Introduction to Environmental Science EMT 201

THE ENVIRONMENT

It is everything that affects an organism during its lifetime e.g. an animal is likely to interact with millions of other organisms (bacteria, predators), mates, drink copious amount of water, breath huge quantity of air and respond daily to changes in temperature and humidity. The list is numerous and complex also. Therefore, the concept of environment has been divided into abiotic (non-living) and biotic (living) components.

ENVIRONMENTAL SCIENCE: Is an inter disciplinary area of study that includes both applied and theoretical aspect of human impact on the world, since humans are generally organized into two groups, environmental science must deal with politics, social organization, economics, ethics and philosophy. Environmental science is therefore a mixture of traditional science, individual and societal values as well as political awareness.

THE EARTH ATMOSPHERE

THE AIR: The atm or air is usually composed of 79% Nitrogen, 20% Oxygen, 1% mixture of CO_2, water vapor and small quantities of several other gases. Most of the atmosphere is held close to the earth by the pull of gravitational force, it therefore gets thinner with increasing distance from the earth. The earth's atmosphere is a thin shell of gases surrounding the globe. The thinness becomes clear when we realize that the part of the atmosphere in which all human activities takes place add less than 0.3% to the radius of the earth.

REGIONS OF THE ATMOSPHERE

The atmosphere can be divided into 4 sections based on the direction of temperature change as one proceeds from lower to higher altitudes (height above the sea level). They are:

1. Troposphere
2. Stratosphere
3. Mesosphere
4. Thermosphere
   Note; both mesosphere and thermosphere are referred to as ionosphere.

TROPOSPHERE: - (0-15km)

This is the part of the atmosphere that is closest to the earth's surface in which humans live and most biological activities occur. It lies between 0-15km and temperature decrease with altitude. The average temperature in the region in which humans live and most biological activities takes place is approximately 14^0C and the atmospheric temperature falls steadily to a value of about -60^oC at an altitude of approximately 15km. The upper boundary of the troposphere, the

troposphere marks the altitude at which the direction of temperature change reverses (temperature inversion).

STRATOSPHERE: - (15-50km)

This region lies next above the troposphere. Here, increasing altitude brings increasing temperature up to approximately -2^{o}C at 50km, the stratosphere; it marks the end of the stratosphere. This temperature profile is called an inversion. The rising temperature, decreasing density with increasing altitude result in little convective mixing and so the stratosphere is a relatively stable region. The ozone layer is also at this region.

MESOSPHERE: - (50-85km)

This region begins at the stratosphere and a second reversal in temperature occurs here. The temperature decreases in the mesosphere with increasing altitude to -90^{o}C at 85km, the mesosphere.

THERMOSPHERE: - (85-500km)

This the region above 85km the temperature increases with altitude to about 1200^{o}C at 500km, the region that lies above the stratosphere is also known as the ionosphere.

WATER:

Greatest global supply is marine water about 97% while 3% of the fresh water that humans can access is not available.

Water is one of the essentials that support all forms of plant and animal life. Many people define environmental quality by the quality of water around more than anything else. Unsafe drinking water, turbid lakes and rivers or ponds green with algae are obvious signs of a degraded environment. Water covers 73% of the earth's surface, almost thrice as much as the continent. Apart from these visible forms of H_2O, it is also an important component of the atmosphere and the terrestrial environment as well. The earths H_2O as a whole is referred to as the HYDROSPHERE or AQUATIC ENVIRONMENT. The distribution of earths H_2O is presented below.

Ocean water - 97%, and fresh water - 3%

Freshwater can further be grouped into: polar icecaps and glaciers 79%, ground water 20%, and accessible water 1%

The 1% accessible water is classified into lake water 52%, soil moisture 20%, atmospheric water vapour 8%, water in biomass 1% and river water 1%

Taking together therefore, the most visible and most available part represents less than 0.02% of the total H_2O supply on earth.

All living organism are composed of cells that contain at least 60% H_2O. Their metabolic activities take place in H_2O solutions. Organism can exist only where there is access to adequate supplies of H_2O. The unique property of water makes it remarkable. H_2O molecules are polar i.e. one part of the molecule is slightly positive and other is slightly negative. Therefore, H_2O molecules tend to stick together and they also have a great ability to separate other molecules from each other. Consequently, H_2O is extremely valuable to humans, societal and industrial activities.

