LECTURE NOTES

For Environmental Health Students

Introduction to Ecology

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In collaboration with the Ethiopia Public Health Training Initiative, The Carter Center, the Ethiopia Ministry of Health, and the Ethiopia Ministry of Education

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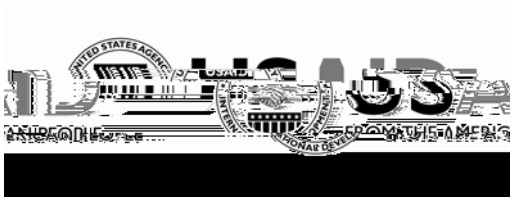

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ACKNOWLEDGMENTS

ABBREVIATIONS

AIDS	-Acquired Immuno Deficiency Syndrome
ALERT	-All Africa Leprosy Rehabilitation and Training Center
ALRI	- Acute Lower Respiratory Infection
AURI	- Acute Upper Respiratory Infection
ANC	- Antenatal Care
ARI	- Acute Respiratory Infection
CHA	- Community Health Agents
CHC	- Community Health Care
CHW	- Community Health Worker
CIH	-COMMUNITY INVOLVEMENT IN HEALTH
CPHC	- Comprehensive Primary Health Care
DPT	- Diphtheria Pertusis and Tetanus
EPI	- Expanded Program of Immunization
FP	- Family Planning
GOBIFF	-Growth monitoring, Oral rehydration, Breast-feeding, Immunization, Female education, Family Planning.
HIV	- Human Immuno Deficiency Virus
HLS	- Household Livelihood Security
HSEP	- Health Service Extension Package
IEC	- Information Education Communication

MCH - Maternal and Child Health

TABLE OF CONTENTS

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Preface

The combination of rapid population growth, industrialization and its associated urbanization has placed an ever-increasing pressure on life supporting systems of developing countries such as Ethiopia.

There is evidence that natural resources of Ethiopia such as rivers and lakes are threatened by pollution discharged from towns/cities, institutions and industries. Indeed the problem becomes more acute in the river systems flowing through major cities. In the face of world climate change polluting such scarce natural resources may become a limiting factor in future development of the nation. In situations where treated water supply is still unaffordable it may also expose the communities to water-borne diseases.

Soil erosion is another eco-disaster affecting may countries. In this respect Ethiopia is believed to be the global spot where the worst soil erosion problem occurs as it is thought to lose 2 billion metric tons of soil each year to erosion. Anecdotal example such as Haiti can also be given where the topsoil has been absolutely removed by soil erosion. Some authorities believe that it may never recover from this eco-disaster.

Improper solid waste disposal such as household refuse and plastics is another area of environmental concern in Ethiopia and it is becoming more acute in urban and sub urban areas. Plastics in use for various purposes at present are not biodegradable and will greatly affect the ecology of health and disease in the region.

Although no authoritative sources exist regarding air pollution status in Ethiopia, use of biomass fuels, congested traffic coupled with excessive dependence on old imported cars is becoming a matter of great concern. The precursors for air pollution formation, at least in Addis, are observed although the problem is not systematically quantified and the problem is not yet put in place.

To achieve sustainable development in Ethiopia, it is vital that the above problems should be properly addressed and ecological integrity of the nation be properly maintained. One mechanism of achieving this could be to incorporate a course in ecology into the curricula of teaching institutions at various levels. This course is thus, and attempt to introduce ecological principles and concepts for students specializing in health profession at intuitions of higher

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Content

INTRODUCTION

1. Learning Objectives:

At the end of this chapter, the student will be able to:

Define the term ecology and discuss the levels of biological organization at which ecological interactions occur.

Discuss the scopes of ecology.

Describe the causes and ways of preventing environmental diseases.

Mention the effects of human activities on health and the environment.

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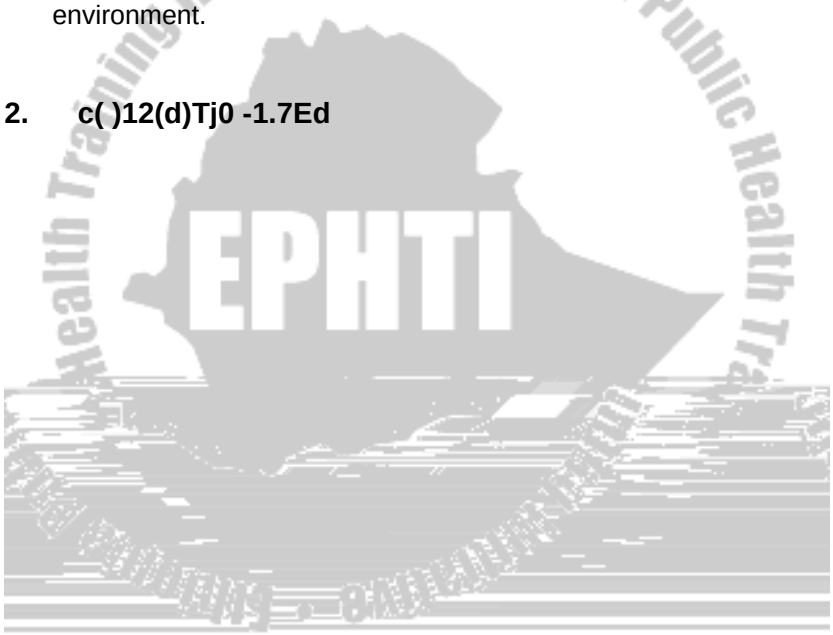

organisms with one another and with the physical and chemical environment. The term “logy” is to mean study.

Another way of defining Ecology is to look at the levels of biological organizations. The molecules of life are organized in specific ways to form **cells**; cells are grouped in to **tissues**; and tissues are arranged to produce functional organs. The body organs are integrated to produce **organ system**, and the entire array of these systems constitutes an **organism**. Organisms exist not just as a single individual, but in-groups called population. The various populations of organisms that interact with one another to form a **community**; interdependent communities of organisms interact with the physical environment to compose an ecosystem. Finally, all the ecosystems of the planet are combined to produce a level of organization known as the **biosphere**. Ecology is concerned with the levels of organization beyond that of individual organism; i.e. population, community, ecosystem, and biosphere.

Scope

Whether we are talking about humans or any other kind of organisms, certain principles govern the growth and stability of their populations over time. These principles influence the pattern of relationships of organisms with one another and their environment. These patterns, in all their varied forms, are the focuses of ecology. As a science, ecology seeks to treat the world of nature including its human component with a single set of concepts and principles.

Ecology deals with such questions as:

- Why natural communities are composed of certain organisms and not others;
- How the various organisms interact with each other and with the physical environment; and
- How we can control and maintain these natural communities.

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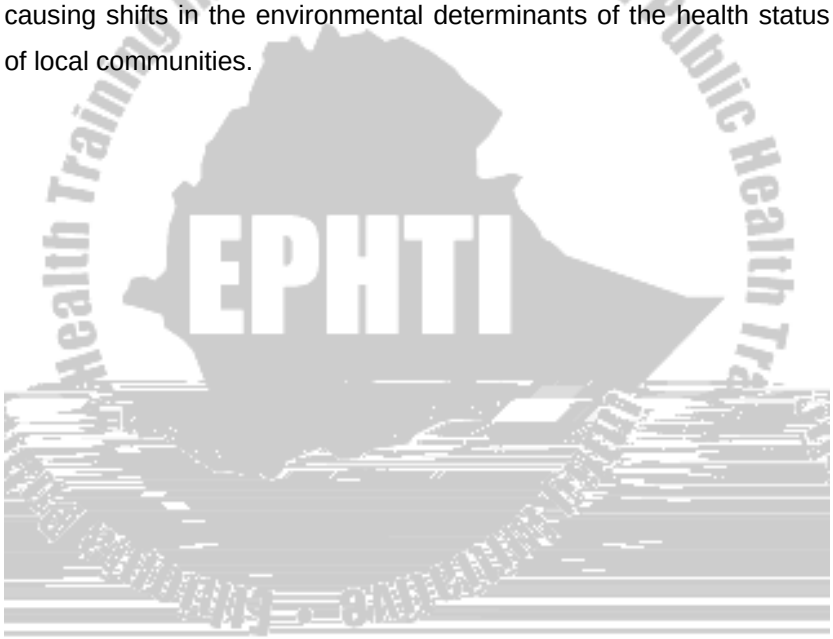
and municipal solid waste continues to increase worldwide, both in absolute and *per*

Land use and agricultural development

Competition for land appears to be intensifying between sectors and production systems. Agriculture, in particular, can be expected to become an even more dominant form of land use. Population increases and the finite extent, to which further land can be converted to agricultural uses, mean that *per capita* arable land availability is becoming an issue.

