JIWAJI UNIVERSITY GWALIOR

SELF LEARNING MATERIAL

FOR

B.SC. 2 YEAR Foundation Course

PAPER 3: Environmental Studies

PAPER CODE: 203

Published By:
Registrar,
Jiwaji University,Gwalior

Distance Education, Jiwaji University, Gwalior

JIWAJI UNIVERSITY GWALIOR

SELF LEARNING MATERIAL

FOR

B.SC. 2 YEAR Foundation Course

PAPER 3: Environmental Studies

PAPER CODE: 203

WRITER

Miss KARUNA MAHOR

Master of Computer Application

UNIT-1

THE CONCEPT OF ECOLOGY AND ENVIRONMENT

(a) Meaning and definition of Ecology:

The science of ecology has had a gradual development through history. The reference to this concept is found in the writings of Aristotle and other philosophers of Greek period.

The term ecology was first proposed by a German Biologist Ernest Hackel in 1866. The word is derived from two Greek words „Oikos" that means house, a place to live and logos i.e. the study of. Therefore ecology is a study of organisms at home. Ecology is mainly concerned with the biological connections and processes of organisms, land, water etc. It can be referred as the scientific study of the interactions that determine the distribution and abundance of organism.

According to Webster's dictionary "ecology is the totality or patterns of relations between organisms and their environment".

For E. Hackel 'It is the science of relation between organisms and their environment".

Taylor defined ecology as "the science of all the relations of all the organisms in relation to all the environments"

According to the United States Council on Environmental Quality, "ecology is the science of the intricate web of relationships between living organisms and their non-living surroundings.

Hence it is imperative to understand and differentiate the concept of ecology with reference to environment or the components of ecosystem.

Importance and principle of ecology:

Importance of ecology:

Ecology is a multidisciplinary science. Because of its focus on higher levels of the organization of life on earth and on the interrelations between organisms and their environment, ecology draws heavily on many other branches of science, especially geology, geography, meteorology, climatology genetics, chemistry, physics, biology, math's and now even computer science.

Ecologists aim to explain the distribution, life processes and adaptations amongst the organisms. Further it tries to analyses the movement of energy flow and successive growth and development of organisms. It tries to comprehend the nature of biodiversity and its complexity.

Along with understanding the interrelation and interdependence of the organisms, ecologists are also concerned about manner in which manipulation and misuse of non-living organisms by human population is taking place, ruining the balance.

Principles of ecology:

All living organisms and their environment are mutually reactive, affecting each other in various ways. Animal population, flora and fauna (vegetation) are interdependent throughout the environment.

Components in ecology are dynamic and works as a sieve (to perforate) selecting organism for growth and others for decay.

The species maintain uniformity in structure, function, reproduction, growth and development by preservation of its genetic pool.

Modification in the organisms of ecology takes place through growth, dispersal, reproduction, death and decay.

Under similar climatic conditions there may be simultaneous development of more than one community and some of which may even reach their climax or critical stage.

Meaning and definition of Environment:

The term environment is derived from French word “environs” meaning around, encircle or encompass. And hence the term environment in short can be used for surrounding. Environment can also be referred as the totality of all the externalities that affect human life. In broader perspective environment consists of human, social, political, economic and physical environment.

Webster’s ninth new college dictionary defines environment as the “circumstances, objects or conditions by which one is surrounded”.

The Encyclopedia Britannica defines environment as the entire range of external influence acting on an organism both physical and biological”.

It can also be defined as the “surrounding in which organization operates including air, water, land and natural resources, flora and fauna, humans and their inter relations”.