THE HYDROLOGICAL CYCLE

All H_2O is locked into a constant recycling process called the hydrological cycle. Two important processes involved in the cycle are evaporation and condensation of H_2O.

Evaporation involves the addition of energy to molecules of a liquid so that it becomes a gas in which molecules are farther apart, condensation is the reverse process in which molecule of a gas gives up energy, gets closer together and become a liquid.

Solar energy provides the energy that causes water to evaporate from the ocean surface, the soil, and bodies of fresh water and from surface of plant.

SOIL:

Processes of mechanical and chemical weathering of rocks are involved in the development of both soil and land. Land is the part of the world not covered by oceans. Soil on the other hand is a thin covering over land consisting of the living organisms, organic material, air and water that together support the growth of plant life. The soil and rocks are together referred to as LAND or the LITHOSPHERE. It is also known as the terrestrial environment. The proportion of the soil component vary with different types of soil but a good agricultural soil is about 45% minerals, 25% air, 25% water and 5% organic matter. This combination provides good drainage, aeration and organic matter. Soil properties include: -

- Soil texture
- Soil structure
- Soil moisture
- Air composition of the soil
- Biotic content

- Chemical composition

Soil texture is determined by the size of the mineral particles within the soil. Soil texture refers to the way various soil particles clump together e.g. particles in sandy soils do not attach to one another and therefore have a granular structure. The particles in clay soils tend to stick to one another to form large aggregate. Other soils that have a mixture of particle sizes tend to form smaller aggregates. A good soil is friable, which means that it crumbles easily, the soil structure and its moisture content determine how friable a soil is. Sandy soils are very friable while clay soils are not. A good soil for agricultural use will crumble and has spaces for air and water. The air and H_2O content of a soil actually depends on the presence of these spaces. Soil biota abundance and diversity also depends on moisture and air content of the soil.

ECOSYSTEMS

An ecosystem is a functional unit of the environment that includes all organisms and physical features within a given area. An ecosystem therefore consists of both living or biotic and non-living or abiotic components. The biotic community is made up of producers and consumers which are distinguished by their major function.

Producers, mainly green plants manufacture their food from H_2O and CO_2 using sunlight as a source of energy. On the other hand, consumers incapable of producing their own food and therefore, consume other organism for energy and nutrition. Based on the food source, consumers can be classified into four:

1. Herbivores (plant only)
2. Carnivores (animals)
3. Omnivores (eat both plant and animal)
4. Detritus feeders or decomposers which feed on detritus either freshly dead or partially decomposed remains of plant and animals. They include: bacteria, fungi, termites and maggots.

In feeding upon detritus decomposers acquire energy and nutrients, in addition, they return simpler decomposition products such as their own waste to the soil and air where these materials can again be taken up by green plants and recycled. The physical environment comprises of Abiotic part of the ecosystem. These components include chemical substances which can be sub-divided into 2 groups:

1. Inorganic component which includes H_2O, O_2, CO_2 and essential and non-essential minerals.
2. Organic component which is mostly produced by organism include carbohydrate, fats, proteins and vitamins.

Apart from chemicals, abiotic components also include physical factor such as temperature, light, wind, all of which are manifestations of energy. It is common to picture ecosystems as being relatively untouched areas like deserts, forests, mountain etc. But areas that have been greatly changed by human activities also function as ecosystems e.g. a corn farm where the farmer intends to grow only corn; insects, carnivorous birds and decomposers are all part of the system.

An urban area, though highly modified is also an ecosystem with few producers and decomposers apart from pigeons, rats, pets, people are the major consumers in the cities.

TYPES OF ECOSYSTEM

TERRESTRIAL ECOSYSTEM: the terrestrial ecosystem is a place where two most common limiting factors are moisture and temperature, air has a drying influence and all terrestrial organisms face the threat of dehydration. To retard dehydration, animals are covered with hair, scales or feathers and they conserve internal H_2O by excreting concentrated urine and relatively dry faeces. Bark protects tree trucks and branches from drying out while leaves are covered with a waxy layer that is relatively impervious to H_2O. Soil is also vital for proper functioning of terrestrial ecosystems. It contains humus and broken down rock usually in form of sand, silt and clay; apart from being the major source of essential mineral nutrients and H_2O for plants. Different terrestrial ecosystem includes:

1. Tundra with characteristic treeless plains, low growing season temperature and a short growing season (60 days or less). The tundra is one of the least productive biomes in the world. It is also very cold.
2. The northern coniferous forest: The climate here is only slightly less severe than that in tundra. Species diversity is low.
3. Temperate deciduous forest: The climate in this biome is temperate with distinct summer and winter seasons, all regions are subject to freezing temperature species diversity is higher than that in coniferous forest.
4. Temperate grassland: The particular combination of climate, composition of parent sediment, plants make the soil in temperate grasslands exceptionally fertile. The biome is more productive than any other soil in the world.

