VII. ENVIRONMENTAL EDUCATION

INTRODUCTION TO OUR ENVIRONMENT

ENVIRONMENT

Our life on earth is highly dependent on a number of factors such as fresh air, clean drinking water, availability of food and climatic conditions. Our living conditions and survival are also dependent on the social, political and economic conditions of the society we live in. Any adverse changes in these external influences would threaten our existence. Not only humans, but all organisms are similarly influenced by such external conditions that decide their living conditions and survival.

Environment is defined as the sum total of all external conditions and influences affecting organisms. Environment is actually what we call as our surrounding.

All living organisms are in constant interaction with a number of external factors in its and other living organisms are some of these. Environment is the sum total of all these factors.

COMPONENTS OF ENVIRONMENT

Environment consists of two components – natural and man-made. The natural environment consists of a ***biotic component*** and an ***abiotic component***. The biotic component consists of all living beings, including plants, animals, fishes, birds, and even micro-organisms. It constitutes the biological and organic environment.

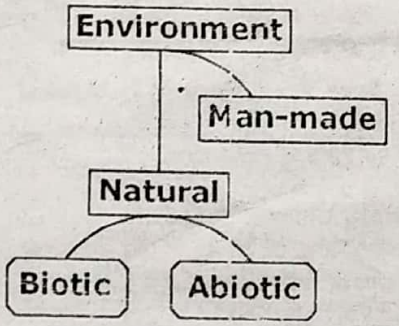

Figure 30 Components of environment

The abiotic component of environment consists of the non-living elements in the biosphere that include the physical elements such as soil, air, water, energy and sunlight. For a life form to exist, both biotic and non-biotic environment are equally important. Both these components are in constant interaction with one another to make life possible on earth.

The man-made environment consists of all that man has created in this earth including social, political and religious institutions; buildings, materials, machineries; wars, rituals, customs, language, consumerism etc. All these factors do influence our life.

PRINCIPLES OF ENVIRONMENT

i. *Principle of Dependence and Mutual Influence*

Every component in the environment is dependent on other components directly or indirectly. The mutual relationship between various components is called *interaction*. For example, an animal can live only if it breathes air, drinks water and eats food that it obtains from its environment. The animal dies if these elements become unavailable or their qualities diminish beyond a certain limit.

ii. Principle of Balance

Nature maintains a balance between different components in the environment and therefore the environment remains more or less stable. Nature does it through various mechanisms like the food chains, food webs and through different cycles like carbon cycle, nitrogen cycle, hydrological cycle (see 208). You can see that the atmospheric temperature, salinity of seas and composition of gases in the atmosphere remain balanced through the actions of such natural processes.

iii. Principle of Unity

All organisms are made of same basic structural and functional units called cells. Therefore the cells of one living organism can be digested and assimilated by another.

iv. Principle of Diversity

Though all organisms are made of cells they differ in their physiology, anatomy and morphology. This diversity among the organisms gives stability to the environment. For example the diseases that affect one species may not have any effect on other species in the same environment and the environment is not very much affected by it.

v. Principle of Active Tendency

The organisms can develop resistance against man-made substances. This is called the resistive tendency or active tendency of living organisms. For example, we see that mosquitoes become resistant to mosquito repellents and pests become resistant to pesticides.

vi. Principle of Continuous Production

Population of plants and animals continuously change. New ones replace those that are killed and those that have potential for over-production are checked.

ECOSYSTEMS

An ecosystem is a community of living organisms constantly interacting with one another and with their physical environment and thus acting as an ecological unit.

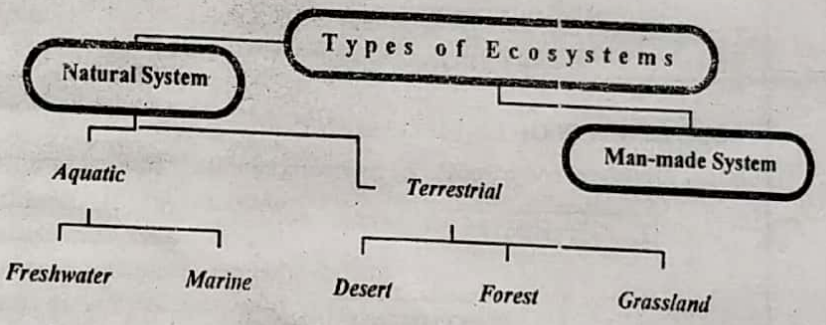

Figure 31 Types of ecosystem

There are two constituents for an ecosystem - the abiotic constituents consisting of minerals, climate, soil, water, sunlight, and all other nonliving elements, and the biotic constituents, consisting of all its living members. Linking these constituents together are two major forces: the flow of energy through the ecosystem, and the cycling of nutrients within the ecosystem.

Ecosystems are found in trees, rivers, ponds, forests, and grasslands and in different systems present in the universe. A river, a forest and a pond are examples of natural ecosystems. An aquarium, a garden and a reservoir are examples of artificial or man-made ecosystems. The biosphere itself is the sum total of all these small and large ecosystems present at various levels.

Characteristics of an ecosystem are:

- All ecosystems contain plants and animals (biotic) and non-living (abiotic) components.
- The plants and animal population of an ecosystem interact with one another and are also dependent on one another.

- Biotic components interact with abiotic components and maintain balance.
- Ecosystem survives because energy flows through various components. Different organisms get their energy in different ways.
- Plants produce food in the ecosystem.
- Ecosystem tends to maintain balance or equilibrium to a certain extent.
- Each plant and animal species plays important roles in the ecosystem.
- Each plant and animal species has tolerance limits for various factors in its environment.

ECOLOGICAL BALANCE

Nature maintains a balance between abiotic and biotic components so that the number or quantity of different components of an ecosystem remains nearly constant. This balance can be maintained only up to a limit and beyond that the ecosystem is permanently disturbed and a new ecosystem takes shape under the changed conditions. If the balance is disturbed due to human influence or otherwise it results in large-scale deaths of one or more species in the food webs. Then a new equilibrium is established. Thus an ecosystem is capable of self-regulation to a certain extent through various processes. This principle is called principle of homeostasis or ecological balance.

ECOLOGY

Ecology is the study of the intricate relationship between an organism and its environment.

Each organism in this world is related to some other organism/s in some way or other. The relationship could be as predator and prey, just as in the case of cat and mouse. Or organisms may mutually help for their survival in symbiotic existence. Honey bird gets honey from flowers while helping the plants in pollination. The relationship need not be direct always. Birds eat grasshoppers for their food and grasshoppers eat grass. If grass is destroyed grasshoppers are deprived of food and they die. Not only the grasshoppers but the birds that prey on grasshoppers also die.

SELF ASSESSMENT TEST

1. Explain what you mean by the term environment?
2. What are the various components of our environment? Describe with the help of examples.
3. What are the principles of the environment?
4. What is ecosystem?
5. Describe the characteristics of an ecosystem.
6. Explain the principles of homeostasis in environment.
7. Describe the following terms: (i) environment; (ii) ecosystem; (iii) ecology
8. What are the components of an ecosystem?

Earth provides enough to satisfy every man's need, but not every man's greed

Mahatma Gandhi

ECOLOGICAL PROCESSES

Ecological processes are natural processes that contribute to the functioning of the ecosystem. They concern the interactions among organisms and interactions with their abiotic environment. The most fundamental ecological processes are about food and food webs. In these terms organisms can be divided into producers (mainly plants and single celled organisms that use photosynthesis), consumers (mainly herbivores), predators (mainly carnivores) and decomposers (mainly soil fungi and bacteria in terrestrial ecosystems) and the related ecological processes are production, consumption, predation and decomposition.

There are many other ecological processes that influence ecosystem and diversity. Some important ones are competition (e.g. between two animals for one prey), mutualism (e.g. pollination of flowers by bees), dispersal (e.g. birds carrying seeds – another mutualism) and ecosystem engineering (e.g. termites building nests that provide new habitats for other organisms). Ecological processes are sustained by various spheres of the earth described below.

THE FOUR SPHERES OF THE EARTH

The area near the surface of the earth can be divided up into four inter-connected "geo-spheres" viz., the lithosphere, hydrosphere, biosphere, and atmosphere. The names of the four spheres are derived from the Greek words; for stone (litho), air (atmo), water (hydro), and life (bio). The life and materials on or near the surface of the earth comes under any of these four spheres.

BIOSPHERE

Life is present only in a very thin layer on the planet earth. This zone is known as the *biosphere* or life zone of the earth. It includes all living organisms, including man, and all organic matter that has not yet died and decomposed. It includes all animals, plants, fungi, and even microscopic one-celled organisms. In short, if there is something that's alive, then it is in the biosphere. Biosphere is not yet discovered in any other planet in this universe.

The biosphere is only about 21 kilometres thick. It is in this narrow band that conditions for life are most favourable. Life in the form of little organisms live in the first few metres depth of soil and most life forms live within a few metres above the earth's surface. Life is also found in almost all water bodies and in the lower part of the atmosphere. Millions of life forms have been identified so far.

The biosphere can be viewed as a system in which various subsystems are dependent on each other for their functioning. It is not a closed system because it requires a constant supply of energy from outside, that is, from the sun. The biosphere can be divided into distinct ecosystems that represent the interactions among organisms, the environment or habitat in which they live. In the biosphere there exist food chains starting from producers to tertiary consumers (see page 210). The energy that the biosphere receives from sun is transferred from one level of the food chain to the next level with an efficiency of about 10%. All organisms in the biosphere are thus intrinsically linked to their physical environment.

The biosphere is made up of the biotic (living) and the abiotic (non-living) components. All the plants and animals in the earth come under the biotic part of the biosphere. The abiotic part of the biosphere consists of all the non-living parts of the ecosystems like the climate or the geological and physical features.

Damage to the biosphere

We have seen that the biosphere is where life exists. Due to the activities of man, and sometimes that of nature, the biosphere is often damaged. Obviously, the damage to the biosphere affects all living creatures. Pollution is an important cause for damage to the biosphere. Man-made pollution from vehicles, factories, and natural phenomena like volcanoes produce large quantities of carbon dioxide and other gases. Changes in the atmospheric gaseous composition by an increase in the amount of carbon dioxide and several other gases can affect the temperature of the earth's surface. This phenomenon is called global warming. There is the larger concern that these emissions will have long-term impacts on global climate.

Human activities are thus causing damage to both biotic as well as abiotic components of the biosphere. Ecosystems are being manipulated or destroyed. Quality of air and water, essential for survival of life, are also being threatened. Burning of fossil fuels, is at present the major source of energy in the world as it releases carbon dioxide, methane and nitrous oxide. Chlorofluorocarbons or CFC released in the atmosphere lead to depletion of the earth's ozone shield that protects life forms from the harmful effects of ultraviolet radiation. Ozone layer depletion can lead to skin cancer and is harmful to living creatures. Chemical pollution and other contamination of groundwater, lakes, rivers, and the oceans are threatening the quality of the water supply in many parts of the world, thus damaging the biosphere. Human activities like agricultural and industrial practices have significantly impacted the supply and quality of water on earth. Due to these activities world's forests have depleted resulting in large scale loss of biodiversity and leading to extinction of many species of animals and birds.

ATMOSPHERE

Atmosphere is essential for land animals, birds and other living creatures for breathing air. It is a thin blanket of gases surrounding the earth, supplying oxygen to the living organisms for breathing and protecting them from the harmful rays of the sun. It consists of a mixture of gases, primarily nitrogen, oxygen, carbon dioxide, and water vapour. Nitrogen gas accounts for most of the atmosphere. One-fifth of the air is oxygen, upon which all life depends. There is a small amount of carbon dioxide (0.03%). Maintaining the earth's climate is another great function of the atmosphere. It uses the sun's energy and also interacts with the land and the oceans for this process. The pressure, temperature and composition of our atmosphere are conducive for supporting life.

Most life forms exist in the few kilometres nearest the earth's surface. Many gases contained in the atmosphere are needed for plants for their survival. Changes in temperature cause the air to rise and fall in the atmosphere along with the movement of cold and warm air. Air moves around the globe in jet streams powered by the sun. Atmosphere density decreases from the earth's surface up till the vacuum of the outer space. The chemical composition of the atmosphere is influenced by chemical reactions of life like photosynthesis. Many of these chemical reactions that sustain the life processes either extract or emit gases from and to the atmosphere. For example, photosynthesis consumes carbon dioxide and generates oxygen whereas respiration does the opposite. The proportion of these gases is balanced by nature to enable life to sustain in it.

The Atmosphere has five layers viz. troposphere, stratosphere, mesosphere, thermosphere and exosphere.

Troposphere: This is the lowermost layer of the atmosphere, extending about 8 to 12 kilometres from earth's surface. It maintains the climatic conditions suitable for life on the planet. It is composed of about 78 percent nitrogen, 21 percent oxygen, trace gases, water droplets,

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All living organisms require water for their survival. The biosphere in the present form exists because of liquid water. Water plays an important role in plant growth as it transports soluble nutrients like phosphate and nitrates essential for plant growth, and also transports the waste products of life's chemical reactions.

Most of the water is contained in the oceans. The high heat capacity of this large volume of water (1.35 million cubic kilometres) protects the biosphere from large temperature changes. Water flows among the various components of earth system through hydrologic cycle.

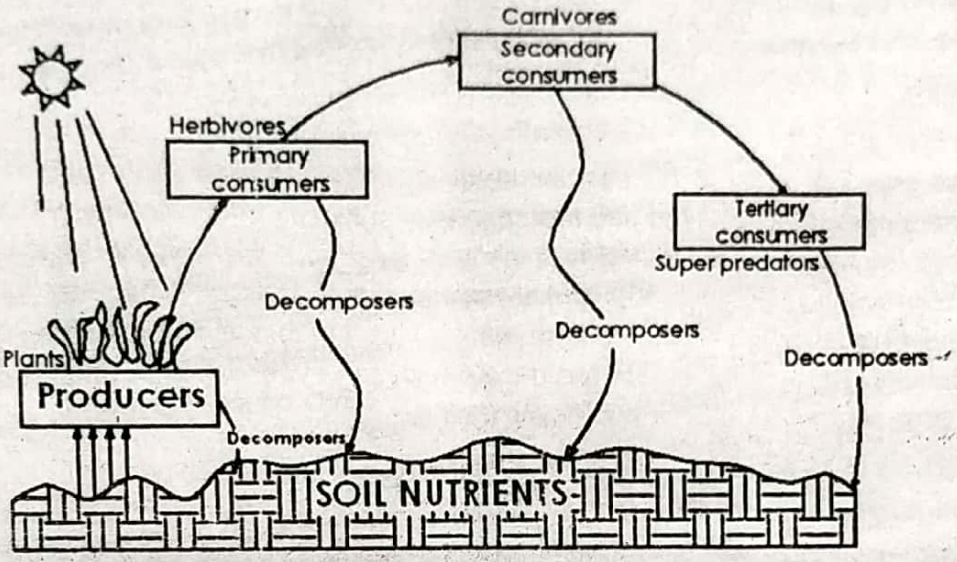

Figure 32 Transfer of energy through food chain

Water is transferred between the hydrosphere and the biosphere by evaporation and precipitation. Energy is also exchanged in this process. Terrestrial plants draw water from the ground using their root systems and use it to transport soil nutrients through the stems and leaves. Evaporation of water from the leaf surface (called transpiration) results in transferring water back to the atmosphere. Water plays an important role in the chemical and mechanical breakdown of rock that result in the formation of soil. As precipitation falls on the land and makes its way to the sea, erosion of rock takes place.

FLOW OF ENERGY

Life exists in the ecosystem only through the flow of energy. Sun is the source of all energy (except atomic energy) and the sun's energy tapped in plants is the main source of energy for animals and many living organisms. Flow of energy in living components is through photosynthesis, respiration, food chain, food web and food pyramids. In the flow of energy the 10% law is followed (see page 205)

Energy is defined as the capacity to do work. Living organisms that grow, reproduce, move about and do works, possess energy. Only a small portion of the solar energy reaches the earth's surface. Out of this plants utilise only a small fraction during photosynthesis to produce organic matter. The energy absorbed by the plants is trapped in the organic matter. When plant-eating animals or insects eat plants, this energy is transferred from their bodies to the bodies of these organisms. Plant eating animals like cow, sheep and elephants or insects like grasshoppers are called ***herbivores***. Herbivores are eaten up by ***carnivores*** (like lion, tiger) or flesh eating birds. When herbivores are eaten up, a portion of the energy trapped in their bodies gets transferred into the bodies of carnivores. Super predators like eagle eat up both herbivores as well as carnivores and in the process the energy gets transferred into their bodies from the bodies of animals they eat.

