II B.Tech II Semester - 2021-2022

ENVIRONMENTAL SCIENCE (20MC2201)

Lecture Notes

UNIT-I

FUNDAMENTALS OF ENVIRONMENTAL SCIENCE

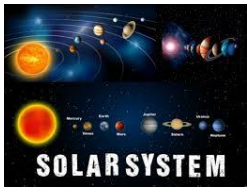
1.INTRODUCTION ON ENVIRONMENT:

The word environment is derived from the French verb environner, which means to "encircle" or "surround." All the biotic and abiotic things surrounding an organism are thus included in environment.

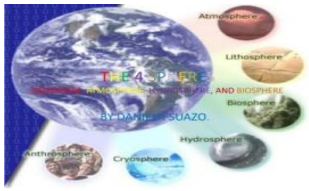
Therefore, our environment can be defined as the physical, chemical and biological world that surrounds us, as well as the complex of social and cultural conditions affecting an individual or community.

It is sum total of water, air and land, inter-relationships among themselves and also with the human beings, other living organisms and property.

Environment (Protection) Act, 1986 clearly indicates that environment includes all the physical and biological surroundings and their interactions.



EARTH



SPHERES ON EARTH

Biodiversity

Pollution on Earth

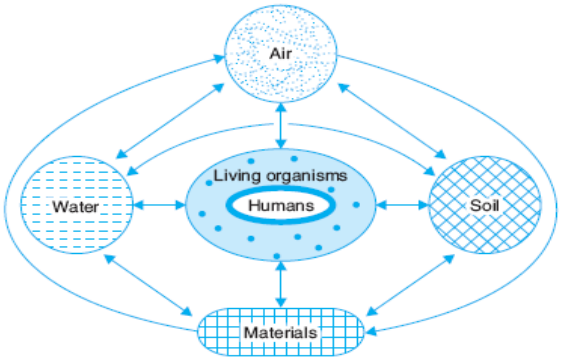


Fig. 1.1 Concept of Environment: air, water, land, living organisms and materials surrounding us and their interactions together constitute environment.

2. DEFINITION OF ENVIRONMENTAL SCIENCE

It is an interdisciplinary science, fundamentals of various subjects like ecology, biochemistry, toxicology, geography, geology, meteorology, sociology, etc. are included under environmental science.

- ✓ Environmental Science refers to an extensive and systematic study about environment as its physical, biological, social, and cultural factors.
- ✓ It also describes characteristics of relationship between man and environment.
- ✓ How far man influences nature or environment and to what extent nature delivers its bounties constitute another objective of environmental science.

3. SCOPE AND IMPORTANCE OF ENVIRONMENTAL SCIENCE

3.1. SCOPE OF ENVIRONMENTAL SCIENCE

The scope of environmental studies is broad based and it encompasses a large number of areas and aspects.

- ➢ Natural Resources—their conservation and management
- ➢ Ecology and biodiversity
- ➢ Environmental pollution and control
- ➢ Social issues in relation to environment and development
- ➢ Human population and environment

These are the basic aspects of Environmental Studies which have a direct relevance to every section of the society. Environmental studies can be highly specialized also which may concentrate on more technical aspects like Environmental Science, Environmental Engineering, Environmental Management, Environmental Biotechnology etc.

Environment belongs to all and is thus important for all. Whatever be the occupation or age of a person, he or she will be affected by environment and will also affect the environment by his or her deeds. Thus, environment is one subject that is actually global in nature.

For example, atmosphere has no boundaries and the pollutants produced at one place can be dispersed and transported to another place. The river water polluted by industrial or municipal discharge at one point would seriously affect the downstream aquatic life.

There are some environmental problems which may be of localized importance but there are some major issues like global warming, depletion of ozone layer, dwindling forests and energy resources, loss of global biodiversity etc. that are going to affect the mankind as a whole and for that we have to think globally.

For dealing with local environmental issues, e.g. the impacts of mining or hydro-electric projects, solid waste management etc. we have to think and act locally. In order to make the people aware about those aspects of environment with which they are so intimately associated, it is very important to make every one environmentally educated.

