

Chapter One

Environment and Ecology

1 Introduction

1.1 Environment

The noun “**environment**” has its etymological roots in the Old French “*environ*” and “*environer* or *environner*” (referring to such terms as ‘*circuit*’, ‘*surround*’, ‘*enclose*’, and ‘*circumstances*’). The Oxford English Dictionary (OED) gives 1603 as the date of the first usage of “**environment**”. This first sense of the term is the action or state of being envired or surrounded, encircled or even beleaguered. However, the second and now much more prevalent sense provided by the OED, referring to that which environs/surrounds and especially ‘the conditions or influences under which any person or thing lives or is developed’, is attributed to Thomas Carlyle in 1827. However, this date is mistaken. The text referred to by the OED is Carlyle’s ‘Goethe’, which was first published in the Foreign Review in July 1828. Translating the word “**Umgebung**” in a work by Goethe, Carlyle coined the term **environment** in the South of Scotland in 1828. Goethe’s usage involves reference to a Scottish subject, Macpherson’s Ossian. **Environment** specialized ecology sense first recorded 1956.

The word “Environment” has different meanings in different disciplines. It was used to describe the entire physical and biological world surrounding us including soil, water and air. Gradually it was realized that the enormous variety of plants, animals and micro-organisms on this earth, including human beings are an integral part of the environment.

Hence, to make a sensible definition of environment, it was necessary to include the interactions and inter-relationships of all living organisms with the physical surroundings. Later, it was further recognized that all types of social,

cultural and technological activities carried out by human beings also have a profound influence on various components of the environment.

Environment literally means surrounding and everything that affect an organism during its lifetime is collectively known as its environment.

In another words “Environment is sum total of water, air and land interrelationships among themselves and also with the human being, other living organisms and materials”.

The concept of environment can be clearly understood from Figure 1.1.

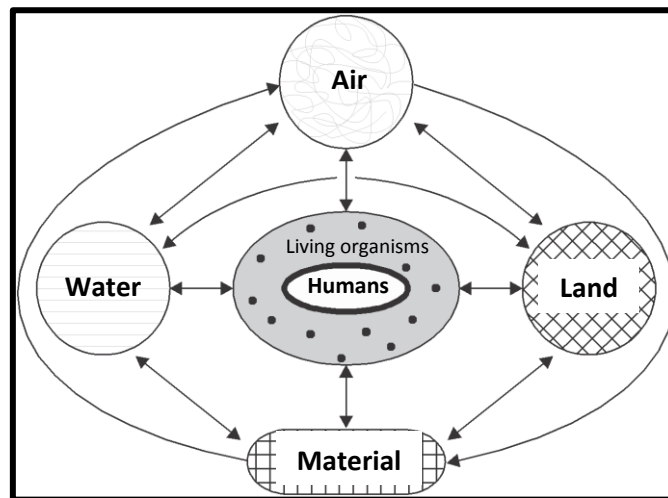


Figure (1.1): Concept of Environment: air, water, land, living organisms and materials surrounding us and their interactions together constitute environment.

Figure 1.1 depicts the environment of human beings. Air, water and land surrounding us constitute our environment, and influence us directly. At the same time we too have an influence on our environment due to overuse or over-exploitation of resources or due to discharge of pollutants in the air, water and land. The flora, fauna and micro-organisms as well as the man-made structures in our surroundings have a bi-directional interaction with us directly or indirectly. The totality of all these components and their interactions constitute the environment.

Thus various built structures, materials and technological innovations also became a part of the environment. So now all biological (biotic) and non-biological (abiotic) entities surrounding us are included in the term ‘environment’.

The impact of technological and economic development on the natural environment may lead to degradation of the social and cultural environment. Thus, environment is to be considered in a broader perspective where the surrounding components as well as their interactions are to be included.

Environmental studies provide an approach towards understanding the environment of our planet and the impact of human life upon the environment. Thus environment is actually global in nature, it is a multidisciplinary subject including physics, geology, geography, history, economics, physiology, biotechnology, remote sensing, geophysics, soil science and hydrology etc.

Environmental engineering is the application of science and engineering principles to protect and utilize natural resources, control environmental pollution, improve environmental quality to enable healthy ecosystems and comfortable habitation of humans. It is based on multiple disciplines including geology, hydrology, biology, chemistry, physics, medicine, engineering, management, economics, law, etc.

Environmental engineering activities involve water supply, waste water management, solid waste management, air pollution control, noise pollution control, radiation protection, environmental sustainability, public health issues, environmental impact assessment, hazardous-waste management, treatment of contaminated land, hazard prevention and mitigation, climate change adaptation and mitigation, renewable energy, etc.