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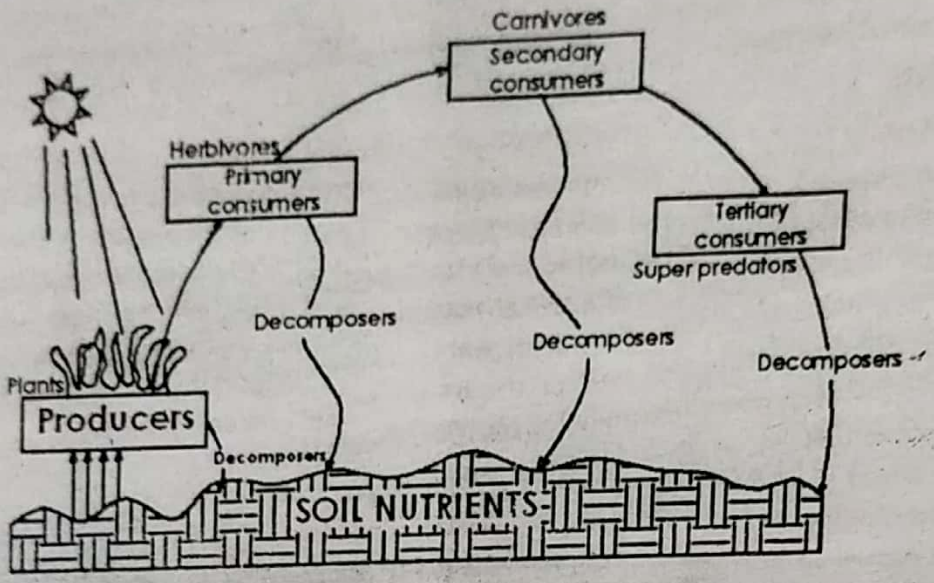

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PRODUCTIVITY

Green plants convert about 3% of incident solar energy into chemical energy. During photosynthesis carbon dioxide and water combines using solar energy to form sugar molecules. The chemical energy thus produced is stored in the organic tissues. When sugar combines with the nutrients organic molecules of protein, nucleic acid, cellulose and hormones are produced.

The total amount of organic matter produced in a unit area within a unit time is termed as productivity. The total biomass fixed by the vegetation (producers) in a unit area within a unit time is termed as primary productivity.

It is possible to measure the total solar energy fixed by an ecosystem by measuring the amount of sugar produced but the only problem is that it is difficult to measure the energy that is lost during respiration by plants immediately after the production of sugar.

ECOLOGICAL PYRAMIDS

Consider a food chain in which there are plants, herbivores, carnivores and super predators. The total number of plants will be about 10 times plant eaters and total number of plant eaters will be about 10 times the total number of carnivores who eat plant eaters and total number of carnivores will be about 10 times the total number of super predators. This rule is not only applicable in case of numbers but also in case of biomass of organisms.

The total biomass of the plants in a food chain will be about 10 times that of plant eaters and total number of plant eaters will be about 10 times that of carnivores. Similarly the total energy contained in the biomass of plants will be about 10 times the total energy contained in the biomass of plant eaters and the total energy contained in the biomass of plant eaters will be about 10 times that contained in the biomass of carnivores.

Each of these factors - numbers, biomass, and energy can be represented in the form of pyramids called ecological pyramids. An ***Ecological Pyramid*** is a diagrammatic representation of energy, biomass or numbers present in different trophic levels of a food chain.

Here we are talking about the total energy stored at each trophic level of individual food chains. In food chains not all energy or organic matter (biomass) is transferred from one trophic level to the other. This is because not all the organic material at one trophic level is eaten by the next trophic level. For example grasshoppers do not eat all grass or snakes do not eat all grasshoppers. Not only that, when one creature is eaten by a consumer at higher level some of its body parts like bones or hairs may be left behind. Energy transferred to a particular level is also lost through heat generated during respiration of the living creatures, their body activities etc. Thus in order to support a few consumers at the tertiary level there should be many consumers at the secondary levels, still more at the primary levels. The number of producers should be even higher.

The energy and biomass transfer between various trophic levels can be represented in the form of pyramids called ecological pyramids. It resembles pyramidal shapes with producers at the bottom and tertiary consumers at the top. There are three types of ecological pyramids viz. ♦ Pyramid of Energy ♦ Pyramid of Biomass ♦ Pyramid of Numbers

Pyramid of energy

The total amount of energy stored at various levels of a food chain when represented diagrammatically resembles a pyramid that can be called pyramid of energy.

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Occupying a higher trophic level, their biomass must be smaller. Hence, the number of individua in the predator population is much smaller than that in the prey population.

Thus in the pyramid of numbers the producers occupy the bottom position with primary consumers at the top of it and secondary consumers at the top of primary consumers and so on. The size of the population of producers is the largest and the population size decreases as we go to the top of the pyramid, progressively decreasing at the rate of 10% at each trophic level.

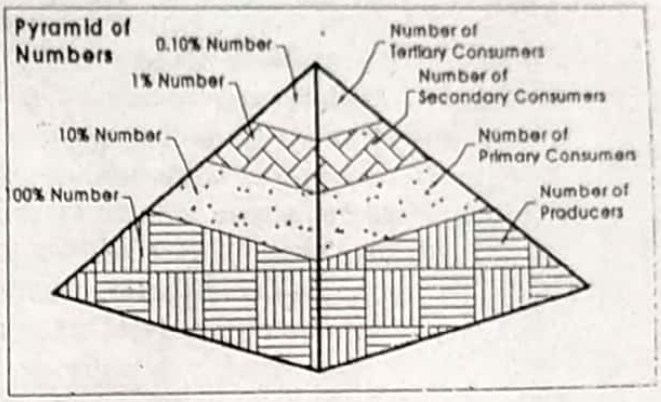


Figure 35

FLOW OF ENERGY IN NON-LIVING COMPONENTS

Due to sun's heat water evaporates from the ocean and the water bodies like rivers ar lakes and turns into water vapour. The water vapour condenses in the clouds and fall down i rain. Rainwater that falls on the hilltops flows down due to gravity. Electricity is generated fro this water by converting the energy of the flowing water into electric energy with the help turbines. Fossil fuels like coal and petroleum contains sun's energy trapped in it. When electrici is converted into mechanical energy it runs electric trains, fans and motors; when converted in heat energy it is used in manufacturing or cooking.

There are three laws of thermodynamics concerned with conversion of energy. The first la of thermodynamics states that: "Energy can neither be created nor be destroyed". According this law, the energy can be converted from one form to another but the total energy befc transformation will be same as total energy after transformation. This law is also known as Law Conservation of Energy. According to second law of thermodynamics no energy transformation 100 percent efficient. This means that during the transformation some energy will be lost and tl cannot be used any further.

NUTRIENT CYCLES

A living organism requires, besides carbon, hydrogen and oxygen, certain chemical elemer called nutrients for its living. They include nitrogen, phosphorus, sulphur, potassium, calciu magnesium, iron and sodium. Ninety five percent of earth's biomass is constituted by the elements.

Nutrients are classified into **macronutrients** and **micronutrients**. Macronutrients are thc that the living organisms require in large quantities while micronutrients are those that a required in small quantities or traces. Hydrogen, oxygen, carbon, phosphorus, sulphur, potassiu and magnesium are macronutrients. Sodium, chlorine, manganese, iron, boron, copper and z are micronutrients. These nutrients flow through various food chains in the biosphere through number of nutrient cycles. Carbon cycle, nitrogen cycle, oxygen cycle, phosphorus cycle a sulphur cycles are some of the nutrient cycles

It is the producers (plants) that first derive energy directly from the sun. When primary consumers eat plants the energy gets transferred from the cells of the plant bodies to the bodies of the herbivores. This means that if you calculate the total energy contained in the cells of primary consumers in a food chain it would be about 1/10th of the total energy contained in the cells of the producers in the food chain. The efficiency of energy transfer is just about 10%. Thus the total energy content at the primary consumer level gets decreased when it passes on to secondary consumer level and from there to the tertiary consumer level following the 10% law.

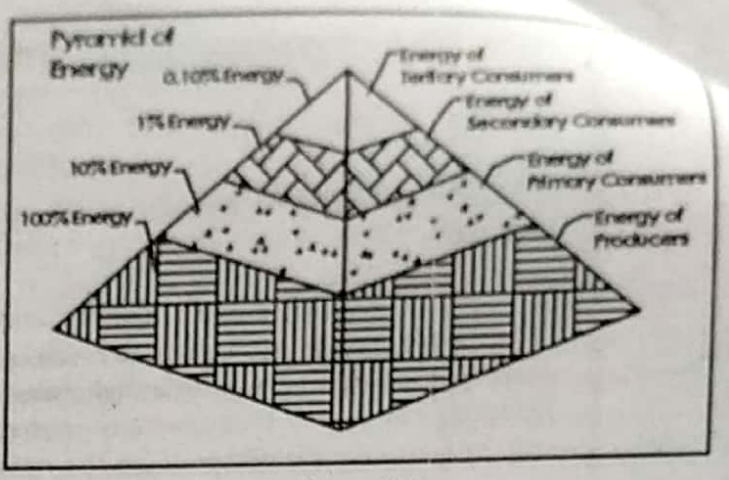


Figure 33

For example, the total amount of energy in a population of frogs is far less than that in the insects on which they feed. The insects, in turn, have only a fraction of the energy stored in the plants on which they feed. This decrease in the total available energy at each higher trophic level is represented diagrammatically in the form of a pyramid called the pyramid of energy.

Pyramid of biomass

Since all organisms are made of roughly the same organic molecules in similar proportions, a measure of their dry weight is a rough measure of the energy they contain. The population of a species, multiplied by the weight of an average individual in it, gives an estimate of the weight of the population. This is called the biomass. That is the biomass is the total dry weight of all living organisms in an ecosystem at a given time. The biomass diminishes in the food chain from the autotrophs to tertiary consumer or higher trophic level to form a pyramid that can be called pyramid of biomass.

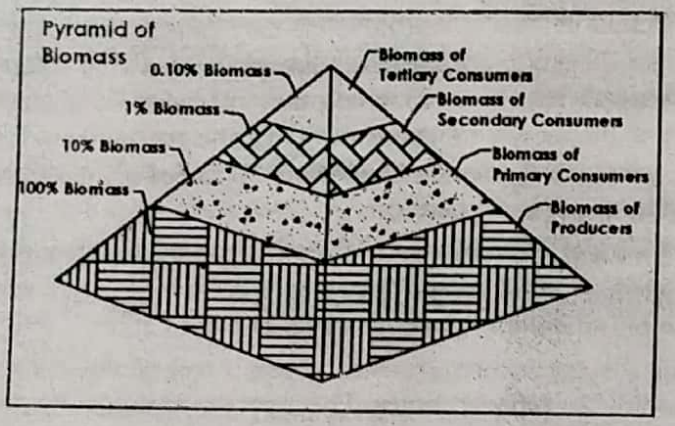


Figure 34

Pyramid of biomass is the graphical representation of biomass present in an ecosystem. The biomass decreases gradually from the bottom of the pyramid to the top at the rate of 10% at each trophic level.

Pyramid of numbers

Small animals are more numerous than larger ones. The pyramid of numbers can be obtained by taking a census of the populations of autotrophs, herbivores, and two levels of carnivores on an acre of grassland is taken. If the size of the individuals at a given trophic level is small, their numbers can be large and vice versa. Predators are usually larger than their prey.

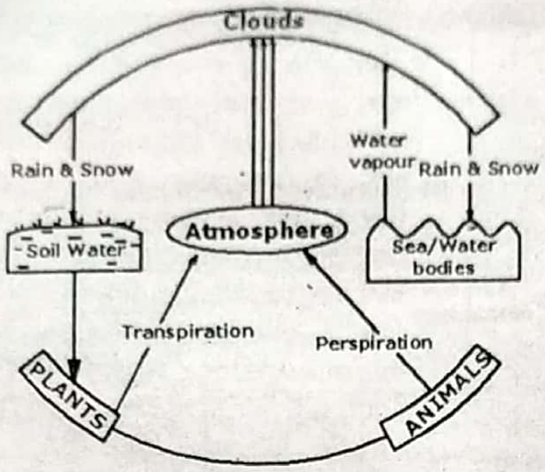


Figure 36 Hydrological cycle

The hydrological cycle or water cycle is of prime importance for sustenance of life on Earth because fresh water is available to living organisms on land due to this cycle. Plants absorb water from the soil while animals drink water from the water bodies or they get water from their food.

Carbon Cycle

In nature carbon is present in the atmosphere as carbon dioxide, in the bodies of organisms as carbohydrates and in water as dissolved carbon dioxide. Plants use atmospheric carbon dioxide during photosynthesis to produce organic matter. Herbivorous animals eat the plants and are in turn eaten up by carnivorous animals. Animals and plants release carbon dioxide to the atmosphere through respiration. Animals and plants when die and decay, carbon dioxide is released into the atmosphere due the activities of bacteria and fungi. Burning of fossil fuels and wood also releases carbon dioxide into the atmosphere (see Figure 37)

Hydrological Cycle

Hydrological cycle is that cycle that involves the continuous circulation of water in the Earth-atmosphere system. Of the many processes involved in the hydrologic cycle, the most important are evaporation, transpiration, condensation, precipitation, and runoff.

Water vapour formed as a result of evaporation from the surfaces of oceans and water bodies rises up and clouds are formed. The water vapour that condenses in the clouds falls down as rain and snow to Earth and reaches back to sea and water bodies through runoff of rivers, groundwater etc. Water that animals take in also reaches the atmosphere during perspiration and urination. Plants absorb water from the soil and release into the atmosphere as transpiration. Thus the hydrological cycle is completed. (See Figure 36)

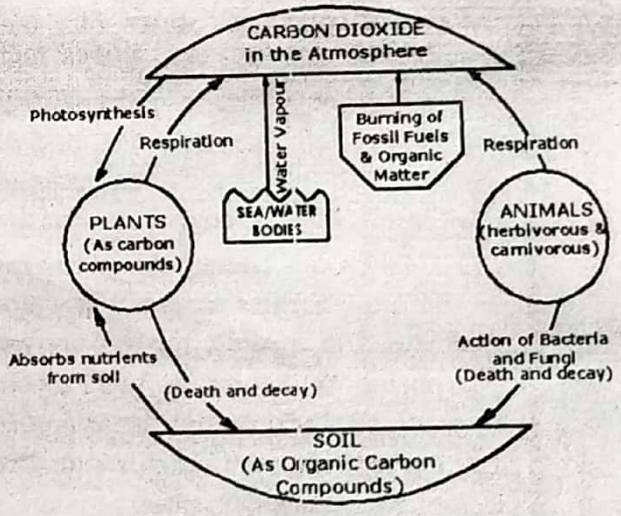
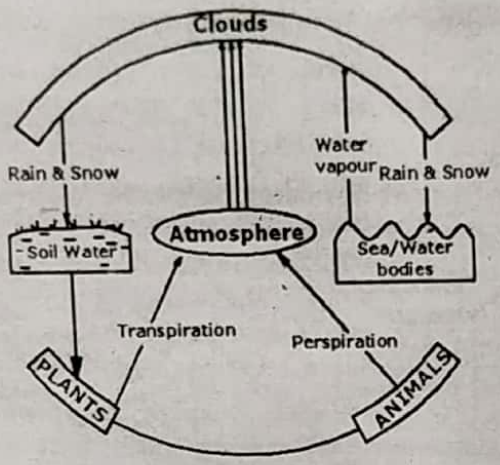


Figure 37 Carbon cycle

Sulphur Cycle

Sulphur exists in nature in both solid and gaseous forms, as sulphides, sulphites, sulphates, and oxides of sulphur. Like nitrogen it is also an essential constituent of organisms and is held up in proteins and amino acids. Oxides of sulphur combine with rainwater and fall to the ground as sulphuric acid. Plants absorb sulphates from the soil and convert them to proteins and amino acids. From plants they enter different food webs and move up from producers to consumers. Sulphur returns to soil and water bodies either through excretion of animals or after their death and decay.



