology is concerned primarily with the interactions between the organism and their biological and physical environment as expressed in adaptations. Adaptations through natural selection allow a species to reproduce successfully under the given set of environmental conditions. All the three approaches are interrelated and are essential for the complete understanding of the subject of ecology.

Another approach divides ecology in to two main subdivisions as

- **Autecology** and
- **Synecology.**

Autecology deals with the study of individual organism like life histories , behaviour and adaptations e.g. study of a n individual *Eucalyptus* tree or a bird in relation to its environment including all the parameters of ecological relevance.

Synecology, deals with the study of groups of organisms, which are associated together as a unit e.g. study of a forest in which the *Eucalyptus* tree grows or a field/ grassland in which the birds live and animals graze. A forest is a relatively stable and complete system of interacting biotic community and abiotic environment as its components.

Since all the levels of organizations of the living system are consistently under the influence of abiotic conditions (matter and energy) therefore, no field of biology can be completely separated or studied in isolation from ecology. One way to subdivide ecology is on the basis of various taxonomic groups such as plant ecology, animal ecology, insect ecology and microbial ecology. Some other

Ecologists divide it into the following subdivisions on the basis of habitat, history and distribution patterns.

- **Terrestrial ecology :** Study of all the ecosystems on land**.**
- **Freshwater ecology :** The study of fresh water bodies. Fresh water is the inland water which is continuously recycled. Freshwater ecology includes the study of both running water in streams, rivers and standing water in lakes, ponds, reservoir and swamps.

Forel introduced the term limnology for the study of freshwater life in his monograph on Lake Leman for the first time.

- **Oceanography or marine ecology:** The study of marine ecosystems.
- **Forestry**: The study of forests.
- **Palaeoecology**: It is the study of the past history of the organisms and their environment. It helps to trace evolutionary lines ,origin of various groups and reasons and causes of their extinction if any.
- **Biogeography:** The study of geographiccal distribution of animals and plants.

Environment science: Environment science deals with every thing collectively that affects an organism during its life time("Environner" in French means "encircle"). The word "everything" here means both the living and nonliving things around an organism. The living stands for the social and the cultural conditions that surround an organism or in a community. It is avery heterogenous subject. For example in a natural pond the population of fish will depend upon the location of pond, dissolved nutrients in it, prey and predatory fish and other aquatic life forms present in it. Human beings have a dual role in the study of environment science. Firstly, they are an integral part of natural biosphere. Secondly they have a self created technological, social and cultural world with the primary responsibility to preserve and protect the natural ecosystems not only for his own survival but for the generations that are to follow. This has resulted in the anthropogenic conditions for themselves as well as for all the other forms of life. **Environmental Science** is the application of basic knowledge of energy-matter interactions for the sustainable ecosystems. In other words it can be stated that the ecology is a pure science like physics and the environment science is applied like Engineering. Both the aspects are essential for the well being of man kind and to enjoy the basic human rights as well as even the right to all life forms.

Earlier, there was only one type of environment for all the living object on the earth. Now it can be conveniently divided into two types: natural and anthropogenic environment. The natural environment is self regulating and also called homeostatic environment because natural processes balance the changes and components within it. Anthropogenic environment is modified by human beings and can be called as human modified environment. Increase in the scientific technology and the technological products of human brain , a boon to mankind are also causing deterioration of the environment.

Why do we need to study the environment science

Learning of **e**nvironmental science has become very important for every one in the recent age since every individual is affected by it and as a civilized individual and responsible citizen should be concerned about the protection his environment. As the human beings are moulding their environment for their own benefits they are harming their own species in the long run as well as the other species. If human's ability to transform his surroundings is used wisely it can bring benefits and opportunity to enhance the quality of human life. In the beginning of the twenty first century we must be conscious that we do not do any injustice to the "Mother Earth". We have already ravaged, destroyed and drained it of its vitality to a large extent.

The population of the world is increasing rapidly and so are its needs and greed. Accordingly the demand for natural energy resources for a luxurious and comfortable life style is increasing. India is the second most populous country of the world Therefore, after independence the rate of industrialization and urbanization in our country has increased tremendously to fulfill these demands. Therefore, it is high time for the human beings to

think of a *sustainable environment that meets the needs of the present without compromising the ability of the future generations to meet their own needs.* Integrating environmental conditions into day to day operations is one of the basic principles of maintaining a sustainable environment. We can take several measures to protect our natural environment to maintain the ecological balance and have a sustainable development at the national and global level. Some important environmental issues irrespective of geographical location are:

- **Resource depletion**
- **Pollution**
- **Change in the climate**
- **Global warming**.
- **Ozone depletion**
- **Soil erosion**
- **Human health and disease:**

Social environment (Unemployment and unrest) :

All these issues are interrelated and inter linked to the various anthropogenic activities, which will be dealt with in detail in this book In this book you will be learning the various abiotic factors affecting the organism, population, community and ecosystem**.** The study of ecology is presently contributing a lot to the socio-economic and political issues of the world as it plays an important role in agriculture, range management, forestry, fishery biology, pest control, conservation of soil, forests and water resources. All the global issues of environment such as pollution,climate change and resource management need a detailed knowledge of ecology.