3.2. IMPORTANCE OF ENVIRONMENTAL SCIENCE:

The environmental science makes us aware about the conservation and protection of our mother earth from destruction of various types of pollution in the environment.
The increase in human and animal population, industries and other issues make the survival clumsy.

A great number of environment issues have grown in size and make the system more complex day by day and threatening the animals and mankind on earth. Therefore environment science has become very important for the following reasons.

3.2.1 Environment Issues are being of Global:

It has been well recognized that environment issues like global warming and ozone depletion, acid rain, marine pollution and biodiversity are not merely national issues but are global issues and hence require international efforts and cooperation to solve them.

3.2.2 Development and Environment:

Development leads to Urbanization, Industrial Growth, Telecommunication and Transportation Systems, Hi-tech Agriculture and Housing etc. Development of the rich countries of the world has undesirable effects on the environment of the entire world.

3.3.3 Explosive Increase in Population

World census reflects that one in every seven persons in this planet lives in India. Evidently with 16 per cent of the world's population and only 2.4 per cent of its land area, there is a heavy pressure on the natural resources including land. Agricultural experts have recognized soil health problems like deficiency of micronutrients and organic matter, soil salinity and damage of soil structure.

3.3.4 Need for an Alternative Solution:

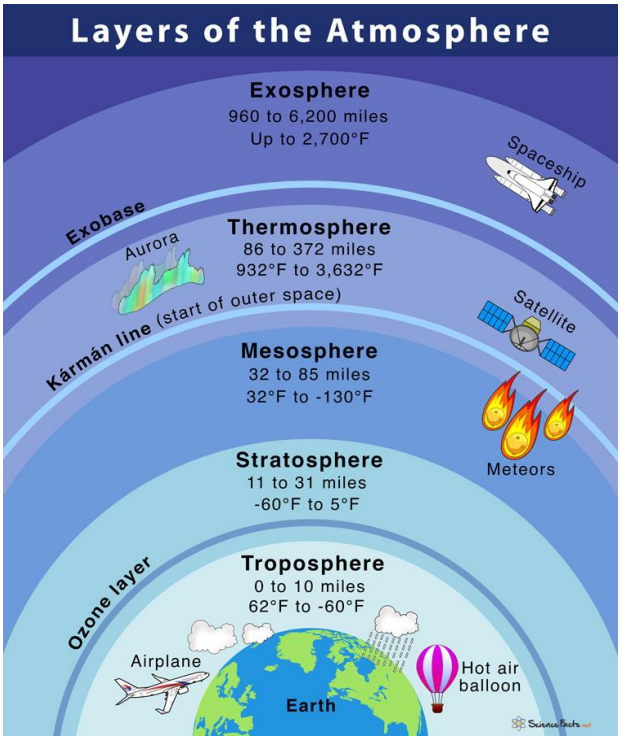
It is essential, especially for developing countries to find alternative paths to an alternative goal. We need a goal as under:
1. A true goal of development with an environmentally sound and sustainable development.
2. A goal common to all citizens of our planet earth.
3. A goal distant from the developing world in the manner it is from the over-consuming wasteful societies of the “developed” world.
It is utmost important for us to save the humanity from extinction because of our activities constricting the environment and depleting the biosphere, in the name of development.

4. COMPONENTS OF ENVIRONMENT

Environment is a combination of physical and biological factors, it contains both living or biotic and non-living or abiotic components. Therefore environment can be divided into physical or abiotic and living or biotic environment.

4.1. PHYSICAL OR ABIOTIC ENVIRONMENT: Physical environment is made up of the following states – gas, liquid, and solid. These three elements signify atmosphere, hydrosphere and lithosphere respectively.

On the basis of spatial distribution, smaller units are termed as coastal environment, plateau environment, mountain environment, lake environment, river environment, maritime environment, etc.



4.1.1 ATMOSPHERE : The layer of gases surrounding earth is called the atmosphere.

The atmosphere of earth is composed of several distinct layers such as troposphere, stratosphere, mesosphere,and ionosphere etc.

