A Complete Guide to the Environment, Climate Change, and Disaster Management

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PART 1:

PRINCIPLES AND CONCEPTS

CHAPTER 1

ENVIRONMENT

Environmental science is a broad field of study that includes geological features, hydrogeology, atmospheric science, chemistry, physics, medical advances, bioscience, agriculture, public health, hygienic engineering, and much more. It is the study of things that happen in the physical world. It looks at the origins, interactions, movements, effects, and fortunes of physical and biological species in the atmosphere, water, and soil, as well as how human actions affect them (Fig. 1.1).

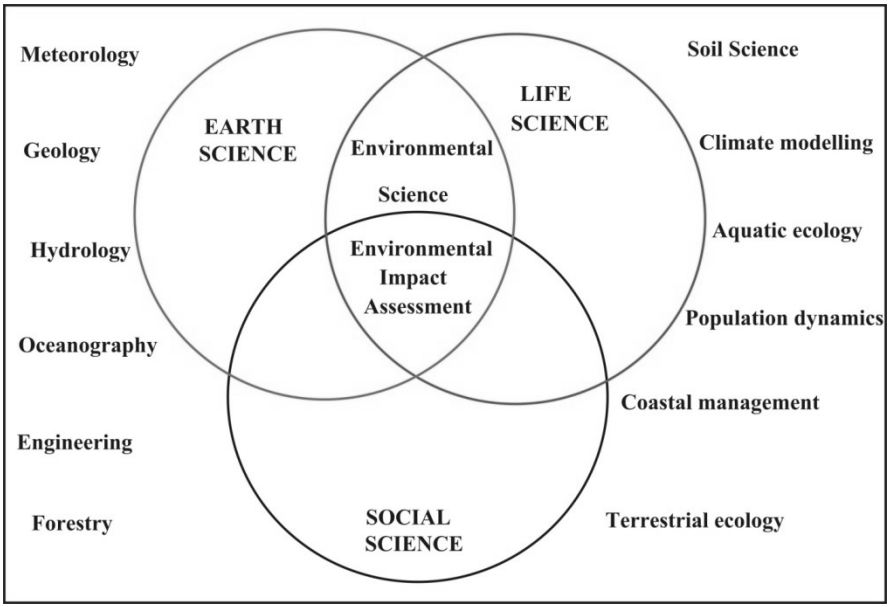

Fig. 1.1: Interaction of various disciplines of Environmental Science

The Definition of Environment

Environment is the sum of all the things that are going on around us at a certain time and place. It is made up of systems of physical, biological, and cultural factors that interact with each other and with each other as a whole. The environment is all of the things that an organism needs to live or keep its life process going. It has an effect on how organisms grow and change.

The Scope of Environment

The environment is comprised of four basic parts as explained below:

1. The atmosphere: this is a layer or several layers of gases that circle a planet and are held in place by the gravity of the planet. A planet keeps its atmosphere when the gravity is strong and the temperature of the atmosphere is low. About 78 percent of the air around the Earth is nitrogen, 21 percent is oxygen, 0.9 percent is argon, 0.3 percent is carbon, and 0.1 percent is made up of other gases. These other gases include methane, water vapour, Helium, Krypton, Hydrogen, and Neon.
   a) It keeps life on earth alive.
   b) It protects earth from the potentially dangerous environment of space.
   c) It absorbs a significant portion of the electromagnetic energy from the sun as well as the majority of cosmic rays from outer space.
   d) It protects us from the Sun's harmful UV rays as well as against minor meteorite strikes from space.

2. The Hydrosphere: this is the term used to describe the total amount of water that exists on a planet. The hydrosphere is made up of the water found on the surface of the planet, as well as the water found below the surface and in the atmosphere. A planet's hydrosphere may be made up of liquid, vapour, or ice, depending on the temperature and density of the planet. Seas, lakes, and rivers are the three primary types of bodies of liquid water found on the surface of the Earth.
   a) The oceans are home to 97 percent of the water that may be found on Earth.

b) The polar icecaps and glaciers hold 2 percent of the world's water supply.
c) Only about 1 percent of fresh surface water—rivers, lakes, streams, and ground water—is available for human consumption and other purposes.
d) Water is in a liquid state when the temperature rises above 32 degrees Fahrenheit and falls below 212 degrees Fahrenheit, and it governs climate.
e) The hydrosphere originated in the primordial atmosphere as a consequence of the condensation and solidification of water vapour induced by the high temperatures that caused the water to be in the form of vapour. The hydrosphere on Earth is thought to be 4 billion years old.