At many universities, environmental engineering programs follow either civil engineering or chemical engineering in engineering faculties with a diverse subject such as hydrology, water resources management, bioremediation, water treatment plant design, environmental chemistry, advanced air and water treatment technologies and separation processes.

In environmental engineering, the environment is where we live. It is divided into two types: natural environment and built environment.

The natural environment encompasses all living and non-living things occurring naturally in the area. *The built environment* refers to the human-made surroundings that provide the setting for human activity (e.g., buildings, parks, cities and supporting infrastructure such as transport, water supply and energy supply).

Modern remote sensing technology has made it easy for us to explore the natural and built environment in our surrounding areas and online mapping tools such as Google Earth are convenient facilities for us to view anywhere on the Earth (even to view many challenging places by foot such as the Everest).

It should be noted that nowadays it is difficult to find absolutely natural environments (i.e., the wilderness, that has not been modified by human activity), and it is common that the naturalness varies in a scale, from ideally 100% natural in one extreme to 0% natural in the other (e.g., intensive farmland).

1.2 Scope of Environmental Studies

Environmental studies are multidisciplinary subjects. They encompass large number of basic areas and aspects that have a direct relevance to every section of the society. Its main aspects may be summarized as follows:

- Conservation and management of nature and natural resources.
- Conservation of Ecology and biological diversity.
- Environmental pollution and control.
- Stabilization of human population and environment.
- Social issues in relation to development and environment.
- Development of non-polluting renewable energy system and providing new dimension to nation's security.

Environmental studies can also be highly specialized concentrating on more technical aspects like environmental science, environmental engineering or environmental management.

In the recent years, the scope of environmental studies has expanded dramatically the world over. Several career options have emerged in this field that are broadly categorized as:

- (i) **Research & Development (R & D) in environment:** Skilled environmental scientists have an important role to play in examining various environmental problems in a scientific manner and carry out R & D activities for developing cleaner technologies and promoting sustainable development. There is a need for trained manpower at every level to deal with environmental issues. Environmental management and environmental engineering are emerging as new career opportunities for environmental protection and management. With the pollution control laws becoming more stringent, industries are finding it difficult to dispose of the wastes produced. In order to avoid expensive litigation, companies are now trying to adopt green technologies, which would reduce pollution. Investing in pollution control technologies will reduce pollution as well as cut on costs for effluent treatment. Market for pollution control technology is increasing the world over. Cleaning up of the wastes produced is another potential market. It is estimated to be more than \$ 100 billion per year for all American business. Germany and Japan having more stringent laws for many years have gained more experience in reducing effluents. Still there is a \$ 200 billion market for cleaning up the former East Germany alone. In India also the Pollution Control Boards are seriously implementing pollution control laws and insisting on up-gradation of effluents to meet the prescribed standards before they are discharged on land or into a water body. Many companies not complying with the orders have been closed or ordered to shift.
- (ii) **Green advocacy:** With increasing emphasis on implementing various Acts and Laws related to environment, need for environmental lawyers has

emerged, who should be able to plead the cases related to water and air pollution, forest, wildlife etc.

- (iii) Green marketing: While ensuring the quality of products with ISO mark, now there is an increasing emphasis on marketing goods that are environment friendly. Such products have ISO 14000 certification. Environmental auditors and environmental managers would be in great demand in the coming years.
- (iv) Green media: Environmental awareness can be spread amongst masses through mass media like television, radio, newspaper, magazines, hoardings, advertisements etc. for which environmentally educated persons are required.
- (v) Environment consultancy: Many non-government organisations (NGOs), industries and government bodies are engaging environmental consultants for systematically studying and tackling environment related problems.

1.3 Importance of Environmental Science

Environment belongs to all the living beings and thus is, important for all. Each and every body of whatever be the occupation or age of a person, he or she may have is affected by environmental issues like global warming, depletion of ozone layer, dwindling forest, energy resources, loss of global biodiversity etc. and also he will affect the environment by his deeds. That is why we find an internationally observed environment calendar to mark some important aspect or issue of environment.

Environment study deals with the analysis of the processes in water, air, land, soil and organisms which leads to pollute or degrade environment. It helps us for establishing standard, for safe, clean and healthy natural ecosystem. It also deals with important issues like safe and clean drinking water, hygienic living conditions and clean and fresh air, fertility of land, healthy food and development. Sustainable environmental law, business administration, environmental protection, management

and environmental engineering are immersing as new career opportunities for environment protection and managements.