A. Troposphere

- It is the lower portion of the atmosphere and extends from 0-18 kms.
- It contains 75% of the atmospheric air mass.
- The temperature of the troposphere changes from 15°C to -56°C.
- The chemical constituents are O_2, CO_2, N_2 water.

Constituents of atmosphere

Constituent	**Percentage**
Nitrogen	78.08
Oxygen	20.95
Argon	0.934
Carbon dioxide	0.0314*
Neon	0.0018
Helium	0.0005
Methane	0.0002*
Trypton	0.00011
Nitrous oxide	0.00005
Hydrogen	0.00005
Xenon	0.000008
Ozone	0.000001*

* Components are highly variable

B.**Stratosphere:**

- It lies above the troposphere and extends from 18-50 kms.
- The temperature of stratosphere changes from -2°C to -56°C.
- The main chemical constituent is ozone.
- Ozone acts as a shield for in the earth's surface.
- It absorbs ultraviolet radiation from the sun.
- This causes a temperature increase in the upper part of the layer.
- The stratosphere exhibits several significant differences from the troposphere. Water vapor is virtually absent.
- The only clouds found in the stratosphere are very thin wispy clouds formed of tiny ice crystals.
- Ozone is present in significant quantities and it forms a well marked ozone layer called ozonosphere within the stratosphere.
- Ozone is formed from oxygen by a photochemical reaction in which energy from the sun splits apart the oxygen molecule to form atomic oxygen.
- The atomic oxygen then combines with molecular oxygen to form ozone.

$$O_2 + \text{Solar energy} \longrightarrow 2O$$
$$O_2 + O \longrightarrow O_3$$

Ozone is in equilibrium with the rest of the air, which means that ozone is being produced from oxygen as fast as it is broken down to molecular oxygen. This is important because ozone absorbs UV radiation from the sun.

In fact, the reason that the stratosphere becomes warmer. With increasing distance from the earth is that the UV energy absorbed by the ozone is transformed into heat. Because of this heat, the ozonosphere also acts like a blanket that reduces the cooling rate of earth and thus adds to the effect of water vapour.

C.Mesosphere:

- It lies above the stratosphere and extends from 50-85 kms.
- It is characterized by cold temperatures about -95°C and very low atmospheric pressure(0.01 millibars).
- The main chemical constituents of mesosphere are N_2, O_2, O_2^+, NO^+.

D.Thermosphere: The thermosphere lies between the exosphere and the mesosphere. *"Thermo"* means *heat*, and the temperature in this layer can reach up to 4,500 degrees Fahrenheit. If you were to hang out in the thermosphere, though, you would be very cold because there aren't enough gas molecules to transfer the heat to you. This also means there aren't enough molecules for sound waves to travel through.

This layer of Earth's atmosphere is about 319 miles (513 kilometers) thick. That's much thicker than the inner layers of the atmosphere, but not nearly as thick as the exosphere. The thermosphere is home to the International Space Station as it orbits Earth. This is also where you'll find low Earth orbit satellites. There's a lot going on in the thermosphere.

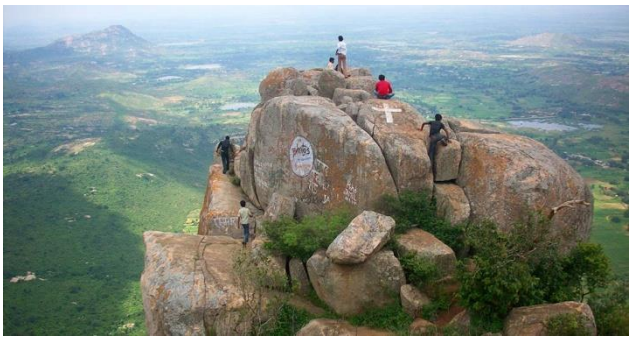
E. Exosphere: The exosphere is the outermost layer of our atmosphere. *"Exo"* means *outside* and is the same prefix used to describe insects like grasshoppers that have a hard shell or "exoskeleton" on the outside of their body.