3. The Lithosphere: the solid crust of the Earth, or the lithosphere, extends from the surface to a depth of around 80–100 kilometres. The crust and the brittle uppermost layer of the mantle make up the lithosphere. The atmosphere and asthenosphere surround it on its top and lower sides, respectively. It features a varied topography, including mountains, plateaus, deserts, plains, valleys, and other landforms. The crust, mantle, and core are the three main layers that make up the Earth's interior.
   a) The Moho discontinuity is the boundary that divides the crust from the mantle. "Discontinuity" refers to the point on the surface where seismic waves change velocity and accelerate.
   b) There exists a conrad discontinuity between the upper and lower crusts.
   c) The upper and lower mantles are separated by a repiti discontinuity.
   d) Between the mantle and the outer core, there is a Guttenberg discontinuity.
   e) Between the outer and inner core, there is a Lehmann discontinuity.

4. The Biosphere: all of the Earth's environments that are home to life together make up the biosphere. The biosphere includes a wide range of ecosystems, including deep tree roots, the deep ocean, beautiful tropical rainforests, high mountainous regions, and transitional regions like estuaries where ocean and terrestrial organisms coexist. For the survival of species and their mutual

interactions, the biosphere is essential. It is a crucial part of climate regulation. Climate changes as a result of changes in the biosphere.

a) The geologist Eduard Suess coined the term biosphere in 1875. The biosphere, according to him, is the portion of the earth's surface where life is present.
b) The biosphere is thought to have developed via a process called biopoiesis or biogenesis at least 3.5 billion years ago. While biogenesis is the process by which life originates from living matter, biopoiesis is the process by which life develops naturally from non-living components.
c) All over the world, there are many biosphere reserves where people work together to protect the environment. In fact, there are 669 biosphere reserves spread over 120 different countries.
d) It is difficult to pinpoint the exact outer edge of the biosphere. This is because the biosphere's depth is uncertain and certain species, such the Ruppell's vulture, may fly as high as 11,300 metres in the air. In the Puerto Rico Trench, fish have been found to live as deep as 8,300 metres.
e) According to statistics from 2022, India has 18 biosphere reserves, 12 of which are also a member of the UNESCO MAB Program.

Elements of Environment

The environment is made up of interdependent systems of physical, biological, and cultural elements that are linked to one another both individually and collectively in a wide range of ways. The following is an explanation of these elements:

1) Physical elements: space, land forms, bodies of water, climatic soils, rocks, and minerals are all examples of physical components. They explain how different the human environment is and what it can and can't do.
2) Biological elements: the biosphere is made up of biological elements such as plants, animals, microorganisms, and humans.
3) Cultural elements: economic, social, and political dimensions are ultimately man-made traits that comprise the cultural world.

Aside from that, the environment may be divided into two categories:(a) microenvironment and (b) macroenvironment. It may also be separated into two further categories:(i) physical environment and (ii) biotic

environment. The term "micro environment" refers to the organism's immediate local surroundings, while "macro environment" refers to all of the physical and biotic variables that surround the organism outside.

Humans and the Environment

Humans cannot be seen in isolation from their environment. People still have a wide range of needs across the world. In the past, the majority of environmental issues that were taken into account by international organisations were those that were acknowledged by developed nations, such as the need to reduce pollution, the importance of preserving of biological and ecological diversity, and the value of protecting the world's natural beauty. Since the United Nations Conference on the Human Environment, however, it has become more and more clear that environmental issues also pose a serious threat to developing countries, and that in a large portion of the world, the environmental issues still revolve around poverty—poor housing, terrible public health, malnutrition, and inadequate employment. The development and understanding of environmental challenges are highly dependent on how society is formed, as well as on its ideals and goals. Changes in the structure and goals of society have a significant impact on how man interacts with his physical surroundings. Man's goal must be to create a society that is inherently compatible with its environment if he is to avoid the situation where a lot of time and money are spent fixing component flaws.

With the growth of theological beliefs, numerous faiths began to see the established natural order as a means of human enslavement. It is said that man was created in God's likeness, given dominion over nature, and the ability to accomplish almost whatever he wanted. Religious moral standards backed activities undertaken by people who destroyed the environment on a large scale without taking into account the need to preserve the biotic and abiotic components of the ecosystem. Among the important ones are:

a) Excessive use of natural resources.
b) Disruption of bio-geochemical cycles.
c) Pollution of water bodies, especially the rivers.
d) Other forms of pollution of the environment.

