Nature, Ecology and Environment

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# **Introduction**

 In life, animals, plants and all the other matter depend on each other. For instance, many animals including human beings rely or depend on plants for food with others depending on plants for shelter. On the same note, numerous recent reports shows that overstocking of livestock animals in a specified area leads to massive loss of the top layer fertile soil through the process of soil erosion. Ecology is the scientific term that is used to describe the relationship between animals and plants in their natural environment. It is a discipline that primarily focuses on the study of the interactions between the different organisms and their environment. In ecology, an ecosystem is dynamic complex communities of plants, animals, microorganisms, and non-living elements, all of which interact in the same functional unit. The characters of an ecosystem dynamically changes as the members of the community and the physical context of the community changes. In some instances, the changes in an ecosystem cross a threshold of balance, which leads to the system’s inability to return to its normal original form.

 In an ecosystem, a species is a self-generating, complete and a unique ensemble of genetic variation that is capable of interbreeding and giving rise to fertile off springs of the same kind. They are mainly considered the only self-replicating units that can function independently in the environment. On the same note, a biodiversity is a term that is used to define or describe life in all the forms that exist in the world and the natural-occurring processes that support and connect all these life forms and their existences in the world. It is a term that refers to the variety of species and ecosystems on the earth and the natural occurring ecological processes that they are part of.

Biodiversity is defined by three main attributes or characteristics including the structure, the composition and the functions. As the name suggests, composition refers to the variety of organisms in the biodiversity. It is the identity and the variety of an ecological system. Composition is described by the list of organisms that are resident in an area or an ecosystem. The structure of an ecosystem is defined by the organization or pattern of the system such as the complexity of the habitat to the patterns of the habitat. Functions refer to the results of the ecological as well as evolutionary processes that take place within an ecosystem. These processes include predation, the flow of genes naturally occurring disturbances in the environment and the associations within the ecosystem. Examples of these naturally occurring processes include predator-prey relationships, water purification cycles and the nutrient cycling. Each of these attributes as described above is multi-scalar and defines both the spatial as well as the temporal dynamics operating in the biodiversity.

## **Branches of Ecology**

 Ecology is a broad topic of discussion and is considered a multi-disciplinary subject since it encompasses numerous other disciplines in one. Among the major branches of ecology include Physiological ecology, population ecology, Community ecology, Ecosystem ecology and landscape ecology. Physiological ecology deals with the adaptation of the individual species in their environments. Population ecology, also known as autecology, deals with the aspects of the population and the dynamics of the population, breeding behavior and the aspects of speciation. Community ecology concentrates on the aspects of the population at the community level. Ecosystem ecology studies the processes that involve communities or organisms and the environment. Landscape ecology focusses on the interrelationships and the processes across ecosystems.

# **Meaning of Environment**

 The term environment is derived from a French word “Environner” which refers to the surrounding. Therefore, in simple terms, environment is used to refer to the organisms, both the living as well as the non-living, that surround an organism. Historically, the term environment was used to refer to the physical world including the soil, the rocks, water, air and the living organisms that surround human beings. However, as time progresses, the definition of environment has gradually changed to incorporate human beings as an integral part of the environment and the different interactions and interrelationships that exist between the living organisms and the physical surrounding. As per the Environment Protection Act 1996, the term environment is defined as the sum of total water, air and land and the inter-relationships that exist among them and with the human beings, other living organisms and non-living materials.

 More specifically, the environment may be described as the sum total of the portions of the hydrosphere, lithosphere and the atmosphere in which life penetrates. The figure shown below shows the interrelationships that exist between human beings and the environment. The air, the water and the land that surrounds us constitute our environment and have a direct influence on our lives. In the same manner, we too have a direct influence on the environment around us due to the overexploitation or overuse of the resources around us.

## **Types of environments**

 The environment can effectively be categorized into three main categories; the biotic environment, the abiotic environment and the cultural environment.