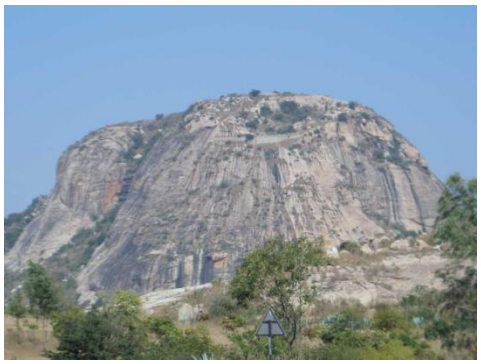
The exosphere is the very edge of our atmosphere. This layer separates the rest of the atmosphere from outer space. It's about 6,200 miles (10,000 kilometers) thick. That's almost as wide as Earth itself. The exosphere is really, really big. That means that to get to outer space, you have to be really far from Earth.

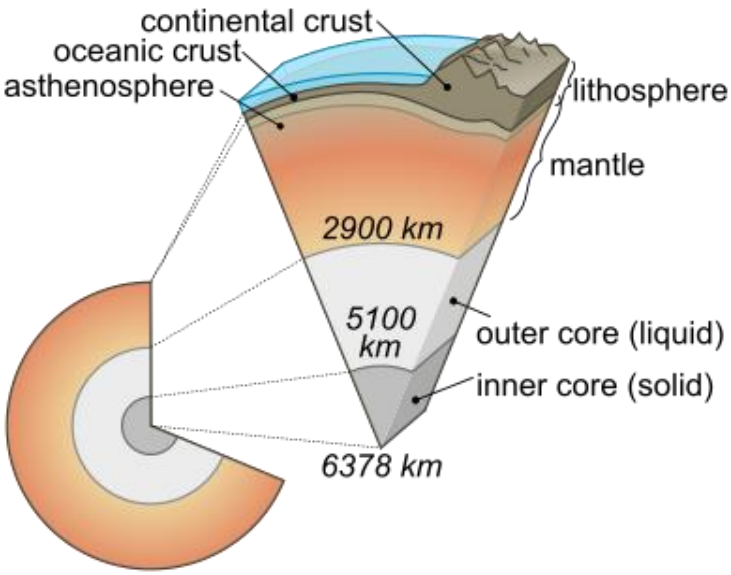
The exosphere has gases like hydrogen and helium, but they are very spread out. There is a lot of empty space in between. There is no air to breathe, and it's very cold.

4.1.2. LITHOSPHERE: Earth's lithosphere, which constitutes the hard and rigid outer vertical layer of the earth, includes the crust and the uppermost mantle.

- The lithosphere includes the solid part of earth's crust.
- It has two parts, the crust and upper mantle.
- The crust includes rocks, minerals, and soil.
- Directly below the crust is called mantle.

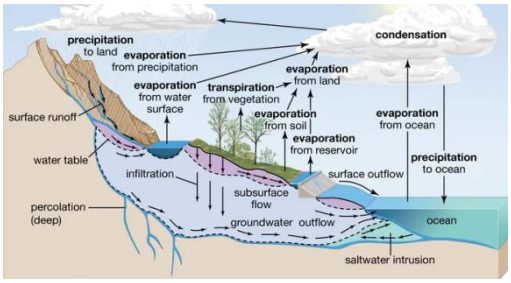






EARTH STRUTURE

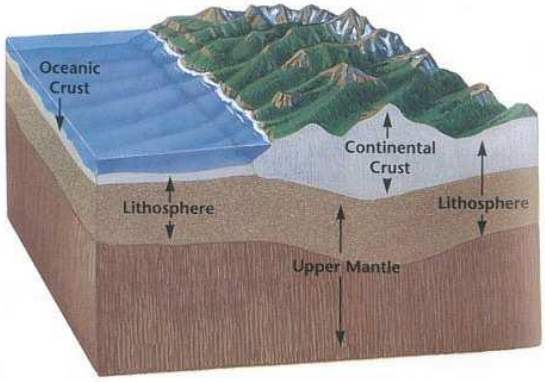
4.1.3 HYDROSPHERE: Discontinuous layer of water at or near Earth's surface. It includes all liquid and frozen surface waters, ground water held in soil and rock, and atmospheric water vapor.