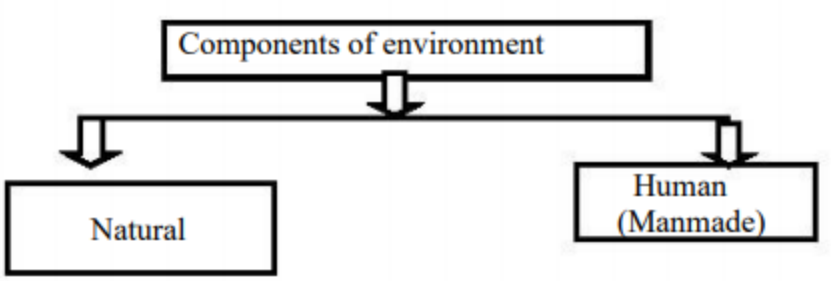
In nutshell environment comprises of all the biotic, a biotic, natural and human components defining the form and survival of each in a given system at a given time or over a period of time.

Components of environment:

Broadly speaking, components of environment can be classified in to two

a) Natural and

b) Human (manmade)



- Lithosphere (land)
  Anthrosphere
- Hydrosphere (water)
- Atmosphere (air)
- Biosphere (flora/fauna/microbes)

Natural environment -:

1. Lithosphere: It is the solid rocky crust covering the entire planet. It is inorganic and composed of minerals. It consists of continents, mountains and ocean floor, which makes up 29% of the earth's surface.

2. Hydrosphere: It is composed of all the water on and around the earth. It includes all the oceans, lakes, rivers, ponds and streams on the earth. It covers 71% of the earth‟s surface of which 97% is in the oceans. Only 3% is fresh water which includes the solid ice sheets as well as liquid form in the rivers and ponds.

3. Atmosphere: The atmosphere is the layer of gases surrounding the earth‟s surface. It consists of 78% of Nitrogen, 21% of Oxygen, 0.03%carbon dioxide and other gases. The atmosphere helps to maintain the temperature near the surface by absorbing the dangerous ultraviolet rays coming from solar radiation.

4. Biosphere: This component comprise of living or non living organisms, flora and fauna, plants and animal species including one-cell organisms. They all are vital to maintain the energy flow via eco-cycles, food webs and food chains (discussed in the following sections) and thus maintain the balance in nature.

Man-made environment-:

Anthrosphere: The part of environment made, modified, or used by humans for their activity is called Anthrosphere. The entire infrastructure made by humans by using the natural components of the environment can be considered as a part of Anthrosphere. For e.g. buildings made with the use of wood, cement or water. Even an ocean-going ship used to ship goods made in the factory.

(b) public participation and public awareness

Elagba H. A. Mohammed, Maushe Kidundo and Mirghani Tagelseed.

Abstract

Environmental education has an effective role in creating healthy awareness and preparing suitable environment for the development and maintenance of human minds. Environmental education prepares the individual to become able to balance between his vital needs and the natural environment that provides spiritual, aesthetical and ethical sources for many communities.

Environmental education includes both formal and informal education and training that increase human capacity and capability to participate in environmental management and in solving environmental crisis and challenges. This could be achieved by increasing awareness and effectively changing the individual outlook on the environment. We need awareness in our behavior; we need ethical values for protecting and conserving the environment and improving the quality of human life.

Every country should care for special attention to select an effective Educational strategy to achieve environmental education by applying the principles recommended by the International Environmental Education Program to implement its objectives and goals. The concept of environmental education must be infused effectively into our world education system. Children and youth should be involved in all local, regional and international environmental issues.

Training program on environmental management and conservation can be designed for school and university students, and for members of all sectors in the society. Trained and skilled persons can provide services to local communities.

In Sudan, environmental education is all ready infused in education program at the general and higher education levels. More than twenty University Colleges teach environmental sciences where nine Departments are specialized and award a university degree in environmental studies. One thousand students are graduated annually from these colleges and they are aware of the environmental issues and the local and international environmental problems. Indeed, more effort is needed for setting the environmentally literate individuals and groups who are willing Workshop on Post Conflict National Plan for Environmental Management in Sudan.

Khartoum, Sudan 18-20 July, 2006. And capable to of taking actions to maintain balanced quality of life. They can be educated to acknowledge the benefits of the environment and to understand the types of behavioral changes necessary for properly managing it. Therefore, there should be a continuous effective environmental education and environmental awareness, based on international standards. This should be motivating at all levels of the society and linked with planning and development programmes and available to every person in the society.