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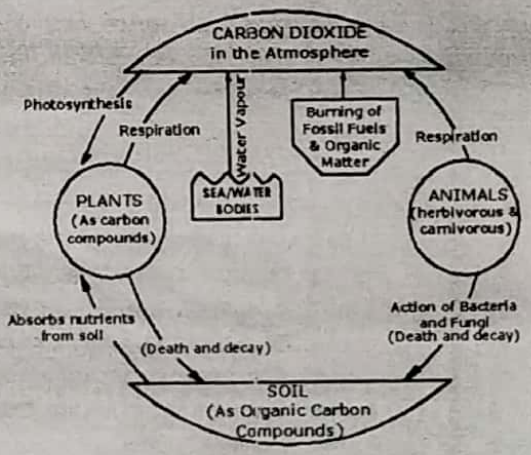

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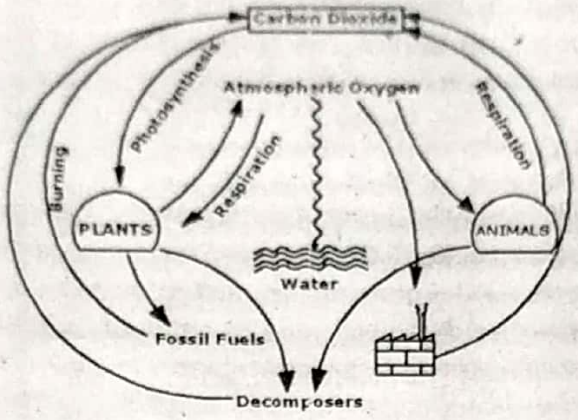

Figure 38 Oxygen cycle

Oxygen Cycle

Oxygen is essential for life of living organisms. Aquatic animals use dissolved oxygen for their respiration. Atmosphere contains 21 percent oxygen. When fossil fuels and organic matter is burned atmospheric oxygen is used up and converted into carbon dioxide. Plants absorb carbon dioxide during photosynthesis and returns oxygen to the atmosphere (See Figure 38)

Phosphorus Cycle

Phosphorus is an essential constituent of living organisms is present in the bones and teeth of animals. Phosphorus is present as phosphates in minerals and rocks. Through disintegration of rocks it reaches the soil. Phosphates dissolve in water and the plants absorb it. From plants it

Nitrogen Cycle

Nitrogen is an essential constituent of living organisms nitrogen exists in their bodies as amino acids, proteins and nucleic acids. The plants cannot directly absorb the atmospheric nitrogen as it is in molecular forms. Atmospheric nitrogen reaches plants through a process called 'nitrogen fixation' carried out by certain organisms called diazotrophs. Most of the nitrogen fixation is done by symbiotic diazotrophs that associate with leguminous plants. The rizobium bacteria living in the root nodules absorb atmospheric nitrogen in its molecular forms and converts into nitrates that can be absorbed by plants.

In another process the atmospheric nitrogen reaches soils through lightning that converts nitrogen into oxides of nitrogen. Oxides of nitrogen are also produced from volcanic eruptions or from industries. Rain dissolves these oxides of nitrogen and mixes with the soil. Plants absorb the nitrates from the soil for their growth. When plants die and decay the nitrogen is returned to the soil. De-nitrifying bacteria converts nitrates in the soil to atmospheric nitrogen.

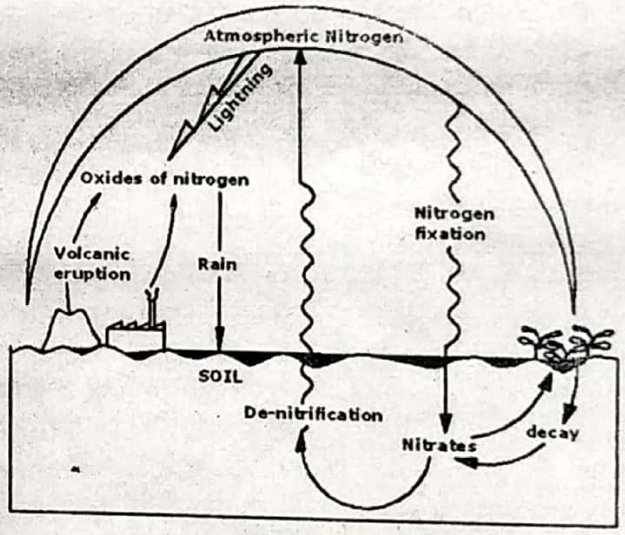

Figure 39 Nitrogen cycle

Most of the nitrogen in the biosphere is locked up in dead plants and animals as nitrates. Bacteria convert nitrates into amino acids and then again act upon amino acids to produce carbon dioxide, water and ammonia. Ammonia is returned to the atmosphere and when acted upon by rainwater reaches back the soil. Man is now interfering with the nitrogen cycle through production of nitrogen fertilisers (See Figure 39)

Phosphorus Cycle

Phosphorus is an essential constituent of living organisms is present in the bones and teeth of animals. Phosphorus is present as phosphates in minerals and rocks. Through disintegration of rocks it reaches the soil. Phosphates dissolve in water and the plants absorb it. From plants it enters the food webs and reaches the bodies of animals. Through the excretory matter and decomposed bodies of animals the phosphorus reaches back the soil. A considerable amount of phosphorus is washed into the sea through running water and reaches the bodies of marine organisms like fishes. Sea birds that feed on these fishes return a large quantity of phosphorus to the land through their droppings.

FOOD CHAIN

We know that plants like grass produce food from soil using sunlight and water. Insects like grasshoppers feed on these plants. Snakes eat grasshoppers. Owls or hawks eat snakes. Thus energy from sunlight is transferred from the plants to the grasshoppers and from there to the snakes and to the hawks. When hawks die their bodies decompose due to action of bacteria or fungi that feed on their carcass, thus breaking down complex organic substances in their bodies into soil nutrients that are again absorbed by plants.

Plants → Grasshopper → Snakes → Owls

The above example is that of a simple food chain. In this example the grass that produce food is called the producer, whereas the grasshopper is the primary consumer. The snake is the secondary consumer and the hawk is the tertiary consumer. Bacteria that decompose the dead matter are the decomposers. Each animal and plant is a link in the chain. Ultimately it is the sun's energy that is transferred from one link in the food chain to another link.

A food chain is a chain of energy transfer from one living being to another and completing the energy cycle in an ecosystem. It consists of producers, consumers (primary, secondary and tertiary) and decomposers. All organisms are part of some food chain or chains in which they eat some other organism for food or are eaten up by some other.

When animals die, fungi or bacteria decompose them by breaking down complex organic compounds into simpler ones and return them to soil so that they can again be used again by the plants. The energy transformation chain starts all over again. These different levels in a food chain are called trophic levels

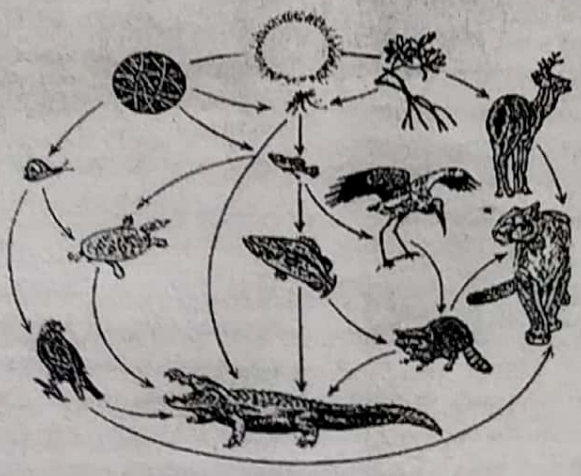

Figure 40 Food web

FOOD WEBS

In an ecosystem the food chains are not as simple as explained in the example above. They are far more complex. Most food chains are interconnected. Animals typically consume a varied diet and, in turn, serve as food for a variety of other creatures that prey on them. These interconnections create food webs. For example, a hawk may eat not just snakes but also many other creatures that are part of other chains. Thus a single creature can be part of a number of food chains. Thus *a number of food chains when represented in a diagram, resemble a web and thus known as food web.* Nature

balances the activities of energy transfer in a food web so that the different species share the same habitat they survive for many years, depending on one another for food.

BIO MAGNIFICATION

Bio magnification is the tendency for increase in concentration of certain chemicals in the bodies of living organisms as they get transferred from the bodies of producers to primary consumers and from there to secondary consumers and to those at higher trophic levels. There was a time when pesticides were considered as a boon and used indiscriminately for killing pests. Later studies revealed that the pesticides we spray are doing larger harm to the ecosystem and to ourselves. The chemicals reach the bodies of many creatures, including fishes, in small quantities and from their bodies to the consumers who eat them. At each trophic level of the food chain the quantity and concentration of the chemicals go on increasing, ultimately becoming lethal in higher trophic levels. They may enter human bodies also though various food chains.

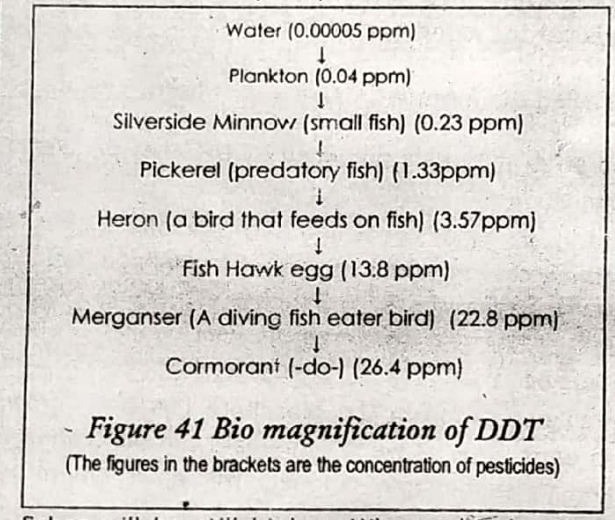

Figure 41 Bio magnification of DDT
(The figures in the brackets are the concentration of pesticides)

The tendency for certain chemicals to accumulate in the bodies of living beings as it passes from one trophic level to a higher level is known as **bio magnification.**

The concentration of DDT sprayed as pesticide in a certain crop may go on increasing as it passes from the producers to tertiary consumers level. If it exceeds a certain threshold at a certain trophic level, that would kill the creatures at that trophic level.

For example the concentration of a chemical found in plankton would be much lesser than that in small fishes that eat them. Its concentration in larger fishes that eat small fishes will be still higher. When a hawk eats many larger fishes the chemicals present in these fishes gets transferred into the body of the hawk cumulatively. If the concentration is sufficiently high it may kill the hawk, and even the entire hawk population in the region. Thus an entire population of tertiary level consumers could be wiped out as a result of bio magnification.

There are different types of chemicals known as pesticides, insecticides, weedicides, herbicides and fungicides used to kill pests, insects and weeds. These are collectively known as biocides. Toxic biocides like DDT, BHC, chlordane and heptachlor are known to show bioaccumulation or bio magnification. Besides these, heavy metals like strontium, cadmium and cobalt also enter food chains and accumulates in the higher levels of food chains.

The noted environmental scientist named Rachel Carson has described in her book *The Silent Spring* (1964) how bio-accumulated DDT wiped out the population of Robin birds.

One of the ways in which water pollution becomes a serious health hazard is through bio magnification. A large quantity of biocides sprayed in the agricultural farms ultimately reaches water bodies like ponds, rivers and the sea. They get deposited in the bodies of millions of planktons and then enter the food chain of fishes, accumulating at higher levels of the food chains and ultimately reaching human bodies.

Figure 41 shows the effect of water pollution on fish eating birds. The concentration of DDT in the water increases as a result of bio magnification and reaches dangerous levels as it reaches

fish-eating birds. Of course, if man eats these birds the concentration of DDT would be much more in his body and it may damage some vital organs and cause death.

CARRYING CAPACITY OF THE ECOSYSTEM

Nature has a system of controlling the population of each species of plant and animal in an ecosystem. The factors that control the population of a species in an ecosystem are availability of food, space, presence of natural enemies, climatic conditions and other physical factors. For controlling the population, nature adopts other strategies also. For example species with high reproductive rate have shorter life spans (e.g. mosquitoes, mice) and those with lower reproduction rate have higher lifespan (e.g. tree, elephant). If the population of a species increases beyond a limit, known as the carrying capacity of the ecosystem, then the ecosystem reaches a new equilibrium.

Carrying capacity of an ecosystem is the maximum number of animals of one or more species that it can be support through the most unfavourable period of the year. It is the maximum population of an organism that an ecosystem can support without being degraded. The carrying capacity of one species would be different from that of another species in the ecosystem. This is because each species have different food habits, shelter requirement and social requirements and faces competition that is different from that of other species. For example, the carrying capacity of an ecosystem for the foxes is not the same as that for the lions.

Carrying capacity of an area is calculated using the formula: $CC = \frac{X}{c}$ where, CC = carrying capacity; X = the quantity of food and other materials produced by the area per year; C = the quantity of materials required by the organism on an average per year

If a village that produce 50 tons (50000 kg) of rice per year and each person requires 250 kg for rice each year for survival, then the carrying capacity (of humans) of the village for rice is CC = 50,000 ÷ 250 = 200 people; where, CC = carrying capacity (number of people); X = the quantity of material (food grains, milk, fuel wood) produced by the area per year; C = the quantity of materials required by one person on an average per year

In this regard it can be seen that human population in the biosphere has been growing steadily, exerting pressure on the resources on earth. Unless we self-regulate the population and also use the natural resources judiciously and in sustainable manner, the environment may deteriorate affecting our own standards of living.

SELF-ASSESSMENT TEST

1. What do you mean by ecological processes?
2. Identify five food chains you can think of..
3. Draw a food web based on various living beings in an ecosystem you are familiar with..
4. What is biosphere? Explain
5. What are the components of an ecosystem?
6. Enlist a few causes for damage to biosphere and explain how they cause damage
7. What are the components of abiotic biosphere?
8. What are the different layers in the atmosphere? Describe each
9. Explain the role of hydrosphere in environment
10. Explain the following terms: (i) food chain; (ii) food web; (iii) food pyramid; (iv) photosynthesis

11. How does transfer of energy takes place in an ecosystem? Explain with the help of a diagram
12. What is 10% Law of ecology?
13. What is meant by productivity?
14. What is law of conservation of energy? How does energy transfer take place in non-living components?
15. What is ecological pyramid? What are the different types of ecological pyramids?
16. Describe any three of the following cycles: (i) hydrological cycle; (ii) carbon cycle; (iii) nitrogen cycle; (iv) oxygen cycle; (v) sulphur cycle; (vi) phosphorus cycle
17. What is bio magnification? What are its implications on public health in the modern times?
18. How does bio magnification affect the environment?
19. What is meant by 'carrying capacity' of the environment?
20. Describe some important measures to conserve natural resources.

It is in man's heart that the life of nature's spectacle exists; to see it, one must feel it

Jean-Jacques Rousseau (1712-1778), *Emile*, 1762

It is a curious situation that the sea, from which life first arose should now be threatened by the activities of one form of that life. But the sea, though changed in a sinister way, will continue to exist; the threat is rather to life itself

Rachel Carson, (1907-1964) *The Sea Around Us*, 1951

CONSERVATION OF NATURAL RESOURCES

NATURAL RESOURCES

Air, land, water, soil, forests, wildlife, marine resources, mineral resources and fossil fuels are some of the natural resources. They also include raw materials and energy.

All of our basic needs like food, shelter, clothes, and consumer items are made from various natural resources after necessary processing. Due to the activities of human population the supply of natural resources in the earth has reduced greatly and at the same time the demand for these resources has gone up. This naturally increases their prices and consequently they are becoming inaccessible to a larger population. It is very clear that if the human population grows uncontrollably and the resources are over-exploited beyond the nature's capacity to replenish them, there will be scarcity for food and basic needs. What happens then is unpredictable and it may lead to massive destruction of human population itself due to famine or forces of nature.

RENEWABLE RESOURCES AND NON-RENEWABLE RESOURCES

Natural resources are classified as renewable or non-renewable. Certain natural resources are considered renewable because when such resources are consumed they are naturally replenished or reproduced. Such resources are called ***renewable resources***. Trees, fishes, oxygen, sun's energy or fresh water are renewable resources. It is possible for us to consume these natural resources at a limited rate without exhausting their continuous supply in future. Nature has a mechanism by which the quantity of these resources be soon replenished even if we consume them. For e.g., the fresh water we drink and the air we breathe do not get exhausted ordinarily as nature has a way to recycle them and make them continuously available to us.