Hydrological Cycle

Earth is special because it has so much water. It's in the ground, forms big oceans, and it's in our atmosphere. It's also in living things. Your body is made up mostly of water.

The Hydrosphere comprises all types of water resources oceans, seas, lakes, rivers, streams, reservoir, polar icecaps, glaciers, and ground water. A very small amount is in our atmosphere, where it exists as water vapor. That's what clouds are made of.



Hydrosphere

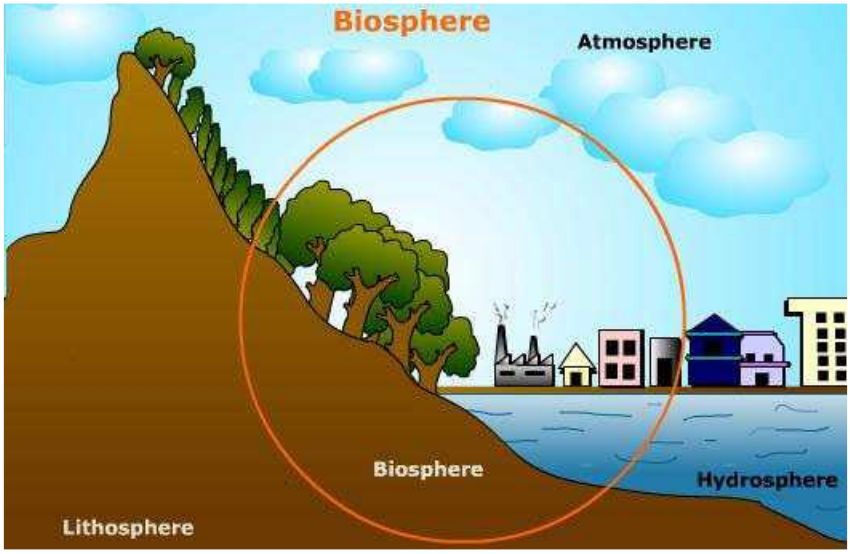
(i) 97% of the earth's water supply is in the oceans.
(ii)About 2% of the water resources is locked in the polar icecaps and glaciers.
(iii)Only about 1% is available as fresh surface water-rivers, lakes streams, and ground water fit to be used for human consumption and other uses.

Source of water	**Percentage**
Oceans	96.5
Ice caps, glaciers, and permanent snow	1.74
Ground ice and permafrost	0.22
Groundwater (total)	1.69
Groundwater (fresh)	0.76
Groundwater (saline)	0.93
Lakes (total)	0.013
Lakes (fresh)	0.007
Lakes (saline)	0.006
Soil moisture	0.001
Atmosphere*	0.001
Swamp water	0.0008
Rivers	0.0002
Biota	0.0001

4.2. BIOTIC ENVIRONMENT

BIOSPHERE: It is the life-zone of the earth and includes all living organisms. The biosphere can be divided into distinct ecosystems that represent interactions between different groups of organisms.

Biosphere indicates the realm of living organisms and their interactions with environment, *viz*., atmosphere, hydrosphere and lithosphere. This sphere includes all of the microorganisms, plants, and animals of Earth. Within the biosphere, living things form ecological communities based on the physical surroundings of an area. These communities are referred to as **biomes**.