Agricultural production carries several risks. Thus extension and intensification of agricultural production systems, together with fluctuation in the supply of and demand for agricultural produce are causing shifts in the environmental determinants of the health status of local communities.



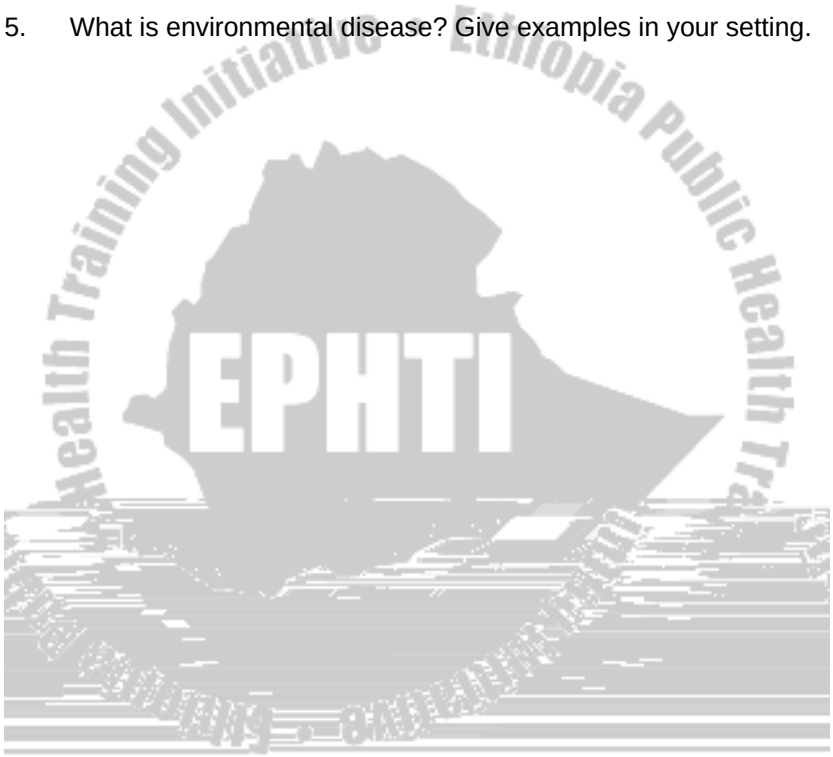
developing countries through transfer of hazardous wastes industries and technologies.

Major industrial impacts also arise from small-scale industry. In developing countries, small-scale industry contributes substantially to economic development, but can create problems for environment and health if environmental safeguards are not used.

b. ***Modern hazard,*** i.e. associated with unsustainable development. Modern hazards are related to development that lacks health- and environment safeguards, and to unsustainable consumption of natural resources. They include: water pollution from populated areas, industry and intensive agriculture; urban air pollution from motor cars, coal power stations and industry resulting

Review Question

1. Define the term ecology.
2. What are the levels of biological organizations at which ecological interactions occur?
3. Discuss the areas that ecology is concerned.
4. Have you observed, in your locality, any changes in pattern of disease occurrence that are related to changes in the environment?
5. What is environmental disease? Give examples in your setting.



CHAPTER ONE

Introduction to Ecological Principles

1. Learning Objective:

At the end of this chapter, the student will be able to:

Explain biotic community and ecological succession.
Explain habitat and ecologic niche of organisms.
Mention the major biomes of the world and the dominant species.
Discuss the factors that affect the distribution of organisms.

2. Definition of Terms

1. **Biomes**: a large, relatively distinct terrestrial region characterized by a similar climate, soil, plants, and animals regardless of where it occurs on earth.
2. **Ecosphere**: The interrelation among and between all the earth's living organisms and the atmosphere, lithosphere and hydrosphere that they occupy.
3. **Limiting factor**: An environmental factor that restricts the growth, distribution, or abundance of a particular population.
4. **Tolerance**: Decreased response to a specific factor in the environment over time.
5. **Niche**: The totality of organism's adaptation and the life style to which it is fitted in its community.

1.1 Introduction

A biological community consists of several to many populations each containing all the members of a single species in a given area. Species are not fixed or unalterable, however. They evolve and adapt in response to the environment in which they live. Because,

environmental conditions also are dynamic and constantly changing, the process of evolution and adaptation of living organisms is never complete. And yet many biological communities are self-perpetuating, resilient, and stable over relatively long times.

A. Biotic Community

The most familiar classification system used for grouping plants and animals is one based upon presumed evolutionary relationships. However, ecologists tend to arrange species on the basis of their

1. It emphasizes the fact that different organisms are not arbitrarily scattered around the earth with no particular reason as to why they live where they do together in an orderly manner.
2. By illuminating the importance of the community as a whole to any of its individual parts, the community concept can be used

dominant role because not only do they provide food and shelter for other organisms but also directly affect and modify their physical environment. That is: -

1. They build up topsoil
2. Moderate fluctuation of temperature
3. Improve moisture retention
4. Affect the pH of the soil.

C. Biomes

The species composition of any particular biotic community is profoundly affected by the physical characteristics of the environment particularly temperature and rainfall. For instance, the kinds of plants and animals one will find in Simen Mountains in Ethiopia would differ significantly from those found in the Awash Park.

Ecologists have divided the terrestrial communities of the world into general groupings called **Biomes,** which are areas that can be recognized by the distinctive life forms of their dominant species. In most cases, the key characteristic of a biome is its dominant type of vegetation. It could also be said that a biome is a complex of communities' characteristic of a regional climatic zone. Each biome has its pattern of rainfall, season, temperature and changes of day length all of which combine to support a certain kind of vegetation.

Starting at the polar region the major biomes of planet earth are:

i. Tundra

Tundra is the northern most of the world's landmasses. It is characterized by permanently frozen subsoil called Permafrost, which has low rainfall. These are bogs and lakes, which propagate mosquitoes more than any thing else.

Dominant vegetation is moss grass and some small perennials

ii. Taiga

Taiga is a Russian world meaning " Swampy forest". Taiga is mostly identified with its abundant coniferous forest.

The trees available, mostly conifers are less diverse in number of species than those in the deciduous trees forests found further south from Taiga and the soil has different kind of humus which is more

vi. Tropical Rain forest

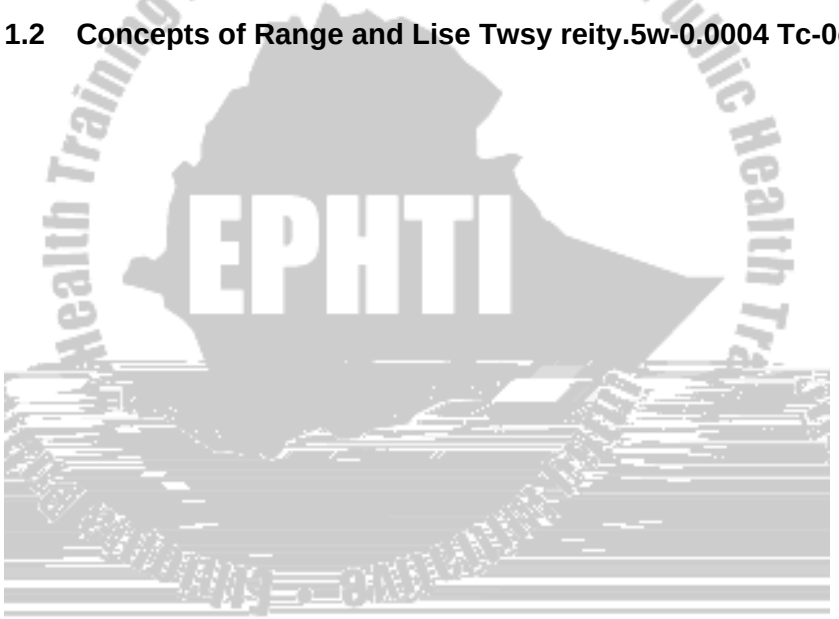
It is characterized by high temperature and high annual rainfall (100 inch or more). Year round tem

or flooding, or by a human activity, such as deforestation, plowing or mining.

Both forms of succession usually follow an orderly sequence of stages as organisms modify the environment in ways that allow one species to replace another.

Eventually in either primary or secondary succession a community develops that seemingly resists further change. Ecologists call this a **climax community**, because it appears to be the culmination of the succession process. The different biomes of our planet discussed earlier are examples of climax community.