The Sixth Mass Extinction

A mass extinction occurs when the Earth loses the majority of its species in a short period of time. There have been five significant mass extinctions throughout the Earth's history. The Holocene extinction is sometimes known as the "sixth great extinction" or the "Anthropocene extinction." It is an ongoing extinction event of species caused by human actions during the modern Holocene epoch. The current rate of extinction is predicted to be 100 to 1,000 times higher than natural backdrop extinction rates. At least five human actions may contribute to extinction, and they are as follows:

a) Continuous greenhouse gas emission.
b) Hazardous chemicals of agriculture, mines, factories and industry.
c) Manmade nuclear arms.
d) Biotechnological misuse.
e) Manmade radioactive waste.

Global Environmental Problems

The environment refers to anything that surrounds or effects an organism throughout its existence. It is made up of both living (biotic) and non-living (abiotic) components. Human civilization and globalisation are the primary sources of continual change in the current world environment. Pollution, global warming, ozone depletion, acid rain, depletion of natural resources, overcrowding, waste disposal, deforestation, and biodiversity loss are all factors that may be considered to be contributing to global environmental issues. Almost all of these processes are the result of unsustainable use of natural resources. Our ecosystem is facing a variety of challenges, many of which seem to be worsening with time, placing us on the verge of a true environmental disaster. As a result, it is becoming more important to raise awareness of the prevalence of these challenges, as well as what can be done to prevent their negative impact. Some of the major issues are:

a) Pollution: Pollution of the air, water, and soil caused by pollutants such as plastics, heavy metals, and nitrates generated by companies, combustion of fossil fuels, acid rain, oil spills, and industrial waste.
b) Global warming: Human activity promotes global warming by emitting greenhouse gases, which causes an increase in

temperature, which ultimately leads to rising sea levels, melting polar ice caps, flash floods, and desertification.

c) Overpopulation: We are running out of resources such as food, water, and fuel to feed the world's growing population, particularly in developing countries. Intensive agriculture, in an attempt to mitigate the problem, causes further damage via the use of chemical fertilisers, herbicides, and insecticides.
d) Waste disposal: A massive amount of garbage is produced and dumped into the oceans. Trash from nuclear power plants, as well as waste from polymers and technology, is among the most dangerous waste types.
e) Ocean acidification: The rise in acidity of the seas, which is caused by a rise in the emission of carbon dioxide by humans, has a significant impact on marine life and has severe repercussions.
f) Loss of biodiversity: Human actions are responsible for the extinction of several species and habitats. As a result, natural processes such as pollination become unbalanced, endangering ecosystems and causing harm to coral reefs in particular.
g) Deforestation: Trees are cut down to make place for residential, industrial, or commercial buildings, which reduces oxygen production and alters temperature and rainfall.
h) Ozone layer depletion: The emission of chlorofluorocarbons (CFCs) into the atmosphere causes pollution, which in turn causes a hole to form in the ozone layer, which protects the earth from potentially harmful ultraviolet radiation.
i) Acid rain: Acid rain is caused by pollutants in the atmosphere, such as sulphur dioxide and nitrogen oxides, and can have negative effects on humans, animals, and aquatic species. Acid rain can also cause damage to buildings.
j) Public health problems: One of the most serious environmental issues today is a lack of pure water. Air pollution may lead to consequences such as respiratory sickness and cardiovascular disease.

The Importance of Environmental Science

Environmental science encourages the investigation and comprehension of environmental processes, including those that occur naturally and those that are induced by humans. Students develop their talents in critical thinking, problem solving, and creative thinking through studying and investigating challenging environmental situations. This helps students

strengthen their existing skills. The study of the environment teaches us about the need to preserve and conserve the environment, especially in light of the indiscriminate discharge of toxins into the environment by humans. There are now a large number of ecological concerns that, over time, have grown in scale and complexity, putting the continued survival of humanity on earth in jeopardy. Along with researching solutions to these problems, our focus in Environment Studies is also on these concerns. The following are some of the reasons why environmental studies are becoming more important:

