



ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

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FOREWORD

This fascinating book "Environment and Sustainable Development" forms an appreciable contribution to the existing reservoir of knowledge and is especially intended for university students and researchers in all academic fields. The book provides a number of papers by several authors who have achieved enormous success in the teaching profession. They provided nine papers which culminate into the nine chapters of this piece as follows; Environment and Sustainable Development, Man-His Origin and nature, Science and Technology in the Society and Service of Man, Scientific Method, Man and his Energy Resources, Man and his Cosmic Environment, Introduction to the Various Areas of Science and Technology, Environmental Effects of Chemicals, Plastics, Textiles, Radiation, and other Waste, and Element of Environmental Studies. All the issues raised were decisively dealt with and are unambiguous enough for easy assimilation. As a core general studies course enshrined in the University of Delta curriculum, it should be given the importance it deserves by all who aspire for academic proficiency and excellence. This work will open new frontiers in the fast-growing concerns on environmental sustainability. I strongly recommend this book, which is a great asset, to all categories of students in tertiary institutions, researchers, lecturers, and private and public organizations. I predict that for a long time to come this book will remain a veritable tool for the attainment of quality education. I thank the authors for putting their career experience in print.

Mr Frank Avwerosuo Omoko
Permanent Secretary,
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CHAPTER SIX MAN AND HIS COSMIC ENVIRONMENT

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6.0 INTRODUCTION

Man can simply be referred to as human race. Man has a symbiotic relationship with the environment. Technological growth and development as well as advancement in scientific frontiers have led to increasing attention on man and the environment he lives in. This is due to the fact that Man's development takes place in the environment and the environment also impact man significantly. A better understanding of human cosmic environment can be of help to equip our analysis of man's activities with different components of the environment. The explanation of human cosmic environment will further provide a clearer understanding of the structure and functions of the environment and how human activities have impacted the environment.

6.1 THE ENVIRONMENT

Environment means to encircle or surround. It is the surroundings or conditions in which a person, animal, or plant lives or operates. It also includes the natural world as a whole or in a particular geographical area especially as affected by human activity. The environment includes air, water, soil, light, temperature and the presence or absence of other organisms (figure 1). A permanent change in any one of these conditions, e.g., a change in the intensity of light is a change in the environment called the external environment. All the biological and non-biological things surrounding an organism and the interrelationship that exist among them with human beings are thus included in the environment. The environment of man therefore means the forces of nature and of the planets and animals around him.

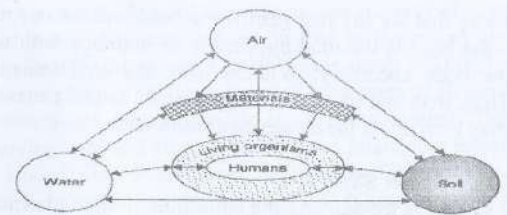


Figure 1: Illustration of the Environment (Digital Notes Environmental Science, 2015)

6.2 THE COSMIC ENVIRONMENT

The word "cosmic" is derived from the Greek "cosmos," which refers to the universe and is understood to be one structured, orderly system with interconnected pieces. The entire cosmos in which we exist is referred to as the cosmic environment, particularly those elements or characteristics that are relevant to human life, her survival, and her interests. According to astronomical studies, the earth, planets and their satellites, the galaxy (a collection of stars), the sun, and other stars are all part of the universe's structure that surrounds humans. Man's survival totally depends on the cosmos' environment, including the air, heat, water, and other natural resources from all across the universe, especially the earth and sun. The ability of the universe in which man lives and exists to support a planet like the Earth and the intricate chemistry of life is a very significant and crucial aspect of it. Man has just learned to comprehend the huge world he lives in on our planet, Earth. As a result, the term "cosmic environment" designates an area of the cosmos other than Earth or outer space, whereas the term "environment" simply refers to all forces affecting an organism from the outside. Temperature, rainfall, weather, climate, and other extrinsic elements are examples of biotic factors, which are living organisms, and abiotic factors, which are non-living organisms. Man, and his cosmic environment constantly work together and are both affected by this interaction. Man and the cosmic environment are addicted to each other

in such a way that we say that man is the head and the environment is the body- the head is the thinking faculty or brainbox with wisdom to discern the body chemistry. Without man, the environment will be useless. Thus, man and his cosmic environment is not a two-way issue but one; they both affect the existence of each other.