### **Biotic environment**

Biotic refers to having to do with living organisms. The biotic elements refer to the living organisms in an ecosystem that primarily consists of animals, the plants and the microorganisms in the ecosystem. The biotic environment is made up of three distinct and different groups of organisms including the producers, the consumers and the decomposers. The producers are those living organisms with the ability to perform photosynthesis thus producing organic matter solely from solar energy and carbon dioxide that already exists in the atmosphere. The output of the photosynthesis acts as both a source of energy as well as a source of nutrients for the producers, the consumers and the decomposers.

 The consumers, on the other hand, are the living organisms that solely depend on the organic materials produced by the producers for both nutrients as well as energy. They depend on the producers for their survival. The consumers are mainly animals. Though not all animals are herbivorous, that is they feed on plants, the dependence of these animals on plants takes different forms. While other animals, such as the herbivores, are directly dependent on the producers, other such as the carnivores are indirectly dependent on the producers. The carnivores depend on the herbivores or other carnivores for nutrients and energy. The final group of organisms is called the decomposers. The decomposers depend on the dead organisms for their survival. They include organisms such as fungi and bacteria. In their efforts to survive, they decompose the materials that are released by living organisms to their original elements such as carbon and nitrogen. The biotic environment is primarily responsible for the cycling of the materials within the ecosystem.

### **Abiotic environment**

The abiotic factors in an ecosystem includes the flow of energy that is necessary to maintain the living organisms, the phsycial factors that affect the organisms and the supply of molecules and materials that are required for the life functions of the organism. According to the article by Hogan (2011), abiotic factors include any number of non-living components of a habitat. Other physical factors that make up the abiotic environment include climate, temperature, precipitation and soil. All forms of life in the environment require atoms such as carbon, nitrogen and phosphorus and molecules such as water for their survival. The living organisms obtain these atoms and molecules by consumption from the food or from the air that they take in.

 In the ecosystem, the abiotic factors perform three main functions to maintain life in the earth. First, they provide water and oxygen to the living organisms. Secondly, the elements of the abiotic factors act as a reservoir for the elements that are important and crucial for the sustenance of life including carbon, hydrogen, oxygen, nitrogen, Sulphur, and phosphorus. It is important to note that the highest fraction of living organisms is made up of these elements or the molecules formed by the reaction or combination of these elements. Thirdly, the earth only contains fixed amounts of these elements and thus the continued operations of the ecosystem require at least one of these elements. It is therefore vital for these elements to be protected and recycled because there are of critical importance to the survival and the correct functioning of the Eco systemic processes.

### **Cultural environment**

 The stages of development that human beings have attained in their path towards success determine their culture as a way of life. The interaction of the human beings with the environment greatly influences the way the ecosystem operates. People from different cultural backgrounds view and perceive their place in the society in different dimensions and angles. The main factors that shape the views of the people to their place or position in the society include their religious understanding, the economic pressures and their primary knowledge of nature and how it works. As a result of these differences in the way people perceive their environment, different people place different values to the natural world. However, a commonality among all these different cultural backgrounds is that the overall attitude is mainly on development rather than on preservation of the existing resources in the environment.

 While technology can be regarded as a key factor and component of human development and progress, it has facilitated and enhanced the quantity and the level of environmental degradation. The level and the way that people interact with their environment has significantly changed over the past two decades as a result of the massive development of technology. For instance, agricultural technology such as greenhouse farming and the application of inorganic fertilizers to facilitate a healthy growth of crops has significantly affected the well-being of the environment. The greenhouse effect, that is now a major concern to the international community, has been discussed to result from changes in the consumption and production of energy, the changing practices and activities in agriculture and the changes in the climatic conditions of the world over the past two decades.