Workshop on Post Conflict National Plan for Environmental Management in Sudan. Khartoum, Sudan 18-20 July, 2006.

Introduction

Environmental education focused on the protection and improvement of our total environment, developing and conserving those components traditionally recognized as natural resources (soil, water, forest products), making the population aware of problems, skilled and willing to participate in environmental management.

The main concept of environmental education is to foster clear awareness of, and concern about ecological, economic, social and political interdependence in urban and rural areas; to provide every person with opportunity to acquire knowledge, values, attitudes, commitment and skills needed to protect and

improve the environment, and to create new patterns of behavior of individuals, groups and society as a whole towards the environment.

The Development of environmental education

The concept of the environmental education became accepted in few countries of the world and environmental education programmes were developed by the early 70's when scientists and political and educational leaders began to recognize the increasing environmental problems.

The local and national movement became international and global efforts in environmental education when the "United Nations Conference on the Human Environment" was held in Stockholm in (1972). Recommendation of the conference led to the creation of the International Environmental Education Programme (IEEP) as a project of the Unesco-United Nations Environmental Programme (UNEP) in (1975).

This was followed by Intergovernmental Conference on Environmental Education in Tbilisi, Georgia, USSR, in (1977). In Tbilisi Conference and under the auspices of IEEP, global environmental education adopted a disciplinary structure and direction. The Declaration and recommendations of the Tbilisi Conference created a landmark beginning for International Environmental Education and established the objectives and pedagogical principles and broad guidelines for developing environmental education nationally and internationally (UNESCO-UNEP, 1978).

Objectives of environmental education

According to UNESCO-UNEP (1978) the main objective of environmental education is to make the individual acquire logical vision about the local and Workshop on Post Conflict National Plan for Environmental Management in Sudan. Khartoum, Sudan 18-20 July, 2006.

International societies and encourage him to participate in resolution of environmental problems through:

1. Awareness- to help individuals and social groups acquire an awareness and sensitivity to the environment and its allied problems.
2. Knowledge: to help them gain a variety of experience in, and acquire a basic understanding of the environment and its associated problems.

3. Attitudes: to help them acquire a set of values and feelings of concern for the environment, and the motivation for the actively participating in environmental improvement and protection.
4. Skills: to help them acquire the skills for identifying and solving
5. Participation: to provide individuals and social groups with an opportunity to be actively involved at all levels in working towards resolution and environmental problems.

Principles of environmental education

According to the Tbilisi Conference (1977) the following principles of environmental education should:

- consider the environment in its totality, natural and built, technological and social;
- be a continuous lifelong process, beginning at the pre-school level and continuing through all formal and informal stages;
- be interdisciplinary in its approach;
- examine major environmental issues from local, national, regional and international points of view;
- focus on current and potential environmental situations while taking into account the historical perspective;
- promote the value and necessity of local national and international cooperation in the prevention and solution of environmental problems;
- consider environmental aspects in plans for development and growth;
- enable learner to have a role in planning and provide an opportunity for making decisions and accepting their consequences;
- relate environmental sensitivity, knowledge, problem- solving skills and values to every age;

- help learners to discover the symptoms and fear causes of environmental problems;

- Emphasize the complexity of environmental problems and thus the need to develop critical thinking and problem- solving skills;
-utilize diverse learning environments and a broad array of educational approaches to learning/teaching about and from the environment.

Environmental Education in Sudan

Environmental movement started in Sudan in (1975) with a growing awareness of the serious environmental problems such desertification, deforestation and pollution and water contamination… etc. This movement was crowned by the establishment of the leading Institute of Environmental Studies (IES) in the University of Khartoum. The IES is the first of it kind in Africa and Middle East. It pursues a programme that blends training, research, education, consultation and environmental awareness. The objectives of IES are to encourage and promote inter- and multidisciplinary research in environmental issues, conduct training courses for capacity building and skills development, to help public in general to acquire knowledge about national and international environmental problems, and to undertake consultancy on environmental problems for the government and private sectors.