1.2 Concepts of Range and Lise Twsy reity.5w-0.0004 Tc-0of thestc- 682.0 be0.surviv0.tprrlimax con



minimum, which states, "the rate of growth of each organism is limited by whatever essential nutrient is present in a minimal amount". The law can also be stated as "the functioning of an organism is controlled or limited by essential environmental factor or combination of factors present in the least favorable amount in the environment".

Example: The yield of crops is often limited not by a nutrient required in large amounts, such as water or carbon dioxide, but by something needed only in trace amounts, such as boron or manganese.

Law of Tolerance (Shelford's Law)

For each species, there is a range in an environmental factor within which the species function near or at optimum. There are extremes both lower and upper towards which the function of the species is curtailed or inhibited. Shelford pointed out that too much of a certain factor would act as a limiting factor just as well as too little of it as has been stated in the Liebig's law. This leads to a concept of range of tolerance, which states, **"** the distribution of each species is determined by its range of tolerance to variation in each environmental factor."

1.3 Habitat and Ecologic Niche

In describing the ecological relation of organisms, it is useful to ten1TD-0.0002 Tc0.0218 Tw[dis(ing)5.1(u)-0.
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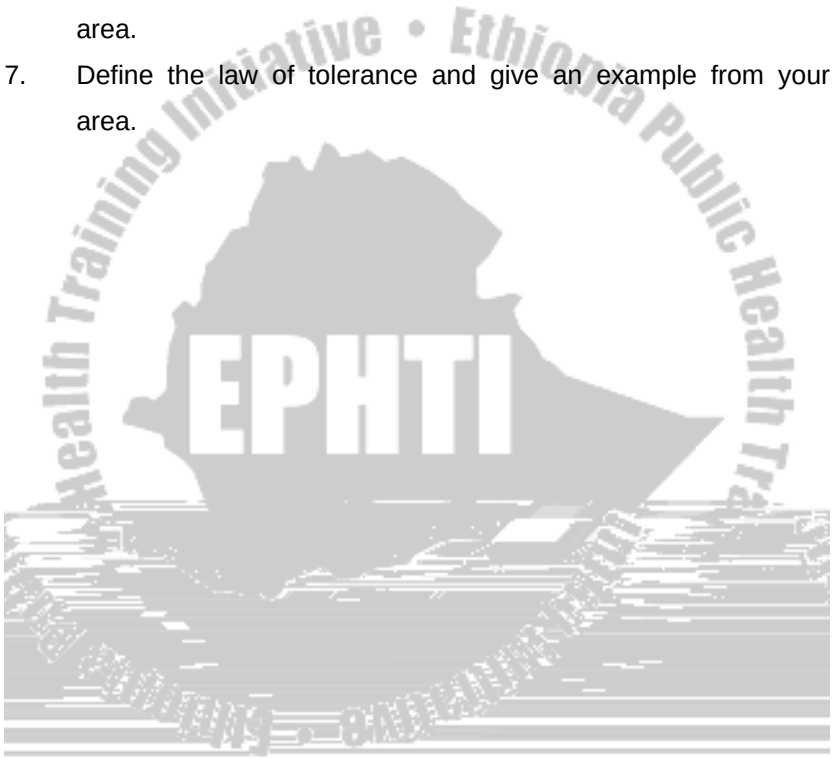
Review Questions

1. What is biotic community?
2. What are the major biomes of our planet?
3. Describe the different kinds of ecological successions.
4. What do we mean by climax community?
5. Explain the difference between habitat and ecologic niche of organisms.
6. Define the law of the minimum and give an example from your area.
7. Define the law of tolerance and give an example from your area.



CHAPTER TWO

Ecosystem

1. Learning objectives

At the end of this chapter, the student will be able to:

Define the term ecosystem.
Describe the components of ecosystem.
Explain the concept of food chain and energy flow in ecosystems.
Explain how materials cycle in the biosphere.
Describe the laws of thermodynamics.
Distinguish between food chain and food web.
Explain the effect of human intervention on material cycling.

2. Definition of Terms

1. **Ecosystem:** a community and its physical and chemical

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be at the same trophic level. From the trophic standpoint, an ecosystem has two components. These are:

Autotrophic part: - in which light energy is captured or "fixed" and used to build simple inorganic substances in to complex organic substances such as carbohydrates, lipids, proteins, etc.

can be converted into biomass (living weight) and utilised in cellular respiration.

In some cases, the relationship between organisms involved are so complex that the chain is in the form of a highly complicated and

The unidirectional flow and efficiency of energy transformation account for the need for a continuos source of energy to prevent collapse of an ecosystem.

B. Material Cycling

Living organisms require at least 30 to 40 elements for their growth and development. Most important of these are carbon, hydrogen, oxygen, phosphorus, potassium, nitrogen, sulfur, calcium, iron, magnesium, boron, zinc, chlorine, cobalt, iodine, and fluorine. These materials flow from the non-living to the living and back to the non-living again, in a more or less circular path known as the **biogeochemical cycle**. Biogeochemical cycles are important because they help retain vital nutrients in forms useable plants and animals, and because they help to maintain the stability of ecosystems.

If nutrient cycling did not occur, the amount of necessary elements would constantly decrease, and would make the development of stable plant and animal population impossible, since there is no constant addition to the source of nutrients from outside (as there is magn205.1(siuTJ)8.1eoum, iar8(e)]2()5.9(cl(ar8(es--0.5(J)8.1a)0lp red m)8.1sorine)8.14 -1.7186 TD-0.0004 Tc0.267 T

2.3 The Carbon Cycle

Carbon is a basic constituent of all organic compounds. Since energy transfer occurs as the consumption and storage of carbohydrates and fats, carbon moves through the ecosystem with the flow of energy.

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sea level (because of glacial melting), submergence of coasts, change in pattern of precipitation, change in the habitable ranges of organisms.

2.4 The Nitrogen Cycle

because plants in the area now have a useable form of nitrogen again.

Nitrogen may be removed from the nitrates in the soil by denitrifying bacteria, and returned to the atmospheric reservoir, from which it can be released again by either nitrogen-fixing bacteria or electrification by lighting. In the latter case, the energy of a lightning bolt passing through the atmosphere binds nitrogen and oxygen together into nitrate, which precipitate onto the soil from the air during electrical storms.

This makes phosphorus available to plants, which absorb it through their roots for use in cellular synthesis. Animals obtain phosphorus from plants; upon death or through normal excretion of waste products from the body, they return phosphorus to the dissolved phosphorus pool. However, in the dissolved state, much phosphorus is lost by downhill transport into shallow marine sediments. Some of this phosphorus is returned to land by sea birds that deposit excrement on the shores.

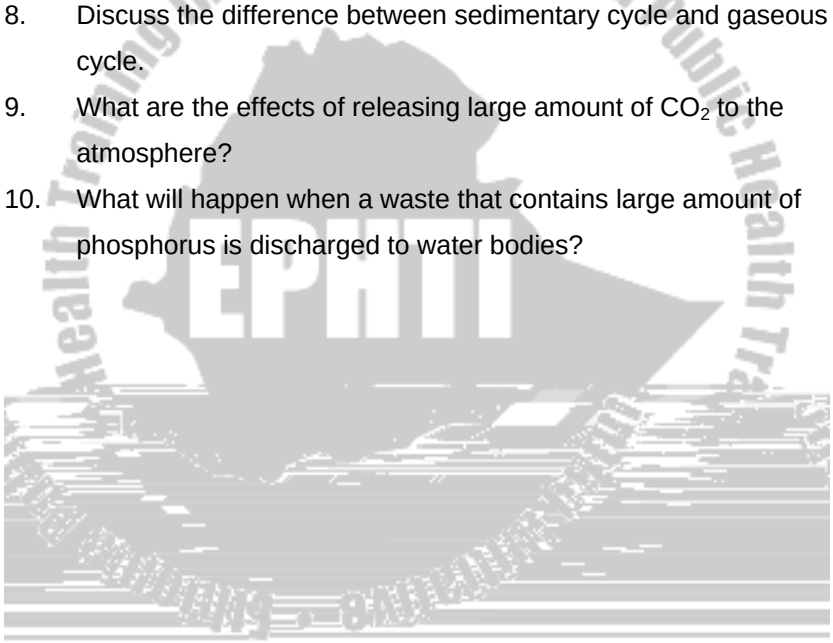
The phosphorus cycle is leaky or incomplete, in that there is, on land, some loss of phosphate into insoluble forms, and there is a slow loss of phosphate from; and into the oceans, from which there is only poor natural return, except over geologically long periods of time.