- (a) **Global vs. Local Importance of Environment:** Environment is one subject that is actually global as well as local in nature. Issues like global warming, depletion of ozone layer, dwindling forests and energy resources, loss of global biodiversity etc. which are going to affect the mankind as a whole are global in nature and for that we have to think and plan globally. However, there are some environmental problems which are of localized importance. For dealing with local environmental issues, e.g. impact of mining or hydroelectric project in an area, problems of disposal and management of solid waste, river or lake pollution, soil erosion, water logging and salinization of soil, fluorosis problem in local population, arsenic pollution of groundwater etc., we have to think and act locally. In order to make people aware about those aspects of environment with which they are so intimately associated, it is very important to make every one environmentally educated.
- (b) **Individualistic Importance of Environment:** Environmental studies is very important since it deals with the most mundane problems of life where each individual matters, like dealing with safe and clean drinking water, hygienic living conditions, clean and fresh air, fertile land, healthy food and sustainable development. If we want to live in a clean, healthy, aesthetically beautiful, safe and secure environment for a long time and wish to hand over a clean and safe earth to our children, grandchildren and great grandchildren, it is most essential to understand the basics of environment.

1.4 Need for Public Awareness

With the ever increasing development by modern man, large scale degradation of natural resources have been occurred, the public has to be educated about the fact that if we are degrading our environment we are actually harming ourselves.

To encourage meaningful public participation and environment, it is necessary to create awareness about environment pollution and related adverse effects. The United Nations conference on Environment and Development held in Rio-de-Janeiro, followed by Earth summit on sustainable Development have high-lighted the key issues of global environmental concern and have attracted the general public towards the deteriorating environment.

Any Government at its own level can't achieve the goal of environment conservation, until the public has a participatory role in it. Public participatory role is possible only when the public is awarded about the ecological and environmental issues. In short, if we want to manage on planet earth, we would have to make the entire population, environmentally educated.

The objectives of environmental awareness should be:

- Improving the quality of environment.
- Creating awareness among people on environmental problems and conservation.
- Creating such an atmosphere as people find themselves fit enough to participate in decision making process of environmental development programmes.

1.4.1 International Efforts for Environment

Environmental issues received international attention about 35 years back in Stockholm Conference, held on 5th June, 1972. Since then we celebrate World Environment Day on 5th June. At the United Nations Conference on Environment and Development held at Rio de Janeiro, in 1992, known popularly as Earth Summit, and ten years later, the World Summit on Sustainable Development, held at

Johannesberg in 2002, key issues of global environmental concern were highlighted. Attention of general public was drawn towards the deteriorating environmental conditions all over the world. Award of the Nobel Peace Prize (2004) to an environmentalist, for the first time, came as a landmark decision, showing increasing global concern towards environmental issues and recognition to efforts being made for environmental conservation and protection.

1.4.2 Public Awareness for Environment

The goals of sustainable development cannot be achieved by any government at its own level until the public has a participatory role in it. Public participation is possible only when the public is aware about the ecological and environmental issues. The public has to be educated about the fact that if we are degrading our environment we are actually harming our own selves. This is because we are a part of the complex network of environment where every component is linked up. It is all the more important to educate the people that sometimes the adverse impact of environment are not experienced until a threshold is reached. So we may be caught unawares by a disaster.

A drive by the government to ban the littering of polythene cannot be successful until the public understands the environmental implications of the same. The public has to be made aware that by littering polythene, we are not only damaging the environment, but posing serious threat to our health. There is a Chinese proverb “If you plan for one year, plant rice, if you plan for 10 years, plant trees and if you plan for 100 years, educate people.” If we want to protect and manage our planet earth on sustainable basis, we have no other option but to make all persons environmentally educated.

1.4.3 Role of Contemporary Indian Environmentalists in Environmental Awareness

In our country, efforts to raise environmental awareness have been initiated, and several landmark judgements related to environmental litigations have highlighted the importance of this subject to general public. Two noted personalities, who need a mention here, are Justice Kuldeep Singh, known popularly as the green judge and Sh. M.C. Mehta, the green advocate, who have immensely contributed to the cause of environment. In 1991, the Supreme Court of our country issued directives to make all curricula environment-oriented.

This directive was, in fact, in response to a Public Interest Litigation (PIL) filed by M.C. Mehta vs. Union of India (1988) that prompted the apex court to give a mandate for creating environmental awareness among all citizens of India. Based on the judgement, Environmental Studies is being taught as a compulsory course to all students. There are some environmentalists in the present time who have made a mark in our country through environmental activism. Sh. Sunderlal Bahuguna, known for his “Chipko movement” and “Tehri Bachao Andolan”, Smt. Medha Patkar and Ms. Arundhati Roy known for their “Narmada Bachao Andolan”, the Magsaysay awardee Sh. Rajender Singh known for his water conservation efforts are some such contemporary figures.