However it is not possible for the nature to reproduce fossil fuels like coal, gas or petroleum that we consume. Same is the case with ores of many chemical elements such as iron, copper or zinc. Once they are consumed they are lost forever. They get used up and are exhausted permanently. Such resources are called ***non-renewable resources***.

Even renewable resources can become non-renewable, if over-exploited. The future generations will not then be able to use them. If forests and the wildlife are massively destroyed they will not be replenished. Renewable resources, many of them—trees and fish, for example—are being used faster than they're being renewed. Many species on the planet have either become extinct or nearly wiped out. Reduction in tree cover is resulting in accumulation of carbon dioxide in the atmosphere thus destroying the delicate balance that exists in nature. Resources, therefore, have to be consumed efficiently and in a sustainable manner. There are many ways to do this. First of all there should be an end to their excessive uses. Over-exploitation should be stopped. Consumption of non-renewable resources should be restricted or curtailed and emphasis should be given to exploit renewable resources, that too, within sustainable rates.

One of the main reasons for exploitation of natural resources is for energy purposes. Energy is required for running factories, vehicles, domestic purposes and for almost all activities that is carried out by humans. Forests are cut down, fossil fuels are extracted and burnt for various purposes including power generation and dams are built for tapping hydro power. Therefore when we talk of renewable and non-renewable resources it is important to discuss about the energy

production and consumption. There are two types of energy – renewable and non-renewable. Solar, hydro and wind energy are renewable sources of energy. They do not get exhausted. They are environmentally friendly, as they do not create pollution. Such energy sources could be tapped effectively to meet our energy needs; however at present they are costlier than fossil fuels.

Fossil fuels such as coal and petroleum creates large-scale pollution and are non-renewable resources. They are obtained from the fossils of organic matter (plants and animals) that were buried millions of years ago. In time, the pressure of the massive weight of rock and mud that covered the organic matter created heat, changing this matter to oil (remains of ancient marine organisms), coal (remains of ancient swamps and forests), and natural gas.

SUSTAINABLE DEVELOPMENT

Excessive consumption of fossil fuels, massive destruction of forests and ecosystems, overexploitation of natural resources and indiscriminate release of hazardous pollutants into the environment are depleting the available natural resources. Future generations may not be able to get the benefits of these natural resources, as our present generation would already have consumed them completely. Therefore we should consume all natural resources only at a sustainable rate. Not only that, every developmental activity should consider the importance of conserving natural resources without exhausting their supply for the present and future generations.

Sustainable development may be defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

We cut down forests for our present needs of firewood, or burn petroleum products for our luxuries of the present day, not bothering that these resources are exhaustible. The damage that we cause to the environment in this process can make it difficult for the future generations to live on earth comfortably. The CFC used in refrigerators and air conditioners leads to ozone layer depletion and consequently our children's world has to suffer a lot of health problems. When we enjoy a quality life, the toxic wastes we generate will create serious health problems and epidemics to future generations. We do not want to accumulate wealth and comforts in the present day and bring total collapse of the world in the near future. Therefore our development should be based on principles of sustainable development, so that a better quality of life is assured for everyone, now and for generations to come.

OBJECTIVES OF SUSTAINABLE DEVELOPMENT

Prudent use of natural resources: Natural resources should be used with care so as to enable the nature to replenish them. Non-renewable resources like oil and gas should be consumed efficiently until alternatives are developed to replace them. Renewable resources, such as water, air and soil should not be allowed to be polluted.

Environmental protection: Sustainable development aims at limiting the threat to global climate change. Human health should be protected from the hazards of poor air quality and toxic chemicals. Things that people need or value, such as wildlife, landscapes and historic buildings are to be protected.

Social progress: Everyone in this world, including the future generations, should get the benefits of prosperity and clean environment. Eradication of unemployment, poverty, poor housing and pollution are aims of sustainable development. In the world's history the stronger nations have been over-exploiting natural resources to become rich. This should not be so and the fruits of development should reach equitably to all the humanity.

SUSTAINABLE ACTIVITIES

Some activities are termed as sustainable activities because such activities satisfy the objectives of sustainable development. Such activities are listed below:

Use renewable resources: Renewable resources are resources that grow and increase through natural processes. The natural cycles bring the needed materials back for reuse like the cycles of water and carbon.

Limit use of non-renewable resources: Non-renewable resources are resources available only in limited quantity. Use of fossil fuels should be limited and renewable energy sources should be tapped. Raw material consumption should be minimised through reuse, recycling and reduce.

Use resources for need, not greed: Once we have secured food and shelter necessary for healthy life, focus on social and individual development through love and service without engaging in activities that harm the earth

Reduce inequitable distribution of wealth: Inequity often leads to social struggles and armed conflict. The poor people exploit the forest resources and other natural wealth for their day-to-day survival and consequently lead to their degradation. The degradation of their territories not only makes life worse for them but also the global level degradation of environment.

Use of renewable resources to be limited by their rate of renewal: Renewable resources like trees, fish stock and soil fertility, when overexploited become non-renewable and get exhausted. The use of renewable resources should be controlled so as to be within the rate of renewal.

Environmental degradation should be controlled and avoided: Natural processes can cleanse certain quantities of pollutants. Beyond this limit the pollutants get accumulated thereby killing different species on earth in the food chain.

Do not destroy wildlife and other species to extinction: Various life forms in the world ecosystem are mutually dependent on one another to maintain the delicate balance of life. If a certain species disappear from the food web the adverse effect on ecosystem would be long lasting and unpredictable. With the loss of species we also lose genetic possibilities for fighting diseases, in people and in food crops, as well as in finding potential new sources of food. If our developmental activities regularly destroy or significantly diminish the presence of other forms of life, we are actually endangering our own existence as a part of the global ecosystem.

Population control: Artificial control of human population may be necessary as we overcome forces of natural control like diseases and wild animals.

POLLUTION

Increase in human population with their rapid rising of living standards is resulting in generation of huge amounts of waste materials that are thrown into land, water bodies and air. These waste materials are generated from houses, municipalities, industries, automobile emissions and from other areas of human activities. Pollution is at present producing harmful effects on the world environment and ecosystems posing

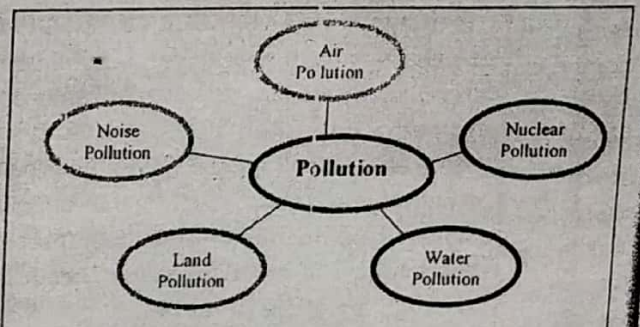

Figure 42 Types of pollution

grave dangers to the very existence of humanity, if the problem is not addressed effectively. Pollution creates diseases, epidemics and climatic changes. Its effects on human environment and climate are seen in the greenhouse effect, ozone layer depletion, El Nino and acid rains.

Air pollution, water pollution, land pollution, noise pollution, and radiation pollution are the main types of pollutions.

AIR POLLUTION

Air pollutants can be indoors or outdoors. Some outdoor air pollutants are:

♦ Carbon monoxide (emitted from vehicles) ♦ Particulate matter ♦ Nitrogen oxides (emitted from power plants) ♦ Sulphur dioxide (emitted from coal-burning power plants) ♦ Lead (from metal refineries) ♦ Natural gas. Smoke, smog, vehicle exhaust, pollen, dust, bacteria, spores, algae, and emissions from factories, refrigerators, aerosols, air conditioners and biocides also cause air pollution.

Air pollutants that are found indoors are fungi, chemicals, cleaning supplies, dust, fibres and pesticides. The sources of air pollution could also be from tobacco smoking, dust, pesticides, lead and people with contagious diseases or laboratories. Improperly designed, installed, operated, and maintained ventilation systems also cause indoor pollution. Typical symptoms associated with poor air quality include headaches, fatigue, coughing, sneezing, eye and nose irritation, dizziness and shortness of breath. Air pollutants may cause even cancer, asthma, kidney failure, liver damage, and birth defects. Magnitude and frequency of exposure to the pollutants decide the degree of the health problems a person would suffer. The symptoms may differ from person to person.

Reducing the use of fossil fuels and wood for energy purposes can reduce air pollution. Alternative sources of energy should be tapped. Designs of engines in vehicles and factories should be improved so as to conform to international emission norms and should aim at zero pollution.

WATER POLLUTION

Fresh water is used not only for drinking and domestic purposes, but also in raising crops, fishing, industries, and in almost every aspect of human activities. Clean drinking water is an indispensable element for good health of human and animal population. Though more than 70 percent of the earth's surface is covered with water, almost 97 percent of it is in the oceans and a large quantity is present as glaciers and ice caps. Of all, only less than 1 percent is fresh water. A large chunk of the world's population still does not have access to clean drinking water.

In early human civilisation rivers were used for disposal of waste materials. Many factories were located close to rivers with a view of discharging effluents. However later in the 19th century scientists found grave dangers in polluting rivers. With the increase of human population and rapid urbanisation, clean drinking water became scarce. Water bodies such as rivers, streams, wells and lakes became insufficient for providing clean drinking water and above all, became polluted.

It is the mindless discharge of waste materials into these water bodies that is mainly threatening their existence. Effluents discharged into water bodies kill the fishes and destroy the ecosystem. When human beings consume polluted water epidemics like cholera breaks out, killing large number of people. Water-borne diseases are estimated to cause 5 million deaths a year, particularly affecting children and the elderly.

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Limit use of non-renewable resources: Non-renewable resources are resources available only in limited quantity. Use of fossil fuels should be limited and renewable energy sources should be tapped. Raw material consumption should be minimised through reuse, recycling and reduce.

Use resources for need, not greed: Once we have secured food and shelter necessary for healthy life, focus on social and individual development through love and service without engaging in activities that harm the earth

Reduce inequitable distribution of wealth: Inequity often leads to social struggles and armed conflict. The poor people exploit the forest resources and other natural wealth for their day-to-day survival and consequently lead to their degradation. The degradation of their territories not only makes life worse for them but also the global level degradation of environment.

Use of renewable resources to be limited by their rate of renewal: Renewable resources like trees, fish stock and soil fertility, when overexploited become non-renewable and get exhausted. The use of renewable resources should be controlled so as to be within the rate of renewal.

Environmental degradation should be controlled and avoided: Natural processes can cleanse certain quantities of pollutants. Beyond this limit the pollutants get accumulated thereby killing different species on earth in the food chain.

Do not destroy wildlife and other species to extinction: Various life forms in the world ecosystem are mutually dependent on one another to maintain the delicate balance of life. If a certain species disappear from the food web the adverse effect on ecosystem would be long lasting and unpredictable. With the loss of species we also lose genetic possibilities for fighting diseases, in people and in food crops, as well as in finding potential new sources of food. If our developmental activities regularly destroy or significantly diminish the presence of other forms of life, we are actually endangering our own existence as a part of the global ecosystem.

Population control: Artificial control of human population may be necessary as we overcome forces of natural control like diseases and wild animals.

POLLUTION

Increase in human population with their rapid rising of living standards is resulting in generation of huge amounts of waste materials that are thrown into land, water bodies and air. These waste materials are generated from houses, municipalities, industries, automobile emissions and from other areas of human activities. Pollution is at present producing harmful effects on the world environment and ecosystems posing

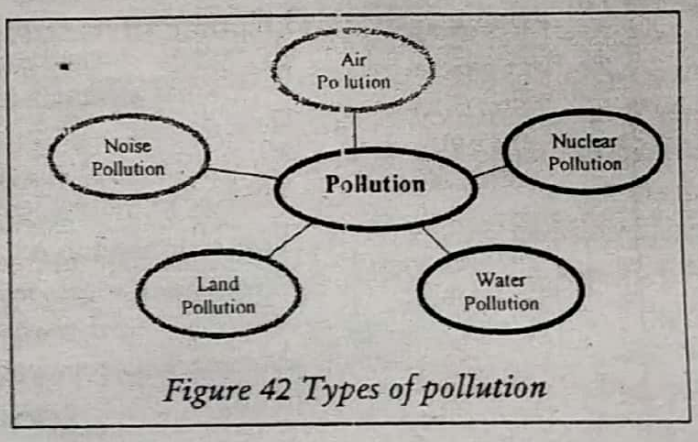


Figure 42 Types of pollution

from reaching the depths and the clarity of water reduces. When algae die and decay the dissolved oxygen in the water gets exhausted, killing fishes and other aquatic life. Moreover, when organic matter increases in a pond, the number of decomposers will increase. The process of rapid plant growth, followed by increased activity by decomposers and a depletion of the oxygen level is called eutrophication. Eutrophication is harmful for fishes and other aquatic life. Weeds can make a lake unsuitable for swimming and boating. If the water is used as a drinking water source, algae can clog filters and impart unpleasant tastes and odours to the finished water.

Suspended and dissolved particulate matter

Insoluble matter in suspension is a common form of pollution. It reduces photosynthetic activity of water-plants. Suspended matter chokes the gills of fish and destroys aquatic life. When these suspended matters settles down they will form silt or mud at the bottom. Toxic materials can also accumulate in the sediment and affect the organisms that live there. Some pollutants are dissolved in wastewater. The individual molecules or ions (electrically charged atoms or molecules) of the substance form chemical compounds with the molecules of water.

Oil

Oil spreads over the surface of water and inhibits the diffusion of oxygen into water. It coats the gills of fishes and affects their respiration. When oil tankers capsizes in the sea large scale pollution of this nature occurs

Ecological pollution

Pollution that is caused by nature rather than by human activity is called ecological pollution. An example of ecological pollution is the increased rate of siltation of a waterway after a landslide that increased the sediments in runoff water. Another example would be when a large animal, such as a wild animal, drowning in a flood adding a large amount of organic material to the water. Major geological events such as a volcano eruption might also be sources of ecological pollution.

Thermal pollution

Thermal pollution can occur when water is used as a coolant near a power or industrial plant and then is returned to the aquatic environment at a higher temperature than it was originally. Thermal pollution can lead to a decrease in the dissolved oxygen level in the water while also increasing the biological demand of aquatic organisms for oxygen.

VARIOUS WATER POLLUTANTS, THEIR SOURCES AND THE HEALTH RISKS

Various sources of water pollution and their related health hazards are listed below:

Detergents: Washing of clothes: Depletes oxygen in the water, endangering aquatic life

Industrial Effluents: From factories: Toxic substances endangering human health.

Pesticides, Insecticides: Carried into the water bodies from agricultural lands: Poisonous substances

Sewage Waste: Untreated human excreta are washed away to lakes, rivers etc: Several kinds of bacteria and virus cause diseases like cholera, typhoid, jaundice, and diarrhoea

Oil: Oil tankers in the seas: Oil spread on the surface of the seawater killing many species

Fertilisers: Washed out of soil by rain to streams and rivers: Increase toxicity of the water

Metallic Pollutants: From Industries: Cancer, neurological ailments, lung diseases etc.

Organic Pollutants: Dead plants and animals in water: Deoxygenated water endangers fish life and higher plants.

Fluorides: From Industries: Poisoning effects. Causes dental and skeletal fluorosis

Benzene: From Industries: Causes redness, burns and blisters on skin.

TYPES OF WATER POLLUTANTS

Some of the pollutants that contaminate water are given below:

Disease-causing agents

Disease-causing (pathogenic) micrporganisms, like bacteria, viruses and protozoa are dangerous water pollutants. Coming in contact with such polluted water can cause serious waterborne diseases like polio and cholera. Fish and shellfish may become contaminated and people who eat them may become ill.

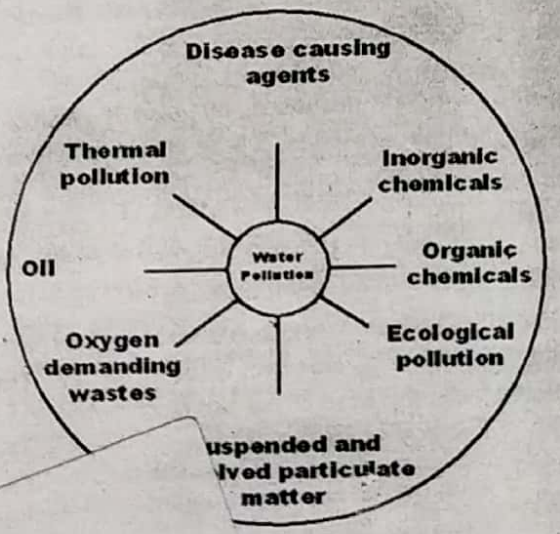
Oxygen demanding wastes

Organic wastes are oxygen-demanding wastes. Organic wastes come from homes, agro-industries, slaughterhouses or municipalities. When organic or biodegradable wastes are dumped into water bodies, aerobic bacteria act upon them and break them down or decompose them. In this process the bacteria uses up the oxygen that is dissolved in the water. Consequently, fish and other aquatic life that depends on the dissolved oxygen in the water will get less oxygen for their survival and die.