Other types of terrestrial ecosystems include:

- Deserts
- Temperate rainforests
- Tropical rainforest
- Tropical savannah
- Tropical scrub
- Deciduous forest

ECOTONES: are transition zones that commonly separate two distinct types of ecosystems. An ecotone contains species of both ecosystem and often its own unique species as well. Ecotones therefore exhibit greater diversity of plants and animals than either of the adjacent ecosystems. This tendency towards increased diversity in an ecotone is called the edge effects.

AQUATIC ECOSYSTEM: The limiting factors here are oxygen availability and sunlight penetration. Sunlight is a limiting factor for aquatic plant life because it can penetrate only to a depth of about 30metres below the H_2O surface. Photosynthesis is therefore confined to this area which is called the EUPHOTIC ZONE. The depth of this zone may be reduced significantly by suspended a material that prevents sunlight penetration into greater depths. Fresh water ecosystem includes lakes, marshes and swamps, streams and rivers. Marine ecosystems comprises of three zones:

1. Intertidal zone
2. Neritic zone
3. Oceanic zone

The inter-tidal zone includes the shoreline between low and high tides. Land in this zone is alternately exposed to H_2O and air daily with the tidal cycle. It is rich in organic matter and dissolves oxygen. Life forms are limited to burrowing organisms like crabs, snails, worms etc.

The neritic zone extends from the shoreline to the edge of the continental shelf where H_2O depth is about 180metres. Sea life is abundant and very diverse throughout the depths of this zone. This zone accounts for only about 10% of the ocean's surface.

Oceanic zone covers the deep H_2O that stretches beyond the edge of the continental shelf. It is enormous in area but quite unproductive. Raw materials of photosynthesis are not present together in sufficient quantities while there is enough light near the surface, nutrients are limiting in the euphotic zone. Open oceans are therefore biological deserts, their productivity is comparable to terrestrial deserts.

HUMAN ACTIVITIES

Farming was the first profession man ever knew, it came with its own associated impact on the environment. Human activities have made an impact on the environment.

AGRICULTURE: - From these man discovered flint i.e. fire (which causes the inflow of CO, CO_2 and other gases in the atmosphere), man then advances into using sharp stones for farming.

Human have undertaken quite a number of activities since creation. One of the earliest activities was farming which was referred to as tilling the soil and sowing seeds. This was soon followed by hunting and fishing. The method used for this activities were crude and cumbersome which in our modern day are referred to as uncivilized or primitive method.

There was need for better and efficient technique which results into higher yield and less stress. Generally, these activities placed the earth on the stress of human activities. Further in the development of mankind, certain discoveries were made leading to increased human activities; these include the discovery of flint for making fire, sharp stones for cultivation etc. further exploration of the earth led to the discovery of metals (metal ore) lead to another profession named blacksmithing.

Population increase/explosion of population was also a major factor resulting in increased human activity in the environment.

EXAMPLE OF HUMAN ACTIVITIES:

- Agriculture
- Exploration and mining
- Transportation
- Communication
- Industrialization/technology

It is very obvious that the earth system has experienced substantial change from creation to the present day as a result of human activities. Many organism/biotic factors have changed in nature in nature own to changes in structure induced as a result of environmental factors brought about as a result of human activities abiotic factors have also experienced significant change over the last period of years ago e.g. deforestation, mining, bush burning etc.

Phenomenon's like desertification also significantly reduce the Plant population and also affect the plant system resulting into loss of habitat.

IMPACTS OF HUMN ACTIVITIES

AQUATIC ENVIRONMENY: Is vast natural resources which according to scientific findings retains the largest population/larger population than the terrestrial environment. Among the resources found in the aquatic environment include fishes, amphibians, coelenterate, sea anemones, water hyacinth, phytoplanktons, algae etc.