Salim Ali is a renowned ornithologist, famous for his work on Indian birds. In modern India, our late Prime Minister Mrs. Indira Gandhi was instrumental in introducing the concept of environmental protection in the Constitution of India as a fundamental duty while Mrs. Maneka Gandhi, formerly environment minister, has worked a lot for the cause of wildlife protection. Citizen’s report on environment was first published by late Sh. Anil Aggarwal, the founder Chairman of Centre for Science & Environment. Even with many such key persons leading the cause to environment, India is yet to achieve a lot in this field.

1.4.4 Role of Government

Concept of Ecomark: In order to increase consumer awareness about environment, the Government of India has introduced a scheme of ecolabelling of consumer products as “Ecomark” in 1991. It is an ‘earthen pitcher’—a symbol of eco-friendliness and our traditional heritage. A product that is made, used or disposed of in a harmless manner is called eco-friendly and is awarded this eco-mark. In a drive to disseminate environmental awareness “Eco-Clubs” for children and “Eco-task force” for army men have also been launched by the government.

Today everybody talks of environment, but only a few have clear ideas about what needs to be done and still fewer people have the actual experience or expertise in the field. Unfortunately, environmental awareness campaigns have very often been exploited for political propaganda rather than being an integral part of our educational programmes in theory and practice. “Environment” is very wrongly taken as a “fashion” by all walks of life, hardly realizing that it is our “real-life-situation” and our sustenance and security are at stake. To sum up, it may be said that it is absolutely essential to create environmental awareness because:

- (i) Environment belongs to all and participation of masses is a must for successful implementation of environmental protection plans.
- (ii) Living in a technologically developing society, our lifestyles and attitudes have become self-oriented. Environmental awareness is needed to change the mind set of modern society for an earth-oriented approach.
- (iii) There is a need to make the public environmentally aware of the serious health impacts of environmental pollution and their right to live in a clean and healthy environment.
- (iv) There is an urgent need to create awareness amongst people that we have no other option but to follow sustainability principles. Only then life of mankind on this earth would be secure and our future generations would be safe. Henry D. Thoreau had rightly said “What’s the use of a beautiful house if you don’t

have a decent planet to put it on?” Even if we begin today, the restoration is expected in the next 40–50 years.

1.5 Ecology and Ecosystem

Various kinds of life supporting systems like the forests, grasslands, oceans, lakes, rivers, mountains, deserts and estuaries show wide variations in their structural composition and functions. However, they all are alike in the fact that they consist of living entities interacting with their surroundings exchanging matter and energy. How do these different units like a hot desert, a dense evergreen forest, the Antarctic Sea or a shallow pond differ in the type of their flora and fauna, how do they derive their energy and nutrients to live together, how do they influence each other and regulate their stability are the questions that are answered by Ecology.

The term Ecology was coined by Earnst Haeckel in 1869. It is derived from the Greek words *Oikos*- home + *logos*- study. So **ecology deals with the study of organisms in their natural home interacting with their surroundings**. The surroundings or environment consists of other living organisms (biotic) and physical (abiotic) components. Modern ecologists believe that an adequate definition of ecology must specify some unit of study and one such basic unit described by Tansley (1935) was ecosystem.

According to A.G. Tansley (1935), “**An ecosystem is a self-regulating ecological unit consisting of biotic factors (living) and abiotic factors (non-living) in a specific area exchanging energy and matter**”. For example forest, grassland, desert, aquatic etc. Now ecology is often defined as “**the study of ecosystems**”.

An ecosystem is an integrated unit consisting of interacting plants, animals and micro-organisms whose survival depends upon the maintenance and regulation of their biotic and abiotic structures and functions. The ecosystem is thus, a unit or a system which is composed of a number of sub-units that are all directly or indirectly linked with each other. They may be freely exchanging energy and matter from

outside—an *open ecosystem* or may be isolated from outside in term of exchange of matter—a *closed ecosystem*.

Ecosystems show large variations in their size, structure, composition etc. However, all the ecosystems are characterized by certain basic structural and functional features which are common. Composition and organization of biological communities and abiotic components constitute the structure of an ecosystem. Thus, ecosystems have basically two types of components, the abiotic and biotic, as described below:

1. Abiotic component includes: Various physico-chemical components of the ecosystem constitute the abiotic structure

(A) *Physical components* include:

- (1) Sunlight and solar intensity (for photosynthesis)
- (2) Water availability and rainfall (essential for living beings)
- (3) Temperature (necessary to get survive)
- (4) Soil texture (provide base and nutrients)
- (5) Wind speed and direction (necessary for ventilation)

(B) *Chemical components* include:

- (1) Proteins
- (2) Carbohydrates
- (3) Fats
- (4) Major essential nutrients like C, N, P, K, H₂, O₂, S etc.
- (5) Micronutrients like Fe, Mo, Zn, Cu and other minerals.
- (6) Salts and toxic substances like pesticides.