The IES also assist in the development of many organizations and associations concerning environment issues such as Sudanese Association of Environment Conservation, Association of Environmentalists; the Higher Council for Environment and Natural resources (HCENR).

The IES has a broad consultancy task and partnership with many types of councils within the Sudan such as The Consultative Council of the Ministry of Irrigation and Water Resources, and The Ministry of Environmental and Urban Development, the National Council for Pesticides, The Council of Higher Education,

The Council of Meteorology Authority, and The Sudanese Standards and Metrology Organization (SSMO). Partnership with private sector such as Zawayia Cooperation, Sudanese Industrial Union is also created for advice, consultancy and cooperation between the IES and these organizations.

Workshop on Post Conflict National Plan for Environmental Management in Sudan. Khartoum, Sudan 18-20 July, 2006.

The IES acted as the national coordinator for Dry land Husbandry Project. It also holds a position of National Focal Centre to UNESCO-Cousteau Ecotechni Network and created links with many Institute and Universities abroad such as the Institute of Terrestrial Ecology and Lund University (Sweden) and Clark University (USA) and Asma (Malaysia). The IES plays a big role in dissemination of information about the environment and its allied problems in Sudan and increase awareness of individuals, and develops a positive change in behavior which improves and/ or maintains environmental health and quality while information may influence their attitudes. This is the main important role of environmental education. At large the IES has established the concept of sustainable development in the Sudan.

The IES achieves these objectives by offering Diploma/MSc, and PhD in environmental studies (by research and courses), in different disciplines and fields of environment, including Arid Land Management, Freshwater Ecosystem Management,

Urban and Rural Management, Coastal Zone Management and Sustainable Development.

The skills, attitudes values and believes of the researchers and communities can be improved and shift to a positive behavior towards the environment, locally and nationally, to conserve and protect the natural resources through wise use and sustainable development. Increase in awareness of the individual of social groups could be achieved definitely through the training courses, seminars and scientific papers published by the staff and the students of the Institute.

The IES also played an important role in the infusion of environmental education and environmental issues in school and university curricula. This lead to the establishment of Departments in Science and Agriculture Facilities, and even to the establishment of new colleges concerned with environmental studies such as The Faculty of Agricultural Science, University of Sudan for Science and Technology; Juba University , Gazira University.. etc.

Strategies for environmental education The challenge of achieving environmental education goals calls for some special attention to selecting effective educational strategies. Education – teaching and learning- is the logical starting point for any cultural effort targeting the Workshop on Post Conflict National Plan for Environmental Management in

Sudan. Khartoum, Sudan 18-20 July, 2006. public. Education is the basic factor for achieving sustainable development and improving the individuals' skills to cope with development and environmental issues. According to Beyton et al. (1997) some recommendations can be offered to guide teachers and curriculum developers in designing approaches to environmental education.

1- Infusion of environmental issues in school curriculum It is a process of integrating environmental education concepts, skills and strategies throughout an existing general education curriculum, instead of a monodisciplinary model in which environmental education is treated in a separate course or as a comprehensive unit within a course. The infusion of environmental education would enhance existing programmes without competing for limited curriculum time and resources. Social sciences, psychology, economy, geography, history together with information technology could be used to develop and implement solutions for complicated problems. Environmental education should also be infused within teacher training-programme.

2- Designing environmental awareness programmes With cooperation between different mass media (TV, radio, newspaper, posters…. etc) a well designed awareness programmes can be conducted to the society to disseminate knowledge about the environment and its problems and the role of community participation in protecting the environment.

3- Exhibitions Dioramas representing the different ecosystems in the country including the fauna and flora especially threatened species of animals and plants are effective educational tools. The Natural History Museum in the University of Khartoum could play a major role in this task due to its mission to disseminate the environmental message to a broad spectrum of the community from a pre-school child to a mature scientist, in addition to its contribution in national and special celebration activities.

Indeed, it has been pursuing this for the last three decades. The IES also has a news letter "Sudan Environment" and "Environmental Monography" series. Workshop on Post Conflict National Plan for Environmental Management in Sudan. Khartoum, Sudan 18-20 July, 2006.

