ANP 314: ENVIRONMENT AND ANIMAL PRODUCTION

Course Developer:

Prof. Isaac S.R. Butswat

Programme leader: Professor Grace Jokthan

Course Coordinator: Dr. Awolumate Samuel

NATIONAL OPEN UNIVERSITY OF NIGERIAN

Headquarters:
14/16 Ahmadu Bello Way,
Victoria Island,
Lagos.

Abuja Annex Office:
245 Samuel AdesujoAdemuLegun Street,
Central Business District,
Opposite Arewa Suites,
Abuja.
E-mail: Centrainfo@nou.edu.ng
url: www.nou.edu.ng

TABLE OF CONTENTS PAGE

MODULE 1

UNIT 1: CONCEPT OF THE ENVIRONMENT; COMPONENTS OF THE ENVIRONMENT

Table of Contents

1.0 Introduction

In this unit you will be studying the concept of the environment, and components of the environment. Since the environment encompasses all living and non-living things, occurring naturally on earth or some regions thereof, we shall be studying them together. Your attention shall be drawn to some particular areas.

1.1 Objectives

By the end of your studying this unit, you shall be able to: -

1. Define the natural environment;
2. Contrast the natural environment with built environment;
3. List the types of water on earth.

1.2 Concept of the environment; components of the environment

The natural environment encompasses all living and non-living things occurring naturally on Earth or some region thereof. It is an environment that encompasses the interaction of all living species. The concept of the natural environment can be distinguished by components:

- Complete ecological units that function as natural systems without massive human intervention, including all vegetation, microorganisms, soil, rocks, atmosphere and natural phenomena that occur within their boundaries.
- Universal natural resources and physical phenomena that lack clear-cut boundaries, such as air, water, and climate, as well as energy, radiation, electric charge, and magnetism, not originating from human activity.

The natural environment is contrasted with the built environment, which comprises the areas and components that are strongly influenced by humans. A geographical area is regarded as a natural environment.

It is difficult to find absolutely natural environments, and it is common that the naturalness varies in a continuum, from ideally 100% natural in one extreme to 0% natural in the other. More precisely, we can consider the different aspects or components of an environment, and see that their degree of naturalness is not uniform. If, for instance, we take an agricultural field, and consider the mineralogic composition and the structure of its soil, we will find that whereas the first is quite similar to that of an undisturbed forest soil, the structure is quite different.

Natural environment is often used as a synonym for habitat. For instance, when we say that the natural environment of giraffes is the savanna.

1.3 Definition

1.4 Earth Science

Earth science generally recognizes four (4) spheres, the lithosphere, the hydrosphere, the atmosphere and the biosphere as correspondent to rocks, water, air and life. Some scientists include, as part of the spheres of the Earth, the cryosphere (corresponding to ice) as a distinct portion of the hydrosphere, as well as the pedosphere (corresponding to soil) as an active and intermixed sphere. Earth science (also known as geosciences, the geosciences or the Earth Sciences), is an all-embracing term for the sciences related to the planet Earth. There are four (4) major disciplines in earth sciences, namely geography, geology, geophysics and geodesy. These major disciplines use physics, chemistry, biology, chronology and mathematics to build a qualitative and quantitative understanding of the principal areas or spheres of the Earth system.

1.5 Geological Activity

The Earth's crust, or lithosphere, is the outermost solid surface of the planet and is chemically and mechanically different from underlying mantle. It has been generated largely by the igneous processes in which magna (molten rock) cools and solidifies to form solid rock. Beneath the lithosphere lies the mantle which is heated by the decay of radioactive elements. The mantle though solid is in a state of rheic convection. This convection process causes the lithospheric plates to move, albeit slowly. The resulting process is known as plate tectonics. Volcanoes result primarily from the melting of sub- ducted crust material or of rising mantle at mid-ocean ridges and mantle plumes.

1.6 Water on Earth

1.6.1 Oceans

An ocean is a major body of saline water, and a component of the hydrosphere. Approximately 71% of the Earth's surface (an area of some 362 million square kilometers) is covered by ocean, a continuous body of water that is customarily divided into several principal ocean s and smaller seas. More than half of this area is over 3,000 meters (9,800 ft) deep. Average oceanic salinity is around 35 parts per thousand (ppt) (3.5%), and nearly all seawater has a salinity in the range of 30 to 38 ppt. though generally recognized as several 'separate' oceans, these waters comprise on global, interconnected body of salt water often referred to as the World Ocean or global ocean. These concept of a global ocean as a continuous body of water with relatively free interchange among its parts is of fundamental importance to oceanography. The major oceanic divisions are defined in part by the continents, various archipelagos and other criteria: these divisions are (in descending order of size) the Pacific Ocean, the Atlantic Ocean, the Indian Ocean, the Southern Ocean and the Arctic Ocean.

1.6.2 Rivers

A river is a natural watercourse, usually freshwater, flowing toward an ocean, a lake, a sea or another river. In a few cases, a river simply flows into the ground or dries up completely before reaching another body of water. Small rivers may also be termed by several other names, including stream, creek and brook. In the United States a river is generally classified as a watercourse more than 60 feet (18 meters) wide. The water in a river is usually in a channel, made up of a stream bed between banks. In larger rivers there is also a wider flood plains shaped by waters over-topping the channel. Flood plains may be very wide in relation to the size of the river channel. Rivers are a part of the hydrological cycle. Water within a river is generally collected from precipitation through surface runoff, groundwater recharge, springs and the release of water stored in glaciers and snowpack.

1.6.3 Streams

A stream is a flowing body of water with a current, confined within a bed and stream banks. Streams play an important corridor role in connecting fragmented habitats and thus in conserving biodiversity. The study of streams and waterways in general is known as surface hydrology. Types of streams include creeks, tributaries, which do not reach an ocean and connect with another stream or river, brooks, which are typically small streams and sometimes sourced from a spring or seep and tidal inlets.

1.6.4 Lakes

A lake (from Latin lacus) is a terrain feature, a body of water that is localized to the bottom of basin. A body of water is considered a lake when it is inland, is not part of an ocean, is larger and deeper than a pond, and is fed by a river.

Natural lakes on Earth are generally found in mountainous areas, roft zones, and areas with ongoing or recent glaciations. Other lakes are found in endorheic basins or along the courses of mature rivers. In some parts of the world, there are many lakes because of chaotic drainage patterns left over from the last Ice Age. All lakes are temporary over geologic time scales, as they will slowly fill in with sediments or spill out of the basin containing them.

1.6.5 Ponds

A pond is a body of standing water, either natural or man-made, that is usually smaller than a lake. A wide variety of man-made bodies of water are classified as ponds, including water gardens designed for aesthetic ornamentation, fish ponds designed for commercial fish breeding, and solar ponds designed to store thermal energy. Ponds and lakes are distinguished from streams via current speed. While currents in streams are easily observed, ponds and lakes possess thermally driven micro-currents and moderate wind driven currents. These features distinguish a pond from many other aquatic terrain features, such as stream pools and tide pools.

Student's Assessment Exercise (S. A. E.) 1.1

List any two (2) types of water on earth.

1.7 Conclusion

In this unit, you have studied the concept of the environment, the components and some regions. Various types of water are also available on earth as you studied.

Answers to Student's Assessment Exercise 1.1

Two types of water on earth are;

a. Ocean;
b. Rivers.

1.8 Summary

The natural environment encompasses all living and non-living things occurring naturally on earth or in a region. It is the environment that encompasses the interaction of all living things. The components of the environment include the various types of water on earth among other things.

1.9 Tutor Marked Assignment

Describe the various types of water on earth.

1.10 References/Further Readings

1. http://en.wikipedia.org/wiki/natural-environment,January2013

2. Bogumol Termiinski. Environmentall – included Displacement. Theoretical Frameworks and Current Challenges. http://www.cedem.ulg.ac.be/wp-content/uploads/2012/09/Environmtally-Induced-Displacement-Terminski-ipdf.

UNIT 2: CLIMATE CHANGE AND THE ENVIRONMENT

Table of Contents

2.0 Introduction

In this unit, you will be studying the effect of climate change and the environment. The principal layers of the earth's atmosphere are described, as well as other layers. Effects of global warming are also described and the environmental scientists described.

2.1 Objectives

At the end of your study of this unit, you should be able to:-

1. Describe the effects climate change and the environment
2. List the five principal layers of the earth's atmosphere;
3. Discuss the effects of Global Warming;
3. Elaborate on the goals of environmental Scientists.

2.2 Atmosphere, Climate and Weather

The atmosphere of the Earth serves as a key factor in sustaining the planetary ecosystem. The thin layer of gases that envelops the Earth is held in place by the planet's gravity. Dry air consists of 78% nitrogen, 21% oxygen, 1% argon and other inert gases, such as carbon dioxide. The remaining gases are often referred to as trace gases among which are the greenhouse gases such as water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Filtered air includes trace amounts of many other chemical compounds. Air also contains a variable amount of water vapor and suspensions of water droplets and ice crystals seen as clouds. Many natural substances may be present in tiny amounts in an unfiltered air sample, including dust, pollen and spores, sea spray, volcanic ash and meteoroids. Various industrial pollutants also may be present, such as chlorine (elementary or in compounds), fluorine compounds, elemental mercury, and sulphur compounds such as sulphur dioxide (SO_2).

The ozone layer of the Earth's atmosphere plays an important role in depleting the amount of ultraviolet (UV) radiation that reaches the surface. As DNA is readily damaged by UV light, this serves to protect life at the surface. The atmosphere also retains heat during the night, thereby reducing the temperature extremes.

2.3 Atmospheric Layers

2.4 Principal layers

Earth's atmosphere can be divided into five main layers. These layers are mainly determined by whether temperature increases or decreases with altitude. From highest to lowest, these layers are:

- Exosphere: The outermost layer of Earth's atmosphere extends from the exobase upward, mainly composed of hydrogen and helium.
- Thermosphere: The top of the thermosphere is the bottom of the exosphere, called the exobase. Its height varies with solar activity and ranges from about 350 – 800 km (220 – 500 mi; 1,100,000 – 2,600,000 ft). The International Space Station Orbits in this layer, between 320 and 380 km (200 and 240 mi)
- Mesosphere: The mesosphere extends from the stratosphere to 80 – 85 km (50 – 53 mi; 260,000 – 280,000 ft). It is the layer where most meteors burn up upon entering the atmosphere.

- Stratosphere: The stratosphere extends from the troposphere to about 51 km (32mi; 170,000ft). The stratosphere, which is the boundary between the stratosphere and mesosphere, typically is at 50 to 55 km (31 to 34mi; 160,000 ft to 180,000ft).
- Troposphere: The troposphere begins at the surface and extends to between 7km (23,000 ft) at the poles and 17km (56,000ft) at the equator, with some variation due to weather. The troposphere is mostly heated by transfer of energy from the surface, so on average the lowest part of the troposphere is warmest and temperature decreases with altitude. The troposphere is the boundary between the troposphere and stratosphere.

2.5 Other Layers

Within the five principal layers determined by temperature are several layers determined by other properties.

- The ozone layer is contained within the stratosphere. It is mainly located in the lower portion of the stratosphere from about 15 – 35 km (9.3 – 22 mi; 49,000 – 110,000 ft), though the thickness varies seasonally and geographically. About 90% of the ozone in our atmosphere is contained in the stratosphere.
- The ionosphere, the part of the atmosphere that is ionized by solar radiation, stretches from 50 to 1,000 km (31 to 620mi; 160,000 to 3,300,000 ft) and typically overlaps both the exosphere and the thermosphere. It forms the inner edge of the magnetosphere.
- The homosphere and heterosphere. The homosphere includes the troposphere, stratosphere, and mesosphere. The upper part of the heterosphere is composed almost completely of hydrogen, the lightest element.
- The planetary boundary layer is the part of the troposphere that is nearest the Earth's surface and is directly affected by it, mainly through turbulent diffusion.

2.6 Effects of Global Warming

The potential dangers of global warming are being increasingly studied by a wide global consortium of scientists. These scientists are increasingly concerned about the potential long-term effects of global warming on our natural environment and on the planet. Of particular concern is how climate change and global warming caused by anthropogenic, or human-made releases of greenhouse gases, most notably carbon dioxide, can act interactively, and have adverse effects upon the planet, its natural environment and humans' existence. Efforts have been increasingly focused on the mitigation of greenhouse gases that are causing climatic changes, on developing adaptive strategies to global warming to assist humans, animal and plant species, ecosystems, regions and nations in adjusting to the effects of global warming. Some examples of recent collaboration to address climate change and global warming include:

- The United Nations Framework Convention Treaty and convention on Climate Change, to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.
- The Kyoto Protocol, which is the protocol to the international Framework Convention on Climate Change treaty, again with the objective of reducing greenhouse gases in an effort to prevent anthropogenic climate change.

- The Western Climate Initiative, to identify, evaluate and implements collective and cooperative ways to reduce greenhouse gases in the region, focusing on a market-based cap-and trade system.

A significantly profound challenge is to identify the natural environmental dynamics in contrast to environmental changes not within natural variances. A common solution is to adapt a static view neglecting natural variances to exist. Methodologically, this view could be defended when looking at processes which change slowly and short time series, while the problem arrives when fast processes turns essential in the object of the study.

2.6.1 Climate

Climate encompasses the statistics of temperature, humidity, atmospheric pressure, wind, rainfall, atmospheric particle count and numerous other meteorological elements in a given region over long periods of time. Climate can be contrasted to weather, which is the present condition of these same elements over periods up to two weeks.
Climate can be classified according to the average and typical ranges off different variables, most commonly temperature and precipitation. The most commonly used classification scheme is the one originally developed by Wildimir Koppen. The Thornthwaite system, in use since 1948, incorporates evapotranspiration in addition to temperature and precipitation information and is used I studying animal species diversity and potential impacts of climate changes.