6.3 THE SOLAR SYSTEM

The solar system is the sun and the collection of eight planets and their moons in orbit round the sun, together with smaller bodies in the form of asteroids, meteoroids and comets. These bodies orbiting round the sun are bound to it by gravitational attraction. The planets of the solar system are (in order of distance from the sun) Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune (figure 2). The sun is one of the innumerable stars in the universe while the solar system is the Earth's cosmic home, its place of origin and development.

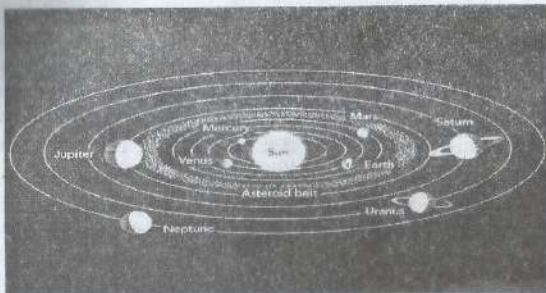


Figure 2: The Solar System (Lecture Finder, 2017)

(a) **The Sun:** The sun is the greater part of nature of a cosmic environment; it is the central fountain hood and the source of energy for all living things in the cosmic environment. The sun is responsible for all the energy and the light in the whole solar system and man's environment. The massive sun is at the center of the solar system. Due to the sun's vast gravitational influence, all of the planets orbit around it in the same plane as the sun's equator, except Pluto. Apart from the sun

and the Earth's moon, five of the planets, an occasional comet and rarely one or two of the asteroids are visible to the naked eyes. The sun's mass of 2×10^{27} tons (about 1.8×10^{30} kg) is about 330,000 times the Earth's mass and about 1000 times the combined mass of all the planets, asteroids, comets and other materials in the solar system. The entire system is moving with and among the stars and interstellar material in a large orbit around the center of our Milky Way Galaxy. The galaxy itself (which is an agglomeration of over 200 billion stars) is about a billion times larger in volume than the space of the solar system.

(b) **The Earth:** The Earth is a planet or satellite of the sun on which man lives. It is one of the nine planets which rotates on their axis and at the same time revolve around the sun. It takes the Earth approximately 24 hours (around the equator) to rotate or make a complete 360° turn on its axis. The rotation gives rise to day when that part of the earth faces the sun, and night when the part of the earth turns away from the sun. Thus, it is easy to deduce that when it is day in one part of the earth, it will be night in another part. The earth has an average radius of 6,371 km. The geophysical scientific discovery showed that the earth is divided into three parts viz: the crust, the mantle and the core (figure 3). The earth is spherical in shape with continuous motion within it in space and it is also made up of several spheres, layers or zones.



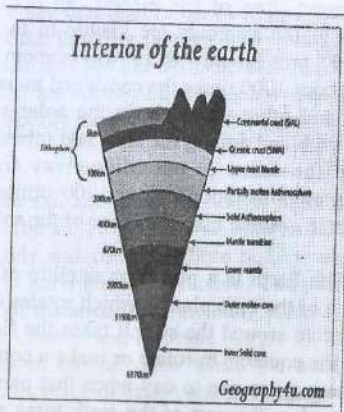


Figure 3: Structure of the Earth (Geological Survey Ireland, 2022; Geography 4u, 2019)

Spheres of the Earth (Scope of the Environment)

The Earth's external surroundings is divided into four parts-viz: the Biosphere, the Hydrosphere, the atmosphere and the lithosphere

(I) The Biosphere: This refers to the part of the earth where life exists and it includes all parts of the earth's crust, water and atmosphere where living organisms can subsist. It indicates the realm of living organisms and their interaction with the environment. The biosphere also includes the forests, grasslands, and familiar animals of the land, together with the numerous creatures that lives in the sea and atmosphere. Microorganisms like bacteria too small to be seen are the most common form of life in the biosphere. It consists of more than 1.6 million described species whereby each species lives within its own limited environmental setting. Almost the entire biosphere exists in a narrow zone extending from the depth to which sunlight penetrates the oceans (about 200m) to the snowline in the tropical and subtropical mountain

ranges (about 6000m above sea level). The biosphere is a truly remarkable part of the Earth's systems because of the factors controlling the distribution of life such as temperature, pressure and chemistry of the local environment.