4- Establishment of environment clubs and societies. Activities on environmental issues conducted in social and cultural clubs by individuals and social groups such

Ecofriends, Consumer Protection Society and Sudanese Environment Conservation Society are playing a leading role in environmental education. Lectures, seminars, posters, exhibitions or any activity of concerning environmental problems can suitable tools for such activities. Can environmental education influence individual's behavior?

The major goal of environmental education is to effectively prepare the populations to be capable and willing to implement behavior which improve and/or maintain healthy environment with high quality. Complexity of factors may influence individual's behavior regarding environmental matters and serve to illustrate some major implication for environmental education (Fig. 1).

As shown in this figure information can influence attitudes and thus behavior, but information actually works by impacting on beliefs, and this may not result in attitude shifts. Belief is simply what an individual perceives to be true about a situation (Rokeach 1968). It is the perception of reality. While values are important standards held by an individual, unfortunately, people often enter into environmental issues lacking a full awareness of all their own values being affected by the issue, a clear definition of their own priorities and/or a good information basis for predicting consequences to those values.

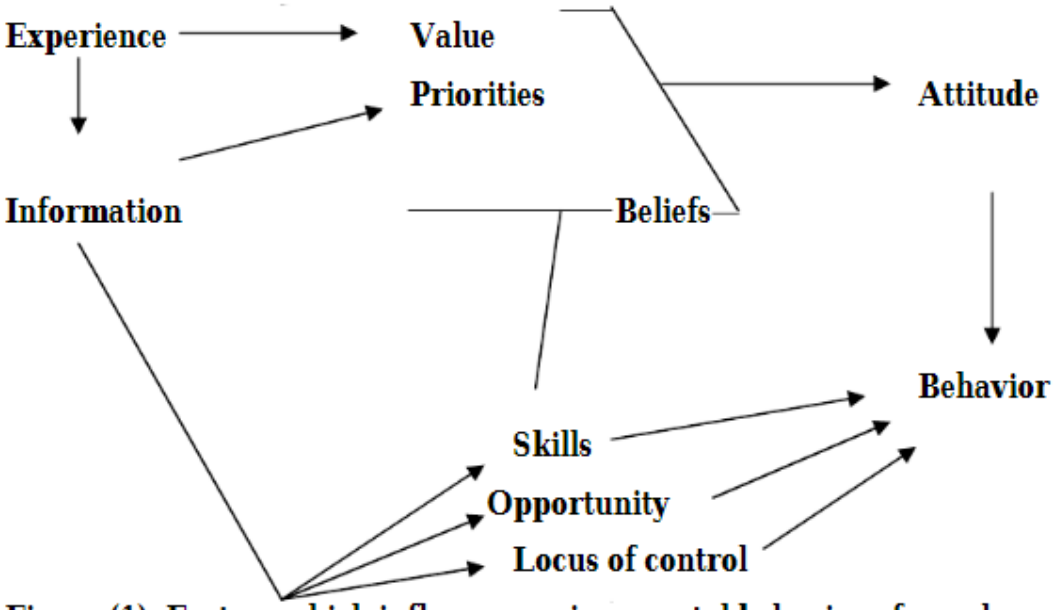


Figure (1). Factors which influence environmental behavior of people.

. Indeed preparing learners to objectively and carefully undergo these difficult processes of values clarification and information gathering is a major task of environmental education. Individuals form attitudes when they evaluate an issue and take a position using held values and salient beliefs. Their attitude for any issue will be influenced by which value is given high priority and evaluation based on the salient beliefs. An individual many support an idea, but not know how to do so (lack of skills), or may not be given or recognize the opportunity, or may lack an internal locus (the perception of his own ability to influence the outcome of a situation).

These and many other factors influence behaviors, but many of these factors can be influenced by environmental education through educational programmes. Hungford and Volk (1990) have proposed components of educational programmes which are critical to influencing many variables involved and thus affecting changes in learner behavior.