2.6.2 Weather

Weather is a set of all the phenomena occurring in a given atmospheric area at a given time. Most weather phenomena occur in the troposphere, just below the stratosphere. Weather refers, generally, to day–to-day temperature and precipitation activity, whereas climate is the term for the average atmospheric conditions over longer periods of time. When used without qualification, "weather" is understood to be the weather of Earth.

Weather occurs due to density (temperature and moisture) differences between one place and another. These differences can occur due to the sun angle at any particular spot, which varies by latitude from the tropics. The strong temperature contrast between polar and tropical air rise to the jet stream. Weather systems in the mid-latitudes, such as extratropical cyclones, are caused by instabilities of jet stream flow. Because the Earth's axis is tilted relative to its orbital plane, sunlight is incident at different angles at different times of the year. On the Earth's surface, temperatures usually range + 40 ^{o}C (100 ^{o}F to – 40 ^{o}F) annually. Over thousands of years, changes in the Earth's orbit have affected the amount and distribution of solar energy received by the Earth and influence long-term climate.

Surface temperature differences in turn cause pressure differences. Higher altitudes are cooler than lower altitudes due to differences in compressional heating. Weather forecasting is the application of science and technology to predict the state of the atmosphere for a future time and a given location. The atmosphere is a chaotic system, and small changes to one part of the system can grow to have large effects on the system as a whole. Human attempts to control the weather have occurred throughout human history, and there is evidence that human activity such as agriculture and industry has inadvertently modified weather patterns.

2.6.3 Life

Evidence suggests that life on Earth has existed for about 3.7 billion years. All known life forms share fundamental molecular mechanisms, and based on these observations, theories on the origin of life attempt to find a mechanism from which all life originates. There are many different hypotheses regarding the path that might have been taken from simple organic molecules via pre-cellular life to protocells and metabolism.

Although there is no universal agreement on the definition of life, scientists generally accept that the biological manifestation of life is characterized by organization, metabolism, growth, adaptation, response to stimuli and reproduction. Life may also be said to be simply the characteristic state of organisms. In biology, the science of living organisms, “life” is the condition which distinguishes active organisms from inorganic matter, including the capacity for growth, functional activity and the continual change preceding death.

A diverse variety of living organisms (life forms) can be found in the biosphere on Earth, and properties common to these organisms – plants, animals, fungi, protists, archaea, and bacteria – are a carbon – and water-based cellular form with complex organization and heritable genetic information. Living organisms undergo metabolism, maintain homeostasis, possess a capacity to grow, respond to stimuli, reproduce and, through natural selection, adapt to their environment in successive generations. More complex living organisms can communicate through various means.

2.6.4 Ecosystems

An ecosystem (also called as environment) is a natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the non-living physical (abiotic) factors of the environment.

Central to the ecosystem concept is the idea that living organisms are continually engaged in a highly interrelated set of relationships with every other element constituting the environment in which they exist. Eugene Odum, one of the founders of the science of ecology, stated: “Any unit that includes all of the organisms (i.e.: the “community”) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (i.e.: exchange of materials between living and non-living parts) within the system is an ecosystem.”

The human ecosystem concept is then grounded in the deconstruction of the human/nature dichotomy, and the emergent premise that all species are ecologically integrated with each other, as well as with the abiotic constituents of their biotope.

A greater number or variety of species or biological diversity of an ecosystem may contribute to greater resilience of an ecosystem, because there are more species present at a location to respond to change and thus “absorb” or reduce its effects. This reduces the effect before the ecosystem’s structure is fundamentally changed to a different state. This is not universally the case and there is no proven relationship between the species diversity of an ecosystem and its ability to provide goods and services on a sustainable level.

The term ecosystem can also pertain to human-made environments, such as human ecosystems and human-influenced ecosystems, and can describe any situation where there is relationship between living organisms and their environment. Fewer areas on the surface of the earth today exist free from human contact, although some genuine wilderness areas continue to exist without any forms of human intervention.

2.6.5 Biomes

Biomes are terminologically similar to the concept of ecosystems, and are climatically and geographically defined areas of ecologically similar climate conditions on the Earth, such as communities of plants, animals, and soil organisms, often referred to as ecosystems. Biomes are defined on the basis of factors such as plant structures (such as trees, shrubs, and grasses), leaf types (such as broadleaf and needleleaf), plant spacing (forest, woodland, savanna), and climate. Unlike ecozones, biomes are defined by genetic, taxonomic, or historical similarities. Biomes are often identified with particular patterns of ecological succession and climax vegetation.

2.6.6 Biogeochemical Cycles

Global biogeochemical cycles are critical to life, most notably those of water, oxygen, carbon, nitrogen and phosphorus.

- The nitrogen cycle is the transformation of nitrogen and nitrogen-containing compounds in nature. It is a cycle which includes gaseous components.
- The water cycle is the continuous movement of water on, above, and below the surface of the Earth. Water can change states among liquid, vapor, and ice at various places in the water cycle. Although the balance of water on Earth remains fairly constant over time, individual water molecules can come and go.
- The carbon cycle is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth.
- The oxygen cycle is the movement of oxygen within and between its three main reservoirs: the atmosphere, the biosphere, and the lithosphere. The main driving factor of the oxygen cycle is photosynthesis, which is responsible for the modern Earth’s atmospheric composition and life.
- The phosphorus cycle is the movement of phosphorus through the lithosphere, hydrosphere, and biosphere. The atmosphere does not play a significant role in the movements of phosphorus, because phosphorus and phosphorus compounds are usually solids at the typical ranges of temperature and pressure found on Earth.

2.6.7 Wilderness

Wilderness is generally defined as a natural environment on Earth that has not been significantly modified by human activity. The WILD Foundation goes into more detail, defining wilderness as: “The most intact, undisturbed wild natural areas left on our planet – those last truly wild places that humans do not control and have not developed with roads, pipelines or other industrial infrastructure.” Wilderness areas and protected parks are considered important for the survival of certain species, ecological studies, conservation, solitude, and recreation. Wilderness is deeply valued for cultural, spiritual, moral, and aesthetic reasons. Some nature writers believe wilderness areas are vital for the human spirit and creativity.

The word, “wilderness”, derives from the notion of wildness; in other words that which is not controllable by humans. The word’s etymology is from the Old English *wildeornes,* which in turn derives from wildeor meaning wild beast (wild + deor = beast, deer). From this point of view, it is the wildness of a place that makes it a wilderness. The mere presence or activity of people does not disqualify an area from being “wilderness.” Many ecosystems that are, or have been, inhabited or influenced by activities of people may still be considered “wild.” This way of looking at wilderness includes areas within which natural processes operate without very noticeable human interference.

Wildlife includes all non-domesticated plants, animals and other organisms. Domesticating wild plant and animal species for human benefit has occurred many times all over the planet, and has a major impact on the environment, both positive and negative. Wildlife can be found in all ecosystems. Deserts, rain forest, plains, and other areas – including the most developed urban sites – all have distinct forms of wildlife. While the term in popular culture usually refers to animals that are untouched by human factors, most scientists agree that wildlife around the world is impacted by human activities.

2.6.8 Challenges

It is the common understanding of natural environment that underlies environmentalism – a broad political, social and philosophical movement that advocates various actions and policies in the interest of protecting what nature remains in the natural environment, or restoring or expanding the role of nature in this environment. While true wilderness is increasingly rare, wild nature (e. g., unmanaged forests, uncultivated grasslands wildlife, wildflowers) can be found in many locations previously inhabited by humans.

2.6.9 Goals

Goals commonly expressed by environmental scientists include:

- Reduction and clean up of pollution, with future goals of zero pollution;
- Cleanly converting non-recyclable materials into energy through direct combustion or after conversion into secondary fuels;
- Reducing social consumption of non-renewable fuels;
- Development of alternative, green, low-carbon or renewable energy sources;
- Conservation and sustainable use of scarce resources such as water, land and air;

- Protection of representative or unique or pristine ecosystems;
- Preservation of threatened and endangered species extinction;
- The establishment of nature and biosphere reserves under various types of protection; and, most generally, the protection of biodiversity and ecosystems upon which all human and other life on Earth depends.

Very large development projects – megaprojects – pose special instructions and risks to the natural environments. Major dams and power plants are cases in point. The challenge to the environment from such projects is growing because more and bigger megaprojects are being built, in developed and developing nations alike.

Student's Assessment Exercise (S.A. E.) 2.1

State any goal commonly expressed by environmental scientists:

2.7 Conclusion

Climate change affects the environment, in most cases negatively. The goals of the environmental scientists in preserving the environment for sustained use and protection should always be taken into consideration when humans engage in certain elaborate activities on the environment.

Answers to Self Assessment Exercise 2.1

Reduction and clean up of pollution, with future goals of zero pollution.

2.8 Summary

In this unit, you have had an overview of the effects o climate change and environment. Because the effects in most cases are negatively, it is paramount that we consider more seriously the goals environmental scientists in our day to day activities.

2.9 Tutor Marked Assignment

1. Describe five (5) goals commonly expressed by environmental scientists.

2.10 References/Further Readings:

1. Upadhayay R. C. (2010). Animal Milk Production Loss Due to Global Warming, Animal Physiology. Nation Dairy Research Institute (NDRI). Press Trust of India/New Delhi, September 26.

2. Noelle O'Brien (2001). Risk Mitigation and Disaster Management Among Rural Communities in Cambodia. (www.europe.eu.int/comm../echo/pdf-files/leaflet/risk-combodia-en.pdf).

3. Johnson, D. L; Ambrose, S. H; Bassett, T. J; Bowen, M. L; Crummey, D. E; Isaacson, J. S; Johnson, D. N; Lamb, P. et al. (1997). "Meanings of Environmental Terms". Journal of Environmental Quality 26 (3): 581 – 589.

MODULE 2

UNIT 3: ENVIRONMENTAL DEGRADATION AND ITS CONSEQUENCES

Table of Contents

3.0 Introduction

In this unit, upon study, you will understand what environmental degradation is, its effects on the ecosystems and the extinction of wildlife. You will also get to understand that environmental degradation is one of the Ten Threats officially cautioned by the High Level Threat Panel of the United Nations. Other consequences of the degradation are also described in this unit.

3.1 Objectives

At the end of your study in this unit, you should be able to:-

1. Define the consequences of environmental degradation;
2. Discuss the consequences of environmental degradation;
3. Elaborate on the effects of environmental degradation on Agriculture.

3.2 Environmental Degradation

Environmental degradation is the deterioration of the environment through depletion of resources such as air, water and soil, the destructions of ecosystems and the extinction of wildlife. It is defined as any change or disturbance to the environment perceived to be deleterious or undesirable.

Environmental degradation is one of the Ten Threats officially cautioned by the High Level Threat Panel of the United Nations.

The United Nations International Strategy for Disaster Reduction defines environmental degradation as *"The reduction of the capacity of the environment to meet social and ecological objectives, and need."*

Student's Assessment Exercise (S. A. E.) 3.1

State the United Nations definition of environmental degradation:
Environmental degradation is of many types. When natural habits are destroyed or natural resources are depleted, environment is degraded.

Environmental Change and Human Health, a special section of World Resources 1998 – 1999 in this report describes how preventable illness and premature deaths are still occurring in very large numbers. If vast improvements are made in human health, millions of people will be living longer, healthier lives than ever before. In these poorest regions of the world an estimated 11 million children, or about one in five, will not live to see their fifth birthday, primarily because of environment-related diseases. Child mortality is larger than the combined populations of Norway and Switzerland, and mostly due to malaria, acute respiratory infections or diarrhea – illness that are largely preventable.

3.3 Water Deterioration

One major component of environmental degradation is the depletion of the resource of fresh water on Earth. Approximately only 2.5% of all the water on Earth is fresh water, with the rest being salt water. 69% of the water is frozen in ice caps located on Antarctica and Greenland, so only 30% of the 2.5% of fresh water is available for consumption. Fresh water is an exceptionally important resource, since life on Earth is ultimately dependent on it. Water transports nutrients and chemicals within the biosphere to all forms of life, sustain both plants and animals, and molds the surface of the Earth with transportation and deposition of materials.

The current top three uses of fresh water account for 95% of its consumption; approximately 85% id used for irrigation of farmland, golf courses and parks, 6% is used for domestic purposes such as indoor bathing uses and outdoor garden and lawn use, and 4% is used for industrial purposes such as processing, washing and cooling in manufacturing centers. It is estimated that one in three people over the entire globe are already facing water shortages, almost one-fifth of the world's population live in areas of physical water scarcity and almost one quarter of the world's population live in a developing country that lacks the necessary infrastructure to use water from available rivers and aquifers. Water scarcity is an increasing problem due to many foreseen issues in the future, including population growth, increased urbanization, higher standards of living and climate change.

3.4 Climate Change and Temperature

Climate change affects the Earth's water supply in a large number of ways. It is predicted that the mean global temperature will rise in the coming years due to a number of forces affecting the climate, the amount of atmospheric CO_2 will rise, and both of these will influence water resources;

evaporation depends strongly on temperature and moisture availability, which can ultimately affect the amount of water available to replenish groundwater supplies.

Transpiration from plants can be affected by rise in atmospheric CO_2, which can decrease their use of water, but can also raise their use of water from possible increase of leaf area. Temperature increase can decrease the length of snow season in the winter and increase the intensity of snowmelt in warmer seasons, leading to peak runoff of snowmelt earlier in the season, affecting soil moisture, flood and drought risks, and storage capacities depending on the area.

Warmer winter temperatures cause a decrease in snowpack, which can result in diminished water resources during the summer. This is especially important at mid-latitudes and in mountain regions that depend on glacial runoff to replenish their river systems and groundwater supplies, making these areas increasingly vulnerable to water shortages over time; and increase in temperature will initially result in a rapid rise in water melting from glaciers in the summer, followed by a retreat in glaciers and a decreased in the melt and consequently the water supply every year as the size of these glaciers get smaller and smaller.