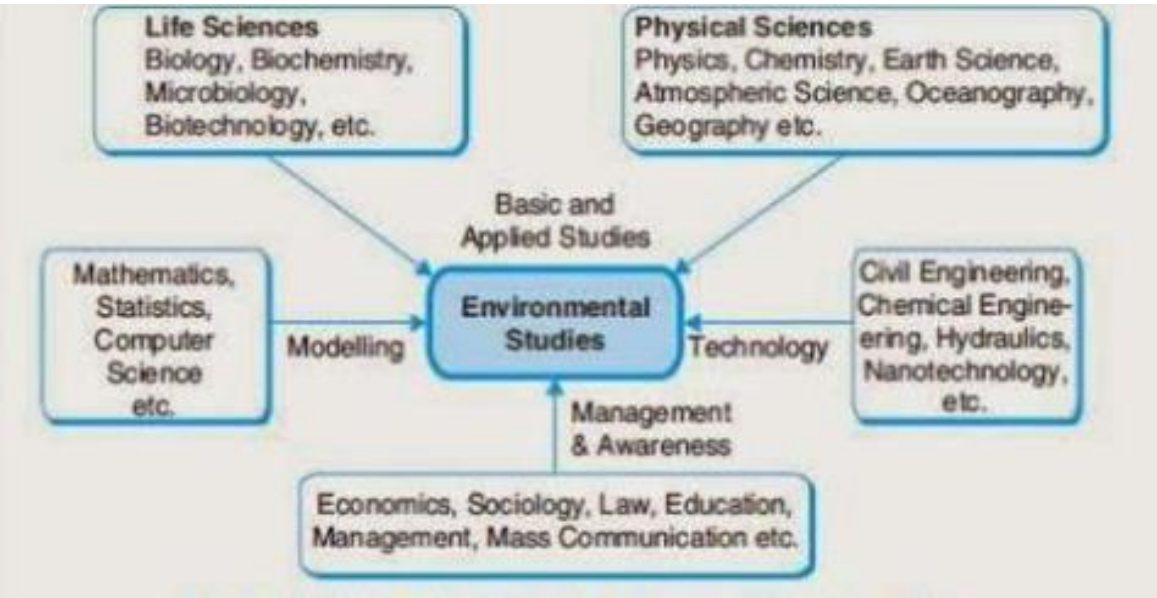


4. MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL SCIENCEC:

Environment is complex and has multifarious aspects. Keeping in view the complex nature of the environment, knowledge and information from various disciplines as science, social science, law and engineering have to be included in environmental studies to understand it completely.

- ✓ Life sciences including botony, zoology, microbiology, genetics and biochemistry help in understanding the biotic components and their interactions.
- ✓ For understanding the physical and chemical structure of abiotic components of environment along with mass and energy transfers we have to make use of basic concepts of physics, chemistry,geology, atmospheric science and geography.
- ✓ Mathematics, statistics and computer science serve as effective tools in environmental modeling.
- ✓ Subjects like economics, management and sociology provide the inputs for dealing with socio-economic aspects associated with various development activities.
- ✓ A synthesis of civil engineering, hydraulics, chemical engg, nano- technology provide the technical solutions to environmental pollution control and waste treatment.
- ✓ Environmental education and mass communication are two important subjects that are instrumental in disseminating environmental awareness.
- ✓ Environmental ethics provide the guidelines for a sustainable lifestyle.

Environmental sciences, therefore is a multidisciplinary subject where we deal with different aspects using a holistic approach.



6. NEED FOR PUBLIC AWARENESS:

As the earth's natural resources are dwindling and our environment is being increasingly degraded by human activities, it is evident that something needs to be done. We often feel that managing all this is something that the Government should do. But if we go on endangering our environment, there is no way in which the Government can perform all these clean-up functions. It is the prevention of environment degradation in which we must all take part that must become a part of all our lives. Just as for any disease, prevention is better than cure. To prevent ill-effects on our environment by our actions, is economically more viable than cleaning up the environment once it is damaged. Individually we can play a major role in environment management. We can reduce wasting natural resources and we can act as watchdogs that inform the Government about sources that lead to pollution and degradation of our environment.

This can only be made possible through mass public awareness. Mass media such as newspapers, radio, television, strongly influence public opinion. However, someone has to bring this about. If each of us feels strongly about the environment, the press and media will add to our efforts. Politicians in a democracy always respond positively to a strong publicly supported movement. Thus if you join an NGO that sup-ports conservation, politicians will make green policies. We are living on spaceship earth with a limited supply of resources. Each of us is responsible for spreading this message to as many people as possible.
Suggested further activities for concerned students:

- ✓ Join a group to study nature, such as WWF-I or BNHS, or another environmental group.

- ✓ Begin reading newspaper articles and periodicals such as 'Down to Earth',WWF-I newsletter, BNHS Hornbill, Sanctuary magazine, etc. that will tell you more about our environment. There are also several environmental websites.