Human intervention is a significant factor in the phosphorus cycle. Large quantities of phosphates are mined and used as fertilizers and for other uses, such as in detergents. The result is that some fresh water streams and lakes have a great excess of biologically available phosphate from runoff and sewage. Since, in such bodies of water, phosphate is often a limiting factor in photosynthesis; excessive growth of aquatic plants ensues.

This process, called **eutrophication**, can totally disrupt aquatic ecosystems with serious consequences.

Review Questions

1. Give brief description of ecosystem.
2. What are the components of ecosystem?
3. What is food chain? What are the differences between food chain and food web?
4. Define the trophic level. Name and give examples of some trophic levels in ecosystem.
5. What are the two laws of thermodynamics?
6. How does energy flow in ecosystems?
7. What is the importance of material cycling in the biosphere?
8. Discuss the difference between sedimentary cycle and gaseous cycle.
9. What are the effects of releasing large amount of CO_2 to the atmosphere?
10. What will happen when a waste that contains large amount of phosphorus is discharged to water bodies?



CHAPTER THREE

Population Dynamics

1. Learning Objectives

At the end of this chapter, the student will be able to:

Explain the factors that affect population size.

Describe environmental resistance and biotic potential in terms of population growth.

Explain the difference between the J-shaped and S-shaped population growth forms.

Discuss the idea of carrying capacity in influencing population growth.

Explain the factors that regulate population growth.

Discuss the factors that contribute to human population growth.

Discuss the impact of unchecked human population growth.

1.2 Definition of Terms

1. **Natality:** the production of new individualsiesfairir.

8. **Exponential growth:** pattern of population growth in which the number of individuals increases in doubling increments (2,4,8,…).
9. **Survivorship:** the proportion of individuals in a population that survive to a particular age.
10. **Density-dependent factor:** any environmental factor whose

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expanding population will contain a large proportion of young

Growth of a population without increase in emigration or removal by other means does cause an increase in density, which is simply the size of the population within a particular unit of space.

Biotic Potential

The maximum growth rate, which a population could achieve in unlimited environment, is referred to as that population's biotic potential. In reality, of course, no organism ever reaches its biotic potential, because of one or more factors which limit growth long before population size attains its theoretical maximum. Such limiting factors include: food shortage, disease, competition, predation, accumulation of toxic wastes, etc.

Environmental Resistance

The environmental pressure which limits a population's inherent capacity for growth rate termed as environmental resistance. Environmental resistance is generally measured as the difference between the biotic potential of a population and the actual rate of increase as observed under laboratory or field conditions **(Fig.3.1).**

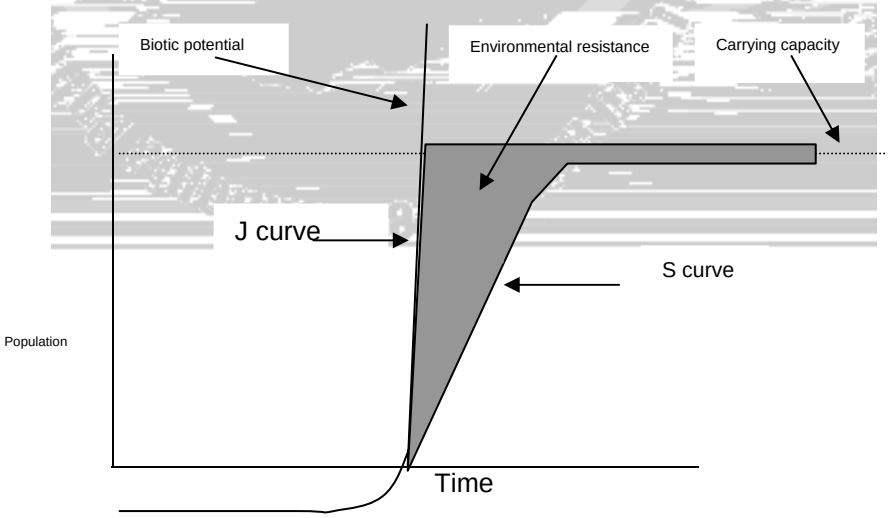


Fig.3.1 J and S population curve. The vertical J represents theoretical unlimited growth. The S represents growth and stabilization in response to environmental resistance.

3.3.1 Population Growth Forms

effect is the same or a constant proportion of the population is affected regardless of population density).

Density-independent Factors

In general, the factors that affect natality or mortality independently of population density tend to be abiotic components of the ecosystem. Often weather or climates are among the most important of these factors. Extreme cold, high heat, drought, excess rain, severe storm, and geologic hazards-such as volcanic eruptions, landslides, and floods-can have devastating impacts on particular populations.

Density-dependent Factors

Density-dependent mechanisms tend to reduce population size by decreasing natality or increasing mortality as the population size increases. Most of them are the results of interactions between populations of a community (especially predation), but some of them are based on interaction within a population.

3.4 Human population Growth

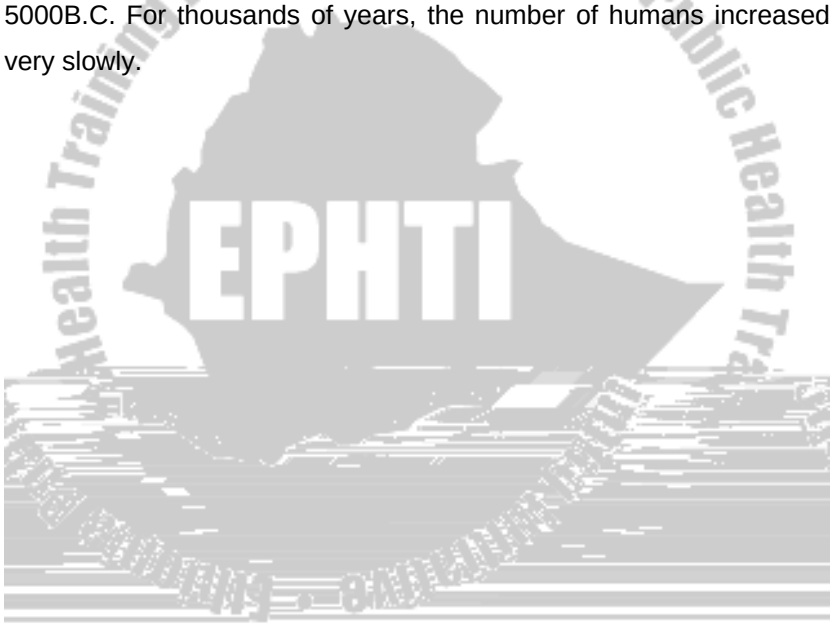
Human population has grown rapidly during the past three centuries. By the year 2000, the world population has reached 6 billion, and it is doubling about every forty-one year. About 92 million more people are added to the world each year, making us now the most numerous vertebrate species on earth. There is good reason to fear that this population explosion, unless checked immediately, will bring disaster of an unknown scale.

Many people share a conviction that overpopulation inevitably will bring crowding, poverty, violence and environmental degradation. In this view, too many people are trying to share limited resources in ways that surpass the earth's carrying capacity and over-stress life-support systems on which we all depend. These fears lead to

demands for immediate, worldwide birth control programs to reduce population growth.

3.4.1 Human Population History

For most of our history, humans have not been very numerous compared to other species. Studies of hunting and gathering societies suggest that the total world population was probably only a few million people before the invention of agriculture and the domestication of animals around ten thousand years ago. The larger and more secure food supply made available by the agricultural revolution allowed the human population to grow, reaching perhaps 50 million people by 5000B.C. For thousands of years, the number of humans increased very slowly.



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3.4.2 Impact of Human Population Growth on Resources and Ecosystem

There are already 1.9 billion people who are very poor, and who always think not of the food they are eating but of their next meal.

harmful and economically counter-productive methods of exploiting

Review Questions

1. Define each of the followings, and explain its effect on population size:
   - Natality
   - Mortality
   - Immigration
   - Emigration
   - Age structure
2. Explain differences between density-dependent and density-independent factors that regulate population growth. Give examples for each factor.
3. Discuss the J-shaped and S-shaped population growth forms in terms of biotic potential and environmental resistance.
4. What defines the carrying capacity of a particular environment?
5. What are the factors that contribute for the rapid growth of human population?
6. What does age structure indicate in human population growth?
7. Define 'doubling time' in terms of human population growth.
8. Discuss the impacts of uncontrolled human population growth on the biosphere.