Thermal expansion of water and increased melting of oceanic glaciers from an increase in temperature gives way to a rise in sea level, which can affect the fresh water supply of coastal areas as well; as river mouths and deltas with higher salinity get pushed further inland, an intrusion of saltwater results in an increase of salinity in reservoirs and aquifers. Seas-level rise may also consequently be caused by a depletion of groundwater, as climate change can affect the hydrologic cycle in a number of ways. Uneven distributions of increased temperatures and increased precipitation around the globe results in water surpluses and deficits, but a global decrease in groundwater suggests a rise in sea level, even after meltwater and thermal expansion were accounted for, which can provide a positive feedback to the problems sea-level rise causes to fresh-water supply.

A rise in air temperature results in a rise in water temperature, which is also very significant in water degradation, as the water would become more susceptible to bacterial growth. An increase in water temperature can also affect ecosystems greatly because of a species' sensitivity to temperature, and also by inducing changes in a body of water's self-purification system from decreased amounts of dissolved oxygen in the water due to rises in temperature.

3.5 Climate change and precipitation

A rise in global temperatures is also predicted to correlate with an increase in global precipitation, but because of increased runoff, floods, increased rates of soil erosion, and mass movement of land, a decline in water quality is probable, while water will carry more nutrients, it will also carry more contaminants. While most of the attention about climate change is directed towards global warming and greenhouse effect, some of the most severe effects of climate change are likely to be from changes in precipitation, evapotranspiration, runoff, and soil moisture. It is generally expected that, on average, global precipitation will increase, with some areas receiving increases and some decreases.

Climate models show that while some regions should expect an increase in precipitation, such as in the tropics and higher latitudes, other areas are expected to see a decrease, such as in the subtropics; this will ultimately cause a latitudinal variation in water distribution. The areas receiving more precipitation are also expected to receive this increase during their winter and actually become drier during their summer, creating even more of a variation of precipitation distribution. Naturally, the distribution of precipitation across the planet is very uneven, causing constant variations in water availability in respective locations.

Changes in precipitation affect the timing and magnitude of floods and droughts, shift runoff processes, and alter groundwater recharge rates. Vegetation patterns and growth rates will be directly affected by shifts in precipitation amount and distribution, which will in turn affect agriculture as well as natural ecosystems. Decreased precipitation will deprive areas of water, causing water tables to fall and reservoirs and wetlands, rivers, and lakes to empty, and possibly an increase in evaporation and evapotranspiration, depending on the accompanied rise in temperature. Groundwater reserves will be depleted, and the remaining water has a greater chance of being of poor quality from saline or contaminants on the land surface.

3.6 Population growth

The available fresh water being affected by climate is also being stretched across an ever-increasing global population. It is estimated that almost a quarter of the global population is living in an area that is using more than 20% of their renewable water supply; water use will rise with population while the water is also being aggravated by decreases in stream flow and groundwater caused by climate change. Even though some areas may see an increase in freshwater supply from an uneven distribution of precipitation increase, an increased use of water supply is expected.

An increased population means increased withdrawals from the water supply for domestic, agricultural, and industrial uses, the largest of these being agriculture, believed to be the major non-climate driver of environmental change and water deterioration. The next 50 years will likely be the last period of rapid agricultural expansion, but the larger and wealthier population over this time will demand more agriculture.

Population increase over the last two decades, at least in the United States and in Nigeria, has also been accompanied by a shift to an increase in urban areas from rural areas, which concentrates the demand for water into certain areas, and puts stress on the fresh water supply from industrial and human contaminants. Urbanization causes overcrowding and increasingly unsanitary living conditions, especially in developing countries, which in turn exposes an increasingly number of people to disease. About 79% of the world’s population is in developing countries, which lack access to sanitary water and sewer systems, giving rises to disease and deaths from contaminated water and increased numbers of disease-carrying insects

3.7 Agriculture

Agriculture is dependent on available soil moisture, which is directly affected by climate dynamics, with precipitation being the input in this system and various processes being the output, such as evapotranspiration, surface runoff, drainage, and percolation into ground water. Changes in climate especially the changes in precipitation and evapotranspiratiion predicted by climate models, will directly affect soil moisture, surface runoff, and groundwater recharge.

In areas with decreasing precipitation as predicted by the climate models, soil moisture may be substantially reduced. With this in mind, agriculture in most areas needs irrigation already, which depletes fresh water supplies both by the physical use of the water and the degradation agriculture causes to the water. Irrigation increases salt and nutrient content in areas that wouldn't normally be affected, and damages streams and rivers from damming and removal of water. Fertilizers enters both human and livestock waste streams that eventually enter groundwater, while nitrogen, phosphorus, and other chemicals from fertilizer can acidify both soils and water. Certain agricultural demands may increase more than others with an increasingly wealthier global population, and meat is one commodity expected to double global food demand by 2050, which directly affects the global supply of fresh water. Cows need water to drink, more if the temperature is high and humidity is low, and more if the production system the cow is in is extensive, since finding food takes more effort. Water is needed in processing of the meat, and also in the production of feed for the livestock. Manure can contaminate bodies of freshwater, and slaughterhouses, depending on how well they are managed, contribute waste such as blood, fat, hair, and other bodily contents to supplies of fresh water.

The transfer of water from agricultural to urban and suburban use raises concerns about agricultural sustainability, rural socioeconomic decline, food security, an increased carbon footprint from imported food, and decreased foreign trade balance. The depletion of fresh water, as applied to more specific and populated areas, increases fresh water scarcity among the population and also makes populations susceptible to economic, social, and political conflict in a number of ways; rising sea levels forces migration from coastal areas to other areas farther inland, pushing populations closer together breaching borders and other geographical patterns, and agricultural surpluses and deficits from the availability of water induce trade problems and economies of certain areas. Climate change is an important cause of involuntary migration and forced displacement.

3.8 Water management

The issue of the depletion of fresh water can be met by increased efforts in water management. While water management systems are often flexible, adaptation to new hydrologic conditions may be very costly. Preventative approaches are necessary to avoid high costs of inefficiency and the need for rehabilitation of water supplies, and innovations to decrease overall demand may be important in planning water sustainability.

Water supply systems, as they exist now, were based on the assumptions of the current climate, and built to accommodate existing river flows and flood frequencies. Reservoirs are operated based on past hydrologic records, and irrigation systems on historical temperature, water availability, and crop water requirements; these may not be a reliable guide to the future. Re-examining engineering designs, operations, optimizations, and planning, as well as re-evaluating legal, technical, and economic approaches to manage water resources are very important for the future of water management in response to water degradation. Another approach is water privatization; despite its economic and cultural effects, service quality and overall quality of the water can be more easily controlled and distributed. Rationality and sustainability is appropriate, and requires limits to overexploitation and pollution, and efforts in conservation.

3.9 Conclusion

The capacity of the environment to meet social and ecological objectives is being reduced through degradation. This degradation affects or has consequences on different aspects of the environment including Agriculture.

Answers to Student's Assessment Exercise 3.1

The United Nation defines environmental degradation as "the reduction of the capacity of the environment to meet social and ecological objectives, and need".

3.10 Summary

In this unit, you have learnt what is meant by environmental degradation and the fact that it has consequences on different aspects of the environment including the supply of food.

3.11 Tutor Marked Assignment

1. Discuss exhaustively the consequences of environmental degradation on Agriculture

3.12 References/Further Readings

1. Young, Gordon J., James Dooge, and John C. Rodda. Global Water Resoursecs Issues. Cambridge UP, (2004).
2. Raliegh, Chiouth, and Henrik Urdal, "Climate Change, Environmental Degradation and Armed Conflict". Political Geography, 26, 6 (2007): 674 – 94.

3. Walladi, Bret. Understanding the Cultural Landscape. New York; Gail Ford, 2005.

UNIT 4: EFFECT OF CLIMATE FACTORS ON FARM ANIMALS (SURVIVAL, PERFORMANCE AND PRODUCTIVITY)

Table of Contents

4.0 Introduction

In this unit, you will study the effects of climate factors on farm animals as it pertains to their survival, performance and productivity. There are also suggested livestock management strategy to be adopted under climate change scenario and other coping strategies to be adopted by farmers.

4.1 Objectives

At the end of this unit, you should be able to:-

1. Discuss exhaustively the effects of climate factors on livestock performance and productivity;
2. List some livestock management strategies to be adopted under climate change scenario;
3. List some other coping strategies.

4.2 Effects of Climate Factors on Farm Animals (survival, performance and productivity)

Livestock sector both contributes to and is affected by climate change. Climate change affects livestock both directly and indirectly. Direct effects from air temperature, humidity, wind speed and other climate factors influence animal performance: growth, milk production, wool production and reproduction. The impact of climate change on animal production has been categorized as: a) availability of feed grain, b) pasture and forage crop production and quality, c) health, growth and reproduction and, d) disease and their spread. Animal health may be affected by climate change in four ways: heat-related diseases and stress, extreme weather events, adaptation of animal production systems to new environments, and emergence or re-emergence of infectious diseases, especially vector borne diseases which are critically dependent on environmental and climatic conditions. The livestock production is an integral part of mixed farming systems practiced in the entire developing countries.

Furthermore, experimental studies have been conducted on effects of season and climate and climate on production, performance and other physiological parameters of dairy animals. These studies have revealed that milk yield of crossbred cows in India (e. g., Karan Fries, Karan Swiss and other Holsten and Jersey Crosses) are negatively correlated with temperature-humidity index). The influence of climatic conditions on milk production has been also observed for local cows which are more adapted to the tropical climate of India. The estimated annual loss at present due to heat stress among cattle and buffaloes at the all-India level is 1.8 million tones, that is nearly two per cent of the total milk production in the country, amounting to a whopping over Rs 2,661 crore (Upadhaya, 2010). No such records are available in Nigeria. Heat stress has detrimental effects on the reproduction of buffaloes, although buffaloes are well adapted morphologically and anatomically to hot and humid climate. Thermal stress on tropical livestock particularly cattle and

buffaloes has been reported to decrease oestrus expression and conception rate. The length of service period and dry period of all dairy animals is increased from normal during drought. The outbreak of the disease is observed to be correlated with the mass movement of animals which in turn is dependent on the climatic factors. There are higher incidences of clinical mastitis in dairy animals during hot and humid weather due to increased heat stress and greater fly population associated with hot-humid conditions. In addition, the hot-humid weather conditions are found to aggravate the infestation of cattle ticks like: boophilus microplus, Haemaphysalis bispinosa and Hyalomma anatolicum.

Table 1: Perceived impact of climate factors on livestock sector

S.N.	Perceived impact	Percentage
1	Climate change affects agriculture and animal husbandry	78
2	Negative impact of climate change on productive performance	58.3
3	Negative impact on milk production	56.6
4	Negative impacts on lactation length	58.3
5	Positive impact on dry period	50.8
6	Negative impacts on reproductive performance	36.3
7	Decreased length and intensity of oestrous period	59.1
8	Decreased conception rate	57.5
9	Effect on livestock disease incidences	60.8
10	Increased incidences of parasitic infestation in livestock	83
11	Feed and fodder resources are decreasing	79.1
12	Shortage of dry fodder	95
13	Decrease water resources	95
14	Depletion of ground water level	82
15	Decreased availability of water for irrigation	69
16	Decreased number of natural water resources	77.5

Source: Sing et al, (2012). Climate Change Impacts on livestock and Adaptation Strategies to Sustain Livestock Production 3. Vet. Adv. 2012, 2(7): 407 – 412.

Student's Assessment Exercise (S. A. E.) 4.1

List any two (2) perceived impacts of climate change on livestock sector.

4.3 Suggested livestock management strategy to be adopted under climatic change scenario:

Over centuries, livestock producers have traditionally adapted to climate changes by building on their in-depth knowledge of the environment in which they live. Farmers own perception and local traditional knowledge help them in evolving measures and technique to deal with situations arising due to climatic vagaries. These measures and techniques are locale specific, require no external help and are inherently scientific. Documentation of such practices and techniques, farmer to farmer dissemination and sharing such innovative approaches at large platforms have helped in influencing research agenda of academic institutions and setting the priorities. A number of strategies adopted by farmers as coping strategies include both modern and traditional methods. From table 2 below; the following inferences can be easily drawn: Majority of the farmers (90%) preserve fodder crop in form of hay for adverse climatic condition; They also stored wheat straw, paddy straw, and crop residues to feed their animals in lean period; Majority of the respondents (89%) changed the planting dates; It was very interesting to note that majority of farmers (81%) did traditional prayer to get rid of adverse climatic conditions; Majority of respondents (79%) told that they provide bedding for livestock during extreme winter/cold to prevent them from cold stress; Majority of farmers (65%) were growing variety of crops (crops diversification) in their field, for e.g. vegetables, fruits, flower and other cash crop; Majority of farmers (60%) told that they sow new crop varieties which required less water (draught resistant), less time to mature (early maturing), pest resistant and well adopted for water logging area (flood resistant); Plantation fodder tree lines around animal shed/house to reduce effects of cold/heat waves was an important coping strategy adopted by most of the farmers (55%); Migration along with livestock was one of the coping strategies of many of the farmers (53%) during adverse climatic conditions; about 48 percent of the respondents kept more livestock and reduced reliance on crops; Majority of the respondents (44%) told that they destock their large animals during adverse climatic conditions and deep smaller animals, those that can well survive in the adverse conditions, required less water and feed; About 38 percent of the respondents told that they destock their livestock during adverse climatic condition; About 34 percent of the respondents told that they sold their animals to fulfill their daily requirement (food, clothes, school fee etc.); Only about 27 percent of the respondents insured their livestock; About 10 percent respondents told that they replaced exotic breeds (Holstein Frisian, Jersey) to indigenous/local breeds (Sahiwal, Haryana, Red Sindhi, Tharparker etc.) which were well adapted to native climatic conditions; Farmers told that local breeds required less water, resistant to many of the diseases and well survive in adverse climatic condition; About 8 percent of the respondents leaved livestock farming and start business/other occupation (carpentry, tailor, etc.); About 5 percent of the respondent did rain water harvesting. These practices can easily be compared to those of our farmers in Nigeria.