These physico-chemical factors of water, air and soil play an important role in ecosystem functioning.

2. Biotic component: Different living organisms constitute the biotic component of an ecosystem and belong to the following categories:

- (A) *Producers (Autotrophs)*: These are self-nourishing organisms, i.e. mainly producing food themselves, which prepare organic compounds from inorganic raw materials, e.g., all Green plants produce food through chlorophyll bearing by the photosynthesis processes in the presence of sunlight from raw materials like water and carbon dioxide. They are known as photo-autotrophs (auto = self, photo = light, troph = food). There are some chemo-autotrophs, which are a group of bacteria, producing their food from oxidation of certain chemicals, e.g. sulphur bacteria.
- (B) *Consumer (heterotrophs)*: These organisms get their food by feeding on other organisms. They depend on the energy, produced by the producer. There are different categories of consumer which are of the following types:
- (1) Herbivores—which feed on plants e.g. rabbit, insect.
 - (2) Carnivores—which feed on herbivores as secondary carnivores (e.g., frog, small fish) or tertiary carnivores (e.g., snake, big fish), which feed on other consumers.
 - (3) Omnivores—which feed on both plants and animals e.g., humans, rats, many birds.
 - (4) Detritivores—which feed on dead organisms e.g., earth worm, crab, and ants
- (C) *Decomposers*: These are micro-organisms which attack on dead animals; producers etc. break down the complex organic matter (locked in to them) and converting these matters to simpler inorganic compounds (by the processes of decomposition and disintegration). Through this process they derive their nutrition. They play a very important role in changing the essential nutrients from unavailable organic form to free inorganic form and then recycle all the nutrients back, that is available for use by plants producers again e.g., bacteria, fungi.

1.6 Structure and Function of an Ecosystem

Every ecosystem performs the following important functions:

- (i) **It has different food chains and food webs.** Food chain is the sequence of eating and being eaten. e.g.,
Grass → Grasshopper → Frog → Snake → Hawk
Phytoplanktons (water-algae) → water fleas → small fish → large fish (Tuna)
These are known as grazing food chain—which start with green plants and culminate with carnivores.
Another type is detritus food chain—which starts with dead organic matter. e.g., Leaf litter in a forest → Fungi → bacteria
Food chains are generally found to be interlinked and inter-woven as a network and known as Food Web.
There are several options of eating and being eaten in a food web. Hence these are more stable.
- (ii) **There is unidirectional flow of energy in an ecosystem.** It flows from sun and then after being captured by primary producers (green plants), flows through the food chain or food web, following the laws of thermodynamics. At every successive step in the food-chain, there is huge loss of about 90% of the energy in different processes (respiration, excretion, locomotion etc.) and only 10% moves to next level (Ten per cent law of energy flow).
- (iii) Nutrients (Materials) in an ecosystem move in a cyclic manner. The cycling of nutrients takes place between the biotic and abiotic components, hence known as biogeochemical cycles (bio = living, geo = earth, chemical = nutrients).
- (iv) **Every ecosystem functions to produce and sustain some primary production (plant biomass) and secondary production (animal biomass).**

- (v) **Every ecosystem regulates and maintains itself and resists any stresses or disturbances up to a certain limit.** This self-regulation or control system is known as **cybernetic system**.

1.7 Balanced Ecosystem:

Ecosystems have a unique property of self-regulation. The ecosystem comprising various sub-components of biotic and abiotic nature, which are inter-linked and inter-dependent, have an inherent property to resist change. That means, the ecosystems have a property to tolerate external disturbance or stress. This property is known as homeostasis.

The ecosystems have a definite structure comprised of certain types of living organisms, which have a definite place and role in the ecosystem, as defined by their position in the food-web. Together, in interaction with the abiotic components, these ecosystems perform the functions of energy flow and material cycling, and finally give a desired output in the form of productivity.

Every ecosystem can operate within a range of conditions, depending upon its homeostasis (capacity to resist change). Within its homeostatic plateau, the ecosystem has the potential to trigger certain feedback mechanisms which help in maintaining the ecosystem functioning by countering the disturbances. Such deviation-counteracting feedbacks are known as negative feedback mechanisms. Such feedback loops help in maintaining the ecological balance of the ecosystem.

A balanced ecosystem has basic biotic components which have evolved with time to suit the environmental conditions. The flow of energy and cycling of nutrients take place in a definite pattern in such an ecosystem, under a set of physical environment.