Aquatic activities seems to be a balanced one because for every define area there is a definite energy flow system (flood chain pattern). This means that a cycle of event of interaction between the various forms of organisms found within an ecosystem is sustained. E.g. plankton→ fishes → shark

Fishing is one major activity that affects the aquatic environment. Aquatic plants and animals naturally undergo their own life cycle resulting into the reproduction of their kinds. Interaction of

the components of the ecosystem will lead into balances in population distribution of the aquatic ecosystem.

Human activities such as fishing have been noted to have removed quite a large number of fishes from the aquatic environment, consequently leading to various degrees of imbalances in the ecosystem communities. Impacts such as these have led to loss of resources that are harvested from the aquatic environment. Excessive removal of marine resources/aquatic will also lead to loss of economy because the rate at which these resources are being removed is not the same as the rate which these resources are been re-introduced into the aquatic environment.

Indirect human activities such as the release of waste water or effluent, as a result of industrial activities into the aquatic environment may also place some degree of stress on the ecosystem adjoining the receiving point.

There are different categories of industrial waste: we have ORGANIC and IN-ORGANIC wastes.

HUMAN IMPACT ON TERRESTRIAL ENVIRONMENT

Is the most noticeable, before the advent of sedentary agriculture human have cultivated the soil in a very un-coordinated manner such that they have made remarkable changes to both the forest system and the land on which they have plied their trade i.e. practiced agriculture.

There were changes in habitat of many organisms found resident in the areas where farming was carried out.

VEGETATION

The impact of humans on the vegetation of the earth is very important because vegetation is a source of food for the world. However, vegetation is also very important as building material, in manufacturing industries, as fuel and as medicine. It was not until humans began widespread harvesting of these vegetations that the earth began to show a negative impact from this change.

The most obvious way that humans impact vegetation is by burning it both intentionally and accidentally. While fires do occur naturally, this generated by humans can harm the environment by causing dangers to animals, properties and themselves. Long time effects of fire are:

- Clearance of vegetation
- Soil erosion
- Flooding
- Wind erosion

Small fires may cause just limited damages but repeated/natural burning of areas can cause the vegetation to lose its ability to regenerate itself.

The most publicized way of destroying the world's vegetation is through deforestation. Humans have been cutting down forest for many years and for several reasons. The most alarming rate of destruction is occurring in the Tropical Rainforest (2^{nd} largest central Africa republic rainforest) where acres are removed every second. At this rate, the inevitable loss of rainforest and its ecosystem will distort nutrient cycle especially the oxygen and CO2 cycle. Loss in rainforest will also cause erosion, flooding and ultimately loss in biodiversity.

Another way through which humans destroy the vegetation is Desertification: is the spread of desert-like condition in a semi arid region and can be caused by deforestation, bad land management, poor farming technique and global climate change.

Developed countries located in Gobi desert in Sudan, Kalahari Desert and the Sahara desert are particularly subject to this problem, up to 60% of the area affected.

Regions fall prey to desertification when resident change from tradition, subsistence farming methods to crops that can be sold quickly for money (cash crops). Experts hope that through irrigation and re-vegetation, desertification can be made a reversible process.

SOIL

Soil is unique in that it depends on plants and vegetation for its existence. Yet plants depend on soil for their support, air, water and nutrients. Soils are variable in nature and there are many factors that can affect the soil chemistry make-up thereby altering the plant species it can support.

SALINIZATION AND LATERALIZATION are 2 major ways in which humans change the chemical content of the soil. Salinization is the accumulation of salt near the surface of the earth, due to evaporation, causing restricted plant growth and soil erosion. It is caused by irrigation and abstraction of H2O from the ground; this is particularly evident in the coastal regions.

Lateralization which also changes the chemical content of soil is the enrichment of soil by Al and Fe oxide. The extent to which lateralization degrades the land is not known but it can be harmful to countries with increasing population that relies heavily on land.

Humans can also cause a change in soil structure. It is important to understand the soil structure because it affects the ability of soil to retain water and soil ability to let H2O flow through it, the soil strength, the degree to which plants can penetrate the soil and the soils resistance to erosion. Soil compaction is severe in developed countries where vehicle are common. The compaction of soil retard plant growth and encourages erosion, unfortunately it is a hard process/problem to reverse because it takes years for soil to regain its original structure.

The largest problem that pertains to soil is erosion of soil which encompasses water running over the surface, rain drops breaking up the soil, and wind erosion. There are many consequences of soil erosion:

- Increased likelihood of flooding
- Landslides
- Increased sediment load leading to silting up of reservoirs.