4.4 Other coping strategy adopted by farmers

- Provide cold water during hot and humid climate;
- Provision of shade to reduce heat stress;
- Provide fresh air/fan/cooler during extreme hot condition;
- Kept their animal outside during the night, in summer;
- Loose housing system;
- Freed their animal during adverse climatic condition in search of feed and safe place;
- Elevated animal house/shed/shelter;
- Constructing “Manchans” (hanging bamboo platforms inside houses)
- Provision of alaw (fire) in animal shed during extreme cold;
- Rotational lopping of vegetative biomass of fodder trees, shrubs, herbs and grasses;

- To minimize landslide, conserve forest, promote plantation and safe landing of running water during the rainy period;
- Coping strategies of farmers to various climate vagaries vary from household to household and region to region based on existing support system and their indigenous knowledge.

There is a serious threat of climatic changes (in the form of severe droughts, flood, intense rainfall, and landslides) undermining development programmes and millennium development goals aimed at reducing poverty. Climate induced disasters directly affect the livelihood of the farmers. Since livelihood of the farmers is based on agriculture and animal husbandry, decrease in the animal-agricultural production weakened the economic condition. Currently India is spending 2.5% of its total GDP on measures to control the adverse impact of climatic change, which is a big amount for any developing nation. That is Nigeria is not yet known. As livestock is and will play very important role in rural economy, it is necessary to find suitable solution to reduce the ill effect of climate change on livestock production.

Table 2: Livestock management strategy adopted by farmers under climatic change Scenario.

S/N.	Strategy	Percentage	Ranks
1	Change in livestock/herd composition (large animal vs. small animal during adverse climatic conditions	44	X
2	Reduction in livestock number	38	XI
3	Replacement of exotic breeds to local breeds	10	XIV
4	Keeping more livestock and reducing reliance on crops	48	IX
5	Preservation of fodder	90	I
6	Crop diversification	65	V
7	New fodder crop variety/type	60	VI
8	Change planting dates	89	II
9	Provide bedding for livestock during extreme winter/cold	79	IV
10	Plantation fodder tree lines around animal shed/house to reduce effects of cold/heat waves	55	VII
11	Selling of livestock in order to buy food	34	XII
12	Migration along with livestock during adverse climate conditions	53	VIII

13	Livestock insurance	27	XIII
14	Farming to non-farming (Business)	08	XV
15	Raining water harvesting	05	XVI
16	Tradition Prayer	81	III

Source: Sing et al, (2012). J. Vet. Adv. 2012, 2(7): 407 – 412.

4.5 Conclusion

There is a serious threat of climatic changes (in the form of severe droughts, flood, intense rainfall, and landslides) undermining development programmes and millennium development goals aimed at reducing poverty. Strategies and coping methods have to be adopted to maintain and sustain livestock survival, performance and productivity.

Answer to Student's Assessment Exercise (S. A. E.) 4.1

1. Decreased water resources;
2. Feed and fodder resources are decreasing.

4.6 Summary

In this unit, you have studied the climate factors affecting livestock survival, performance and productivity. You have also learnt some strategies to be adopted and some coping measures, to reduce the impact of the threat.

4.7 Tutor Marked assignment

List five other coping strategies that can be adopted by farmers.

4.8 References/Further Readings

1. Maurya R. K. (2010). Alternate dairy Management Practices in Draught Prone Areas of Bundelkh and Region of Uttar Pradesh. M. V. Sc. Thens, Deemed University Indian Veterinary Research Institute, Izatnagar, India.

2. Kumar S. Prasad K. D., Reb A. R. (2004). Seasonal Prevalence of Different echo-parasites Infecting Cattle and Buffaloes. BAU J. Res. 16(1): 407 – 412.

3. Singh S. K., Meena H. R., Kolekar D. V. and Singh Y. P. (2012). Climate Impacts on Livestock and Adaptation Strategies to Sustain Livestock Production. J. Vet. Adv. 2(7): 407 – 412.

MODULE 3

UNIT 5: GREENHOUSE GAS EMISSION

Table of Content

5.0 Introduction

In this unit, you will be studying greenhouse gas emission. What they are and their effects will also be elaborated. The knowledge of their sources will help you in getting to know how to reduce them.

5.1 Objectives

At the end of your study in this unit, you should be able to:-

1. Define greenhouse gases;
2. List the main greenhouse gases;
3. Elaborate on gases effects on climate change.

5.2 Greenhouse Gas emission

Gases that trap heat in the atmosphere are called greenhouse gases. This section provides information on emissions and removals of the main greenhouse gases to and from the atmosphere.

- Carbon dioxide (CO_2): Carbon dioxide enters the atmosphere through burning fossil fuels (coal, natural gas and oil). Solid waste, trees and wood products, and also as a result of certain chemical reactions (e.g. manufacture of cement). Carbon dioxide is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
- Methane (CH_4): Methane is emitted during the production and transport of coal, natural gas and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- Nitrous oxide (N_2O): Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.

- Fluorinated gases: Hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for stratospheric ozone-depleting substances e.g. chlorofluorocarbons, hydrochlorofluorocarbons and halons). These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases, they are sometimes referred to as High Global Warming Potential gases ("High GWP gases").

Student's Assessment Exercise (S. A. E.) 5.1

List the four main greenhouse gases.

5.3 Gas's Effect

Each gas's effect on climate change depends on three main factors;

How much of these are in the atmosphere?

Concentration, or abundance, is the amount of a particular gas in the air. Larger emissions of greenhouse gases lead to higher concentrations in the atmosphere. Greenhouse gas concentrations are measured in parts per million, and even parts per trillion. One part per million is equivalent to one drop of water diluted into about 13 gallons of liquid (roughly the fuel tank of a compact car).

How long do they stay in the atmosphere?

Each of these gases can remain in the atmosphere for different amounts of time, ranging from a few years to thousands of years. All of these gases remain in the atmosphere long enough to become well mixed, meaning that the amount that is measured in the atmosphere is roughly the same all over the world, regardless of the source of the emissions.

How strongly do they impact global temperatures?

Some gases are more effective than others at making the planet warmer and "thickening the Earth's blanket."

For each greenhouse gases, a Global Warming Potential (GWP) has been calculated to reflect how long it remains in the atmosphere, on average, and how strongly it absorbs energy. Gases with a higher GWP absorb more energy, per pound that gases with a lower GWP and thus contribute more to warming Earth.

5.4 Sources of Greenhouse Gas Emissions

Greenhouse gases trap heat and make the planet warmer. Human activities are responsible for almost all of the increase in greenhouse gases in the atmosphere over the last 150 years. The largest source of greenhouse gas emissions from human activities in the United States is from burning fossil fuels for electricity, heat and transportation.

EPA tracks total U.S. emissions by publishing the Inventory of U.S. Greenhouse Gases and Sinks. This annual report estimates the total national greenhouse gas mission and removals associated with human activities across the United States.

The primary sources of greenhouse gas emissions in the United States are:

- Electricity Production (34% of 2010 greenhouse gas emissions) – Electricity production generates the largest share of greenhouse gas emissions. Over 70% of the electricity comes from burning fossil fuels, mostly coal and natural gas.
- Transportation (27% of 2010 greenhouse gas emission) – Greenhouse gas emissions from transportation primarily come from burning fossil fuel for cars, trucks, ships, trains and planes. About 90% of the fuel used for transportation is petroleum based, which includes gasoline and diesel.
- Industry (21% of 2010 greenhouse gas emission) – Greenhouse gas emissions from industry primarily come from burning fossil fuels for energy as well as greenhouse gas emissions from certain chemical reactions necessary to produce goods from raw materials.
- Commercial and Residential (11% of 2010 greenhouse gas emissions) – Greenhouse gas emissions from businesses and homes arise primarily from fossil fuels burned for heat, the use of certain products that contain greenhouse gases, and the handling of waste.
- Agriculture (7% of 2010 greenhouse gas emissions) – Greenhouse gas emissions from agriculture come from livestock such as cows, agricultural soils and rice production.
- Land Use and Forestry (offset of 15% of 2010 greenhouse gas emissions) – Land areas can act as a sink (absorbing CO_2 from the atmosphere) or a source of greenhouse gas emissions. In the United States, since 1990, managed forests and other lands have absorbed more CO_2 from the atmosphere than they emit. In Nigeria, this is not measured.

5.5 Emissions and Trends

Since 1990, U. S. greenhouse gas emissions have increased by about 10%. From year to year, emissions can rise and fall due to changes in the economy, the price of fuel, and other factors. In 2010, U. S. greenhouse gas emissions increased compared to the 2009 levels. This increase was primarily due to an increase in economic output that increased energy consumption across all sectors. In addition, much warmer summer conditions resulted in an increase in electricity demand for air condition that was generated primarily by combusting coal and natural gas. In Nigeria, more use of ACs results in more of the greenhouse gas emissions.

5.6 Conclusion

Gases that trap heat in the atmosphere are called greenhouse gases. Each gas's effect on the climate change depends on three main factors i. e. how much of these are in the atmosphere, how long they have stayed in the atmosphere, and how strongly they impact global temperatures. The knowledge of the sources of these greenhouse gas emissions is important to reducing their output.

Answers to Student's Assessment Exercise 5.1

The four main greenhouse gases are: CO_2, CH_4, N_2O and fluorinated gases.

5.7 Summary

In this unit, you have learnt what greenhouse gases are, the four main ones (CO_2, CH_4, N_2O and fluorinated gases) and each gas's effect on climate change. Sources of greenhouse gas emissions were also elucidated. Precautionary measures should be taken to reduce the output of these gases since they have some deleterious effects on the climate.

5.8 Tutor Marked Assessment

1. Discuss the primary sources of greenhouse gas emissions in any developed country.

5.9 References/Further Readings

1. Adams, Simon, David Lambert (2006). Earth Science: An Illustrated Guide to Science. New York NY10001: Chelsea House. Pp 20, ISBN 0-8160-6164-5.

2. Smith, Gary A., Aurona Pun (2006). How does the Earth Work? Upper Saddle River, N. J. 07458: Pearson Practice Hall, pp 5, ISBN 0-13-034129-0

3. http://www.epa.gov/climatechange/ghgemissions/source.homejanuary2013

UNIT 6: POLLUTION

Table of contents

6.7 References/Further Readings

6.0 Introduction

As you study this unit, you will get to know what is meant by pollution, different kinds of pollution and heir control measures.

6.1 Objectives

It is the aim of this unit that at the end of your study, you should be able to:-

1. Define Pollution;
2. List the different kinds of pollution;
3. Discuss some control measures for the various kinds of pollution

6.2 Pollution

Pollution is the addition to the ecosystem of something which has a detrimental effect on it. One of the most important causes of pollution is the high rate of energy usage by modern, growing populations.

6.3 Kinds of Pollution

Different kinds of pollution are found. In this section we will discuss;

1. Air Pollution.
2. Water Pollution.
3. Land Pollution.

Student's Assessment Exercise (S. A. E) 6.1

List three main kinds of pollution:

6.3.1 Air Pollution

Air pollution is the accumulation in the atmosphere of substances that, in sufficient concentrations, endanger human health or produce other measured effects on living matter and other materials. Among the major sources of pollution are power and heat generation, the burning of solid wastes, industrial processes and especially, transportation. The six major types of pollutants are carbon monoxide, hydrocarbons, nitrogen oxides, particulates, sulfur dioxide and photochemical oxidants.

6.3.1.1 Examples of air Pollution;

- Noise Pollution – Noise pollution or unwanted sounds that are carried by air, have an irritating and detrimental effect on humans and other animals. Careful planning of streets and buildings in towns and better control over noisy vehicles may add to the control of noise pollution.
- Tobacco Smoke – Tobacco smoke is one of the major forms of pollution in buildings. It is not only the smoker who is infected, but everyone who inhales the polluted air. There is a very strong connection between smoking and lung cancer. Bronchitis is common among smokers and unborn babies of mothers who smoke also suffer from the harmful effects of smoking.
- Exhaust Gases of Vehicles – Pollution from exhaust gases of vehicles is responsible for 60% of all air pollution and in cities up to 80%. There is a large variety of harmful chemicals present in these gases, with lead being one of the most dangerous.
- Combustion of Coal – The combustion of coal without special precautions can have serious consequences. If winds do not blow away the poisonous gases, they can have fatal effects and may lead to death.
- Acid Rain – Acid rain is the term for pollution caused when sulfur and nitrogen dioxides combine with atmosphere moisture to produce highly acidic rain, snow, hail, or fog. The acid eats into the stone, brick and metal articles and pollutes water sources. Coal in South Africa is rich in sulphur and the power stations in the Mpumalanga Province could be responsible for acid rain over other areas of our country. The sulphur content of coal from Enugu in Nigeria is yet to be determined.

6.3.1.2 Control Measures

Although individual people can help to combat air pollution in their own immediate environment, efficient control can be best achieved by legislation. Some commonly enforced control measures include;

- the establishment of more smokeless zones;
- control over the kinds of fuel used in cars, aeroplanes, power stations, etc.

6.3.2 Water Pollution

Water pollution is the introduction into fresh or ocean waters of chemical, physical, or biological material that degrades the quality of the water and affects the organisms living in it. This process ranges from simple addition of dissolved or suspended solids to discharge of the most insidious and persistent toxic pollutants (such as pesticides, heavy metals and nondegradable, bioaccumulative, chemical compounds).