After the aerobic bacteria had used up all oxygen in the water for decomposing purpose, anaerobic bacteria that do not need dissolved oxygen take over. But while aerobic micro organisms convert the nitrogen, sulphur, and carbon compounds that are present in the wastewater into odourless—and relatively harmless—oxygenated forms like nitrates, sulphates and carbonates, these anaerobic micro organisms produce toxic and smelly ammonia, amines, and sulphides, and flammable methane (swamp gas). The water bodies thus become stinking.

Inorganic chemicals

Inorganic chemicals mainly come from chemical effluents from industries, mines etc. Toxic chemicals include metals such as mercury, cadmium, lead, chromium, copper and arsenic. A variety of chemicals discharged into water bodies from industries are poisonous to fish and other aquatic life. Toxic chemicals such as pesticides, insecticides, herbicides and other chemicals used for controlling insects and weeds reach water bodies. Some of these accumulate in fish and other organisms and can poison people, animals, and birds that eat them. Detergents and oils not only create unpleasant appearances and odours to the water body but also are toxic.



es of pollutants that cause pollution

Organic chemicals

Organic pollution occurs when an excess of organic matter, such as manure or sewage, enters the water. Algae growth in the water bodies is accelerated due to the inflow of fertilisers into the water bodies from the agricultural lands.

The elements phosphorus and nitrogen necessary for plant growth are plentiful in wastewater. They cause nuisance growth of aquatic weeds and "blooms" of algae. This will cut off sunlight

without causing pollution and selecting alternate non-hazardous materials can reduce hazardous waste. Production of hazardous substances should be curtailed. Adopt processes and technology that use fewer raw materials in production; and the materials should be used again after its original use is completed. An example of source reduction is printing both sides of a paper so as to reduce the volume of paper used. Another example is backyard composting of solid wastes at households so that these wastes do not reach public places.

Reuse: If we reuse goods it helps in reducing production of more goods. The tendency of companies to produce 'use and throw' goods such as ball pens is against this concept. A pen can be reused by just replacing its ink refill or filling ink. This will help reduce the generation of plastic wastes. Instead of using throwaway items start using items that are durable. Materials can be reused if they are donated to charity or sold as seconds rather than throwing away. Use a product more than once, either for the same purpose or for a different purpose. Reusing, when possible, is preferable to recycling because the item does not need any chemical processing before it can be used again.

Recycle: Recycling is the process by which a used and unserviceable material is converted into a new product. The new product need not be the same as the original product but may serve another purpose. Waste materials should be recycled wherever possible. If the waste cannot be recycled, it should be treated to neutralise its harmful contents. Traditionally rag pickers collect paper, metal, glass and plastics from the backyards to collection centres, from where they are sent to recycling factories. Recycling of products depends on economic viability and marketability of recycled products. Recycling not only reduces the emission of many greenhouse gases and water pollutants but also saves energy. It supplies valuable raw materials to the industry, creates jobs, conserves resources for the next generation, and reduces the need for new landfills and combustors. Governments can promote buying recycled products through their own purchasing programmes and guidelines.

Landfills: Land filling is a common method for handling solid waste. Garbage collected by the municipalities are carried over to low lying areas and dumped there. Some studies suggest that about 40 percent of materials entering landfills in cities are paper products, 20 percent yard waste, 9 percent metals, 9 percent food, 8 percent glass, and 7 percent plastic. However this proportion could vary widely. Modern landfills are not just dump yards but are compacted, closed and regulated sanitary landfills to safeguard the environment and health of local population. Landfills must not contaminate groundwater. Today in many cities of the developed nations landfill wastes are systematically divided into smaller units called cells to minimise waste exposure to weather elements. Only one cell will be open at a time and that too would be covered at night to reduce odour and vermin problems. As organic wastes decompose they generate gases including methane that is a greenhouse gas. In closed landfill cells pipes are often installed to vent or incinerate gases to reduce the risk of explosion. Methane gases can be trapped and used as fuel.

Composting: Composting is the process by which organic waste, such as food waste from houses or hotels, are decomposed with the help of micro-organisms (mainly bacteria and fungi), to produce humus-like substance. Backyard composting can prevent millions of tonnes of solid waste from reaching landfills. It also generates useful garden manure for vegetable and flower gardens and landscaping. Vermin-composting that uses the help of a type of earthworms is becoming popular these days.

Combustion: Combustion involves burning the solid waste at high temperature. It can reduce waste volume and enable electricity generation. Incinerators are used for burning hospital wastes that are hazardous.

Biological Oxygen Demand (BOD):

Biological oxygen demand or BOD is a term used to indicate the quantity of organic waste materials present in water. The organic matter is broken down in presence of oxygen, by a type of bacteria called aerobic bacteria. BOD is the amount of dissolved oxygen needed by aerobic decomposers to break down organic materials in a certain volume over a 5-day incubation period at 20° C. More the quantity of biodegradable wastes in water, more will be the BOD and less the dissolved oxygen (DO). Dissolved oxygen in water is an indicator of water quality. Generally water with DO below 4 ppm at 20°C is considered gravely polluted and above 8 ppm is considered good.

Water that is safe to drink is free of pathogens and toxic chemicals and will have no offensive characteristics such as taste, odour, and colour.

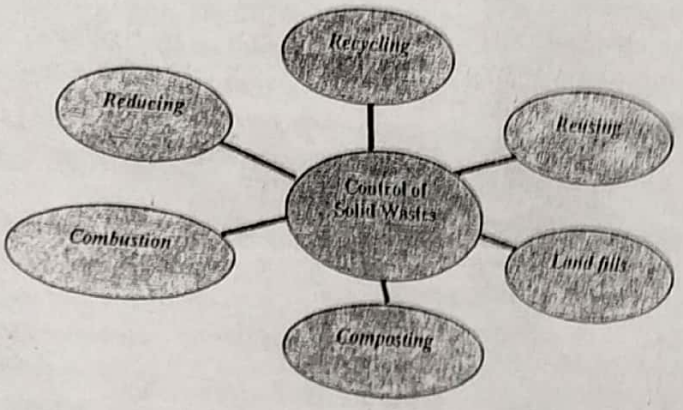


Figure 44 Methods of controlling solid waste

LAND POLLUTION

Land pollution is caused due to large-scale generation and improper disposal of waste materials from residential, commercial, and industrial sources. Solid wastes are waste materials in solid form, generated from the normal community activity. Garbage, kitchen and food wastes, rubbish materials like paper, rag, glass bottles, metallic cans, plastics, fibres, residues from home fuels, street sweeping, building debris, rubbles and abandoned vehicles are examples of solid wastes.

Industrial wastes are produced from manufacturing activities and can be either hazardous or non-hazardous. They can be in solid form, sludge form, or liquid form. Hazardous wastes are any solids, liquids, or gas that poses a hazard to human health or the environment when mishandled. Actually, many substances we use commonly such as paint, batteries, used-oil from vehicles, shoe polish, and detergents are hazardous. Many goods generate hazardous wastes during their production process. Households, hospitals, industry and agriculture also produce hazardous waste. Municipal solid waste is one of the main pollutants in cities and towns. It mainly consists of everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries.

CONTROLLING LAND POLLUTION

Three 'R's that are recommended for reduction of municipal solid waste are reduce, reuse and recycle. Landfills, composting and combustion are some other ways to dispose off solid wastes.

Reduce: It is the most preferable method of waste management. Source reduction of wastes, meaning controlling generation of solid wastes from houses and other places, has many environmental benefits. It prevents emissions of many greenhouse gases during their production process, reduces pollutants, saves energy, conserves resources, and reduces the need for new landfills and combustors. Modifying industrial processes to produce goods

human skin. Beta particles can penetrate through skin, while can be blocked by some pieces of glass and metal. Gamma rays can penetrate easily to human skin and damage cells on its way through, reaching far, and can only be blocked by very thick, strong, massive concrete walls.

Radiation has many uses for the humanity. In atomic power plants nuclear energy is used to generate electricity. Radiation is also used in medicines and industrial applications. However the effect of radiation on human health is horrendous, lasting for generations, genetically mutilating the newborns for decades. The harmful effects of radiation from atom bombs dropped in Hiroshima and Nagasaki during Second World War is well known. The destruction was massive, killing the entire life in the affected region.

Major sources of radiation pollution are: ♦ Nuclear power plants ♦ Nuclear weapons ♦ Transportation of nuclear materials ♦ Disposal of nuclear wastes ♦ Uranium mining ♦ Nuclear tests. One of the worst radiation sources is nuclear explosion tests. The radioactive materials released during the tests affect not only the test sites but also remote corners of the world. The radiation from the nuclear wastes can last for thousands of years. The time that it takes for half way of decaying process is called half-life, and this differs for each radioactive element (half-life of Uranium 238 is 4.5 billion years). Though generation of nuclear energy is generated in the power plants do not create atmospheric or other pollutions, disposal of nuclear wastes is a major problem.

IMPACT OF SOCIO -CULTURAL AND ECONOMIC FACTORS, POVERTY AND CHANGING LIFE STYLES ON ENVIRONMENT

In recent years, the direct link between poverty and environmental destruction has been understood more clearly. Poverty is both a cause and an effect of environmental destruction. As natural resources vanish, or access to them is restricted, poverty spreads.

Environment plays an important role in the socio-cultural and economic conditions of rural and urban poor. The damage to the environment affects the poor the worst. In the rural areas close to forest areas the poor are dependent on the forest for livelihood. They collect forest products and sell them for livelihood and collect firewood for cooking purpose. Meat from wild animals has been a critical source of food and income. The economies of many third world countries depend on export of forest products and natural resources to the developed and industrialised nations. This has been causing massive exploitation and destruction of natural wealth in these countries and endangering the livelihood of the rural poor. Thus poverty and environmental degradation acts like a vicious circle (for livelihood environment is degraded, and because environment is degraded, means of livelihood is affected).

Women in developing countries suffer particularly acutely as a result of environmental destruction. In rural areas they are responsible for supplying the family with water, firewood, food and animal fodder, making them direct victims of the increasing overexploitation of natural resources. Overexploitation and soil erosion have also reduced harvests, so that less quantity of food can be produced. The lack of alternative sources of income leads to the overexploitation and degradation of natural resources. It is the poor people who are less cushioned from the impacts of environmental destruction and natural disasters, and it is they who bear the brunt of the health-related consequences of environmental change most. Thus economic efficiency, social justice and the conservation of the natural environment are interrelated and interdependent. Some of the ways in which the poor are affected are:

Natural resource degradation and poverty: Examples include nutrient depletion leading to falling yields and hence falling incomes among the poor. Deforestation can have substantial off-

NOISE POLLUTION

Noise is unwanted sound that disturbs us and reduce our quality of life. Long and severe exposure to noise may result in hearing loss, stress and high blood pressure, sleep loss, distraction and loss of productivity. Noise is a characteristic of all industrial societies. Sources of noise are innumerable like those from road traffic, jet planes, construction equipment, or machines. Probably the biggest increase in urban noise levels has come from road transport. Although trucks consist of only about 20% of the traffic, they produce 70% of the noise.

The effects of noise exposure are of two types viz., auditory and non-auditory. Even short exposure to noise can produce temporary hearing losses. Prolonged exposure to noise can lead to a gradual deterioration of the inner ear, leading to deafness. Constant noise causes the blood vessels and muscles to contract. This causes a gradual loss of hearing, tension, nervousness and psychiatric illness. High intensity sounds emitted by many industries and supersonic aircraft are harmful. Noise level of 80 decibels or more for more than 8 hours a day increases tension and changes in breathing patterns. When exposed to high levels of noise people may suffer from fatigue or even total loss of hearing, changes in blood circulation and changes in breathing. Noise pollution above 120 decibels can cause many adverse biochemical changes including increase in blood cholesterol, white cell counts and hypertension. Noise has harmful effects on non-living materials too. Old buildings and even new constructions can develop cracks under the stress of explosive sounds.

The intensity of sound is measured in logarithmic units known as decibels; this means that an increase in level of noise from 10 decibels to 20 decibels actually represents a 100-fold increase in the sound level. Beginning of hearing damage takes place due to prolonged exposure over 85-dBA levels.

Control of noise pollution

The basic principles of noise control are –

Control at source: This may be achieved by segregating the noisy machines from others and through applications of mufflers or other noise reducers to machines.

Control of transmission: This may be achieved by building enclosures around machines and covering the room walls in machine rooms with sound absorbing materials.

Protection of exposed persons: Hearing protection is recommended for all workers who are consistently exposed to noises louder than 85 dB. Protection devices basically consist of earplugs or earmuffs.

Legislation: Many nations have adopted legislations against noise pollution. Legislations enable workers to claim compensation if they suffer health problems due to noise pollution. Specific legislation and regulations for designing and operation of machines to include vibration control, soundproof cabins and sound-absorbing materials are also helpful.

Green Belt: About 20 feet thick greenbelt around residential area and open spaces can effectively reduce noise levels. Greenbelts can also reduce air pollution.

Loud speakers: Use of loud speakers should be restricted.

Education: Public education can help create awareness about the hazards of noise.

RADIATION POLLUTION

Radiation is a form of energy that travels through space. It is released by the splitting of atoms. Some elements like Uranium and Radium are naturally radioactive while some others are made to be. Radiation is emitted when a radioactive element become unstable and begin to decay in the attempt to regain their molecular stability. There are commonly three types of radiation, namely alpha, beta and gamma rays. Alpha particles can be blocked by a piece of paper and

wars. The divides on the basis of ideology, religion and politics have increased conflicts and competition.

With the depletion of forest resources the poor are deprived of means of livelihood and this leads to rural-to-urban migration, resulting in over-crowded cities and increasing urban poverty in many low-income nations. Rural migrants are mainly young women and men, whose absence often results in labour shortages in home areas. They stay away for longer periods from home and are often unable to return home for the farming season. Small farming families do not have the means to resort to wage labourers, and often end up selling or leasing their land to wealthier groups.

Although tourism was once thought of as a "smokeless" industry it has been blamed for damaging sensitive habitats and ecosystems, increasing traffic near tourist destinations. Health care industries have been producing hazardous waste from hospitals due to improper disposal of materials.

POPULATION EXPLOSION

Population may be defined as a group of organisms of the same species occupying a given area at a particular time. It may also be defined as the whole number of inhabitants occupying an area (such as a country or the world) and continually being modified by increases (births and immigrations) and losses (deaths and emigrations).

Here we are discussing human population and its growth. The human population has been steadily growing in this world over the past decades. The world human population has grown from 2.5 billion people in 1950 to 5.7 billion people at present. Due to ever growing population, in the last 50 years the world has lost nearly twenty-five percent of the topsoil; a third of the forests of the world has been cut down; carbon dioxide in the atmosphere increased by about 25% resulting in global warming; stratospheric ozone layer has been depleted increasing the incidence of malignant skin cancer by about twenty-five percent.

Increased availability of food, healthcare and good living conditions have prolonged the lifespan of individuals and reduced the death rate. Infant mortality has reduced. Birth rate has increased. Many diseases and epidemics and natural disasters are controlled. All these factors led to explosion of human population in most countries.

What happens if human population grows uncontrollably? Malthus, two centuries back, warned that the population was growing exponentially and the food production was growing only arithmetically and this would lead to food shortages and famine. Population growth may impose severe pressure on natural resources available on earth such as soil, land, forests, freshwater, forests or wildlife. This would result in shortage of food, freshwater, housing, sanitation, and consumer items. Area available for waste disposal would be limited. Diseases and deaths may be widespread. Though technology has improved the production of food at a faster rate than predicted by Malthus, the availability of resources is getting limited.