GLOSSARY

S.No.	***Term***
1.	***Ecological balance****:* Maintenance of a state of equilibrium in an ecosystem
2.	***Environmental induction****:* It was given by Buffon in 1756 that animals and plants developed adaptations which enabled them to favourbly respond to their environmental conditions.
3.	***True law of population***,: When ever a species is threatened , nature made a corresponding effort to preserve it by increasing its fertility (Doubleday 1841).
4.	***Providential ecology***: It states the philosophical idea of Plato's time that there is a harmony in nature.
5.	***Monetary investment versus profit:*** Richard Bradleys's conceptual framework in production ecology describing the profits
6.	***Basic division of biology:*** A basic division of biology is one which is concerned with the fundamentals common to all life, such as ecology,

	morphology, physiology etc.
7.	***Levels of organization:*** Each step of independent interaction between the living and nonliving is called a level of organization such as genes, cell, tissue, organ, organism, population, and community.
8.	***Population:*** All the similar organism belonging to the same species, living at one place at any given time make a population**.** A population is a unit for the transfer of energy through an cosystem.
9.	***Species:*** Species is a very frequently used term in ecology and evolution. It is defined as a group of organisms which when brought together can interbreed successfully and produce offspring..
10.	***Biological community:*** All the populations of the different species occupying a particular area at a given time make a **biological community** .
11.	***Ecosystem:*** An ecosystem is a functionally independent unit to study ecology. An ecosystem can range in size from a puddle of water to a stream or a patch of wood to entire forest or even the entire ecosphere. Ecosystems can be natural or man made (artificial), like croplands, farm ponds and reservoirs.
12.	***Atmosphere:*** The atmosphere is an insulating blanket of air around the earth without which the fluctuations in day and night temperature would be very high .It burns up meteors that would otherwise bombard the surface of the earth from the space.
13.	***Lithosphere:*** A thin layer of earth's crust and mantle make the lithosphere. This is the source of nutrients and renewable and nonrenewable sources of energy.
14.	***Hydrosphere:*** The hydrosphere is a discontinuous shell of water on the earth. It comprises oceans with their connecting rivers, streams, ground water, water vapours snow and ice. Oceans cover nearly 71 % of the earths surface and earth is also sometimes called the watery planet.
15.	***Autecology:*** Autecology deals with the study of individual organism like life histories, behaviour and adaptations.
16.	***Synecology:*** Synecology deals with the study of groups of organisms which are associated together as a unit e.g. study of a forest.
17.	***Forestry:*** It is the study of forests **.**
18.	***Palaeoecology:*** It is the study of the past history of the organisms and their environment. It helps to trace evolutionary lines and origin of various groups.
19.	***Biogeography*****:** It is the study of geographical distribution of animals

	and plants
20.	**Ozone:** It is formed by the combination of molecular oxygen with nascent oxygen in the presence of a catalyst (O_2 + O = O_3).
21.	**Sustainable environment:** It is the environment that meets the needs of the present without compromising the ability of the future generations to meet their own. For the sustainable development of a country it is essential to have a sustainable environment.
22.	**Meteors:** Interplanetary space is littered with rocks called meteoroids which may range in size from 1micrometer to 50 meters. When meteoroids strike the Earth's atmosphere, they become visible from the ground as shooting stars or meteors..

Suggested readings:

1. Elements of Eecology By Robert Leo Smith and Thomas M. Smith, Forth edition Pub: Benjamin/Cumming publishing company Inc.
2. Ecology and Field Biology by Robert Leo Smith (Third edition), 1980 Pub: Harper and Row , New York
3. Ecology by G.L. Clarke John, Pub: Wiley and Sons, Inc. (NY,London, Sydney0
4. Fundamentals of Ecology by E.P.Odum Pub: W.B.Saunder's Company Ltd
5. Environmental Science by William.P.Cunningham and Barbara Woodworth Saigo Pub: Mc Graw Hills
6. Comprehensive Environmental Studies by J.P.Sharma Pub: Laxmi Publications(P) Ltd
7. Environmental Science , Towards a Sustainable Future.eighth edtion, 2002, Richard T. Wright and Bernard J Nebel. Pub: Prentice Hall of India Private Limited. New Delhi - 110001
8. Environmental Science by G.J.Miller Jr. Tenth edition, 2004, Pub: Thomson Brooks /Cole.