6.3.2.1 Examples of Water Pollution;

- Industrial Affluents – Water is discharged off, after having been used in production processes. This waste water may contain acids, alkalis, salts, poisons, oils and in some cases harmful bacteria.

- Mining and agricultural Wastes – Mines, especially gold and coal mines are responsible for large quantities of acid water. Agricultural pesticides, fertilizers and herbicides may wash into rivers and stagnant water bodies.
- Sewage Disposal and Domestic Wastes – Sewage as well as domestic and farm wastes were often allowed to pollute rivers and dams.

6.3.2.2 Control Measures

The following measures can be used to stop water pollution;

- every intelligent people should be wise enough not to pollute water in any way;
- by research and legislation, the pollution of water bodies, even though not entirely prevented, must be effectively controlled.

6.3.3 Land Pollution

Land pollution is the degradation of the Earth's land surface through misuse of the soil by poor agricultural practices, mineral exploitation, industrial waste dumping, and indiscriminate disposal of urban waste. It includes visible waste and litter as well as pollution of the soil itself.

6.3.3.1 Examples of Land Pollution;

- Soil Pollution – Soil pollution is mainly due to chemicals in herbicides (weed killers and pesticides (poisons which kill insects and other invertebrate pest). Litter is waste material dumped in public places such as streets, parks, picnic areas, at bus stops and near shops.
- Waste Disposal – the accumulation of waste threatens the health of people in residential areas. Waste decays, encourages household pests and turns urban areas into unsightly, dirty and unhealthy places to live in.

6.3.3.2 Control Measures

The following measures can be used to control land pollution:

- anti-litter campaigns can educate people against littering;
- organic waste can be dumped in places far from residential areas;
- inorganic material such as metals, glass and plastic, but also paper, can be reclaimed and recycled.

6.4 Conclusion

You have studied pollution. Its meaning, main kinds and the control measures. Pollution should be controlled because of its deleterious effects to other living organisms.

Answers to Student's Assessment Exercise 6.1

The three (3) main kinds of pollution are

(a) Air pollution;
(b) Water pollution;
(c) Land pollution.

6.5 Summary

This unit has given the meaning of pollution, its main kinds and the control measures for each of the three (3) main kinds of pollution found. The control measures should particularly be noted so as to reduce the adverse effects of pollution in the environment.

6.6 Tutor Marked Assignment

Discuss exhaustively examples of water pollution, stressing their control measures.

6.7 References/Further Readings

1. http://www.botany.uwc.ac.za/sa-ed/grade10/ecology/conservation/poll:httm January2013
2. Pritpal Kaur (2011). Environmental Sustainability: A Global Perspective. 01DA International Journal of sustainable Development Vol. 2, No. 8 pp23 – 28.

MODULE 4

Unit 7: EROSION

Table of contents

7.0 Introduction

In this unit, you will be studying erosion, the physical processes, water erosion, gravitational erosion, exfoliation and factors affecting erosion rates. Human activities that increase erosion rates are also elaborated. Global environmental effects are also discussed, as well as prevention and remediation measures in erosion.

7.1 Objectives

At the of your study of this unit, you should be able to:-

1. Define erosion;
2. List the various types of erosion;
3. Discuss the factors affecting erosion rates;
4. Elaborate on some prevention and remediation methods for erosion.

7.2 Erosion

Erosion is the process by which soil and rock are removed from the Earth's surface by natural processes such as wind or water flow, and then transported and deposited in other locations.

While erosion is a natural process, human activities have dramatically increased (by 10 – 40 times) the rate at which erosion is occurring globally. Excessive erosion causes problems such as desertification, decreases in agricultural productivity due to land degradation, sedimentation of waterways, and ecological collapse due to loss of the nutrient rich upper soil layers. Water and wind erosion are now the two primary cause of land degradation; combined, they are responsible for 84% of degraded acreage, making excessive erosion one of the most significant global environmental problems we face today.

Industrial agriculture, deforestation, roads, anthropogenic climate change and urban sprawl are amongst the most significant human activities in regards to their effect on stimulating erosion. However, there are many available alternative land use practices that can curtail or limit erosion – such as terrace –building, no-till agriculture, and revegetation of denuded soils.

7.3 Physical Processes

7.4 Water Erosion:

7.4.1 Rainfall;

There are three primary types of erosion that occur as a result of rainfall – sheet erosion, rill erosion and gully erosion. Sheet erosion is generally seen as the first and least severe stage in the soil erosion process, which is followed by rill erosion and finally gully erosion (the most severe of the three).

The impact of a falling raindrop creates a small crater in the soil, ejecting soil particles. The distance these soil particles travel (on level ground) can be as much as 2 feet vertically, and 5 feet horizontally. Once the rate of rain fall is faster than the rate of infiltration into the soil, surface runoff occurs and carries the loosened soil particles down slope. Sheet erosion is the transport of loosened soil particles by surface runoff that is flowing downhill in thin sheets.

Rill erosion refers to the development of small, ephemeral concentrated flow paths, which function as both sediment source and sediment delivery systems for erosion on hill slopes. Generally, where water erosion rates on disturbed upland areas are greatest, rills are active. Flow depths in rills are typically on the order of a few centimeters or less and slopes may be quite steep. This means that rills exhibit very different hydraulic physics than water flowing through the deeper, wider channels of streams and rivers.

Gully erosion occurs when runoff water accumulates, and then rapidly flows in narrow channels during or immediately after heavy rains or melting snow, removing soil to a considerable depth.

7.4.2 Rivers and Streams;

Valley or stream erosion occurs with continued water flow along a linear feature. The erosion is both downward, deepening the valley, and headward, extending the valley into the hillside. In the earliest stage of stream erosion, the erosive activity is dominantly vertical, the valleys have a typical V cross-section and the stream gradient is relatively steep. When some base level is reached, the erosive activity switches to lateral erosion, which widens the valley floor. In all stages of stream erosion, by far the most erosion occurs during times of flood, when more and faster-moving water is available to carry a larger sediment load. In such processes, it is not water alone that erodes: suspended abrasive particles, pebbles and boulders can also act erosively as they traverse a surface, in a process known as traction.

Bank erosion is the wearing away of the banks of a stream or river. This is distinguished from changes on the bed of the watercourse, which is referred to as scour. Erosion and changes in the form of river banks may be measured by inserting metal rods into the bank and marking the position of the bank surface along at different times.

Thermal erosion is the result of melting and weakening permafrost due to moving water. It can occur both along rivers and at the coast. Rapid river channel migration observed in the Lena River of Siberia is due to thermal erosion, as these portions of the banks are composed of permafrost-cemented non-cohesive materials. Much of this erosion occurs as the weakened banks fall in large slumps. Thermal erosion also affects the Arctic coast, where wave action and near-shore temperature combine to undercut permafrost bluffs along the shoreline and cause them to fail. Annual erosion rates along a 100-kilometer segment of the Beaufort Sea shoreline averaged 5 – 6 meters per year from 1955 to 2002.

7.4.3 Coastal Erosion;

Shoreline erosion, which occurs on both exposed and sheltered coasts, primarily occurs through the action of currents and waves but sea level (tidal) change can also play a role.

Hydraulic action takes place when air in a joint is suddenly compressed by a wave closing the entrance of the joint. This then cracks it. Wave pounding is when the sheer energy of the wave hitting the cliff or rock breaks pieces off. Abrasion or corrosion is caused by waves launching seaload at the cliff. It is the most effective and rapid form of shoreline erosion (not to be confused with corrosion). Corrosion is the dissolving of rock by carbonic acid in sea water. Limestone cliffs are particularly vulnerable to this kind of erosion. Attrition is where particles/seaload carried by the waves are worn down as they hit each other and the cliffs. This then makes the material easier to wash away. The material ends up as shingle and sand. Another significant source of erosion, particularly on carbonate coastlines, is the boring, scraping and grinding of organisms, a process termed bioerosion.

Sediment is transported along the coast in the direction of the prevailing current (longshore drift). When the upcurrent amount of sediment is less than the amount being carried away, erosion occurs. When the upcurrent amount of sediment is greater, sand or gravel banks will tend to form as a result of deposition. These banks may slowly migrate along the coast in the direction of the longshore drift, alternately protecting and exposing parts of the coastline. Where there is a bend in the coastline, quite often a buildup of eroded material occurs forming a long narrow bank (a spit). Armoured beaches and submerged offshore sandbanks may also protect parts of a coastline from erosion. Over the years, as the shoals gradually shift, the erosion may be redirected to attack different parts of the shore.

7.4.4 Glaciers;

Glaciers erode predominantly by three different processes: abrasion/scoring, plucking and ice thrusting. In an abrasion process, debris in the basal ice scrapes along the bed, polishing and gouging the underlying rocks, similar to sandpaper on wood. Glaciers can also cause pieces of bedrock to crack off in the process of plucking. In ice thrusting, the glacier freezes to its bed, and then as it surges forward, it moves large sheets of frozen sediment at the base along with the glacier. This method produced some of the many thousands of lake basins that dot the edge of the Canadian Shield. These processes, combined with erosion and transport by the water network beneath the glacier, leave moraines, drumlins, ground moraine (till), Kames, Kame deltas, moulins and glacial erratic in their wake, typically at the terminus or during glacier retreat.

7.4.5 Floods;

At extremely high flows, kolks, or vortices are formed by large volumes of rapidly rushing water. Kolks cause extreme local erosion, plucking bedrock and creating pothole-type geographical features called Rock-cu basins. Examples can be seen in the flood regions resulting from glacial Lake Missoula, which created the channeled scablands in the Columbia Basin region of eastern Washington.

7.4.6 Freezing and Thawing.

Cold weather causes water trapped in tiny rock cracks to freeze and expand, breaking the rock into several pieces. This can lead to gravity erosion on steep slopes. The scree which forms at the bottom of a steep mountainside is mostly formed from pieces of rock (soil) broken away by this means. It is a common engineering problem wherever rock cliffs are alongside roads, because morning thaws can drop hazardous rock pieces onto the road.

7.5 Wind Erosion

Wind erosion is a major geomorphological force, especially in arid and semi-arid regions. It is also a major source of land degradation, evaporation, desertification, harmful airborne dust, and crop damage – especially after being increased far above natural rates by human activities such as deforestation, urbanization, and agriculture.

Wind erosion is in two primary varieties: deflation, where the wind picks up and carries loose soil particles and abrasion, where surfaces are worn down as they are struck by airborne particles carried by wind. Deflation is divided into three categories: (1) surface creep, where larger, heavier particles slide or roll along the ground; (2) saltation, where particles are lifted a short height into the air, and bounce and saltate across the surface of the soil; and (3) suspension, where very small and light particles are lifted into the air by the wind and are often carried for long distances. Saltation is responsible for the majority (50 – 70%) of wind erosion, followed by suspension (30 – 40%), and then surface creep (5 – 25%).

Wind erosion is much more severe in arid areas, and during times of drought. For example, in the Great Plains, it is estimated that wind erosion soil loss can be as much as 6100 times greater in drought years, than in wet years.

7.6 Gravitational erosion

Mass movement is the downward and outward movement of rock and sediments on a sloped surface, mainly due to the force of gravity.

Mass movement is an important part of the erosional process, and is often the first stage in the breakdown and transport of weathered materials in mountainous areas. It moves material from higher elevations to lower elevations where other eroding agents such as streams and glaciers can then pick up the material and move it to even lower elevations. Mass-movement processes are always occurring continuously on all slopes; some mass-movement processes act very slowly; others occur very suddenly, often with disastrous results. Any perceptible down-slope movement of rock or sediment is often referred to in general terms as a landslide. However, landslides can be classified in a much more detailed way that reflects the mechanisms responsible for the movement and the velocity at which the movement occurs. One of the visible topographical manifestations of a very slow form of such activity is a scree slope.

Slumping happens on steep hillsides, occurring along distinct fracture zones, often within material like clay that, once released, may move quite rapidly downhill. They will often show a spoon-shape isostatic depression, in which the material has begun to slide downhill. In some cases, the slump is caused by water beneath the slope weakening it. In many cases it is simply the result of poor engineering along highways where it is a regular occurrence.

Surface creep is the slow movement of soil and rock debris by gravity which is usually not perceptible except through extended observation. However, the term can also describe the rolling of dislodge soil particles 0.5 to 1.0 mm in diameter by wind along the soil surface.

7.7 Exfoliation

Exfoliation is a type of erosion that occurs when a rock is rapidly heated up by the sun. This results in the expansion of the rock. When the temperature decreases again, the rock contracts, causing pieces of the rock to break off. Exfoliation occurs mainly in deserts due to the high temperatures during the day and cold temperatures at night.

7.8 Factors Affecting Erosion Rates

7.8.1 Precipitation and wind speed

Climatic factors include the amount and intensity of precipitation, the average temperature, as well as the typical temperature range, seasonality, wind speed, and storm frequency. In general, given similar vegetation and ecosystems, areas with high-intensity precipitation, more frequent rainfall, more wind, or more storms are expected to have more erosion.

Rainfall intensity is the primary determinant of erosivity, with higher intensity rainfall generally resulting in more erosion. The size and velocity of rain drops is also an important factor. Larger and higher-velocity rain drops have greater kinetic energy, and thus their impact will displace soil particles by larger distances than smaller, slow-moving rain drops.

7.8.2 Soil structure and composition

The composition, moisture, and compaction of soil are all major factors in determining the erosivity of rainfall. Sediments containing more clay tend to be more resistant to erosion than those with sand or silt, because the clay helps bind soil particles together. Soil containing high levels of organic materials are often more resistant to erosion, because the organic materials coagulate soil colloids and create a stronger, more stable soil structure. The amount of water present in the soil before the precipitation also plays an important role, because it sets limits on the amount of water that can be absorbed by the soil (and hence prevented from flowing on the surface as erosive runoff). Wet, saturated soils will not be able to absorb as much rain water, leading to higher levels of surface runoff and thus higher erosivity for a given volume of rainfall. Soil compaction also affects the permeability of the soil water, and hence the amount of water that flows away as runoff. More compacted soils will have a larger amount of surface runoff than less compacted soils.