Conclusion

Environmental education can implant incentives and goals and build skills which change the human behavior and attitude and call for participation and reaction with the environment as a whole. More considerations should be taken to implement environmental education and fill the gaps, starting from preschool level to higher education and including the whole public at the local level. Environmental awareness is the suitable tool for conservation of our natural resources and their valuable components. Environmentally illiterate individuals cannot successfully solve complex problems.

References

1. Anonymous. 1983. Trends, needs and priorities of environmental education since the Tbilisi Conference an overview. Environmental Education Series No. 1. Unesco-UNEP International Environmental Programme. Paris, France. 43 pp.

2. Hungerford, H. R. and T. L. Volk. 1990. Changing learner behavior through environmental education. The Round Table on Environment and Education at the World Conference on Education for All. Sponsored by UNESCO, UNICEF and UNEP. Jomtien, Thailand. March. 28 pp.

Workshop on Post Conflict National Plan for Environmental Management in Sudan. Khartoum, Sudan 18-20 July, 2006.

3. Peyton, B., Campa. H., Winterstein, S. R., Peyton, M. and Peyton, J. 1997. Biological Diversity for Secondary Education. Environmental Education Module. UNESCO- UNEP. International Environmental Education Programme (IEEP). 153 pp.

4. Rokeach Milton. 1968. Beliefs, attitudes and values: a theory of organization and change. Josssey- Bass, Inc., Publishers. San Francisco, Calif. 214 pp.

5. United Nations Educational, Scientific and Cultural Organization and United Nations Environment Programme., 1978. The Tbilisi Declaration. Connect. UNESCO- UNEP Environmental Education Newsletter. January, 111(1) 8 pp.

6. United Nations Educational, Scientific and Cultural Organization and United Nations Environment Programme. 1987. International strategy for action in the field of environment United Nations education and training in the 1990's.UNESCO, 7, Place de Fonteny, 75700, UNEP, Nairobi, Kenya. 21 pp.

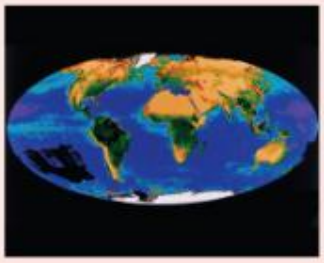
(c) An Introduction to Ecology

Ecology is the study of the interactions of living organisms with their environment. Within the discipline of ecology, researchers work at four specific levels, sometimes discretely and sometimes with overlap. These levels are organism, population, community, and ecosystem. In ecology, ecosystems are composed of dynamically-interacting parts, which include organisms, the communities they comprise, and the non-living (abiotic) components of their environment.

Ecosystem processes, such as primary production, pedogenesis (the formation of soil), nutrient cycling, and various niche construction activities, regulate the flux of energy and matter through an environment. These processes are sustained by organisms with specific life-history traits. The variety of organisms, called biodiversity, which refer to the differing species, genes, and ecosystems, enhances certain ecosystem services.

Organisms, Populations, and Communities: In a forest, each pine tree is an organism. Together, all the pine trees make up a population. All the plant and animal species in the forest comprise a community.

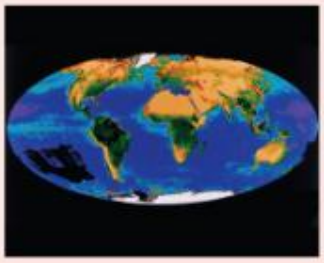
Ecosystems: This coastal ecosystem in the southeastern United States includes living organisms and the environment in which they live.