With the growth of human population more and more land is brought under cultivation by destroying forests. Application of pesticides and chemical fertilisers has been destroying natural ecosystems leading to extinction of many species of plants and animals. Soil erosion and water logging are increasing. For producing consumer goods to satisfy the needs of the growing population, mining and industrialisation increased. All these human activities are producing pollution of land, air and water and radiation pollution that are adversely affecting the earth's atmosphere and climate, including greenhouse effect and ozone layer depletion. Slums with

abysmal living conditions have come up in the urban regions. Human beings are manipulating ecosystems at such a rate that many natural resources are being lost irreversibly.

Usually population of a species undergoes natural regulation. Natural regulation population occurs through predators, parasites, competition, diseases, changes in weather such natural calamities. Populations of all organisms are limited by the biosphere's carrying capacity. As natural regulation of human population would bring much sufferings and deaths, it necessary for us to go for artificial regulation. Artificial regulation involves mainly birth control Many social and religious factors influence the adoption of such technologies for birth control. The improvement in education, particularly women education, promotes artificial birth control Population control can be done through a number of socio-economic measures such as:

- Educating the people on the benefits of small families and motivating them
- Promoting family planning programmes and birth control through the use of contraceptives
- Promoting women's education
- Increasing the age of marriage
- Providing incentives for birth control and disincentives for larger family size
- Propaganda through mass media like television and newspaper

ENVIRONMENTAL PROBLEMS AT GLOBAL LEVEL

Global warming & Greenhouse effect

Greenhouse effect is the warming of the earth's atmosphere due to air pollution. A large

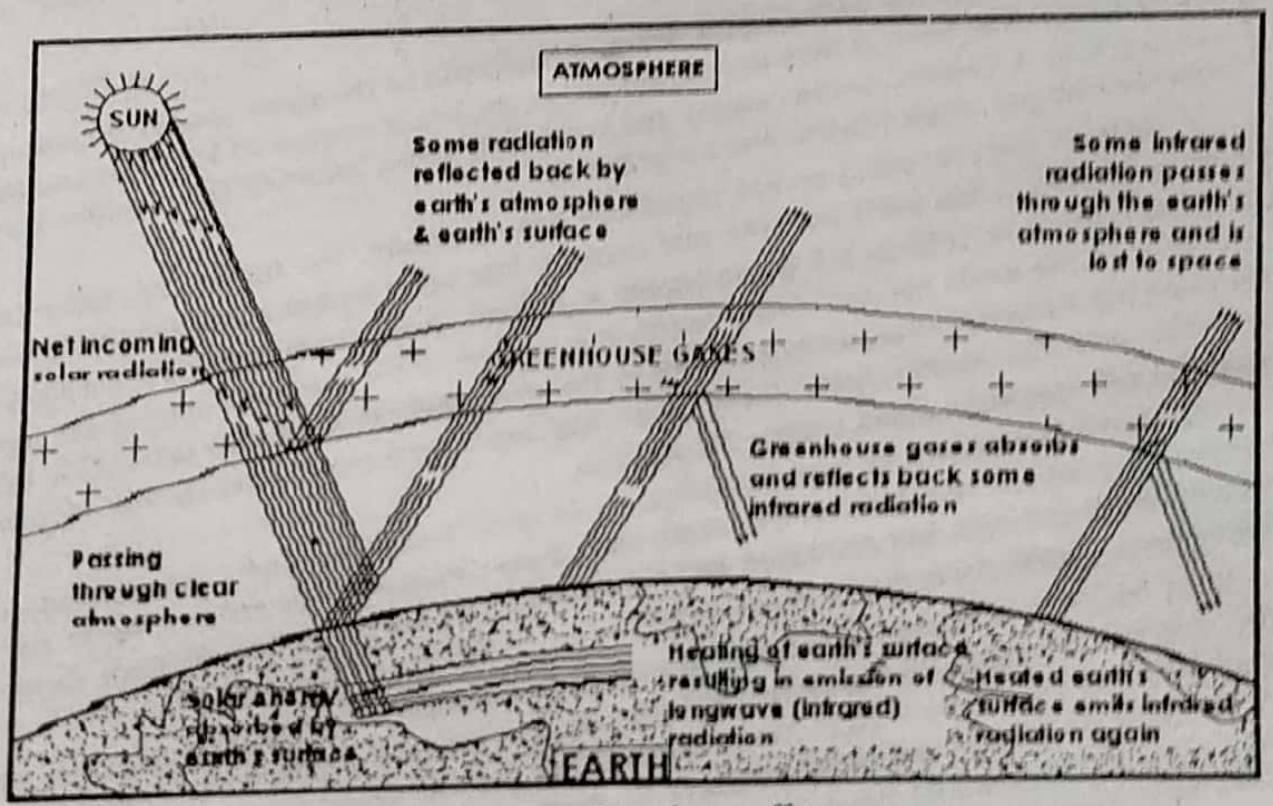


Figure 45 Greenhouse effect

portion of the solar energy that falls on the earth's surface penetrates the atmosphere to reach the surface of the earth. Much of this radiation is absorbed by the earth, resulting in surface warming. (A portion of the solar energy is reflected back into the space from the surface of the earth. The earth's atmosphere also reflects back some of the energy into space. Another portion is dispersed and scattered by the molecules in the atmosphere.) Much of the solar energy that is absorbed by

earth's surface is eventually re-radiated into space. Some of this energy escapes to space, but much is reflected back to the earth's surface by molecules in the earth's atmosphere. This reflected energy further warms the surface of the earth. The molecules of water vapour (H_2O), nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2) responsible for this phenomenon are called greenhouse gases, because they act like the glass in a greenhouse, trapping energy.

This warming is essential because the surface temperature would probably be about 15°C colder otherwise. The greenhouse gases acting like a blanket above the earth keeps the heat in and thus prevents earth becoming very cold. However if the concentration of these gases increases, the atmosphere gains more ability to block the escape of infrared radiation. In other words, the earth's insulation gets thicker and earth becomes hotter due to trapped radiation. This phenomenon is called ***global warming***.

When fossil fuels like petroleum and coal burn, carbon dioxide and certain other gases gets accumulated in the atmosphere, thus increasing the thickness of the greenhouse gases. An increased concentration of these gases can have dramatic effects on climate and cause many harmful effects on living beings. Consequently it results in global warming. It is estimated that the earth's temperature would go up by 2 to 3 degree centigrade in this century. A one percent rise in surface temperature of earth can cause glaciers in the mountains as well as ice shelves in the Antarctic and the Artic to melt and cause flash floods.

The sea level may rise up, submerging land along the seashores. The climatic pattern may be disturbed causing draughts or floods. These will severely affect the global ecosystem and threaten the existence of many life forms. The global warming will create many diseases and epidemics, including cancer.

In India the greenhouse effect is said to increase the rainfall. Many cities and towns including Mumbai and Goa face the threat of partial submergence. The ever-increasing sea erosion problem along the coastal Kerala may be due to the impact of global warming. Serious steps are to be taken to reduce the emission of carbon dioxide and other air pollutants from factories, automobiles, burning of wood etc. Forest cover that is rapidly disappearing from earth's surface is capable of absorbing some greenhouse gases and therefore should be re-established by massive tree plantation.

Acid rains

Acid rains occur mainly due to atmospheric pollution caused by industries. The gaseous effluents released by the industries and automobiles contain oxides of sulphur and nitrogen that react with rainwater and turn the rainwater into dilute acidic solutions. These acid solutions fall to the earth as rain, snow, hail, dew and fog. The main sources of oxides of sulphur and nitrogen are electric power plants that burn coal to generate electricity. Sulphur that is present in coal is converted to sulphur dioxide when burned. They also come from the industrial as well as automobile emissions.

Acid rains commonly occur in industrialised areas. A peculiarity of acid rain is that while the causative agents are emitted at one place, the acid rain falls at another. Though these acid rains contain only weak concentrations of acids, they are harmful to the plants, crops, soil fertility and various man-made structures. This rain turns freshwater sources acidic and polluted. Forests are destroyed as it causes harm to trees. Irreversible damage occurs to many monuments and buildings of historical importance and architectural values.

Ozone layer depletion & CFCs

In the earth's atmosphere the ozone layer is mainly found in the stratosphere and the troposphere. It is the ozone layer that prevents harmful ultraviolet rays from the sun from reaching the earth's surface. Air pollutants deplete the ozone layer thus permitting these rays from the sun to fall into the earth's surface. The continuous exposure to ultraviolet rays can cause skin cancer in humans. Moreover it also damages the earth's ecosystems.

It is the accumulation of chlorofluorocarbons [CFC] in the upper atmosphere that is thinning the ozone layer. CFC is used in air conditioners, refrigerators, aerosol sprays and as coolants. Halogens (chlorine, bromine etc.) used in fire extinguishers and other compounds can also react with atmospheric ozone causing its depletion.

Biodiversity

Life originated on earth 3.5 billion years ago and human beings evolved about 5 lakh years ago. At present there are about 10 million species of living beings on earth. In developing countries in particular, biodiversity is a vital resource, a key component in poverty reduction and crisis prevention. The term "biological diversity" or "biodiversity" covers not only species diversity, but also the diversity of ecosystems (e.g. forests, rivers, oceans) worldwide, and genetic diversity. The decline in biodiversity worldwide is alarming. A major portion of biodiversity is thus lead to extinction due to all these actions.

The biodiversity is useful to mankind in a number of ways. Many of the world's poorest people directly depend for their livelihoods on the diversity of plant and animal species and their habitats. We know very little about the characteristics of millions of species on earth, and therefore the kind of uses they have for us. A large number of medicines, including life saving drugs, are extracted from plants, fishes and animals. Two thirds of the people in the world depend directly on plants as their source of medicine; many of the prescribed drugs are also derivatives of plant extracts. A number of products for industry and domestic consumption are also derived from them. Out of the 70000 species of fungi some are used for preparation of antibiotics and manufacture of beer. Many fungi are disease causing agents and therefore it is important to study them.

It is said that the greatest danger that humanity is now facing is loss of species and biodiversity. Loss of biodiversity is caused due to:

- destruction of the habitats of species and their degradation;
- overexploitation of plant and animal species;
- introduction of non-native species into habitats;
- pollution and contamination, and
- global warming.

Steps to preserve biodiversity

- There should be urgent measures globally to control human population by all acceptable means.
- Social justice and elimination of poverty has to be achieved to reduce the dependency of the poor on the natural resources like forests.
- Appropriate technology should be adopted for industrial processes to avoid factors that cause global warming, cutting down of trees, prevention of topsoil erosion, acid rain and ozone layer depletion.

- The most effective way of saving biodiversity is to preserve areas that have all their organisms in them, intact as natural communities. For example it is absolutely essential to preserve the remaining tropical forests as they are.
- Limiting the use of chemicals as fertilisers and pesticides and adopting better and eco-friendly farming techniques is very important. Clearing of forest for agricultural use should be curtailed whereas better farming practices should be adopted to improve land productivity.
- Genetic engineering can be used to improve the yield and develop pest resistant and disease resistant varieties of plants.
- Developing countries right now have about 78 percent of the world's population and 6 percent of the world's scientists and engineers and about 80 percent of the world's biodiversity. Scientists and engineers from the developing countries should be trained on ecology and environmental management.
- For those species that are in the verge of extinction, captive breeding can be adopted to increase their numbers.
- Wastage of energy must be avoided
- Large scale awareness campaigns must be undertaken to enlighten the world population about the grave dangers in loosing biodiversity.

Extinction of species

Millions of years ago mass extinction of species took place, in which dinosaurs perished. This was caused due to some unknown natural phenomena. Scientists believe that once again in the earth's history such a mass extinction is about to happen, this time due to human activities. Many species will be lost for ever from this world, posing grave danger to human existence. There is a clear gap in the understanding of different plant and animal species even now and before we understand them they will be lost forever.

Figure 46 A model of the Dodo bird extinct in 1600s. Within 8 years after the Dutch sailors landed in Mauritius the bird became extinct; because of destruction of forests, killing for meat and attacked by dogs, cats and other animals that came with the sailors

Around 1 in 10 of all the world's bird species and a quarter of its mammals are officially listed as threatened with extinction, while up to two-thirds of other animal species are also endangered. Many scientists believe that biodiversity loss as a more serious environmental problem than the depletion of the ozone layer, global warming, or pollution and contamination. Surveys have revealed that the general public, in contrast to the scientists, are totally unaware of the dangers involved in extinction of species. Scientists believe that the public, the government, the teaching community and the media underestimates the loss of species. Only by a stronger stance by policymakers and governments and by individuals, making changes in their daily lives, the biodiversity crisis could be addressed.

The most important effects of species loss are:

- Destruction of the natural systems that purify the world's air and water
- Increased flooding, drought, and other environmental disasters
- Reduction of the potential for the discovery of new medicines
- Serious impairment of the environment's ability to recover from natural and human-induced disasters

- Degradation of the world's economies, thereby weakening the social and political stability of nations across the globe
- Damage of agriculture, fisheries, and food production.
- Decrease in the ability to control infectious diseases.
- The main causes of extinction of species are the growing size of human populations and the rate at which humans consume resources.

It is essential to disseminate information about the grave dangers of mass extinction of species to the public, educate the teaching community and teach students in schools and colleges about it. A massive educational effort is needed to alert the public to the biodiversity crisis and its implications, and to provide a clear idea of what individuals can do in their daily lives to meet this challenge. Preserving the biodiversity is important not only to ensure our own existence, but also due to the moral responsibility to future generations and the planet itself.

ENVIRONMENTAL PROBLEMS AT STATE LEVEL

Some of the environmental problems to be addressed at State level are:

a)Soil erosion b) Deforestation c) Bad water management d) Solid waste and its disposal e) Destruction of mangroves f) Over fishing and marine pollution, shrinking of backwaters g) Quarrying, sand mining h) Food adulteration i) Changing crop patterns and j) land use.

Deforestation

Forests are important for maintaining the balance of ecosystems. They help in conservation of biodiversity and gene pool by supporting a large variety of wildlife and plant species. They also control soil erosion as the roots of trees bind the soil together. They also prevent loss of rainwater through runoff by recharging aquifers by improving water seepage into soil. Large-scale deforestation leads to reduction of vegetation available for absorbing carbon dioxide and affects the world climate and enhances greenhouse effect.

Even though the desired forest cover as per National Forest Policy is 33% it has reduced to just 11% in India at present. Forests are destroyed due to forest fires, human settlements, cattle grazing, fuel and fodder collection, collection of raw materials for industries and commerce, clearing of forests for agriculture etc. Construction of large dams and hydroelectric projects in ecologically sensitive areas has resulted in destruction of forests either by inundation under reservoir or through forest clearance for project construction. Third world countries are increasingly becoming dependent on timber export for supporting their economies. Population explosion is thus putting much pressure on.

Deforestation cause serious environment problems. It results in elimination of many species of animals and plants and destroys the ecosystem. It results in soil erosion and cause landslips and flash floods.

Government of India has several measures for forest conservation. The Wildlife (Protection) Act (1972) and the Forest Conservation Act (1980) is enacted for this purpose. There are about 89 national parks, 504 sanctuaries and 10 biosphere reserves in India at present. Besides these there are other conservation programmes such as Project Tiger, Crocodile Rehabilitation and Project Elephant. There is a Central Zoo Authority that looks after deer parks, safari parks, aquaria and about 275 zoos.

Bad water management

Fresh water is essential for most human activities like drinking, washing, cooking, agriculture, industries, and animal husbandry and for producing electricity. Water is a critical element for sustaining ecosystems and bio-diversity. Scarcity of freshwater water brings a lot of miseries to the people and leads to outbreak of epidemics and starvation. Traditionally water tanks have been used for rainwater conservation in the Indian villages. Tank irrigation is very common in Rajasthan and many southern States like Andhra Pradesh, Tamilnadu and Karnataka. In the past many decades the potential of water tanks were being neglected in favour of more centralised irrigation systems, mega projects, tube wells etc and as a result many age-old tanks have deteriorated.