a) Environmental issues must be of global significance: It is clear that environmental problems like global warming, ozone depletion, acid rain, marine pollution, and the loss of biodiversity are not just national problems, but also global problems that must be solved by people from all over the world working together.
b) As a result of development, new problems have emerged: In its wake, development spawned urbanisation, industrial growth, transportation systems, agriculture, and housing, among others. However, it has been steadily eliminated in modern nations. To sanitise their own environment, the Global North has succeeded in shifting the 'dirty' industries to the Global South. When the West developed, it likely did so without considering the environmental ramifications of its actions. Even if the rising world follows such a route, it is manifestly unrealistic and unacceptable.
c) Exponential Rise in Pollution: One in seven people on this planet live in India, according to a world census. With 16 percent of the world's population and only 2.4 percent of its land area, it is clear that there is a lot of pressure on natural resources, especially land. Agricultural experts have noticed problems with the health of the soil, such as the loss of micronutrients and organic matter, soil salinity, and the breakdown of its structure.
d) Call for a Better Approach: Especially for developing countries, the establishment of alternative routes leading to alternative goals is of the greatest priority. We need an aim which encompasses the following:
    1) A target, which in the end becomes the primary purpose of the development being carried out in order to ensure long-term sustainability.
    2) A goal that should unite all of the inhabitants on our planet.
e) Need To Save Earth from Extinction: We have a moral obligation to save humanity from extinction. In the name of progress, we have constrained the environment and depleted the biosphere.

f) Need For Smart Management and Development: We depend on the environment for both our life and for nourishment. In any strategy for development, the extraction of resources, the processing, and the use of the product all need to be coordinated with the natural cycles. Our actions should be organised ecologically for the purpose of maintaining the environment while simultaneously advancing development. With this in mind, Misra (1991) identified the four fundamental principles of ecology: holism, ecosystem, succession, and conversation. He has emphasised the following four crucial aspects of environmental management, which are as follows:
   1) Impact of human activities on the environment
   2) Value system
   3) Plan and design for sustainable development
   4) Environmental education

Need for Awareness

There is no doubt that people are to blame for a lot of the damage to the environment. Since the beginning of the industrial revolution, the amount of greenhouse gases in the air has gone up by more than a third. So, it's up to us to learn more about the environment and change the way we act. The greenhouse effect is gaining strength because more greenhouse gases are being released into the air. This has caused temperatures around the world to rise. The air, land, and water are also harmed by these gases. Pollution lowers the quality of food, which could cause people to eat compounds that are bad for them. Poor air quality also poses serious health risks to people.

Destruction of forests is another way that people cause damage to the environment. The things we need most, like food and medicine, come from forests. Trees are also important "carbon sinks," which means that they help keep the amount of carbon dioxide in the air in balance by taking it in when they photosynthesise. By cutting down more trees, we are making the greenhouse effect worse, which means that temperatures around the world are going up. This causes big changes in the weather, like storms, droughts, and floods. Climate change and other problems are also putting many species at risk of going extinct because they can't adapt to the changing climate. All ecosystems are connected, so the loss of a species, no matter how small it may seem, can have big effects on humans. For example, many people don't know that the loss of honeybees can cause

a lot of serious problems. Some people might even be happy about the idea of bees going extinct because they are known for having painful stings. People don't care much about bees, except when they discover that honey in oats makes the best meal ever. 35 percent of the 100 different crop species that provide us with the majority of our food are pollinated by them. So, getting rid of honeybees has a direct effect on how long people will be able to keep eating. This shows how something we might think of as annoying is actually important to our survival as a species. Even if there isn't a clear link between what we do and the serious environmental problems, that doesn't mean that the results won't affect us. This is why it's so important to take care of the environment whenever and wherever we can.

CHAPTER 2

COMPONENTS OF ENVIRONMENT

Introduction

The physical limits imposed by the environment are unique. It consists of four major components: the atmosphere, the hydrosphere, the lithosphere, and the biosphere. It has been shown that interactions between abiotic-abiotic, abiotic-biotic, and biotic-biotic components are continuous. These interactions involve the movement or transformation of elements, compounds, and other forms of energy (Fig. 2.1).