However, as the outside disturbance or stress increases beyond certain limit (exceeding the homeostatic plateau of the ecosystem), the balance of the ecosystem is disrupted. This is because now another type of feedback mechanisms, which are deviation accelerating mechanisms start operating. Such feedbacks are called positive

feedback mechanisms, which further increase the disturbances caused by the external stress and thus take the ecosystem away from its optimal conditions, finally leading to collapse of the system. Figure 1.2 depicts the control system of a balanced ecosystem within a range.

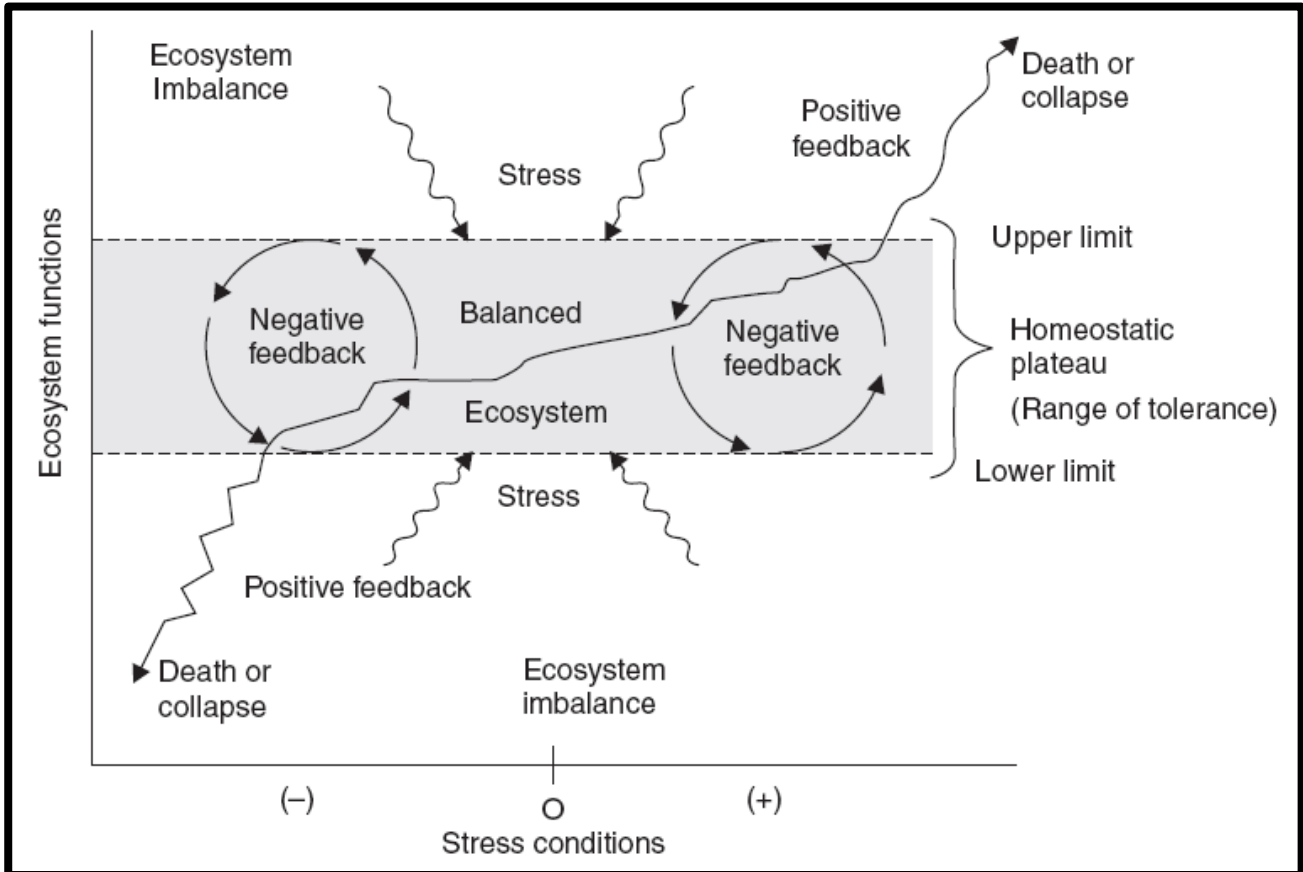


Figure 1.2 Ecosystem regulations by homeostasis. On application of a stress, the negative feedback mechanisms start operating, trying to counter the stress and regulate the balance of the system but beyond homeostatic plateau, positive feedback starts which further accelerate the stress effects causing ecosystem imbalance.

To understand the concept we can consider the following example. Carbon dioxide is required by green plants to manufacture their food during photosynthesis and the food produced by green plants is actually the base of food chains, energy flow and material cycles.