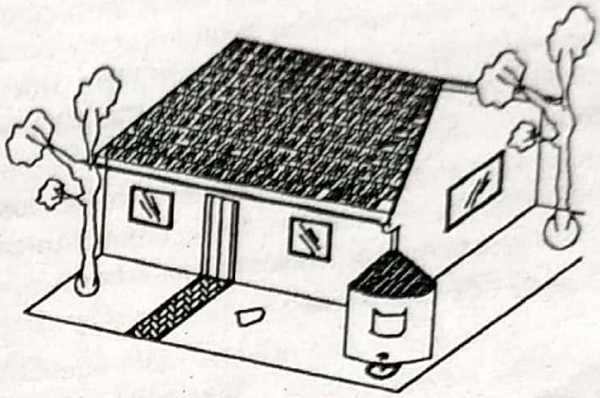


Figure 47 Rainwater harvesting from roof top

At present 80% of domestic water and a sizeable portion of water for industrial and agricultural use is obtained from groundwater. Excessive use of groundwater has resulted in decline of water table in many parts of the country. Due to deforestation the water retention capacity of the soil has reduced. Soil erosion and siltation have affected many water reservoirs. Discharge of industrial and other pollutants into water bodies have also reduced the supply of freshwater.

Irrigation is essential for expansion of agriculture and to become less dependent on rains and climatic factors. However irrigation has also some negative effects like increase in soil salinity and water logging. Water logging promotes weed growth and unhealthy conditions for humans besides impairing soil fertility. Large irrigation projects have caused deforestation and displacement of tribal and other population and large scale destruction of flora and fauna.

Kerala government has realised the importance of conserving rainwater for drinking and domestic purposes. It is promoting rainwater harvesting structures in the form of water tanks constructed close to buildings, where the rainwater than falls on the roofs is collected and stored. Groundwater recharging using rainwater is also being adopted widely. Building regulations has now made it mandatory to construct a water tank close to all new buildings to conserve rainwater.

Solid Waste and its disposal: (See land pollution p.220)

Like in other parts of the world in Kerala also land pollution has been causing lots of social and health problems in recent years. Municipalities and local authorities are finding it difficult to find places to dump solid wastes collected. The people who stay close to the dump yards complain about a variety of health problems and have been agitating. There are no sufficient facilities available for disposing hospital wastes and the people nearby the hospitals are suffering from stench, flies, pollution of their drinking water from wells and a variety of health problems. Waste produced from slaughter houses and chicken stalls are creating much nuisance to general public.

Government is trying to promote "clean Kerala" by educating the public. Waste processing plants have been installed in many cities and towns, but with problems. These plants convert bio degradable waste into compost and manure. There has been an attempt to ban plastic covers of certain categories but its enforcement cannot be said to be successful.

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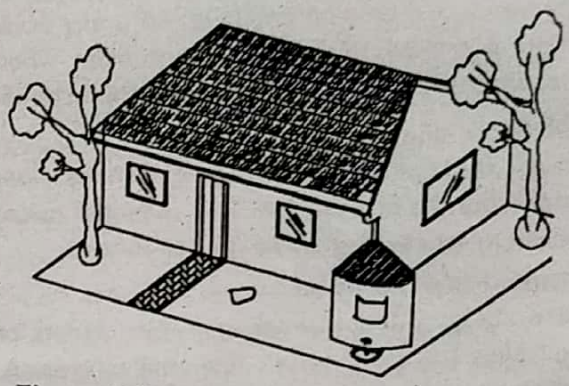

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Effects of soil erosion

- The most significant effect of soil erosion is the loss of soil nutrients. Its serious long-term impact is that it adversely affects agricultural productivity, decreasing agricultural yields.
- Intense rainfall produces large gullies, and creates flooding and property damage in the long run.
- The soil that is detached by accelerated water or wind erosion may be transported to considerable distances giving rise to sedimentation in watercourses and dams.
- Due to soil erosion the agricultural chemicals move with eroded sediment into downstream watercourses and water bodies and pollute them. Costs of removal of such pollutants from drinking water can be quite high.
- Erosion removes 'the cream of the soil'. Agricultural tillage also redistributes soil, resulting in thinner soils on topographically convex areas within a field.

Preventing soil erosion

- afforestation and cultivating plants whose roots bind the soil
- leaving unploughed grass strips between ploughed land;
- making sure that there are always plants growing on the soil, and that the soil is rich in humus (decaying plant and animal remains). This organic matter is the "glue" that binds the soil particles together and plays an important part in preventing erosion;
- avoiding overgrazing and the over-use of crop lands;
- allowing indigenous plants to grow along the river banks instead of ploughing and planting crops right up to the water's edge;
- encouraging biological diversity by planting several different types of plants together;
- conservation of wetlands
- Small stone and live checks in the field area would stabilise the soilscape and reduce soil erosion.
- Stabilisation of gullies in black soil by constructing check dams would be more effective to check soil erosion.
- Earthen and concrete water structures should be constructed to collect maximum run off. Diversion drains from upper reaches of watershed should be provided for safe disposal of rain water and prevention of soil erosion.

Plants provide protective cover on the land and prevent soil erosion.

- Plants slow down water as it flows over the land (runoff) and this allows much of the rain to soak into the ground;
- plant roots hold the soil in position and prevent it from being washed away;
- breaks the impact of a raindrop before it hits the soil, thus reducing its ability to erode;
- plants in wetlands and on the banks of rivers are of particular importance as they slow down the flow of the water and their roots bind the soil, thus preventing erosion.

SAND MINING

Sand is an essential ingredient in cement concrete and cement mortar and therefore an indispensable element in construction. As the construction activities pick up in the villages demand for sand goes up. Sand mining has become a lucrative business in Kerala because of construction activities in rural areas. Indiscriminate sand mining from the beds of several rivers in Kerala has been going on for the past several years. The sand mining activity provides employment opportunity to a large number of people.

The quantity of sand mined from river beds is several folds higher than the natural replenishments and hence impose severe environmental problems. Further, there is no viable alternative available to this crucial construction at present.

Sea sand mining, practiced in many countries worldwide, is suggested as an alternative to river sand mining. It requires large capital investment and machinery for desalination of sand so as to be made fit for construction purpose.

- Indiscriminate sand mining adversely affect the environment and ecology of the region.
- Sand mining from up and down streams in the rivers threatens the stability of a number of river bridges.
- Sand mining had transformed the river beds into large and deep pits. As a result, the underground water level has dropped, leaving the drinking water wells on the embankments of these rivers to dry up.
- To add to these, the fall in river bed levels has resulted in sliding of the embankments and consequently threatening the residential buildings.
- Sand mining would certainly cause ecological imbalance and cause havoc on riverine ecology.
- Sand mining cause obstruction and diversion of the river course. It is aggravating the rate of lowering of river beds and also causing drastic changes in river bed configuration thus destroying the ecology and the aquatic life in the rivers.
- The depletion of sand in the riverbed has resulted in saline water ingression in many areas and shortage of drinking water.
- The extraction of sand leaves deep pits endangering the lives of swimmers and those depend on rivers for their daily needs.
- The villagers along the river basin face the severe problem of drinking water shortage because of the lowering of the water table.

MANGROVES

Mangroves are salt tolerant forest ecosystem, found along the coastal areas and in the estuaries. They comprise of diverse, salt-tolerant tree and other plant species. They can be found in 50 different varieties along the tropical coasts of Africa, Asia, Australia, and the America. In India, there are about 65 different species of mangroves identified. The term tidal forest is used as a synonym of mangrove.

Benefits of mangroves.

Mangroves have been traditionally used for food production, medicines, fuel wood, and construction materials. Mangrove is an open ecosystem which exchanges energy and nutrients with the neighbouring marine and land eco systems and influences them. Mangrove forest acts as nursery and breeding ground for numerous species of fish and crustacean and many reef organisms. A wide variety of animals and plants, including many commercially important species, are found in these forests. Many local coastal species, both terrestrial and aquatic are also found there. The fallen leaves and organic material from mangrove trees serve as a nutrient source for planktons and algae thus serving as the starting place for the food web for many organisms. Their intricate root systems provide shelter for many marine and terrestrial animals, protecting them from ocean currents and strong winds. Many endangered species are also found living in mangrove forests.

Mangroves also help to control sediment pollution and other forms of pollution from nitrogen and phosphorous, petroleum products, and halogenated compounds. They stop these contaminants from polluting the ocean waters. Thus, they act as a filter system for the local communities, keeping the ocean waters free of pollution and thus the fish and other food sources

free of contaminants. They also act as an important carbon dioxide reduction system. Mangroves protect the coastal land areas from erosion and siltation problems, preventing a great deal of property damage. They act as a buffer zone between the open ocean and the land, protecting the shores from damage and preventing washing away of the human settlements there.

Destruction of mangroves

Planners and administrators had earlier considered mangrove areas as useless and hostile territory and they were therefore destroyed in different ways. Large areas of mangroves are destroyed with the establishment of shrimp ponds for agriculture and for firewood purposes. Most of the previously existing mangrove forests have been devastated or have been subjected to degradation as a result of land deposits, construction of sanitary landfills or simply due to overuse. This destruction has been either due to natural causes or man-made causes.

Natural destruction: Mangrove forests are subjected to natural destruction due to severe cyclones, tsunami caused by seaquakes and devastating tropical storms that destroy millions of trees. Large scale environmental changes, abnormal sea level fluctuations, salt accumulation in soil or flooding have also contributed for their destruction. Besides these, diseases and pests also have severe impact on both individual plants as well as on the whole forest ecosystem. Epidemics of bacteria, fungi, spiders, wood-destroying insects and attack by many invertebrates such as leaf eating crabs, small fishes, shrimps and wild mammals also has been damaging mangrove forests.

Man made destruction: Most of the recent mangrove destruction around the world has been due to human activities. Mangrove forests are destroyed in order to provide places for residential, commercial, and industrial development. Many mangroves have been cut down to provide ocean-side land for local housing and tourist hotels. The most destructive process, however, has been the shrimp aquaculture industry.

Mangrove areas have always suffered from conversion due to colonisation, migration and population explosion, when areas were reclaimed for agriculture settlement sites, industrial setup, industrial estates and road networks for an ever-increasing coastal population. In Kerala, where the rate of population increase is the highest in the country, only 3.5% of the former mangrove vegetation survives. Extensive mangrove clearance has severely affected the water quality in the area and shrimp production has been reduced significantly. Air and water pollution, chlorine pollution from domestic sewage and industrial pollution also inflict severe damage on mangrove communities. Untreated human waste, domestic garbage, industrial discharge and chemical pollutants, insecticides and herbicides from agricultural fields also contribute to the general degradation and contamination of the mangrove and continually reduce the number of species living there.

Consequences of destruction

Destruction of mangroves has lead to reduction in the number of species or population of large water birds, fishes and mammals and decreasing levels of spawning in fish and prawns. Wetlands are critically important for many migratory species. Many of the medicinal plants are being lost. Most people living in or associated with mangroves suffer economic losses once this ecosystem is disturbed or eliminated. The destruction of local fisheries affects the local communities economically and socially.

Mangrove trees, once abundant along the Kerala coast, prevented soil erosion and tidal waves. Erosion disrupts the flow of nutrients to the sea, needed for fish to spawn and grow. Most of India's mangroves were destroyed over the past 100 years resulting in tremendous coastal soil erosion.

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FOOD ADULTERATION

Food provides us various nutrients essential for the body functioning, gives us energy for carrying out our activities, regulate our body processes, protects us from diseases and give us satisfaction. Good food gives us health, happiness, and longevity. Good food should be wholesome and free from anything that does any harm to us. The nature, quantity and quality of food pay a vital role in the maintenance of health of individuals.

The dictionary meaning of adulteration is "act of intentionally debasing the quality of food offered for sale either by the admixture or substitution of inferior substances or by the removal of some valuable ingredient." Preparation and processing of food products may modify their nutritional value and use of food additives may introduce direct or indirect toxicity. But the real hazards to health are caused due to food adulteration.

A food item is considered adulterated if

- inferior or cheaper substance has been substituted wholly or partly for the article;
- the article contains any substance affecting its quality or if it is so processed as to injuriously affect its nature, substance or quality
- the article had been prepared, packed or kept under unsanitary conditions whereby it has become contaminated or injurious to health
- the article contains any poisonous or other ingredient which is injurious to health
- the article contains any prohibited colouring matter or preservative, or any permitted colouring matter or preservative in excess of the prescribed limits.

Food adulteration is mainly done by greedy merchants whose only intention is to make lot of money even if it harms thousands and lakhs of men, women and children. Rice, cereals, bakery items and sweets are often subjected to adulteration. Even milk that is fed to babies and children are not spared. Recently Maneka Gandhi has exposed the widespread practice of injecting the cows with oxytoxins for smooth flow of milk and torturing the cows to extract more milk. The resultant milk contains hazardous chemicals that may cause chronic and deadly diseases like cancer (She convincingly argues that milk of animals itself is bad for health as it causes in humans, a number of diseases like cancer, osteoporosis, heart attack, asthma and arthritis). Milk is adulterated commonly by addition of water, flour, or any other starchy material like industrial starch. Addition of water and extraction of fat is very common and not harmful. But these days, criminals are producing and distributing 'synthetic milk' by a combination of urea, liquid detergent, a little sugar, vegetable oil and water. The health hazards due to such crimes on those especially the children who consume this are inexplicable.

Many of the food items that we consume daily are susceptible to adulteration. Prohibited food colours, sweeteners, preservatives, flavours and additives are used to manipulate food substances so as to make them appear more attractive to consumers or to prevent their decay. Substances harmful to humans are added to food substances to increase their weight and thus earn higher profits. Adding stones to rice and cereals are quite common. Hazardous chemicals are added to change the properties of food items. Use of acetylene gas (carbide gas) for ripening of fruits is an example.

Another way of adulteration is substituting a portion of the food items with cheaper alternatives without much affecting the looks and tastes. Adulteration of edible oils is commonly done in this manner. Even harmful and hazardous substances like crude castor oil, industrial palmolein-oil and mineral oils are mixed with edible oil. Metanil yellow, a non-permitted coal tar dye, commonly known as 'Kishori Rang', Rhodamin-B, lLead Chromate, Ultra Marine Blue, that are carcinogenic, are used to give attractive colours to food items. These are all non-permissible and

banned colours and cause serious health hazards and even cancer in the long run. Turmeric is adulterated using lead chromate, a very toxic salt of lead, that can cause anemia, paralyses, mental retardation and brain damage in children and abortion in pregnant women. Not only sawdust, rice bran and sand, but even horse-dung and cow-dung are used as adulterants for coriander powder and chilli powder. Argemone seeds that grow as weeds in the mustard fields are mixed with mustard seeds and its oil is mixed with mustered oil. It causes serious health hazards and even death. It may also cause swelling, irregular fever, low pulse rate, enlargement of the liver and respiratory distress which may lead to heart failure. Ghee is often adulterated to the extent of 80 to 85 percent with Vanaspati. Sand, dirt, earth, gritty matter, soap stone, common salt are added to flour, refined flour (maida), gram flour (besan), spices, sugar, tea-dust and coffee. And washing soda is added to table salt.

In order to curb the menace of food adulteration, Government of India introduced the prevention of Food Adulteration Act, 1954 with Prevention of Food Adulteration rules 1955. The object of this food legislation is to prevent adulteration and misbranding of foods as defined there in and punish those involved in this crime against humanity.

IMPORTANT ENVIRONMENTAL MOVEMENTS IN INDIA

Many major projects are conceived without paying attention to their adverse impacts on the lives and livelihoods of people. There are projects that damage the rare ecosystems of the region. Some projects cause serious public health hazards through air and water pollution. Some others deprive large number of people of their means of livelihood. When people become aware of the negative impacts of projects and such other consequences they agitate against their implementation. Such environmental movements have been taking place worldwide and also in India.

There have been a number of environmental movements in India for a wide range of environmental related issues ranging from protection of trees, protection of flora and fauna, protection of public health and resettlement of the affected people in development projects. Some important movements include the Chipko movement, Silent Valley agitation, Narmada agitation and the Ganga Action Plan.

CHIPKO MOVEMENT

In Hindi, Chipko literally means "tree-huggers." Chipko movement was an environment protection movement of the people in the northern region that gained strength in the 1970s. The people of Uttarakand and some other regions agitated against felling of trees and destruction of forests. A notable aspect of this movement was that women were at the forefront of the agitations.

Destruction of forests affected the livelihood of the poor villagers and the women were the worst affected. They depended on forests for firewood and fodder for cattle. When forests are destroyed they have to walk miles and miles to collect twigs and branches for firewood. Besides, the forests prevent soil erosion and siltation of river basins. Destruction of forests had lead to erosion of soil and floods. The Government had not recognised the importance of forests on the livelihood of the poor in rural areas and forest policy had provisions for cutting trees and exporting forest produce.