CHAPTER FOUR

The Biosphere and its Pollution

Learning Objectives

At the end of this chapter, the student will be able to:

Describe the components of the biosphere.

List the types and sources of water pollution.

Explain the effect of water pollution on human health and on the environment.

Mention the major air pollutants and their sources.

Discuss the effects of air pollutants on human health and on the environment.

Discuss the effects of solid wastes on human health and the environment.

Explain the benefits and problems of pesticides.

Definitions

1. **Biosphere**: narrow zone that harbors life, limited to the waters of the earth, a fraction of its crust, and the lower region of the surrounding air.
2. **Pollutant**: any substance with which an ecosystem has had no prior evolutionary experience, in terms of kinds or amounts, and that can accumulate to disruptive or harmful level.
3. **Pollution**: Addition of some exogenous substances in the environment, which are harmful for organisms including human beings.
4. **Biological concentration**: increasing concentration of a relatively non-degradable(stable) substance in body tissues, beginning at low trophic levels and moving up through those organisms that are diners, than are dined upon in food web.
5. **Environmental pollution:** the introduction of undesirable changes such as the constitution or quality, of water, air and soil.

6. **Point-source pollution:** pollutants which enter waterways from a specific point through a pipe, ditch, culverts, etc.
7. **Non-point source pollution:** pollutants those which runoff or seep into waterways from broad areas of land rather than entering the water through a discrete pipe or conduit.
8. **Biochemical Oxygen Demand (BOD):** the amount of oxygen required degrading (stabilize) wastes.

4.1 Introduction

The Planet Earth along with its living organisms and atmosphere (air, land, and water), which sustains life, is known as the Biosphere. The biosphere extends vertically into the atmosphere to about 10Km, downward into the ocean to depth of about 35,000ft, and into about 23,000ft. of the earth surface itself where living organisms have been found.

The biosphere, a thin shell that encapsulates the earth, is made up of the atmosphere (a mixture of gases extending outward from the surface of the earth), lithosphere (the soil mantle that wraps the core of the earth) the hydrosphere (consists of the oceans, the lakes and streams, and the shallow ground water bodies that inter-flow with the surface water.

4.2 Water Pollution

Water is one of the most important and most precious of natural resources, and a regular and plentiful supply of clean water is essential for the survival and health of most living organisms. As a consequence of rapidly expanding industrialization and excessive population growths, and most of our rivers, lakes, stream and other water bodies are being increasingly polluted. Water is regarded as " polluted " when it is changed in its quality or composition, directly or indirectly as a result of human's activities so that it becomes less

suitable for drinking, domestic, agricultural, and recreational, fisheries or other purposes.

Sources of Water pollution

Pollutants can enter waterways by a number of different routs. Sources of pollution can be categorized into two: **point source pollution** and **non-point source pollution**. Factories, power plants, sewage treatment plants, latrines that are directly connected to water bodies are classified as **point sources**, because they discharge pollution from specific locations. In contrast, non-point sources of water pollution are scattered or diffuse, having no specific location where they discharge into a particular body of water. Non-point sources include runoff from farm fields and feedlots, construction sites, roads, streets and parking lots.

Types and Effects of Water pollution

Although the types, sources and effects of water pollutants are often interrelated, it is convenient to divide them into major categories for discussion **(Table 4.1).** The followings are some of the important sources and effects of each type of pollutant.

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or stream. The process by which a body of water becomes over-enriched with nutrients and as a result produces an over-abundance of plant life is known as **eutrophication**. Boye Pond, can be a classic example of eutrophication, which has been receiving a sustained solid and liquid waste discharge from inhabitants of Jimma Town, Southwestern Ethiopia, and now on the process being converted to a marshy area.

Although eutrophication can occur in sluggish streams, bays, and estuaries, it is most common in lakes and ponds. This is because lakes, unlike flowing bodies of water, flush very slowly; thus nutrient-laden wastewaters or runoffs introduced into a lake tend to remain there for many years.

iv. Toxic Inorganic Chemicals

Toxic, inorganic chemicals introduced into water as a result of human activities have become the most serious forms of water pollution. Among the chemicals of greatest concern are heavy metals, such as mercury, lead, tin, and cadmium. Other inorganic materials, such as acids, salts, nitrates and chlorine that normally are not toxic in low concentrations may become concentrated enough to lower water quality or adversely affect biological communities.

V. Organic Chemicals

Thousands of different natural synthetic organic chemicals are used in the chemical industry to make pesticides, plastics, pigments and other products. Many of these chemicals are highly toxic. Exposure to very low concentrations can cause birth defects, genetic disorder, and cancer. They also can persist in the environment because they are resistant to degradation and toxic to the organisms that ingests them. Contamination of surface waters and groundwater by these chemicals is a serious threat to human health.

Important sources of toxic organic chemicals in water are improper disposal of industrial and household wastes and runoff of pesticide from farm fields, forests, roadside and other places where they are used in large quantities.

VI. Thermal Pollution

Many industrial processes create problem of thermal pollution by discharging heat (in the form of hot water, air or effluent) into the

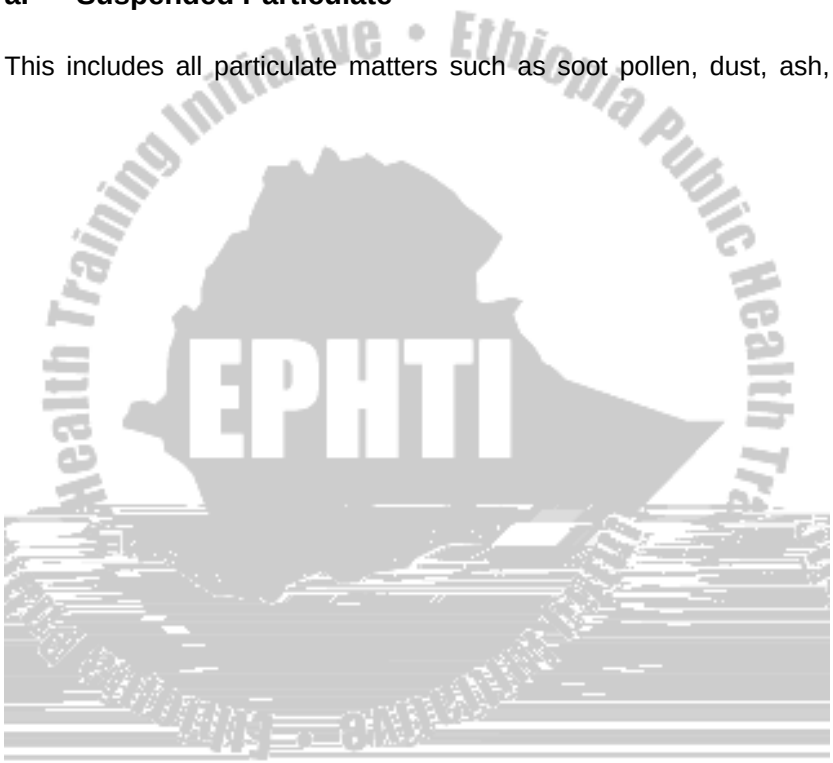
of organic matter. In contrast to the natural sources of air pollution, there are contaminants of anthropogenic origin. Coal-burning power plants, factories, metal smelters, vehicles are among the main anthropogenic sources of air pollutants.

Major Air Pollutants and Their Effects

The most common and well-identified air pollutants are: -

a. Suspended Particulate

This includes all particulate matters such as soot pollen, dust, ash,



c. Carbon monoxide (CO)

Carbon monoxide, odorless, colorless, non-irritant but highly toxic gas is found at high concentrations in urban areas. It is mostly released from motor vehicles, fuel wood combustion and industry. CO is a product of incomplete combustion. Its effect is that it:

- Binds to hemoglobin in the blood, displacing oxygen and thereby reducing the amount of oxygen carried in the blood stream.
- Slow down mental processes and reaction time

d. Nitrogen Dioxide (NO_2)

This is a colored gas than any other gas. It is formed when combustion occurs at high temperatures. The sources of NO_2 are power plants and automobile emission.

Nitrogen dioxide:

Stunt plant growth

Reduce visibility by its yellow brown smog it forms

Contribute to the formation of acid rain.

e. Ozone (O_3)

This is one of the constituents of photochemical oxidant. Photochemical oxidants are formed from a complex series of chemical reaction when NO_2 and hydrocarbons react with O_2 and sunlight to produce photochemical smog.