The ecosystems have an excellent balance of regulating the levels of carbon dioxide through carbon cycle, where all living organisms produce CO₂ during respiration and the green plants use them up during photosynthesis, liberating

oxygen. Upto certain limits, increase in CO₂ concentrations can help in improving production by green plants. But beyond a limit, the increased CO₂ will cause an imbalance in the ecosystem triggering various harmful positive feedbacks.

As a result, several adverse environmental impacts occur including global warming, changing rainfall patterns, crop insecurity, storms, flooding, and emergence of new types of pests— all leading to degradation of the ecosystem.

1.8 Human Activities and their Affects on Environment

1.8.1 Agriculture

It is the oldest and widespread occupation of the people in rural areas. Over the years, there have been notable changes in the pattern of farming; Manual farming has been replaced by ‘mechanized farming’ due to the advancement of different technologies.

Ploughing is done by tractors in place of bulls. Modern agricultural techniques have eventually changed into both ways. Some are favourable and some of these are unfavourable.

The changes in the earlier form of agriculture have been brought by the following ways:

- (i) Mechanical factors: Tractors, tube wells and agricultural equipments.
- (ii) Chemical factors: Fertilizers and pesticides.

The chemical factors have brought a revolution in the agriculture, as they express growth in a very short span of time but their affects in the long run are detrimental.

a) Affects of Tractors: It is a mechanized means of cultivation. Use of tractors has considerably increased in agriculture these days. It is a multitasked machine which helps in ploughing, levelling, weed controlling and sowing etc.

b) Fertilizers: Crops require basic food like nutrients for their growth. Fertilizers are used to provide nutrients to plants. It helps in the growth of

plants and contributes greatly to increase yields of the crops. Natural fertilizers do not harm the environment.

c) Artificial Fertilizers: In the form of agricultural practices today artificial fertilizer is used in abundance. They are easy to handle, transport and store and helps in better crop yield. Its increasing use is polluting the environment and contaminating the surface and ground water resources. In the long run, it reduces the fertility of land and also leads to loss of organic matter from the soil. It also affects the lakes, ponds and underground water due to the accumulation of fertilizers in them and the soil.

d) Pesticide Problem: Pesticides are used to kill pests, it help in killing pests but it is harmful in many respects also.

1.8.1.1 Advantages

1. Helps in the reduction of crop lose.
2. It controls the probable disease in plants which would cause diseases to human beings.
3. Weeds are controlled.

1.8.1.2 Disadvantages

1. Non-targeted species are also killed.
2. Some pests are beneficial to the crops; when they are killed fewer new also emerge.
3. Soil fertility is reduced.
4. Food chain and food web are disturbed.
5. It results into many incurable diseases.

1.8.2 Industries

Industrial activities generate a huge amount of waste products which are usually discharged into the water bodies. The smoke from industries also pollutes the air. Its noise causes noise pollution too. Processing of wastes from large chemical plant is a very complex process because many chemicals are produced that way. In recent years, emphasis is laid on the industrial waste treatment, for the recovery of useful byproduct.

By and large, it should be kept in mind that no industrial product is more important than our environment. Nowadays various measures have been taken to transform industrial waste into profitable products in order to save our environment as well as money. For example waste papers can be used to make thick covers of note books.

Industrialization is considered the synonym to development but it is necessary to review the impact of industrialization on society and environment otherwise it can bring the following consequences:

- 1. Ecosystem imbalance:** Industrial plants discharge a number of contaminants to the air and water and thus pollute them equally. Man's uncontrolled actions for the fulfilment of his desires are contaminating the atmosphere and leading the biosphere to undesirable changes that will result into the ecosystem imbalance.
- 2. Biodiversity loss:** To set up new industries, the biologically rich habitats are being destroyed and fragmented. Today, biodiversity loss is one of the most concerning crises. A rich biodiversity is essential for the health of biosphere and industrial development of a country.
- 3. Toxic metal and non-metal discharge:** Toxic metals and non-metals from the industries, cause great harm to the biosphere. The organic impurities cause harmful affects on the water basins and the regions adjoining them. Discharge of effluents form industries, decreases the amount of DO

(dissolve oxygen) in water. It is leading us towards the deficiency of pure drinking water.