(II) The Hydrosphere: This is the total mass of water on the surface of man's planet earth. Water covers about 71% of the earth's surface while 98% of this water is in the oceans; only 2% is in the streams, lakes, groundwater, polar icecaps and glaciers. This is the reason why the earth is called the "water planet". It has been estimated that if all the irregularities of earth's surface were smoothed out to form a perfect square, a global ocean would cover the earth to a depth of 2.25km. Water permitted life to evolve and flourish; every inhabitant on earth is directly or indirectly controlled by it. All of earth's weather patterns, climate, rainfall and even the amount of carbon dioxide in the atmosphere are influenced by the water in the oceans. The hydrosphere is in constant motion; water evaporates from the oceans and moves through the atmosphere, precipitating as rain and snow and returning to the sea in rivers, glaciers and groundwater. As water moves over the earth's surface, it erodes and transports weathered rock materials and deposits it. These actions constantly modify earth's landscape such that many earth's distinctive features are formed by action of the hydrosphere.

(III) The Atmosphere: This refers to the gaseous envelope (air) or the protective blanket of gases surrounding the earth. The atmosphere is of mixed gases consisting of nitrogen (78%), oxygen (21%), argon (0.9%), carbon dioxide (0.04%) and water vapour. The atmosphere is particularly significant because it moves easily and is constantly interacting with the ocean and land. It plays a part in the evolution of most features of the landscape and it sustains life on the earth. It as well saves human beings or living organisms from the hostile environment of outer space by absorbing most of the cosmic rays from the outer space and a major portion of the electromagnetic radiation from the sun. The atmosphere transmits only ultra violet, visible, near infra-red radiation

(300 to 2500 nanometer (nm)) and radio waves (0.14 to 40nm) while filtering out tissue-damaging ultra violet waves or radiation below 300nm. The atmosphere is divided into several layers of different thickness and densities.

Layers (Zones) of the Atmosphere: The atmosphere is made up of several layers or zones from the earth surface based on temperature, chemical composition and electric properties. They are: (i) the troposphere; (ii) the stratosphere; (iii) the mesosphere; (iv) the thermosphere; and (v) the exosphere.

(IV) The Lithosphere: This is the solid, strong and rigid outer layer of the solid planet earth. The lithosphere includes the crust and the uppermost part of the mantle of the solid earth. It varies greatly in thickness, from as little as 10km in some oceanic areas to as much as 300km in some continental areas. The lithosphere consists of minerals, organic matter, air and water occurring in the earth's crust and the soil as shown in figure 3.

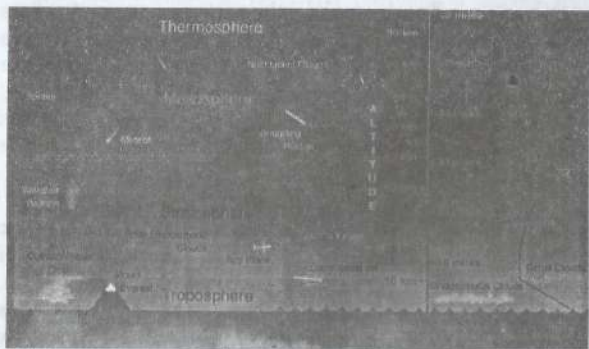


Figure 4: Layers of the Atmosphere (Lecture Finder, 2017)

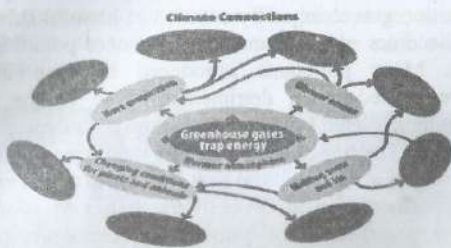
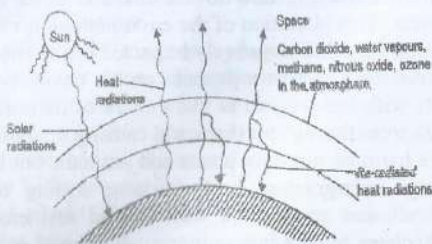
6.4 Effect of Man's Activities and Innovations on the Cosmic Environment

For normal and healthy living, a conducive environment is required by all the humans, livestock, plants, microorganisms and wild life.