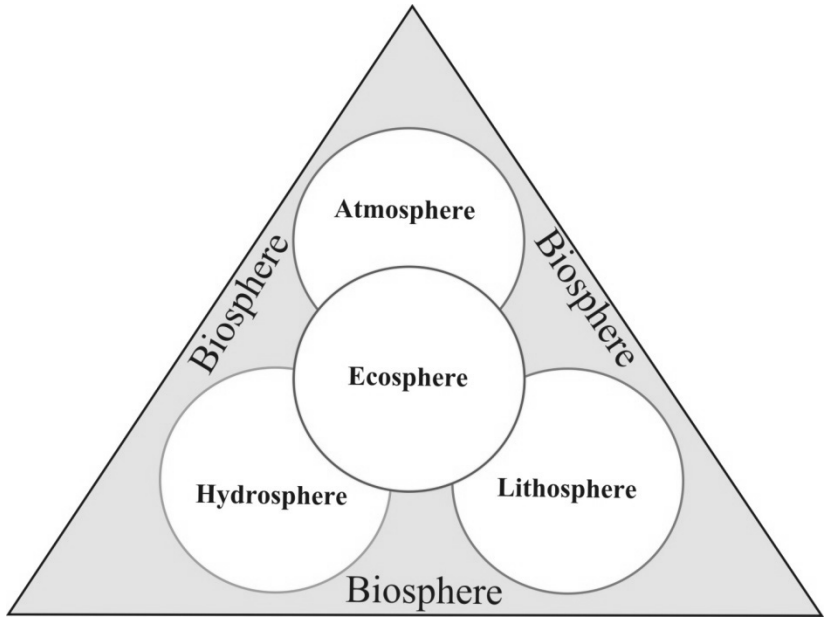

Fig. 2.1: Environmental components interaction

Atmosphere

When Earth first formed, there was no atmosphere, which is a fluid system of gases and particles in the air. Today's atmosphere was made by chemical and biological interactions on the planet itself. The fluid system makes a gaseous envelope around the globe, but it is hard to say where its limits are. They can be called anything you want, but in this book, we call them the Earth's atmosphere and space.

The air we breathe is a stable mix of 78 percent nitrogen, 21 percent oxygen, about 1 percent argon, and small amounts of carbon dioxide and water vapour (Table 2.1). But our planet's atmosphere was very different 4.6 billion years ago when it was first formed. Most likely, early on in the Earth's history, its atmosphere was made up of hydrogen, helium, methane, ammonia, carbon dioxide, and water vapour. These were the most common gases in the early solar system. Hydrogen and helium, which were the lightest of these gases, couldn't stay on Earth because it wasn't strong enough to hold them. The strong solar winds of a young, active Sun probably sent most of the remaining gases into space. The first permanent atmosphere on Earth was made by a process called "outgassing" in which gases trapped inside the planet are released into space. On a global scale, the gases that come out of hundreds of active volcanoes are still an important part of how the planet works. Early on, the planet's interior must have been very hot and moving like a fluid, which must have caused a lot of gas to escape. Based on what we know about volcanic eruptions today, Earth's original atmosphere was probably made up of water vapour, carbon dioxide, and sulphur dioxide, along with small amounts of other gases but no nitrogen. The most important problem was that there was no oxygen to breathe.

Gases	Formula	Percent by volume
Nitrogen	N_2	78.084
Oxygen	O_2	20.946
Argon	Ar	0.934
Carbon dioxide	CO_2	0.036
Neon	Ne	0.00182
Helium	He	0.000524
Krypton	Kr	0.000114
Hydrogen	H_2	0.00005

Table 2.1: Permanent gases of the Atmosphere

The earth's surface is covered by a layer of atmosphere, which is made up of gases and different solid and liquid particles. The gaseous materials go up several hundred kilometres, but it's not clear what the highest point of the atmosphere is. The first 80 kilometres of the Earth's atmosphere hold more than 99 percent of the mass of the whole atmosphere. Based on how the temperature changes up and down, the atmosphere is divided into five layers: the troposphere, stratosphere, mesosphere, thermosphere, and ionosphere (Fig. 2.2). In addition to the layers that have different temperatures at different heights, there are also other layers or zones in the atmosphere. The atmosphere is usually divided into two layers, the homosphere and the heterosphere, based on their chemical makeup. From the surface of the Earth to a height of about 80 kilometres, the amounts of the gases that make up the air are the same. This layer is called the homosphere, which means "zone of uniform composition." In contrast, the atmosphere above 80 kilometres is not uniform even though it is not very thick. Because it is made up of different things, it is called a heterosphere. Here, the gases are put into four almost-spherical shells, each of which has a different mix of gases. The lowest layer is mostly made up of molecules of nitrogen. The next layer is mostly made up of atoms of oxygen. The next layer is mostly made up of helium atoms, and the last layer is mostly made up of hydrogen atoms. The gases that make up the heterosphere are arranged in layers that depend on how heavy they are. Since molecular nitrogen is the heaviest, it is also the one at the bottom. Hydrogen is the most common and outer gas. It is also the lightest.