- 4. Food chain imbalance:** Industrial discharge carries a variety of organic and inorganic contaminants that enters into the food chain and causes imbalance. It disrupts the energy flow of the ecosystem as well.
- 5. Disturbance of self-purification mechanism:** The organic matter gets oxidized by bacteria which break it into simpler substances such as ammonia, nitrates, sulphates etc. These substances are utilized by protozoa, fish, insects etc. Discharge of organic matter into the streams, results into the growth of bacteria and consequently, it depletes the dissolved oxygen, which is replenished by the atmosphere. This process is called Self-Purification. When large amount of industrial sewage is disposed off into the natural water bodies, the self-purification mechanism gets disturbed.
- 6. Gaseous emissions:** Natural resources have been exploited at their fullest, in the race of development, all over the world. In recent times, due to industrial coal burning, large amount of gases like CO₂, CH₄, N₂O, CFCs are increasing in the lower atmosphere. The emission of these greenhouse gases results into global warming, at the same times SO₂ and NO₂ emitted from industries cause acid rain and formation of smog.

1.8.2.1 Control Measures

1. Scientific techniques should be adopted for the reprocessing of the industrial waste.
2. Recycling practices should be made a must in the industrial plants.
3. Reasonable funds should be provided for the construction of treatment plants for industrial effluents.
4. Legal provisions should be enforced by proper administration.
5. Eco-friendly industrial plants should be taken into consideration.

1.8.3 Mining

Mining is the Act of extracting ores, coal etc. from the earth. Mining on Industrial scale can produce environmental damages from exploitation and development even long after the mining is closed. The major effects of mining operations on human being and plants are as follows:

1. Mining produces enormous quantities of waste compared to any other natural resource extraction activity. Water dissolves these wastes to produce contaminated fluid that pollute soil, river and ground water.
2. Mining also leads to air pollution due to release of greenhouse gases and other toxic gases, for example CH₄, CO₂ etc.
3. It leads to deforestation including loss of flora and fauna.
4. Mining operations produce a lot of noise. The deafening sound of machinery used in mining and the blasting create conditions that may become unbearable to local people and the forest wild life.
5. It leads to migration of tribal people from mining areas to other areas in search of land and food.
6. Mining results in lowering of ground water table.
7. Formation of ponds which can alter the hydraulic gradient and drainage basin limits in local regions.

1.8.4 Transportation

Way back two centuries, the atmospheric gases were balanced, atmosphere had the capacity to protect itself from the encroaching pollutants. But the various means of transport released oxides of nitrogen, hydrocarbon, and various harmful gases in the atmosphere. The affect, after all was the disturbance in the atmospheric.

1.8.4.1 Road Transport *Various pollutants that emit from automobiles:*

a) Carbon dioxide (CO₂/CO): It emits from automobiles. Its concentration during 1990's was 1.5 ppm. Carbon monoxide reacts with haemoglobin of the blood to form carboxyhaemoglobin and minimizes the oxygen carrying capacity of blood. The

symptoms are headache, fatigue, tiredness, unconsciousness and cardiovascular damage.

b) Nitrogen oxides (NO₂): It is toxic at the highest rate, attacks the lungs and it also reduces the oxygen carrying capacity of blood. It causes many diseases like lung cancer and Asthma. It occurs due to the breakdown of the air sacs in the lungs. It harms even the plant lives by reducing plant growth, its productivity and its yield at a high rate.

c) Hydrocarbons: It causes lung and skin cancer as it is carcinogenic.

1.8.4.2 Sea Transport

It consists of ships and submarines etc. that covers the distance between countries. Sometimes, due to storms and icebergs, accidents take place due to which oil spills into the ocean. This floating oil is absorbed and consumed by billions of tiny phytoplankton and other organisms, since these organisms play a vital role in the food chain, and other forms of marine life depend upon them, they, eventually pass this oil to the other organisms as well via food chain.

1.8.4.3 Air Transport

It is one of the fastest modes of transportation and pollution too. Various pollutants such as CO, CO₂, oxides of nitrogen and oxides of sulphur are spread in the atmosphere through airplanes. Jet planes travel in the stratosphere and disrupt the Ozone layer by emitting pollutions such as SO₄, and Cl₂ etc. Airplanes create supersonic booms which harms people physiologically and psychologically. Important pre-requisites for controlling vehicular pollutions are:

- (a) Reduction of lead content in motor fuel.
- (b) Joining of areas for regulation of traffic movements.
- (c) Improvement in the processes of automobile technology.
- (d) Improvement in the traffic system and conditions of roads.

- (e) Restriction in the growth of urban centres, industries and commercial centres.
- (f) Implementation of emission norms for new and in use vehicles.
- (g) Use of unadulterated fuel.
- (h) Keeping a check on evaporative emission from storage tanks, fuel distribution system and vehicles.
- (i) Improvement in fuel quality and usage of cleaner fuel.
- (j) Phasing out of grossly polluting vehicle.
- (k) Streamlining traffic management.
- (l) Reformation in public transportation system.