7.8.3 Vegetative cover

Vegetation acts as an interface between the atmosphere and the soil. It increases the permeability of the soil to rainwater, thus decreasing runoff. It shelters the soil from winds, which results in decreased wind erosion, as well as advantageous changes in microclimate. The roots of the plants bind the soil together, and interweave with other roots, forming a more solid mass that is less susceptible to both water and wind erosion. The removal of vegetation increases the rate of surface erosion.

7.8.4 Topography

The topography of the land determines the velocity at which surface runoff will flow, which in turn determines the erosivity of the runoff. Longer, steeper slopes (especially those without adequate vegetative cover) are more susceptible to very high rates of erosion during heavy rains than shorter, less steep slopes. Steeper terrain is also more prone to mudslides, landslides and other forms of gravitational erosion processes.

7.9 Human Activities that Increase Erosion Rates

7.9.1 Agricultural practices

Unsustainable agricultural practices are the single greatest contributor to the global increase in erosion rates. The tillage of agricultural lands, which breaks up soil into finer particles, is one of the primary factors. The problem has been exacerbated in modern times, due to mechanized agricultural equipment that allows for deep plowing, which severely increases the amount of soil that is available for transport by water erosion. Others include mono-cropping farming on steep slopes, pesticide and chemical fertilizer usage (which kill organisms that bind soil together), row-cropping, and the use of surface irrigation. A complex overall situation with respect to defining nutrient losses from soils could arise as a result of the size selective nature of soil erosion events. Loss of total phosphorus, for instance, in the finer eroded fraction is greater relative to the whole soil. Extrapolating this evidence to predict subsequent behaviour within receiving aquatic systems, the reason is that this is more easily transported material may support a lower solution phosphorus concentration compared to coarse sized fractions. Tillage also increases wind erosion rates, by dehydrating the soil and breaking it up into smaller particles that can be picked up by the wind. Exacerbating this is the fact that most of the trees are generally removed from agricultural fields allowing winds to have long, open runs to travel over at higher speeds. Heavy grazing reduces vegetative cover and causes severe soil compaction, both of which increase erosion rates.

7.9.2 Deforestation

In an undisturbed forest, the mineral soil is protected by a layer of *leaf litter* and *humus* that cover the forest floor. These two layers form a protective mat over the soil that absorbs the impact of rain drops. They are porous and highly permeable to rainfall, and allow rainwater to slow percolate into the soil below, instead of flowing over the surface as runoff. The roots of the trees and plants hold together soil particles, preventing them from being washed away. The vegetative cover acts to reduce the velocity of raindrops that strike the foliage and stems before hitting the ground, reducing their kinetic energy. However, it is the forest floor, more than the canopy that prevents surface erosion. The terminal velocity of rain drops is reached in about 8 meters. Because forest canopies are usually higher than this, rain drops can often regain terminal velocity even after striking the canopy. However, the intact forest floor, with its layers of leaf litter and organic matter, is still able to absorb the impact of the rainfall.

Deforestation causes increased erosion rates due to exposure of mineral soil by removing the humus and litter layers from the soil surface, removing the vegetative cover that binds soil together and causing heavy soil compaction from logging equipment. Once trees have been removed by fire or logging, infiltration rates become high and erosion low to the degree the forest floor remains intact. Severe fires can lead to significant further erosion if followed by heavy rainfall.

Globally one of the largest contributors to soil loss in the year 2006 is the slash and burn treatment of tropical forests. In a number of regions of the earth, entire sectors of a country have been rendered unproductive. For example, on the Madagascar high central plateau, comprising approximately ten percent of that country's land area, virtually the entire landscape is sterile of vegetation, with gully erosive furrows typically in excess of 50 meters deep and one kilometer wide. Shifting cultivation is a farming system which sometimes incorporates the slash and burn method in some regions of the world. This degrades the soil and causes the soil to become less and less fertile.

7.9.3 Roads and Urbanization

Urbanization has major effects on erosion processes – first by denuding the land of vegetative cover, altering drainage patterns and compacting the soil during construction; and next by covering the land in an impermeable layer of asphalt or concrete that increases the amount of surface runoff and increases surface wind speeds. Much of the sediment carried in runoff from urban areas (especially roads) is highly contaminated with fuel, oil and other chemicals. This increased runoff, in addition to eroding and degrading the land that it flows over, also causes major disruption to surrounding watersheds by altering the volume and rate of water that flows through them and filling them with chemically polluted sedimentation. The increased flow of water through local waterways also causes a large increase in the rate of bank erosion.

Student's Assessment Exercise (S. A. E.) 7.1

List any three (3) human activities that increase erosion rates.

7.10 Climate Change

The warmer atmosphere temperatures observed over the past decades are expected to lead to a more vigorous hydrological cycle, including more extreme rainfall events. The rise in sea levels that has occurred as a result of climate change has also greatly increased coastal erosion rates.

Studies on soil erosion suggest that increased rainfall amounts and intensities will lead to greater rates of erosion. Thus, if rainfall amounts and intensities increase in many parts of the world as expected, erosion will also increase, unless amelioration measures are taken. Soil erosion rates are expected to change in response to change in climate for a variety of reasons. The most direct is the change in the erosive power of rainfall. Other reasons include: (a) change in plant canopy caused by shifts in plant biomass production associated with moisture regime; (b) changes in litter cover on the ground caused by changes in both plant residue decomposition rates driven by temperature and moisture dependent soil microbial activity as well as plant biomass production rate; (c) changes in soil moisture due to shifting precipitation regimes and evapo-transpiration rates, which changes infiltration and runoff ratios; (d) soil erodibility changes due to decrease in soil organic matter concentrations in soils that lead to a soil structure that is more susceptible to erosion and increased runoff due to increased soil surface sealing and crusting; (e) a shift of winter precipitation from non-erosive snow to erosive rainfall due to increasing winter temperatures; (f) melting of permafrost, which includes an erodible soil state from a previously non-erodible one; and (g) shifts in land use made necessary to accommodate new climatic regimes.

Studies by Pruski and Nearing indicated that, other factors such as land use not considered, we can expect approximately a 1.7% change in soil erosion for each 1% change in total precipitation under climate change.

7.11 Global Environmental Effects

Due to the severity of its ecological effects, and the scale on which it is occurring, erosion constitutes one of the most significant global environmental problems we face today.

7.11.1 Land degradation

Water and wind erosion are now the two primary causes of land degradation; combined, they are responsible for 84% of degraded acreage.

Each year, about 75 billion tons of soil is eroded from the land – a rate that is about 13 – 40 times as fast as the natural rate of erosion. Approximately 40% of the world's agricultural land is seriously degraded. According to the United Nations, an area of fertile soil the size of Ukraine is lost every year because of drought, deforestation and climate change. In Africa, if current trends of soil degradation continue, the continent might be able to feed just 25% of its population by 2025, according to UNU's Ghana-based Institute for Natural Resources in Africa.

The lost of soil fertility due to erosion is further problematic because the response is often to apply chemical fertilizers, which leads to further water and soil pollution, rather than allow the land to regenerate.

7.11.2 Sedimentation of aquatic ecosystems

Soil erosion (especially from agricultural activity) is considered to be the leading global cause of diffuse water pollution, due to the effects of the excess sediments flowing into the world's waterways. The sediments themselves act as pollutants, as well as being carriers for other pollutants, such as attached pesticide molecules or heavy metals.

The effect of increased sediments loads on aquatic ecosystems can be catastrophic. Silt can smother the spawning beds of fish, by filling in the space between gravel on the stream bed. It also reduces their food supply and causes major respiratory issues for them as sediment enters their gills. The biodiversity of aquatic plant and algal life is reduced and invertebrates are also unable to survive and reproduce. While the sedimentation event itself might be relatively short-lived, the ecological disruption caused by the mass die off often persists long into the future.

One of the most serious and long-running water erosion problems worldwide is the people's Republic of China, on the middle reaches of the Yellow River and the upper reaches of the Yangtze

River. From the Yellow River, over 1.6 billion tons of sediment flows into the ocean each year. The sediment originates primarily from water erosion in the Loess Plateau region of the Northwest.

7.12 Airborne dust pollution

Soil particles picked up during wind erosion are a major source of air pollution, in the form of airborne particulates – "dust". These airborne soil particles are often contaminated with toxic chemicals such as pesticides or petroleum fuels, posing ecological and public health hazards when they later land, or are inhaled/ingested.

Dust from erosion acts to suppress rainfall and changes the sky color from blue to white, which leads to an increase in red sunsets. Over 50% of the African dust that reaches the United States affects Florida. Dust events have been linked to a decline in the health of coral reefs across the Caribbean and Florida, primarily since the 1970s. Similar dust plumes originate in the Gobi desert, which combined with pollutants, spread large distances downwind, or eastward, into North America.

Tectonic effects: The removal by erosion of large amounts of rock from a particular region, and its deposition elsewhere, can result in a lightening of the load on a lower crust and mantle. This can cause tectonic or isostatic uplift in the region.

7.13 Monitoring, Measuring and Modeling Erosion

Monitoring and modeling of erosion processes can help us better understand the causes, make predictions, and plan how to implement preventative and restorative strategies. However, the complexity of erosion processes and the number of areas that must be studied to understand and model them (e. g. climatology, hydrology, geology, chemistry, physics, etc.) makes accurate modeling quite challenging. Erosion models are also non-linear, which makes them difficult to work with numerically and makes it difficult or impossible to scale up to making predictions about large areas from data collected by sampling smaller plots.

The most commonly used model for predicting soil loss from water erosion is the Universal Soil Loss Equation (USLE), which estimates the average annual soil loss A as:

$$A = RKLSCP$$

Where R is the rainfall erosivity factor, K is the soil erodibility factor, L and S are topographic factors representing length and slope and C and P are cropping management factors.

Erosion is measured and further understood using tools such as the micro-erosion meter (MEM) and the traversing micro-erosion meter (TMEM). The MEM has proved helpful in measuring bedrock erosion in various ecosystems around the world. It can measure both terrestrial and oceanic erosion. On the other hand, the TMEM can be used to track the expanding and contracting of volatile rock formations and can give a reading of how quickly a rock formation is deteriorating.

7.4 Prevention and Remediation

The most effective known method for erosion prevention is to increase vegetative cover on the land, which helps prevent both wind and water erosion. Terracing is an extremely effective means of erosion control, which has been practiced for thousands of years by people all over the world. Windbreaks (also called shelterbelts) are rows of trees and shrubs that are planted along the edges of agricultural fields, to shield the fields against winds. In addition to significantly reducing wind erosion, windbreaks provide many other benefits such as improved microclimates for crops (which are sheltered from the dehydrating and otherwise damaging effects of winds), habitat for beneficial bird species, carbon sequestration, and aesthetic improvements to the agricultural landscape. Traditional planting methods, such as mixed-cropping (instead of monocropping) and crop rotation have been shown to significantly reduce erosion rates.

Student's Assessment Exercise 7.2

Mention one method of erosion prevention.

7.15 Conclusion

In this unit, you have learnt and studied about erosion. There are various types of erosion. These are means to monitor, measure and model erosion as well as prevention and remediation methods. Because of the adverse effect of erosion on the environment, preventive and remediation methods should be employed.

Answer to Student's Assessment Exercise 7.1

The three (30 human activities that increase erosion rates are;

1. Agricultural practices;
2. Deforestation;
3. Roads and Urbanization.

Answer to Student's Assessment Exercise 7.2

One method of erosion prevention is increase vegetation cover on land.

7.16 Summary

Erosion takes place through various means like water, wind, gravitational erosion, and exfoliation. However, certain factors affect the erosion rates, such as precipitation and wind speed, soil structure and composition, vegetation cover and topography. Many human activities also increase erosion rates. As explained in this unit, monitoring, measuring and modeling erosion is crucial as are preventive and remediation steps.

7.17 Tutor Marked Assignment

Write short notes on any three (3) types of erosion.

7.18 Reference/Further Readings

1. Boardman, john, Poesen, Jean (2006). Soil Erosion in Europe. Willey, ISBN 978-0-470-85910-0.

2. Montgomery, David R. (2007). Soil Erosion and Agricultural Sustainability (http://www.pras.org/content/04/33/03268abstract) PNAS 104: 13268 – 13272.

3. Brown, John, Drake, Simon (2009). Classic Erosion. Wiley.

UNIT 8: DESRTIFICATION

Table of contents

8.0 Introduction

In this unit, you will be studying desertification, the causes, the effects as well as the spread. The example of desertification in South Africa is given, because similar information in that of Nigeria is not readily available. The crux of the matter is how desertification can be halted/controlled. These are all spelt out in this unit.

8.1 Objectives

At the end of this unit, you should be able to:-

1. Define desertification;
2. List some causes of desertification;
3. Discuss some effects of desertification;
4. Elaborate on some halting or control measures for desertification.

8.2 Desertification

Desertification is the process which turns productive into non-productive desert as a result of poor/and management. Desertification occurs mainly in semi-arid areas (average annual rainfall less than 600 mm) bordering on deserts. In the Sahel, (the semi-arid area south of the Sahara Desert), for example, the desert moved 100 km southwards between 1950 and 1975.

8.3 Causes of Desertification

- Overgrazing is the major cause of desertification worldwide. Plants of semi-arid areas are adapted to being eaten by sparsely scattered, large, grazing mammals which move in response to the patchy rainfall common to these regions. Early human pastoralists living in semi-arid areas copied this natural system. They moved their small groups of domestic animals in response to food and water availability. Such regular stock movement prevented overgrazing of the fragile plant cover.