Ozone formed on the upper part of the atmosphere (stratosphere) provides a valuable shield for the biosphere by absorbing incoming ultraviolet radiation. In ambient air (troposphere), however, ozone is a strong oxidizing agent and damages vegetation, building materials (such as paints, rubber, and plastics), and sensitive tissues (such as eyes, and lungs).

f. Hydrocarbons

Those compounds containing hydrogen and carbon atoms in various combinations are the hydrocarbon groups. Examples are benzene, and benzo(a)pyrene, which is potent carcinogen. Apart from their long time effect, they being catalysts for photochemical smog is the most felt problem.

g. Lead

Lead is a toxic metal, which is traced to automobile emissions from leaded gasoline. Lead is a metabolic poison and a neurotoxin that binds to essential enzymes and cellular components and inactivates them.

4.4 Land/Soil Pollution

Humans and animals used resources that earth could supply for existence for millions of years. Earth (Land) being natural resources is also used for disposal of the wastes we generate. Even in the primitive society the hunters and gathers dispose their waste near and by their caves.

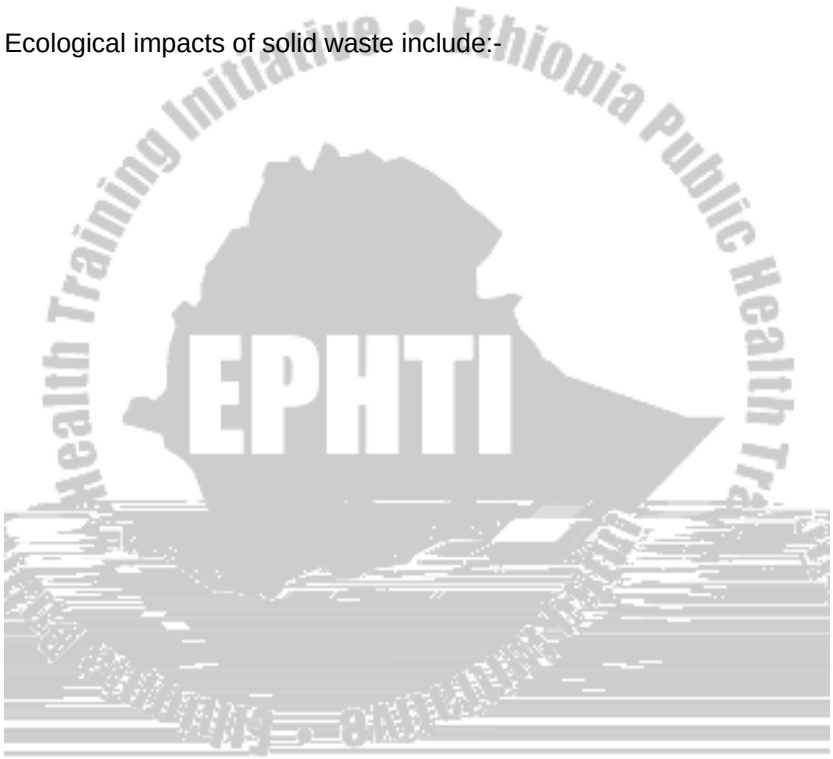
Solid wastes are the wastes arising from human and animal activities that are normally solid and that are discarded as useless or unwanted. It encompass the heterogeneous mass of throw away from mostly urban communities as well as the more homogenous accumulation of agricultural, industrial and mineral wastes.

The problem of solid waste was not as bad as it is now. In the past, the number of population in urban and rural communities was not so populated. But, the problem of solid waste began when first humans congregate in tribes, villages and communities. The practice of throwing waste into the streets, galleries, any where in the yard, and vacant areas led to the breeding of rats and flies. For example, in Europe because of waste accumulation at the time of formation of

large communities resulted in increment of the rat population. It was during that time that the great plague pandemic killed hundreds of thousands of people in the world.

Present public health science proved that those rats, flies and other diseases vector breed in open dumps, in food storage facilities, and in other areas and houses. One study in USA revealed that there is 32 human diseases which have relationship to improper solid waste management.

Ecological impacts of solid waste include:-



Pesticides

Pesticides are substances, which kill pests and disease vectors of agriculture and public health importance. Pesticides are subdivided into groups according to target organisms:

Insecticides; kill insects
Rodenticides; kill rats and mice
Herbicides; kill weeds
Nematicides; kill nematodes

Insecticides: the largest numbers of pesticides are employed against a wide variety of insects, and include: stomach poison (taken into the body through the mouth); contact poisons (penetrate through the body wall); and fumigants (enter insects through its breathing pores).

Inorganic insecticides

These insecticides act as stomach poison. Lead arsenate, Paris Green, and a number of other products containing copper, zinc, mercury, or sulfur are examples of inorganic insecticides. Many of these products are quite toxic to man as well as to insects.

Botanical

Certain plant extracts are very effective contact poisons, providing quick knockdown of insects. Most botanical preparations are non-toxic to humans, and can be safely used.

Chlorinated hydrocarbons

These are contact poisons. DDT,

very slowly, and therefore, retaining their effectiveness for a relatively long period after application.

Organophosphates

Organophosphate are broad-spectrum contact poisons. Unlike chlorinated hydrocarbons, organophosphates are not persistent, usually breaking down two weeks or less after application. They are nerve poisons, which act to inhibit the enzyme cholinesterase, causing the insect to lose coordination and go into convulsion. Methyl parathion, phosdrin and malathion are examples of this group.

Carbamates

These are contact poisons, which act in a manner similar to the organophosphates. Carbamates are widely used in public health work and agriculture because of their rapid knockdown of insects and low toxicity to mammals.

Pesticide Benefits

Disease control

Insects, rodents and ticks serve as vectors in the transmission of a number of disease-causing pathogens and parasites. Malaria, yellow fever, trypanosomiasis, onchocerciasis and plague (Black Death) are some of human diseases that are transmitted by disease vectors (insects and rodents). All of these diseases can be reduced by careful use of insecticides.

Crop protection

Plant diseases, insects, bird predation, and competition by weeds reduce crop yield worldwide by at least one-third. Post-harvest losses to rodents, insects, and fungi may as much as another 20 to 30 percent. Without the use of pesticides, these losses might be much higher.

Pesticide Problems

While synthetic chemical pesticides have brought us great economic and social benefits, they are also causing a number of serious problems. Some of the problems are:

Killing of beneficial species;
Development of resistance;
Environmental contamination
Hazards to human health especially workers who do not use personal protection equipment during application (See **Fig 4.1**).

Fig 4.1. A Farmer in Jimma Zone ready to spray a herbicide with out wearing any form of personal protective equipment.

Radioactive Materials

There are various kinds of atoms of each elemental substance, each with a slightly different make-up, some radioactive, some not radioactive.

When radioactive materials are released into the environment, they become dispersed and diluted, but they may also become concentrated in living organisms and during food chain transfers by a variety of means. Radioactive substances may also simply

accumulate in water, soils sediments, or air if the input exceeds the rate of natural radioactive decay.

Radioactive materials have the same chemical properties as the non-radioactive forms. Thus, radioactive iodine (I^{131}), for example, can be incorporated into thyroxin, the thyroid hormone, as easily as non-radioactive iodine (I^{127}). Strontium 90 is a radioactive substance. It is chemically very similar to calcium, and thus tends to be accumulated in the bones and other tissues rich in calcium. It can also damage the blood-forming center in the bone marrow.