- ✓ Lobby for conserving resources by taking up the cause of environmental issues during discussions with friends and relatives. Practice and promote issues such as saving paper, saving water, reducing use of plastics, practicing the 3Rs principle of reduce, reuse, recycle, and proper waste disposal.

- ✓ Join local movements that support activities such as saving trees in your area, go on nature treks, recycle waste, buy environmental friendly products.

- ✓ Practice and promote good civic sense such as no spitting or tobacco chewing, no throwing garbage on the road, no smoking in public places, no urinating or defecating in public places.

- ✓ Take part in events organized on World Environment Day, Wildlife Week, etc.

- ✓ Visit a National Park or Sanctuary, or spend time in whatever nature you have near your home.

INSTITUTIONS IN ENVIRONMENT

- **Bombay Natural History Society (BNHS),Mumbai:**

The BNHS began as a small society of six members in 1883. It grew from a group of shikaris and people from all walks of life into a major research organization that substantially influenced conservation policy in the country. The influence on wildlife policy building, re-search, popular publications and peoples action have been unique features of the multi-faceted society. Undoubtedly its major contribution has been in the field of wildlife research. It is India's oldest conservation research based NGO and one that has acted at the forefront of the battle for species and ecosystems. The BNHS publishes a popular magazine called Hornbill and also an internationally well-known Journal on Natural History. The BNHS has over the years helped Government to frame wildlife related laws and has taken up battles such as the 'Save the Silent Valley' campaign.

- **World Wide Fund for Nature (WWF-I), New Delhi**:

The WWF-I was initiated in 1969 in Mumbai after which the headquarters were shifted to Delhi with several branch offices all over India. The early years focused attention on wildlife education and awareness. It runs several programs including the Nature Clubs of India program for school children and works as a think tank and lobby force for environment and development issues.

- **Center for Science and Environment (CSE),New Delhi**:

Activities of this Center include organizing campaigns, holding workshops and conferences, and producing environment related publications. It published a major document on the 'State of India's Environment', the first of its kind to be produced as a Citizen's Report on the Environment. The CSE also publishes a popular magazine, 'Down to Earth', which is a Science and Environment fortnightly. It is involved in the publication of material in the form of books, posters, video films and also conducts workshops and seminars on biodiversity related issues.

- **Botanical Survey of India (BSI)**:

The Botanical Survey of India (BSI) was established in 1890 at the Royal Botanic Gardens, Calcutta. How-ever it closed down for several years after 1939 and was reopened in 1954. In 1952 plans were made to reorganize the BSI and formulate its objectives. By 1955 the BSI had its headquarters in Calcutta with Circle Offices at Coimbatore, Shillong, Pune and Dehra Dun. Between 1962 and 1979, offices were established in Allahbad, Jodhpur, Port Blair, Itanagar and Gangtok. The BSI currently has nine regional centres. It carries out surveys of plant resources in different regions.

- **Zoological Survey of India (ZSI)**:

The ZSI was established in1916. Its mandate was to do a systematic survey of fauna in India. It has over the years collected 'type specimens' on the bases of which our animal life has been studied over the years. Today it has over a million specimens! This makes it one of the largest collections in Asia. It has done an enormous amount of work on taxonomy and ecology. It currently operates from 16 regional centers.

- **Centre for Environment Education (CEE),Ahmedabad:**

The Centre for Environment Education, Ahmedabad was initiated in 1989. It has a wide range of programs on the environment and produces a variety of educational material. CEE's Training in Environment Education {TEE} program has trained many environment educators.

- **Wildlife Institute of India (WII), Dehradun**:

This Institution was established in 1982, as a major training establishment for Forest Officials and Research in Wildlife Management. Its most significant publication has been 'Planning A Wildlife Protected Area Network for India' (Rodgers and Panwar, 1988). The organisation has over the years added an enormous amount of information on India's biological wealth. It has trained a large number of Forest Department Officials and Staff as Wildlife Managers. Its M.Sc. Program has trained excellent wildlife scientists. It also has an Environment Impact Assessment (EIA) cell. It trains personnel in eco-development, wildlife biology, habitat management and Nature interpretation.