  In modern times, the use of fences has prevented domestic and wild animals from moving in response to food availability and overgrazing has often resulted. However, when used correctly, fencing is a valuable tool of good veld management.

  The use of boreholes and windmills also allows livestock to stay all-year round in areas formerly grazed only during the rains when seasonal pans held water. Where not correctly planned and managed, provision of drinking water has contributed to the massive advance of deserts in recent years as animals gather around waterholes and overgraze the area.

- Cultivation of marginal lands, i. e. lands on which there is a high risk of crop failure and a very low economic return, for example, some parts of South Africa where maize is grown.

- Destruction of vegetation in arid regions, often for fuel wood.

- Poor grazing management after accidental burning of semi-arid vegetation.

- Incorrect irrigation practices in arid areas can cause salinization, (the buildup of salt in the soil) which can prevent plant growth.

When the practices described above coincide with drought, the rate of desertification increases dramatically.

Increasing human population and poverty contribute to desertification as poor people may be forced to overuse their environment in the short term, without the ability to plan for the long term effects of their actions. Where livestock has a social importance beyond food, people might be reluctant to reduce their stock numbers.

Student's Assessment Exercise (S. A. E.) 8.1

List one major cause of desertification.

8.4 The Effects of Desertification

Desertification reduces the ability of land to support life, affecting wild species, domestic animals, agricultural crops and people. The reduction in plant cover that accompanies desertification leads to accelerated soil erosion by wind and water. South Africa losing approximately 300 – 400 million tones of topsoil every year. As vegetation cover and soil layer are reduced, rain drop impact and run-off increases.

Water is lost off the land instead of soaking into the soil to provide moisture for plants. Even long-lived plants that would normally survive droughts die. A reduction in plant cover also result in a reduction in the quantity of humus and plant nutrients in the soil, and plant production drops further. As protective plant cover disappears, floods become more frequent and more severe. Desertification is self-reinforcing i. e. once the process has stated, conditions are set for continual deterioration.

8.5 Spread of Desertification

About one third of the world's land is arid or semi-arid. It is predicted that global warming will increase the area of desert climates by 17% in the next century. The area at risk to desertification is thus large and likely to increase.

Worldwide, desertification is making approximately 12 million hectares useless for cultivation every year. This is equal to 10% of the total area of South Africa or about 38% of the total area of Nigeria.

In the early 1980s It was estimated that, worldwide, 61% of the 3257 million hectares of all productive dry lands (lands where stock are grazed and crops grown without irrigation) were moderately to very severely desertified. The problem is clearly enormous.

8.6 Desertification in Southern Africa

About half of Southern Africa is semi-arid and thus at risk of desertification. The area already transformed into desert-like conditions is not accurately known because uncertainty surrounds the precise definition of a desert and what the original state of the vegetation was in the semi-arid areas.

The areas which are known to have deteriorated in South Africa are mainly on the southern Kalahari. The deterioration of the Karoo is less well established. It is possible that desertification of the Karoo began in the last century, when sheep were first introduced, and before good records were available for the area.

In recent years the introduction of artificial water points into the Kalahari within Botswana, together with the widespread erection of veterinary fences, has led to the rapid desertification of huge areas. Similar schemes have had the same effect in the southern Kalahari within South Africa and Bophuthatswana. In Nigeria, desertification has taken over half of the northern fringes.

8.7 How can Desertification be Halted/Control of the Environment

To halt desertification the number of animals on the land must be reduced, allowing plants to grow. Soil conditions must be made favourable for plant growth by, for example, mulching. Mulch (a layer of straw, leaves or sawdust covering the soil) reduces evaporation, suppresses weed growth, enriches soil as it rots, and prevents runoff and hence erosion. Reseeding may be very necessary in badly degraded areas. Mulching and reseeding are expensive practices.

However, the only realistic large-scale approach is to prevent desertification through good land management in semi-arid areas.

What You Can Do:

Desertification often occurs over many generations, on a very large scale and so it is difficult for individuals to take action. Some ideas for combating this problem include:

- Take part in the activities of conservation group.
- Bring overgrazing and land mismanagement to the attention of the Directorate of Resource Conservation.

8.8 Conclusion

Desertification reduces the ability of land to support life, affecting wild species, domestic animals, agricultural crops and people. To halt desertification, the number of animals on the land must be reduced, allowing plants to grow. However, the only realistic large-scale approach is to prevent desertification through good land management in semi-arid areas.

Answers to Student's Assessment Exercise 8.1

Overgrazing is a major cause of desertification worldwide.

8.9 Summary

In this unit, you have studied desertification, its causes, its effects and its spread. There are many methods of trying to halt desertification, but the only realistic large-scale approach is through good land management especially in the semi-arid areas. We are also encouraged to participate in conservation activities.

8.10 Tutor Marked Assignment

Write on the major cause of desertification.

8.11 References/Further Readings

1. World Resources 1988 – 89. WORLD RESOURCES INSTITUTE. Basic Books, New York, (1988).

2. AFRICA IN CRISIS. Lloyd Tiaber Lake, Earthscan, London, (1991).

3. Your Heart Your Planet, H. Diamond, J. Buruham and H. Tyalor, Eartheast, Cape Town, 1991.

4. http://www.botany.uwc.ac.za/envfactors/facts/desertification.html, January 2013.

MODULE 5

UNIT 9: STRATOSPHERIC OZONE

Table of contents

9.0 Introduction

In this unit, you will be studying stratospheric ozone. You will discover its importance in absorbing ultraviolet radiation from the sun, protecting life on earth. You will also learn about the two regions of the atmosphere where ozone is found and also about the ozone hole. You will also learn what ozone hole is and the series of processes that result in ozone hole. Efforts to reduce chlorofluorocarbons in the atmosphere are also discussed.

9.1 Objectives

By the end of your study in this unit, you should be able to:-

1. State the importance of atmospheric ozone;
2. Define ozone hole;
3. Discuss the series of processes that result in ozone hole.
4. Elaborate on the efforts to reduce chlorofluorocarbons in the atmosphere.

9.2 Stratospheric ozone

Stratospheric ozone is important in the earth system because it absorbs ultraviolet radiation from the sun, protecting life on earth. Ozone is a relatively rare and unstable molecule composed of three oxygen atoms O_3. The normal oxygen molecule has two oxygen atoms O_2. It is the second most common gas in the atmosphere and it is relatively stable.

Ozone is found in two regions of the atmosphere;

1. In the stratosphere at heights around 20 – 30 km, where it is produced by sunlight. This is good ozone. It is critical for life because it protects all life on earth from dangerous solar ultraviolet radiation, especially UVB, a band of ultraviolet radiation with wavelengths from 280 – 320 nanometers produced by the sun. Ultraviolet radiation with wavelengths from 320 – 400 nanometers. UVA is not absorbed, and it is much less dangerous to life.

2. Close to the surface, where it is produced by sunlight acting on atmospheric pollutants. It is produced from nitrogen oxides and volatile carbon-based compounds when there is intense sunshine above all in the spring and summer. This is bad ozone. It causes respiratory illness; it damages plants; and it attacks rubber.

Student's Assessment Exercise (S. A. E.) 9.1

1. State one importance of ozone.

Stratospheric Ozone Chemistry up to 1984

Ozone concentration in the stratosphere is due to a balance production and destruction of ozone. Here is a somewhat oversimplified overview off key reactions that were known up to 1984; leaving out many other possible chemical reactions in the stratosphere.

1. Production. Ultraviolet (UV) radiation from the sun splits molecules O_2 into two free oxygen atoms O, which immediately combine with oxygen to produce ozone O_3 with the help of a random air molecule M (N_2 or O_2).

   Eq. (1) O_2 + uv-light -> 2 O

   Eq. (2) 2 O + 2 O_2 + M -> 2 O_3 + M

Production is greatest high in the tropical atmosphere at heights near 40 km. the circulation in the stratosphere then carries the ozone to other regions.

2. Destruction. Solar radiation of any wavelength from near infrared to ultraviolet can destroy ozone. This too is greatest high in the tropical atmosphere at heights near 40 km.

   Eq. (3) O_3 + sunlight -> O_2 + O

   Eq. (4) O+ O + M -> O_2 + M

   Eq. (5) O + O_3 -> 2 O_2

This reaction is relatively weak because almost all the O atoms combines with molecular oxygen to remake ozone (Eq. 2). These interactions among o, o_2 and o_3 are called the Chapman reactions, described by Sydney Chapman in 1929 and 1930.

As a result, one chlorine atom can catalyze the destruction of about 100,000 ozone molecules before the chlorine atom is incorporated into inert molecules of HCl (hydrochloric acid) and $ClONO_2$ (chlorine nitrate) through the reactions:

Chlorine deactivation:

Eq. (8) $Cl + CH_4 \rightarrow CH_3 + HCl$

Eq. (9) $OH + ClO \rightarrow O_2 + HCl$

Eq. (10) $H_2O + Cl \rightarrow O_2 + HCl$

Eq. (11) $ClO + NO_2 + M \rightarrow ClONO_2 + M$

Both HCl and $ClONO_2$ are relatively stable and remain in the air. Their concentrations gradually increase as CFCs are destroyed by sunlight. Winds eventually carry HCl into the troposphere where it is rained out. This is the primary pathway for removal of CFCs from the atmosphere: Transport to the stratosphere, conversion of fluorine and chlorine to acids (HF and HCl), the transport of the acids to the troposphere and removal of HF and HCl from the troposphere by precipitation.

Notice that there are two types of chlorine molecules in the stratosphere.

1. Active, ozone destroying molecules in the stratosphere.
2. Non-ozone destroying molecules: HCl and $ClONO_2$.

Our understanding of how chlorine can remove ozone is the result of three studies:

1. Paul Creutzen showed in 1970 that NO and NO2 are catalysts able to destroy ozone.
2. Richard Stolarski and Ralph Cicerone showed in 1973 that chlorine is even more effective than nitrogen oxides in destroying stratospheric ozone. Each free chlorine atoms in the stratosphere can rapidly destroy thousands of ozone molecules.
3. Building on this work, Mario Molina and John Rowland showed in 1974 that man-made chlorofluorocarbon (CFC) gases are the most important source of free chlorine in the stratosphere, and that they would cause significant reduction in ozone levels. Ultraviolet light splits chlorine atoms from the chlorofluorocarbon molecules producing free chlorine. The production of chlorine from CFCs caused much concern because CFCs have long lifetimes (50 – 500 years) in the atmosphere:
    a. They do not dissolve in water, so they are not rained out of the atmosphere as are many other pollutants.
    b. They are chemically inert; they do not react easily with other molecules.
    c. They are broken down mostly in the stratosphere, by ultraviolet radiation. The breakdown produces Cl atoms in the stratosphere.
    d. Cl reacts to produce HCl (hydrochloric acid), which enters the troposphere and rains out.

9.3 The Ozone Hole

Ozone concentration in the stratosphere over Antarctica in the southern hemisphere in Spring has become much less than it was in the period up to 1980. The large area of low ozone concentration is called the ozone hole.

The first measurements of ozone concentration in the stratosphere above Antarctica were made by the British Antarctica survey at Halley Bays starting in 1965. Global measurements began in 1978 when the Total ozone Mapping Spectrometer TOMS was launched into space on Nimbus-7. Scientists from the survey first noticed that ozone over Antarctica was slowly decreasing in the 1960s. Then Joseph Farman, Brain Gardiner and Jonathan Shanklin measured extraordinarily low ozone in October 1984 during the Antarctica spring. They published their measurements in May 1985. At the same time, the TOMS team also measured very low values, but they were slower to report their values. Both teams at first thought their instruments were wrong because the ozone values were far too low. Clearly, something was destroying ozone in the Spring over Antarctica much faster than anyone had anticipated.

The very low ozone measurements in 1984 were the first indication of an ozone hole above Antarctica. Since then, ozone values continued to decrease, and the area of the ozone hole continued to expand from about 5 million square kilometers in 1984 to 28 million square kilometers in 2006. For comparison, 24 million square kilometers is about the size of North America.

Student's Assessment Exercise (S. A. E.) 9.2

1. What is ozone hole?

9.4 Antarctica ozone Theory

The reactions described by Chapman, Creutzen, Molina and Rowland (Eq. 1 to Eq. 11) cannot explain the ozone hole. The reaction preidict only a small global reduction of ozone. Why was the reduction so large? Why in Antarctica? Why in the Spring? A series of field experiments that included flying instruments on airplanes in the Antarctic stratosphere and new detailed satellite measurements of different types of molecules in the stratosphere answered the questions.

9.5 The ozone hole is the result of a series of processes

1. During the winter, the very cold air over Antarctica is surrounded by warmer air at lower latitudes. This creates a low pressure region with strong winds blowing around the region at the boundary between warm and cold air. The rotating air, a strong polar vortex, isolates the stratosphere above Antarctica from the rest of the stratosphere.

2. As the air cools, Polar stratospheric Clouds from inside the vortex. When temperatures drop to 195 K, nitric acid, sulfluric acid and water condense to form Type I Polar Stratospheric Clouds. Then, as temperatures drop to 188 K, H_2O molecules condense on the Type I cloud particles to form Type II Polar Stratospheric Clouds. Type II particles are large enough (10 microns in diameter) that they fall out of the stratosphere, removing nitric acid and water from the stratosphere. Type I cloud particles are so small (1 micron in diameter) that they remain in the stratosphere.