Prevention and Control of Pollution

As in disease, pollution prevention is far better and more desirable than its cure. There are various measures that can be taken for preventing pollution. The followings are some of the measures:

a. Recycling and reuse of waste materials;
b. Waste reduction;
c. Control the use of chemicals;
d. Proper disposal of wastes;

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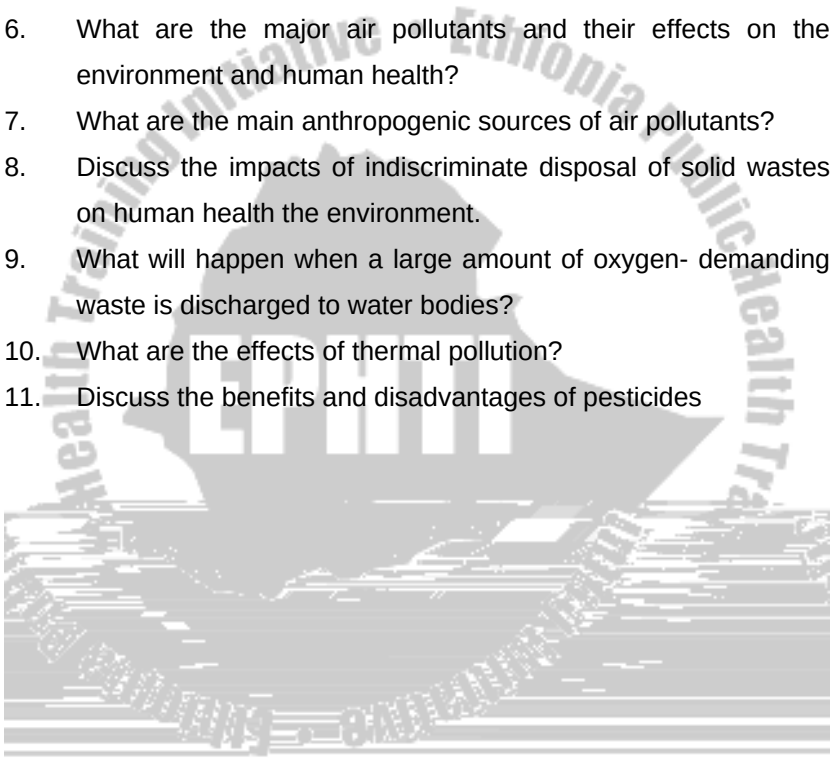
Review Questions

1. What are the three main components of the biosphere?
2. What are the types and sources of water pollution?
3. What are point-source and non-point source of pollution? Give examples for each.
4. Give some examples of diseases that are related to water pollution.
5. What is eutrophication? What causes it?
6. What are the major air pollutants and their effects on the environment and human health?
7. What are the main anthropogenic sources of air pollutants?
8. Discuss the impacts of indiscriminate disposal of solid wastes on human health the environment.
9. What will happen when a large amount of oxygen- demanding waste is discharged to water bodies?
10. What are the effects of thermal pollution?
11. Discuss the benefits and disadvantages of pesticides



CHAPTER FIVE

Natural Resources and their Conservation

Learning Objective:

At the end of this chapter, the student will be able to:

List the different types and groups of resources

Discuss the different conservation methods

Mention environmentally friendly/ safe/ energy sources

Definition of terms:

1. **Energy:** The capacity to do work
2. **Mineral:** Inorganic nutrient, which is mostly found in the earth's crust.
3. **Mulch**: A layer of organic material applied to the ground surface to the ground surface to retain and conserve moisture.
4. **Renewable resource:**

enterprise). It is useful to distinguish between **exhaustible (non-renewable)**, **renewable (non-exhaustible)** and **intangible** resources.

Modern civilization entails the high risk of irreversible deterioration of the environment, which accompanies overpopulation, overproduction, over wastage and the exploitation of ever-increasing amounts of natural resources such as source rocks for ever-declining proportions of useful products, e.g., Minerals. Any perturbation in the broad framework of the inter-relationships between living organisms and their environment may influence the availability of resources to human societies.

Natural resources can be broadly classified into biological and non-biological, and includes such resources as minerals and industrial, agricultural, forestry and food resources, power and energy, plant and animal, range and water. As explained above, resources may be renewable or non-renewable. Biological resources such as fish are of course, can be replenished, but such resources as nitrogen, iron and energy may also some time be renewable through not to the same extent as forests and fisheries.

Abstract or intangible resources include open space, beauty, serenity, genius, information, diversity and satisfaction. Unlike tangible resources often are increased by use and multiplied by sharing. These non-material resources can be important economically.

5.2 Types of Natural Resources

The functioning of ecosystems, including man's survival and happiness, depends on the availability, preservation and recycling of natural resources such as minerals, water, land and energy sources. These resources are, however, not unlimited and many countries still continue to dream of an ever increasing Gross National Product based on obsolescence and wasteful practices.

Fig 5.1. Forest clearance at the site of Gilgel Gibe Hydroelectric dam construction, Region 4, Southwestern Ethiopia. Trees measuring up to 1.6 m in diameter have been removed.

Consequences of Forest Destruction

Forests are important regulators of ecosystem. They exert significant effects on the water budget and the hydrological cycle. In areas of heavy rainfall, forest plants intercept a large fraction of the rain. This water evaporates quickly and returns to the hydrological cycle.

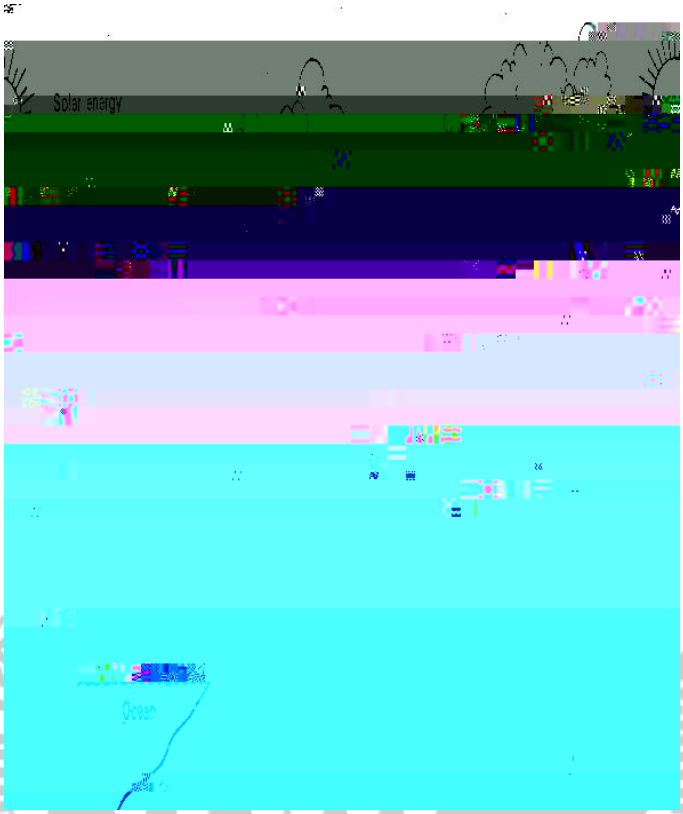


Fig 5.2. The Hydrologic Cycle (Source: Kumar, 1997).

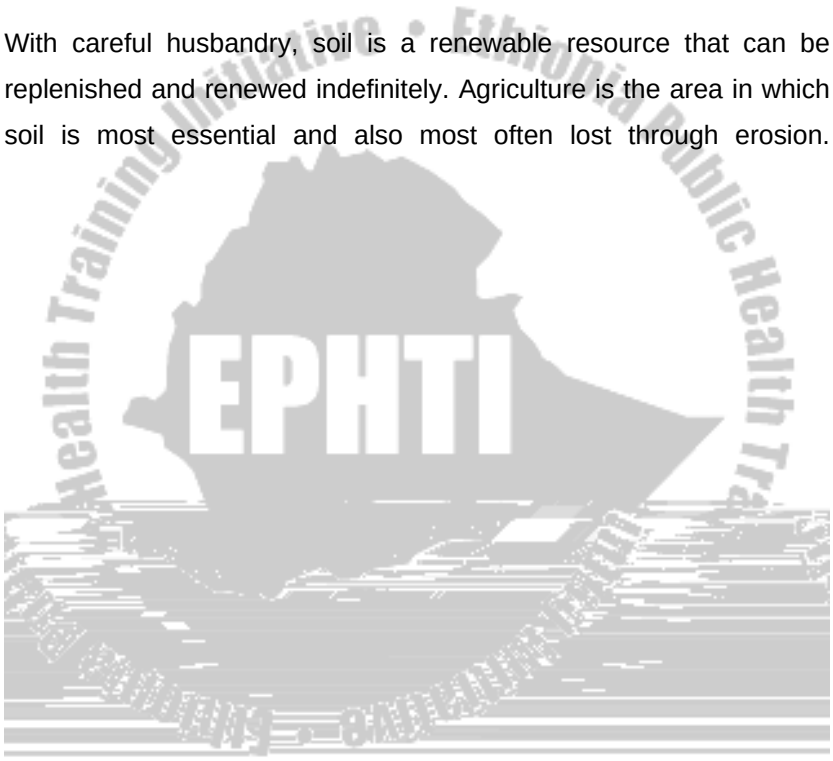
Some of the water reaching the forest floor penetrates into the soil through the litter and the loose soil surface, and there is little surface run-off. It is only after some period of time that the seeped water reaches the streams and rivers. This time lag is an important device to regulate the water discharge into rivers, and in this way, flooding is prevented or minimized. On the other hand, in dry periods also the forest soil continues to supply water slowly to the streams and rivers.