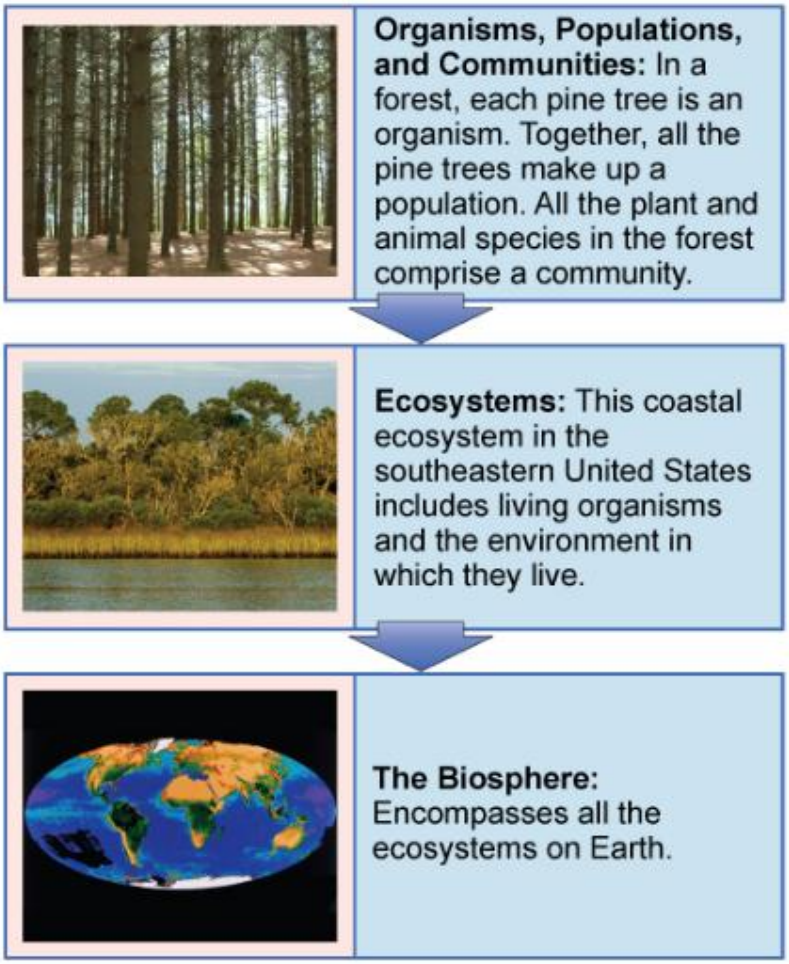
The Biosphere: Encompasses all the ecosystems on Earth.

Organisms, Populations, and Communities: In a forest, each pine tree is an organism. Together, all the pine trees make up a population. All the plant and animal species in the forest comprise a community.

Ecosystems: This coastal ecosystem in the southeastern United States includes living organisms and the environment in which they live.



The Biosphere: Encompasses all the ecosystems on Earth.



Levels of ecological study: Ecologists study within several biological levels of organization, which include organism, population, community, and ecosystem.

In essence, ecologists seek to explain:

- life processes
- interactions, interrelationships, behaviors, and adaptations of organisms
- the movement of materials and energy through living communities
- the successional development of ecosystems
- the abundance and distribution of organisms and biodiversity in the context of the environment

There are many practical applications of ecology in conservation biology, wetland management, natural resource management (agroecology, agriculture, forestry, agroforestry, fisheries), city planning (urban ecology), community health, economics, basic and applied science, and human social interaction (human

ecology). Organisms and resources comprise ecosystems which, in turn, maintain biophysical feedback mechanisms that moderate processes acting on living (biotic) and nonliving (abiotic) components of the planet. Ecosystems sustain life-supporting functions and produce natural capital, such as biomass production (food, fuel, fiber and medicine), the regulation of climate, global biogeochemical cycles, water filtration, soil formation, erosion control, flood protection, and many other natural features of scientific, historical, economic, or intrinsic value.

There are also many subcategories of ecology, such as ecosystem ecology, animal ecology, and plant ecology, which look at the differences and similarities of various plants in various climates and habitats. In addition, physiological ecology, or ecophysiology, studies the responses of the individual organism to the environment, while population ecology looks at the similarities and dissimilarities of populations and how they replace each other over time.

Finally, it is important to note that ecology is not synonymous with environment, environmentalism, natural history, or environmental science. It is also different from, though closely related to, the studies of evolutionary biology, genetics, and ethology.