However, because of man's quest for knowledge about his environment since creation, he started learning how to use fire and other tools to modify his environment. This alteration of the environment has resulted to increase in technology that has negatively impacted the environment. Hence, man has continued to act as a parasite on his environment by taking what he wants with little regard to the welfare of its host. He is engaged in a war with trees throughout the world causing disruption and deforestation that are harming not only plants and animals, but humans as well. Tree-cutting, over-grazing, bush burning, killing of wild animals for both foods and sports, and wide spread soil erosion is turning millions of hectares of land into unredeemable desert each year. The favourable unpolluted environment has a specific composition; when this composition gets changed by addition of harmful substances, the environment becomes polluted and the substances polluting it are called pollutants. Many pollutants introduced by man into the environment have caused much detrimental havoc to the cosmic environment resulting in global warming and ozone layer depletion.

(i) Global Warming: The troposphere which is the lowermost layer of the atmosphere, traps heat by a natural process due to the presence of certain gases. This effect is called Green House Effect as is similar to the warming effect observed in the horticultural greenhouse made of glass. The amount of heat trapped in the atmosphere depends mostly on the concentrations of the "heat trapping" or "greenhouse" gases and the length of time they stay in the atmosphere. The major heat trapping gases or greenhouse gases are carbon dioxide, ozone, methane, nitrous oxide, chlorofluorocarbons (CFCs) and water vapour. Heat trapped by greenhouse gases in the atmosphere keeps the planet warm and is called global warming. Thus, greater concentrations of greenhouse gases mean more solar radiation is trapped within the Earth's atmosphere, making temperatures rise.

Figure 5: Radiation from the Sun showing heat trapping (Greenhouse) gases in the troposphere (Elder, 2020)



Green House Effect/Effect of Green House Gases: The enhanced greenhouse effect will not only cause global warming; it will also affect various other climatic and natural processes such as:

- (a) **Global Temperature Increase:** It is estimated that the earth's mean temperature will rise between 1.5 to 5.5°C by 2050 if input of greenhouse gases continues to rise at the present rate. Even at the lower value, earth would be warmer than it has been 10,000 years ago.
- (b) **Rise in Sea Level:** With the increase of global temperature, sea water will expand. Heating will melt the polar ice sheets and glaciers resulting in further rise in sea level. Current model indicates that an increase in the average atmospheric temperature of 3°C would raise the average global sea level by 0.2-1.5 metres over the next 50-100 years.

One metre rise in sea level will inundate low lying areas of cities like Shanghai, Cairo, Bangkok, Sydney, Hamburg and Venice as well as agricultural lowlands and deltas in Egypt, Bangladesh, India and China, and will affect rice productivity. This will also disturb many commercially important spawning grounds, and would probably increase the frequency of storm damage to lagoons, estuaries and coral reefs.

(c) **Effect on Human Health:** The global warming will lead to changes in the rainfall pattern in many areas, thereby affecting the distribution of vector-borne diseases like malaria, filariasis, and elephantiasis. Areas which are presently free from diseases such as malaria, schistosomiasis, and filariasis may become the breeding grounds for the vectors of such diseases. The countries likely to be affected in this manner are Nigeria, Ethiopia, Kenya and Indonesia. Warmer temperature and more water stagnation would favour the breeding of mosquitoes, snails and some insects which are the vectors of such diseases. Higher temperature and humidity will increase/aggravate respiratory and skin diseases.

(d) **Effects on Agriculture:** Tropical and subtropical regions will be more affected since the average temperature in these regions is already on the higher side. Even a rise of 2°C may be quite harmful to crops. Soil moisture will decrease and evapotranspiration will increase, which may drastically affect wheat and maize growth/production. Increase in temperature and humidity will increase pest growth like the growth of vectors for various diseases. Pests will adapt to such changes better than the crops. To cope with the changing situation, drought resistant, heat resistant and pest resistant varieties of crops have to be developed.