Destruction of forest changes the above situation immediately. The hydrological cycle is disrupted and the water level of the rivers cannot be properly regulated. This causes flooding. In dry periods, the rivers

negative terms. Soil is a marvelous substance, a living resource of astonishing beauty, complexity and frailty. Half of the soil content is mineral, and the rest is air and water together with a little organic matter from plant and animal residue.

We face a growing scarcity of good farmland to feed the world's rapidly growing human population. Only about 10% of the earth's land area (14.78 million sq. km of a total of 144.8 million sq. km) is currently used for agricultural production.

With careful husbandry, soil is a renewable resource that can be replenished and renewed indefinitely. Agriculture is the area in which soil is most essential and also most often lost through erosion.



ocean and tides. Water wheels, windmills and hot water from thermal springs have been used as energy sources in some countries, and of course coal has been a major source of energy for a century or more in England.

Renewable energy resources like Hydropower, the sun, wind, tides and biomass are nor likely to make significant contributions to the world's energy for the developed nations. But these renewable sources are expected to play an increasingly important role in the energy use pattern of many developing countries like Ethiopia. It is not environmentally friendly to completely shift the hunger for petroleum to the more abundant but still finite coal, shell and heavy oil reserves; because it will increase the level of CO_2 which is the known greenhouse gas.

In this case, biomass conversion has unique advantages over the commonly used energy technologies. Unlike petroleum or coal, biomass resources are renewable. Conversion of municipal and industrial wastes in to useful fuels amounts to killing two birds with one stone; the energy supplies are increased, and the environment is cleaned up.

Many developing countries have a substantial reliance up on wood fuel (e.g. charcoal) and, to a lesser extent, crop wastes as their

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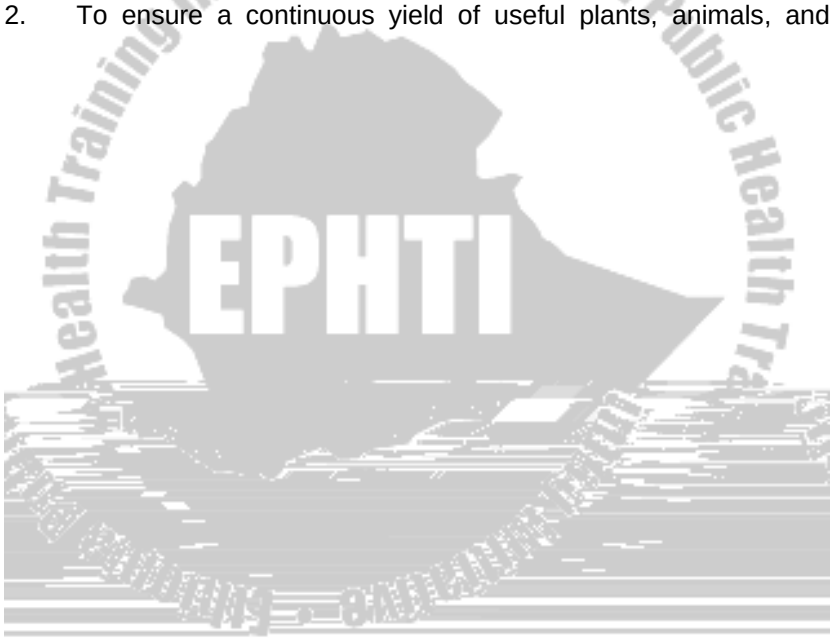
of protected area and characteristically contain a rich variety of organisms, some of which can serve as reliable indicators for disturbance in the system. As a consequence of increasing tampering of nature by man, natural reserves are greatly dwindling and are becoming the main sanctuaries for
wild plants and animals.

The aim of conservation is twofold:

1. To ensure the preservation of a quality environment that considers esthetic and recreational as well as product needs and
2. To ensure a continuous yield of useful plants, animals, and



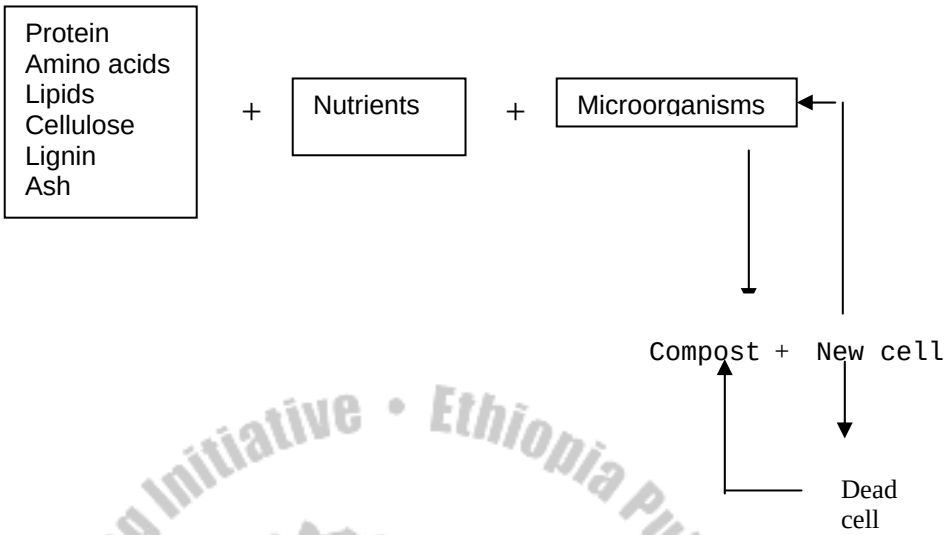


Fig.5.3. Composting process (Ehlers and Steel, 1965)

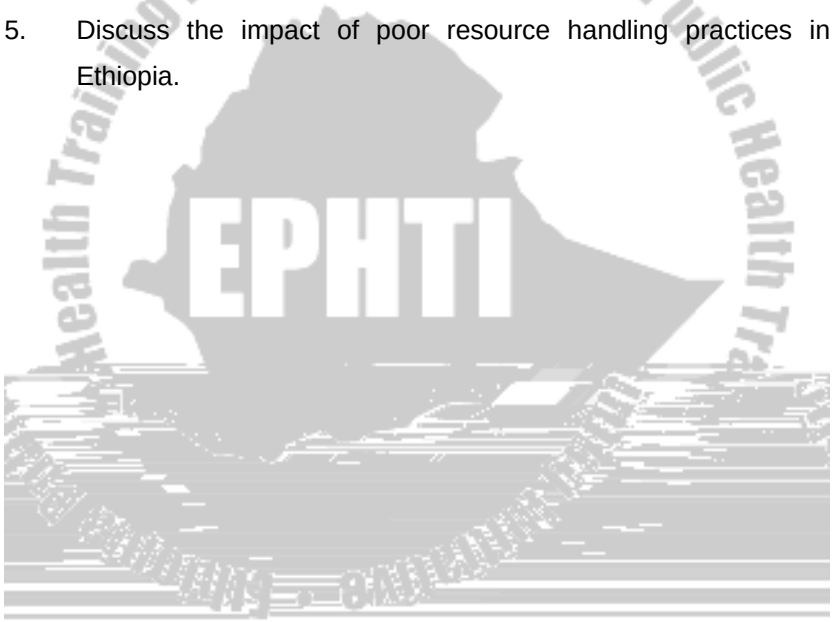
The other method of resource conservation is by forestation, which is actually important for soil, wildlife and plant conservation. In fact, wild life is often a reliable indicator of the state of health of an environment.

The historical record of resource management in much of Ethiopia, particularly in the area of seed/plow agriculture, has been rather dismal, characterized by exploitation, crises, and lack of a harmonious relationship between man and the environment. Formulated in 1990, the National conservation strategy tries to develop a more integrated and participatory approach to natural resources issues. Integrated, participatory planning is essential if Ethiopia's renewable and nonrenewable resources are to be utilized in a rational and sustainable manner and ecologically sound agricultural systems are to be developed to support the rapidly growing population.

In general the conservation of natural habitats and the protection of biological diversity is important for sustainable development at levels ranging from the global to the local.

Review questions:

1. Define the following terms
   - Resource
   - Exhaustible and non-exhaustible resource (give examples for each).
2. What are the current activities that are undertaking in our country regarding resource conservation?
3. What is the importance of recycling and reuse of resources other than conservation of a specific resource? Give example.
4. What are clean/environmentally friendly/ energy sources? Which one is feasible to our country, Ethiopia?
5. Discuss the impact of poor resource handling practices in Ethiopia.



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