# **Interrelation between the concepts**

 Energy enters into ecosystems in the form of light and heat from the sun, which the plants absorb for the purpose of photosynthesis. However, during the transmission of the light energy from the sun to the surface of the earth, most of the energy is lost in the form of heat energy but is continually replenished by the continued supply of light from the sun. In contract to light energy, the amount of carbon and nitrogen in the atmosphere is fixed and does not change. These components go through cycles, which are of importance to the survival of the living organisms in the earth. The following discussion seeks to describe and explain the three main cycles that affect the ecosystem in the earth.

## **The water cycle**

 Though it may not be realized, the water that is used by the population in the world is the same water that existed in the earth billions of years ago. Approximately 7% of the earth’s surface is composed of water and only the remaining 30% is terrestrial. Water in the environment is recycled over and over and does not change in quantity. The water cycle is a simple and natural cycle of evaporation, transpiration, condensation and precipitation where water continuously circulates between the earth and the atmosphere. During the process of evaporation, the heat energy from the sun heats up the millions of litters of water in the oceans, lakes, and the earth’s surface and the soil converting the liquid water into water vapor that rises into the atmosphere. Water can also enter into the atmosphere through the process of transpiration. In transpiration, water is lost from the plants through the leaves.

Water vapor is less dense than the air and thus rises to the atmosphere. However, as it rises it cools back to water drops and into ice due to the low temperatures in the atmosphere. The process in which the water vapor cools to water droplets and into clouds is called condensation. In the atmosphere, the clouds become heavy and thus fall back to the earth as gravity applies in the form of precipitation. Precipitation can be in the form of rain, snow, hail, fog or fall directly into the oceans and other water catchment areas or soaks into the surface of the earth. The cycle then repeats again.

According to Alavian et al. (2009) and Narasimhan (2009), the other processes that contribute to the water cycle include surface runoffs and water infiltration. Surface runoff is an important process to transport the precipitated water along the slopes of the earth to the streams, the rivers, lakes and oceans where evaporation takes place. They explain that it is a significant process in closing down the water cycle. Water infiltration and ground water flow are processes that are parallel to the surface runoffs. Infiltration refers to the process by which goes down through the earth to the underground water aquifers.

**The Nitrogen cycle**

The other key component for the existence of the ecosystem is nitrogen. Nitrogen forms approximately 78% of the air in the atmosphere (Smith, 2015). However, even with it forming a significant portion of the atmosphere, the plants cannot use nitrogen directly from the atmosphere as it is unreactive and thus cannot be directly used to manufacture proteins. Like water, the utilization and the production of nitrogen also takes the form of a cycle called the nitrogen cycle. The waste products of animals and plants and the remains of the dead living organisms or the food that have not been decomposed are broken down by bacteria and fungi into ammonia. Bacteria consume ammonia and produces or excretes chemicals known as nitrites. Other bacteria in the environment converts the nitrites, which are harmful to living organisms especially the aquatic life, to the non-toxic nitrates. Anaerobic bacteria then work on the nitrates to release free nitrogen into the atmosphere.

 The nitrogen cycle has numerous processes. The first process is the nitrogen fixation. Nitrogen fixation refers to the conversion of the unreactive atmospheric nitrogen into reactive compounds such as ammonia and nitrate ions. However, the breaking of the bonds between the nitrogen atoms requires significant amounts of energy. This naturally happens in two main methods namely the abiotic and the biological fixation. The primary causes of abiotic nitrogen fixation are lightning and the cosmic radiation. In abiotic fixation, Nitrogen is combined with oxygen in the presence of energy to form oxides of nitrogen which are then carried down to the surface of the earth through acidic rain. The biological fixation is done my soil microorganisms such as the aerobic or the anaerobic bacteria. In legumes, a bacteria called Rhizobium provides a direct source of ammonia to the plants. These bacteria break down molecular nitrogen into free nitrogen atoms which then combines with hydrogen to form ammonia.