(ii) **Ozone Layer Depletion:** For the past 450 million years, the earth has had a natural sun screen in the stratosphere called the Ozone layer. This layer filters out harmful ultra violet (UV) radiations from the sunlight and thus protects various life forms on the earth. Ozone is a form of oxygen with three oxygen atoms (O₃). Ozone is continuously being created in the stratosphere by the absorption of shortwave ultraviolet radiations. However, some substances in the stratosphere such as chlorofluorocarbons (CFCs), 2-Fluorochloromethanes, halons,

hydrogen sulphides, lead sulphides, sulphur dioxide, nitrous oxide and carbon dioxide decomposes by UV-radiations which then reacts with ozone thereby depleting the ozone layer and resulting in the thinning of the ozone layer which is generally called Ozone hole. These ozone depleting substances are virtually man-made chemicals and gases which when released into the atmosphere, are non-reactive at the ground level, but when they drift to the stratosphere, could tear apart due to the effect of UV-radiations. Ozone layer depletion can therefore be defined as the destruction of the ozone at the stratosphere by man's production and consumption of Chlorofluorocarbons, halons and other non-environmentally friendly noxious substances.



Figure 6: Human Enhanced Greenhouse Effect (Elder, 2020)

Effects of Ozone Depletion

- (1) It allows UV-radiations to reach the earth especially UV-B. The UV-B radiations affect Deoxyribonucleic acid (DNA) and the photosynthetic chemicals. Any change in DNA can result in mutation and cancer (skin cancer).
- (2) Easy absorption of UV- rays by the lens and cornea of eyes will result in increase in incidents of cancer.
- (3) Melanin producing cells of the epidermis (important for human immune system) will be destroyed by UV-rays resulting in immune-suppression. Fair people will be at a greater risk of UV-exposure because they cannot produce enough melanin.

(4) Arising from the fact that phytoplankton are sensitive to ultra violet exposures, ozone depletion will result in decrease in their population thereby affecting the population of zooplankton, fish, marine animals, and infaci, the whole aquatic food chain.

(5) Yield of vital crops like corn, rice, soybean, cotton, bean, pea, sorghum and wheat will decrease.

(6) Degradation of paints, plastics and other polymer material will result in economic loss due to effects of UV-radiations from ozone depletion

5.5 Achieving Sustainable Development in Man's Cosmic Environment

Due to the alteration of the environment by man, it has become imperative for mankind to evolve an intelligent approach to the sustainable exploitation of the environment for the survival of mankind. For instance, climate systems have collapsed due to the huge quantities of greenhouse gases being released into the atmospheric environment over the last 100 years from industries and high-flying aircrafts. And more is being released everyday such that future generation may be unstable with the climate systems of floods, storms, droughts and extreme temperatures. To this end sustainable development must be adopted.

Sustainable development is defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable development implies using the natural resources like coal, crude oil, forests in such a manner which doesn't eliminate or diminish its usefulness for future generations. Hence, the concept of sustainable development could be termed development without destruction.

As numerous industries are coming up by consuming the natural resources and releasing the toxic substances into the atmosphere thereby causing imbalance in the ecosystem, the following strategies should be adopted to reduce the greenhouse gas effects and achieve sustainable development.

- (1) Taxation of about 100-300% on industries emitting greenhouse gases or on fossil fuel producing industries. This will cause the producers who do not meet up with this tax to fold up, at least saving the situation to some reasonable extent or degree.
- (2) A gradual ban on coal production to drastically reduce the production of carbon dioxide (CO₂).
- (3) Afforestation and re-forestation should be greatly encouraged so that the vegetation could serve as a sink to some volume of CO₂.
- (4) The global population today had already crossed 7 billion and has been projected by the United Nations to reach 8.6 billion by 2030, 9.8 billion by 2050 and 11.2 billion by 2100 while the per capita availability of forests, pasture lands, crops lands and other natural resources will be decreased. Thus, world population growth rate should be checked since an increased population translates to the use of additional energy, so also is the use of more aerosol and CFCs. All these contribute to the generation of greenhouse gases.
- (5) Steps to change current energy use pattern away from fossil fuels should be encouraged. Alternative sources of energy like wave energy from the sea and solar energy could be developed in its place.

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