The Chipko Movement began in 1973 in the village of Mandal in the upper Alakananda valley. In Chamoli district, the villagers led by Sri Chandiprasad Bhatt and Dasholi Gram Swarajya Mandal (DGSM) stopped an Allahabad based sports company from felling 14 trees by embracing the trees. Women took their children to the forests and formed a circle around the trees to

prevent the slaughtering of trees.Chipko Antolan leaders enlightened the villagers on the importance of forests and trees in their lives. Between 1973 and 1977 there were a number of agitations against felling of trees by the forest department. In 1974 the women of Reni village agitated and drove away the contractors and their labourers who came to cut 680 ha of forest auctioned by the forest department. In Kumaon in UP, the Chipko activists had blocked forest auctions at several places. One of the notable leaders of the Chipko movement was Sri. Sundarlal Bahuguna. People participated in the agitations in large numbers and also planted a number of trees. Eco-development camps were organised. The Chipko movement received worldwide attention.

NARMADA AGITATION

Narmada project envisages 30 big dams, 300 medium dams and 3000 small dams to be built across the river Narmada. It is an inter-State project with Madhya Pradesh, Maharashtra and Gujarat as beneficiaries. The dam is expected to bring irrigation to vast tracts of land in Gujarat including the drought prone Kutch region. The project would submerge 30000 hactares of land in the three States and displace more than 1 lakh people including villagers and tribals from their settlements besides affecting lakhs of people downstream.

The Narmada agitation that has been going on since more than a decade now is an environmental movement against large dams. The agitation was initially against lack of any resettlement plans for the displaced persons and later turned into an agitation against large dams. One of the most vociferous leaders of Narmada Bachao Andolan is Ms. Medha Patkar.

At the initial stages the three State governments had not considered the resettlement of the villagers and tribals. There was no concern about the environmental impact of the project including the possibilities of water logging and malaria outbreak. Later Maharashtra and Madhya Pradesh offered to give two hectares of land per displaced family. In 1991 the World Bank who were the funding agency of the project appointed a committee to independently review of the whole situation including human and environmental impacts of the project. In 1994 the World Bank pulled out of its commitment to finance the project. However the State Government of Gujarat was determined to go ahead with the project and raised funds through public bonds.

The construction of the project is in progress; and so is the agitation.

SILENT VALLEY AGITATION

The silent valley is located in Palghat district of Kerala. Silent valley project is a multipurpose project conceived in 1963, envisaging generation of 240 MW of hydroelectric power and irrigation of 10000 ha of land. In 1976, a non-governmental organisation named Kerala Sastra Sahitya Parishad (KSSP) conducted a study on the project and came out with certain findings on possible environmental damage if the project is implemented. They found that large tracts of forestland would be inundated with the construction of the dam thereby destroying rare flora and fauna. That included the lion tailed macaques, rare species of monkeys found in the Western Ghats.

In the following days the KSSP spearheaded the 'save silent valley' struggle that received national attention. Ultimately, based on the report of a joint committee headed by Prof. MGK Menon, the project was abandoned and the silent valley was declared a national park.

SELF-ASSESSMENT TEST

1. What are the renewable and non-renewable resources on earth? Give examples.
2. What is meant by sustainable development? What are its objectives?
3. Describe three sustainable activities

4. Define pollution. How can we control pollution?
5. What are the various types of pollution?
6. What are the common causes of (i) air pollution (ii) water pollution and (iii) land pollution?
7. What are the common water pollutants?
8. What are the various sources of water pollution?
9. What are the various human activities that result in pollution of water bodies
10. What are the various means of controlling land pollution?
11. Write short notes on: (i) hazards of noise pollution (ii) control of noise pollution (iii) radiation pollution (iv) thermal pollution
12. What are the environmental problems at a global level?
13. List two examples of food adulteration
14. Describe how acid rain occurs and the effects of acid rain.
15. What is meant by (i) ozone layer depletion (ii) greenhouse effect?
16. What are the environmental impacts of deforestation?
17. Write short notes on: (a) Narmada agitation (b) Silent valley agitation (c) Chipko movement
18. Write short notes on how population explosion affects the environment adversely.
19. Explain the role of 'reduce', 'reuse' and 'recycling' in land pollution management
20. What do you mean by over exploitation of environment? How can you check it through education?

When the well's dry, we know the worth of water

Benjamin Franklin, (1706-1790)

VII. ENVIRONMENTAL EDUCATION

TEACHING LEARNING STRATEGIES IN ENVIRONMENTAL EDUCATION

ENVIRONMENTAL EDUCATION

With the rapid advancement of science and technology there has been a great increase in the rate at which we exploit natural resources. The uncontrolled exploitation of natural resources has severe impact on the environment and ecology, even threatening the existence of life on earth if adequate measures are not taken. The activities of humans are capable of creating environmental disasters like those happened in Bhopal and Chernobyl or that occurred due to the atomic bombings. It is therefore necessary to adopt sustainable methods of using natural resources to avoid causing damage to the environment. It is essential that, while we enjoy the resources in this planet, we should also be able to pass on its natural wealth to the future generations. We should ensure that they are able to enjoy clean and healthy environment. We should not drive animal and plant species to extinction.

Mere legal and executive measures are not sufficient to protect the environment. Creating environmental consciousness in the public is also very important. There are so many activities like tree felling, hunting or creating pollution by improper disposal of things that people do, without being aware of the damage they are doing. There are also vested interested groups who cause environmental damage for immediate monetary gains. Setting fire to the forests is an example. Many Governments may go for large projects, neglecting the environmental consequences so as to gain immediate political mileages. Therefore it is necessary to create awareness of the environmental issues among the masses and make them conscious of the intensity of the problem. Not only that, it is necessary to create a basic shift in the value system of the people. This can be achieved only by educating the whole humanity into a new way of thinking and living. Environmental education cannot be limited to institution-based formal education programmes. It has to be a lifelong process, educating people from childhood through adulthood and elderly age. General public should be educated irrespective of age and nature of work they are doing.

Environmental education aims at increasing people's *knowledge and awareness* about the environment and associated challenges. Besides it aims at developing necessary *skills* and *expertise* to address the challenges, and to *foster attitudes, motivations, and commitments* to make informed decisions and take responsible actions (UNESCO, Tbilisi Declaration, 1978). Environmental education does not advocate a particular viewpoint or course of action. It teaches individuals to weigh various sides of an environmental issue, to make informed and responsible decisions.

The goal of environmental education is to develop a world population that is aware of and concerned about the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones.

OBJECTIVES OF ENVIRONMENTAL EDUCATION (EE)

To develop awareness: To develop awareness and sensitivity to the environment and environmental challenges

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To develop knowledge: To help individuals and social groups to acquire knowledge and understanding of the environment, its associated problems and environmental challenges

To develop attitudes: To help individuals and social groups to acquire attitudes of concern for the environment and motivation to improve or maintain environmental quality. For e.g. a person with the right attitude towards environment will be deeply concerned if he sees a tree being cut down or a wild animal or bird being harmed.

To develop skills: To help individuals and social groups to acquire skills to identify and help resolve environmental challenges e.g. the skill to construct a vermi-compost plant to dispose of organic waste or the skill to undertake afforestation.

To develop evaluation: To help individuals and social groups to evaluate environmental measures and education programmes in terms of social, economic, political, ecological and other factors e.g. people will be able to evaluate the pros and cons of a new project coming up in their locality.

To develop participation: To help individuals and social groups to participate in activities that lead to the resolution of environmental challenges

PRINCIPLES OF ENVIRONMENTAL EDUCATION

Principle of Totality: EE should consider the environment in its totality – natural and man-made, social, economical, political, cultural, legislative and technological

Principle of Continuity: EE should be continuous life-long process, beginning at pre-school level and continuing through all formal and non-formal education.

Principle of Interdisciplinary: EE should be inter-disciplinary in approach drawing information from many disciplines and forming a holistic and balanced perspective.

Principle of Complexity: EE should emphasis the complexity of environmental problems and also emphasis the need to develop problem solving skills and critical thinking.

Principle of Practicality: Practical activities and first hand experiences should be given stress in environmental education. A broad range of approaches to teaching learning and diverse learning environments shall be utilised

Principle of Historical Perspective: EE should focus on current and potential environmental challenges by considering historical perspective.

Principle of Local and Global Issues: Environmental issues at local, national and global levels should be examined so that the student gets insights on environmental issues in different geographical areas.

Principle of Environmental Sensitivity: Emphasis should be given to sensitise the learner on environmental matters.

APPROACHES TO ENVIRONMENTAL EDUCATION

Different approaches, methods and techniques of teaching are used in environment education. Two approaches – infusion approach and problem-solving approach – are discussed below.

Infusion approach

The dictionary meaning of infusion is "to blend" or "to mix". In infusion method of environmental education, contents and skills in environment are carefully blended into existing curriculum without disturbing its main focus.

Infusion can be done in two ways, through inter-disciplinary and multi-disciplinary approaches. In inter-disciplinary approach environmental education is imparted by drawing concepts and inputs from various disciplines like sociology, economics, biology, mathematics, life sciences and physics. Environmental education is taught as a separate subject that contain the

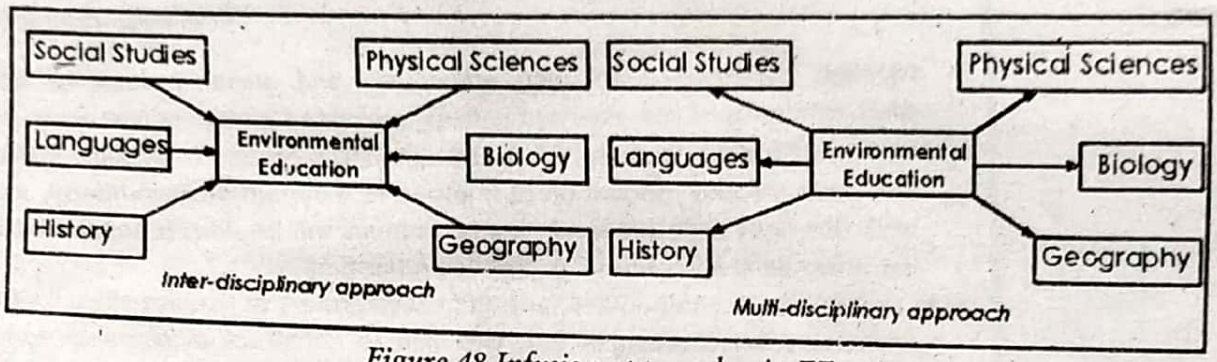

Figure 48 Infusion approaches in EE

relevant aspects of sociology, economics or science. For example, while teaching environment, you can discuss the economics of environmental consequences of a new project of a certain region.

In multi-disciplinary approach the process is reverse with environmental topics dispersed or infused into various disciplinary courses. For example you can include environmental topics in chemistry or biology text books and thus impart environmental education as part of teaching the latter e.g. in chemistry, a topic on petroleum can discuss about the gases produced while burning petroleum and their environmental consequences.

Table 47 Interdisciplinary vs. multidisciplinary approaches in EE

Inter-disciplinary approach	Multi-disciplinary approach
Easier to implement and train teachers	More teachers to be trained; requires greater coordination
Fewer teachers to be trained; Intensive training to EE teachers required	Teachers of all disciplines to be trained on EE; Depth of training less
EE as an additional discipline in already crowded curriculum	Demands on existing curriculum load comparatively less
Components easier to identify and sequence	Difficult to integrate components into the existing curriculum

Problem solving approach

A problem is a difficult and doubtful situation that requires a solution. A problem can have a single solution or a number of solutions. For e.g. the students may discus and find solutions to the problem of drying up of wells or the problem of water logging in their locality.

Problem solving is a method aimed to help the participants to arrive at a solution or alternate solutions of a given problem. A problem is identified along with the underlying concepts and principles. Teachers and the students discuss the various aspects of the problem to arrive at alternative solutions from which the most appropriate one is chosen. The problem solving approach has the following features: ♦ it is student centred ♦ it is activity based ♦ it is process-oriented rather than content oriented ♦ it is conceptual rather than factual.

METHODS USED IN ENVIRONMENTAL EDUCATION

Discussion, demonstration and projects are the commonly used methods of imparting environmental education.

DISCUSSION METHOD

This is a teaching method in which the teacher and the students freely discuss a given issue by analysing it in detail and arriving at possible solutions. A discussion involves consideration of a question in open and usually informal debate by a group of people. During a discussion the participants first tries to understand the issue or the question raised. Then they analyse the issue critically and communicate their views and ideas with reasons. They may consider various alternatives available for resolving the issue and evaluate them.

There are several types of discussions like student-initiated discussion, teacher-initiated discussion, symposium or panel discussion. In a classroom the teacher may introduce a topic or problem or the students may be asked to present a situation. There are mainly four steps in the discussion method: (i) identification of the problem and outlining its significance, scope and nature (ii) analysing the problem (iii) arriving at solutions, formulation of recommendations and drafting the report and (iv) finalising the report.

The teacher has to play an important role in conducting a class through discussion method. She has to formulate the topic and outline its significance, scope and nature. She must encourage active participation of the members and at the same time regulate the discussion by discouraging domination by one individual or group over other/s, offensive statements and personality clashes. An atmosphere for freewheeling of ideas and expressions must be created. The teacher may ask some relevant questions at appropriate points. She may train the students in planning, organising and conducting similar discussions.

There are several advantages in discussion method of teaching. It promotes critical thinking of the participants and the power to analyse issues critically. It improves the ability of the participating student to communicate ideas and views with reasons. The participants learn to appreciate others' points of view and to respond suitably. The group learning activity has positive impact on their values and develop good behaviours in them. The participants develop the ability to evaluate arguments and modify individual positions according to new ideas and views and to identify alternatives available for resolving problems.

Example of use of discussion method in EE

Statement of the problem: The problem of disposal of domestic waste in a certain residential locality is the problem. There has been epidemic outbreak in the city and people believed that it was caused due to unsanitary conditions. Many people have died of fever and many are hospitalised. The city corporation is unable to handle all the solid wastes generated in the city and effectively and safely dispose them.

Analysing the problem: The following questions may be raised during discussion on the issue: What are the types of domestic wastes generated? How can they be reduced at source? What are the various methods available of disposal of domestic wastes? How can biodegradable and non-biodegradable wastes be separated? How can the residents be educated on the dangers of haphazard disposal and ways of safe disposal of the wastes? Can biogas plants or bio-composting be constructed at household level and what are the costs and benefits involved in it? Which are the agencies that provide technical assistance? How can the city corporation initiate various steps in this regard?

Arriving at solution: The class may be divided into various groups and discuss different issues. After the discussion the students arrive at some solutions that are practicable in the given situation and write down their solutions.

Drafting report: The students may write down the solutions they have arrived at through discussion. The answers and solutions are discussed in a general class session and an action plan is prepared. The teacher evaluates the discussion. The action plan may be published in newspapers or school magazines.

PROJECT METHOD

A project is a task or problem engaged in by a group of students to supplement and apply classroom studies. The project method of teaching involves an activity that is carried out in the school or outside and usually involves data collection and investigation, analysis and report making. The students carry out project individually or in groups.

Some examples for projects related to environment are:

- A study of suitability of pipe water and well water at different areas in a town for drinking purpose
- Scope for rainwater harvesting as a means for drinking water in residential premises
- Role of slaughterhouses and chicken farms in the pollution of the city
- Census of environment related disease cases in the city hospitals
- Study of noise levels at public places

Project method involves the following steps:

i. Description of the problem and definition of the goals and objectives.
ii. Library research – Reading, discussing, clarifying issues, collecting information)
iii. Field investigation – Data collection, observations, interviews, surveys, recording and analysing data
iv. Discussions, combining the findings, arriving at conclusions, report making

Advantages of project method: Students involved in project method get trained in observing, investigating, sample and data collection, analysing data and report making. It improves teamwork and collective thinking skills while collecting information for the project. It creates confidence in interacting with the community. It improves their scientific attitude and critical thinking skills

An example for the project method in EE

Title of the project: Census of environment related disease cases in the city hospitals

Objectives:

1. To identify the common diseases prevalent in the city that are caused due to poor environmental conditions
2. To find out the number of disease cases that occurred during the past three years caused due to poor environmental conditions
3. To seek measures that could help reduce the incidences of such diseases

Procedure:

i. Collect data of all hospitals in the city along with their capacities
ii. Visit city hospitals and interview doctors to identify the common diseases prevalent in the city that are caused due to poor environmental conditions like unsanitary conditions, mosquitoes and micro-organisms