 The next phase of the nitrogen cycle is the nitrification process. Nitrification refers to the process by which ammonia is oxidized to nitrite ions and then to nitrate ions. Nitrate ions is the form of nitrogen that is usable to plants. Microorganisms mainly do the process of nitrification. Two main groups of bacteria are involved during nitrification. Nitrosomas bacteria oxidizes ammonia to nitrite which the nitrobacter oxidizes the nitrite ions into nitrate ions. The next process in the nitrogen cycle is the assimilation of the nitrate ions. Ones the nitrites have been converted to nitrate ions, they can readily be assimilated by plants through the root hairs. Since the heterotrophic organisms cannot assimilate nitrogen in the same process as plants do, they depend on the assimilation of nitrogen by plants and then feeding on the plants. Moreover, since plants form the base of food chains, the nitrogen assimilated by plants continue pass from one organism to another.

 The fourth process in the nitrogen cycle is known as the ammonification process. During this process, the host of decomposing microorganisms break down nitrogenous waste and organic matter that is found in waste products from animals and the dead plants and animals and converts it back to ammonia. Ammonia is them re-absorbed back by plants as ammonium ions. The final process in the nitrogen cycle is the denitrification process. Nitrates are decomposed or broken down to gaseous nitrogen and given off to the atmosphere through this process. Denitrification occurs through both the anaerobic as well as the aerobic processes and is the reverse of the nitrification.

## **The carbon cycle**

 All life is based on the element carbon. Carbon is a major component of living this including human beings. In the planet, carbon is stored through a variety of methods. First, it is found as an organic compound in living and dead organisms in the biosphere. Secondly, carbon may be found in the atmosphere as a gas in the form of either carbon dioxide or methane. Thirdly, it may be found as organic matter in the soil. It is also found in the earth’s crust as fossil fuels and forming a component of the sedimentary rocks such as limestone. Finally, carbon is found in water sources such as oceans as dissolved hydrocarbons of as calcium carbonate in the shells of marine creatures.

 The flow of carbon between the atmosphere, hydrosphere, biosphere, pedosphere and the lithosphere is described by the carbon cycle. The carbon cycle is a great natural recycler of the carbon atoms. Similar to the other components as discussed does not change in quantity and level in the atmosphere. In the carbon cycle, the atmospheric carbon provides the link between the biological, the physical and the anthropogenic processes in the environment. During the carbon cycle, carbon is exchanged between the atmosphere, the oceans, and the terrestrial biosphere and in a more slow process with the sediments and the sedimentary rocks.

According to Wigley and Schimel (2000), over the last two decades, there have been numerous changes to the flow of carbon and thus the entire carbon cycle. Biology plays a significant role in the movement of carbon in the carbon cycle through the processes of photosynthesis and respiration. Through the process of photosynthesis, green plants use light from the sun to turn carbon dioxide from the atmosphere into carbohydrates according to the chemical reaction shown below.

Carbon dioxide + water + energy = carbohydrates + oxygen

Carbohydrates are the primary compounds that are necessary and required to build up biomass for plants and the bodies of animals. Most of the carbon from plants and animal leaves the bodies of plants and animals through the process of respiration. Respiration is the process through which dead organic matter is decomposed and is the opposite of photosynthesis. In the presence of oxygen, aerobic respiration occurs in which carbohydrates is broken down to its constituent carbon dioxide and water releasing energy in the process. The process is as shown in the equation below:

Carbohydrates + Oxygen = carbon dioxide + water + energy

After respiration, most of the produced carbon dioxide is released back to the atmosphere and then the cycle repeats. Over time, human activities have significantly disturbed free flow of carbon and the balance in the amount of carbon in the atmosphere and in the land. The resulting accumulation of carbon dioxide in the atmosphere has led to major challenges and problems including the increased changes in the global climatic conditions. Burning of the fossil fuels, industrialization and the extensive harvest of trees from the forests leads to excessive carbon dioxide in the atmosphere. Nature and the environment are the most commonly used terms in ecological studies. Human beings are perceived as a form of force that reshapes the ecosystems, favoring some different types of living organisms and destroying other types, changing the composition of the ecosystems and beginning new chains of radio activity and atomic explosions.

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