3. Polar stratospheric clouds are important for two reasons.
   a. Chlorine nitrate $ClONO_2$ and hydrochloric acid molecules in the air strike the cloud particles and are become attached to the surface of the particles. Chemical reactions on the particle surface converts the non-ozone destroying molecules HCl and $ClONO_2$ into Cl_2, building up a reservoir of Cl_2 during the winter. The important reactions are:

      Eq. (12) $HCl + ClONO_2 \rightarrow Cl_2 + HNO_3$

      Eq. (13) $ClONO_2 + H_2O \rightarrow HOCl + HNO_3$

      Eq. (14) $HCl + HOC \rightarrow H_2O + Cl_2$

      The nitric acid (HNO_3) becomes incorporated into the cloud particle.
   b. The clouds remove most of nitrogen oxides from the air inside the vortex so the nitrogen oxides can no longer contribute to the destruction of ozone.
      i. The nitric acid produced by the chlorine reactions on the particle surface (Eq. 12 and Eq. 13) remains on the particle.
      ii. In addition, nitrogen oxides condense to form the clouds.
      iii. Other nitrogen oxides react with H_2O on the ice surface to produce nitric acid.
      iv. The cloud particles fall out of the stratosphere, removing nitric acid (HNO_3) and other nitrogen-containing molecules from the polar vortex. Type II Polar Stratospheric Cloud particles have a diameter of about 10 micrometers, and they fall at a rate of 1.5 km/day.

4. In Spring, the first sunlight warms the cloud particles, releasing large amounts of Cl_2 built up during the winter. Ultraviolet light quickly splits Cl_2 into two chlorine atoms which begin the ozone-destroying reactions described above. The chlorine rapidly destroys ozone within the polar vortex, leading to the ozone hole.

   This answers the questions: why was the reduction so large? Why in the spring?

9.6 Efforts to Reduce Chlorofluorocarbons in the Atmosphere

The work by Mario Molina and John Rowland in 1974 convinced the US and other governments to ban the use of CFCs as a propellant in aerosol cans in 1977. The legislation was easily passed because other gases could be substituted for CFCs. At that time the threat to stratospheric ozone was predicted to berelatively small even if CFC continued to increase in the atmosphere from other uses of CFCs, primarily for refrigeration.

The discovery of the Antarctica Ozone Hole in 1985 showed the destruction of ozone was much worse than expected. The dramatic growth of the ozone hole from 1980 to 1990 and the threat that low ozone posed for life on earth led to an international effort to ban the production and use of CFCs. The Montreal Protocol of 1987 and later amendments at meetings in London (1990). Copenhagen (1992) Montreal (1997) and Beijing (1999) banned the manufacture of most ozone depleting gases.

9.7 Conclusion:

Stratospheric ozone is important in the earth system because it absorbs ultraviolet radiation from the sun, protecting life on earth. You have also learnt that ozone is a relatively rare and unstable molecule composed of three (3) oxygen atoms O3. The concept of the ozone hole was discussed and efforts to reduce chlorofluorocarbons in the atmosphere were also mentioned.

Answer To Student's Assessment Exercise 9.1

One importance of ozone is that it absorbs ultraviolet radiation from the sun, protecting life on earth.

Answer To Student's Assessment Exercise 9.2

The large area of low ozone concentration is called the ozone hole.

9.8 Summary

The unit elaborated on the concept of stratospheric ozone, stressing its importance to life on planet earth. The discovery of the ozone hole in 1985 showed the destruction of ozone was much worse than expected. Efforts to reduce chlorofluorocarbons (one of the greenhouse gases) in the atmosphere should therefore be intensified.

9.9 Tutor Marked Assignment

Ozone is found in two regions of the atmosphere. Discuss.

9.10 . References/Further Readings

1. http://oceanworld.tamu.edu/resources/environment-books/stratospheric ozone.html, January 2013.

2. Robert Stewart (2008). Environmental Geoscience. Environmental Science in the 21st Century – An Online Textbook.

UNIT 10: PHYSIOLOGICAL FACTORS CONTRIBUTING TO HEAT LOAD IN FARM ANIMALS

Table of contents

10.0 Introduction

This unit presents for your study, the physiological factors contributing to heat load in the farm animals using cattle as an example. The methods used to alleviate the heat load are also discussed.

10.1 Objectives

At the end of your study in this unit, you should be able to:-

1. Write out the 'homeothemic equation'.
2. List out the environmental means of gaining heat by the animal;
3. List some physiological ways of gaining heat by the animals;
4. List ways of heat loss through the environment and the animals;

10.2 Physiological Factors Contributing To Heat Load In Farm Animal

Although when cattle are exposed to high temperatures, the chief cause of heat loss from the animal is by evaporation of water from the internal and external body surfaces, water evaporation is not the only means by which animals may lose heat. The following equations often spoken of as the 'homeothemic equation', indicates all the various ways by which an animal may lose or gain weight from its environment:

M-E-F-Cd-Cv-R-0

Where
M = the metabolic heat produced by the living animal;
E = the heat lost through evaporation of water from the body Surfaces;
F = the heat lost by the consumption of feed which is either hotter or cooler than the body temperature;
Cd = the heat lost by conduction (i. e. the transfer of heat energy from particle to particle by increased molecular activity);

Cv = the heat lost by convection (i. e. the transfer of heat energy by a circulation of heated material, usually air);
R = the heat loss through radiation (i. e. the transfer of energy

across space without heating the space through which it passes).

Or

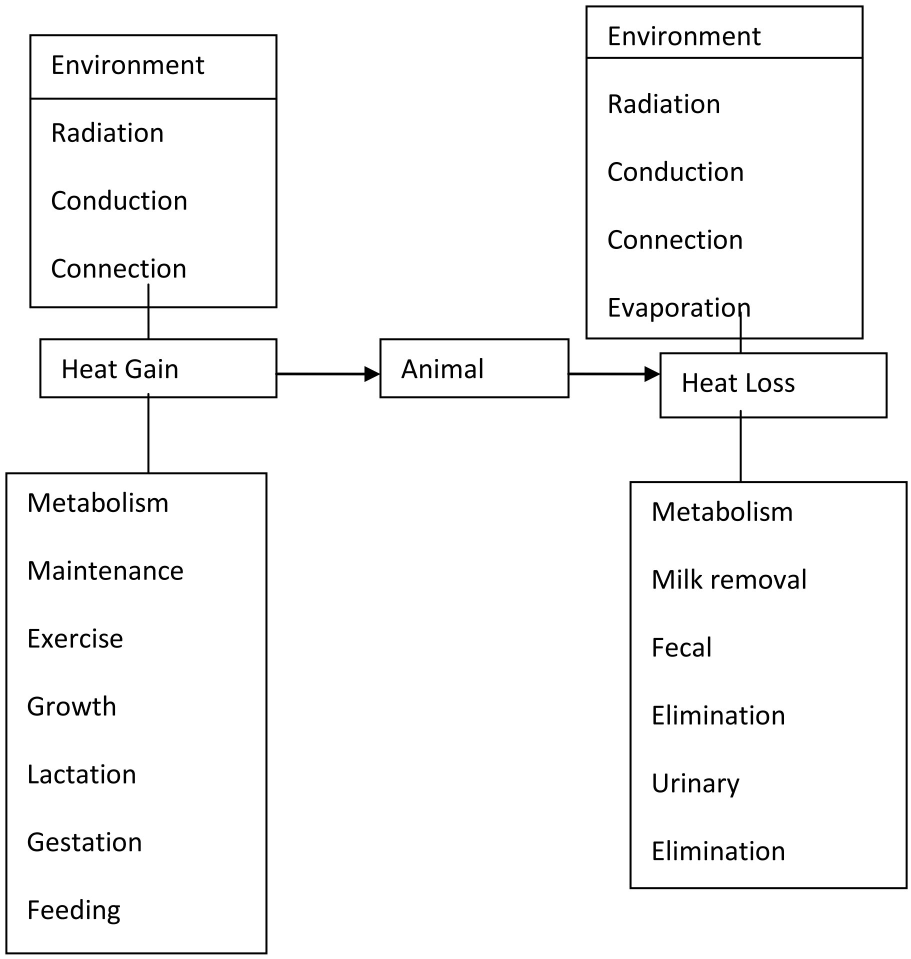

Figure 1: Increments of heat gain and heat loss, which are balanced to constitute thermal regulation in an animal (Fuquay, 1981).

Student's Assessment Exercise (S. A. E.) 10.1

List the two sources of heat gain and heat loss in farm animals.

Where the environmental temperature is above the normal body temperature, a cow clearly cannot lose heat to its environment by convection, conduction or by radiation. The animal may possibly lose heat if, during the period of heat stress it ingests river or well water, which will invariably be below body temperature, then taking in water which has been standing in an exposed trough or shallow pond.

It is pertinent to add a comment on this stage concerning the various ways by which the animal is affected be the radiation received from the sun. Radiation may be divided into infrared or heat radiation (long wavelengths): visible light (medium waves): and ultra-violet radiation (short waves).

The proportion of long and medium waves in the total radiation will increase as one moves from the poles towards the equator. The proportion of shor-waves present in the radiation will increase as one moves from sea level to high altitudes. It follows that the greatest radiation intensity is found on farm animals kept at a high altitude on the thermal equator.

The coat will absorb most of the infrared radiation received by the animal. The characteristics of skin colour will influence this absorption since light, sleek hairs will enable a proportion of the infrared radiation to be reflected. The visible light falling o the animal can also be readily reflected, the amount equally depending upon the physical characteristics of the coat surface.

10.3 Conclusion

In this unit, you have learnt that, there are many physiological processes that contribute to heat load in the animal. The main ones are metabolism, maintenance, exercise, growth, lactation, gestation and feeding. There are ways too to loss heat either through the environment or through some physiological processes.

Answer to Student's Assessment Exercise 10.1

The two sources of heat gain and heat loss are; the environment and the animal's physiological activities.

10.4 Summary

In this unit, the importance of maintaining a balance in heat load was discussed using the 'homeothemic equation'. Heat load can be through the environment or physiological activities of the animal itself, but so also is the heat loss. Striking a good balance is important for optimum productivity by the animals.

10.5 Tutor Marked Assignment

List the physiological processes of heat gain or load by the farm animals.

10.6 References/Further Reading

1. Webster, C. C. and P. N. Wilson (1980). Adaptation of Livestock to Tropical Environments In Agriculture in the Tropics, 2nd Edition. C. C. Webster and P. N. Wilson, Book society and Longman Group Limited, London.

2. Butswat I. S. R. (1999). Effects of heat Stress and Related Environmental Factors on the Productivity of Farm Animals in the Saheho-Sudan area of Nigeria. Product of International Seminar Held in March 7th November, 1999. At Zaranda Hotel, Bauchi, Nigeria. pp74 – 91.organized by Face-Pam/Abubakar Tafawa Balewa University, Bauchi. Editors, E. R. Orskon, T. A. Adegbola, S. Bogoro and I. S. R. Butswat.

3. Webster, J. J. and Wilson, P. N. (1966). "Agriculture in the Tropics". Longman, London, pp 640.

UNIT 11: GLOBAL VIEW ON THE ENVIRONMENT

Table of Contents

11.0 Introduction

In this unit, you will be studying a global view of the environment. that means what you will be studying will encompass the whole world get the global view, but act local for the benefit of the local environment and the living things around you.

11.1 Objectives

At the end of your study in this unit, you should be able to:-

1. Discuss the concept of protecting the global environment as one of the major challenges in international relations.
2. Elaborate on the concept of 'Sustainable Development' at various levels – International and National.

11.2 Global View on the Environment

In the past three decades, protecting the global environment has emerged as one of the major challenges in international relations. No fewer than ten global environmental treaties have been negotiated as well as literally hundreds of regional and bilateral agreements. Environmentalism can be seen as a social movement that seeks to influence the activism and education in order to protect natural resources and ecosystems. A concern for environment protection has recurred in diverse forms, in different parts of the world, throughout history. The environmental movement is a diverse scientific, social and political movement. In its recognition of humanity as a participant in ecosystems, the movement is centered on ecology, health and human rights. Today, it is universally recognized that environmental protection is a parcel of national policy and programme. The well recognized mode of achieving this humble goal is "Sustainable Development". In fact, modern law and policy governing environmental protection and human development whether at national or international level, have the objective of achieving "Sustainable Development". In spite of the gigantic environmental protective measures promoted by man over three decades of period, neither the warming of earth is put at naught, nor are the growing abnormal incidents of atmosphere reduced with the available scientific and technological knowledge. Despite the many environmental regimes and action plans negotiated in the past quarter century, important gaps still exist in the international environmental policy framework. The framework has not developed in any systematic or strategic way. Rather it is a collection of numerous treaties, each addressing relatively discrete global or regional environmental issues. Nature has become unnatural causing adverse impact on the atmosphere on one side and the health and safety of all the living and non-living on the other hand. The ecosystem is echoing with abnormal noises, vibrations, dust and smoke due to human activities. These incidents remind the mankind about the compelling need for protecting the environment willy-nilly with all zeal and vigor. Given how far we have come in damaging the global environment, international environmental efforts in the future will have to be focused more on environmental restoration than protection. Human rights laws may also present important opportunities for gaining better environmental protection.

Student's Assessment Exercise (S. A. E) 11.1

Concerning the environment, what shall we likely be focusing on in the future?

11.3 Conclusion

Environmentalism can be seen as a social movement that seeks to influence the activism and education in order to protect natural resources and ecosystems globally. Think globally, but act locally to protect the environment.

Answer to Student's Assessment Exercise 11.1

In the future, we are likely to be focusing on environmental restoration than protection.

11.4 Summary

In this unit, you have studied a global view of the environment, the fact that the protection of the environment affects relationship between international communities and the international activism to protect the environment globally. Given how far we have come in damaging the global environment, international efforts in the future will have to focus more on environmental restoration than protection.

11.5 Tutor Marked assignment

Elaborate on the Global View on the Environment.

11.6 References/Further Readings

1. Prithpal Kaur (2011). Enironmetal Sustainability: A Global Perspective. CIDA International Journal of Sustainable Development, Vol. 2 No. 8 pp 23 – 28.

2. Partnership for peace – Environmental Degradiation and it Consequencies. http://www.partnershipforpeace.eu/nyenza/research-findings/136-en