(d) Ecosystem

Living organisms seem to interact amongst themselves and with the physical environment. This, in short, can be called an ecosystem. There can be different types of ecosystems. The biosphere, for example, can be a global ecosystem. It all depends on the different components and the extent to which you want to define the space, to consider it as an ecosystem. And hence to be able to learn more about them, ecosystems are generally divided into smaller forms.

Ecology or environmental biology is the field that studies this complex set of relationships between the living organisms and their surrounding environment. The scope of this field is very large and covers things like global warming, environmental pollution, plant and animal extinctions etc.

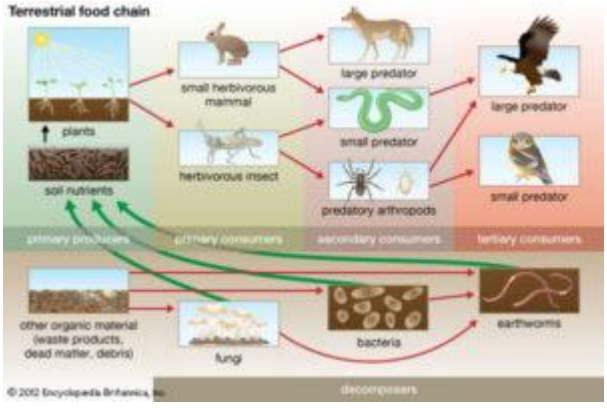
Components of Ecosystem

There are two main components of an ecosystem which are in constant communication with each other. They are the biotic components and the abiotic components.

Biotic Components of Ecosystem

The living components of an ecosystem are called the biotic components. Some of these factors include plants, animals, as well as fungi and bacteria. These biotic components can be further classified, based on the energy requirement source. Producers, consumers, and decomposers are the three broad categories of biotic components.

- ***Producers*** are the plants in the ecosystem, which can generate their own energy requirement through photosynthesis, in the presence of sunlight and chlorophyll. All other living beings are dependent on plants for their energy requirement of food as well as oxygen.
- ***Consumers*** include the herbivores, carnivores, and omnivores. The herbivores are the living organisms that feed on plants. Carnivores eat other living organisms. Omnivores are animals that can eat both plant and animal tissue.
- ***Decomposers*** are the fungi and bacteria, which are the saprophytes. They feed on the decaying organic matter and convert this matter into nitrogen and carbon dioxide. The saprophytes play a vital role in recycling the nutrients so that the producers i.e. plants can use them once again.



Abiotic Components of Ecosystem

Abiotic components are the physical and/or the chemical factors that act on the living organisms at any part of their life. These are also called as the ecological factors. The physical and chemical factors are characteristic of the environment. Light, air, soil, and nutrients etc. form the abiotic components of an ecosystem.

The abiotic factors vary from ecosystem to ecosystem. In an aquatic ecosystem, the abiotic factors may include water pH, sunlight, turbidity, water depth, salinity, available nutrients and dissolved oxygen. Similarly, abiotic factors in terrestrial ecosystems can include soil, soil types, temperature, rain, altitude, wind, nutrients, sunlight etc.

Here, the sun is the energy source. Producers/plants use this energy to synthesize food in the presence of carbon dioxide and chlorophyll. The energy from the sun, through several chemical reactions, turns into chemical energy.

The herbivores are dependent on plants for the energy requirements. The carnivores, in turn, feed on the herbivores and other carnivores. At any level, microbes then decompose any dead and decaying organic matter. These decomposers, after various chemical reactions, release molecules back to the environment in the form of chemicals. The chemicals are again used by the producers, and the cycle starts again.

In conclusion, ecosystems have a complex set of interactions that happen between the biotic and abiotic components. The components of an ecosystem are linked to each other through the energy flows and nutrient cycles. Even though ecosystems do not have clear boundaries, these interactions get affected, even if one factor is changed or removed. This ultimately has the capacity to affect the entire ecosystem.

Functions of Ecosystem

The functional attributes of the ecosystem keep the components running together. Ecosystem functions are natural processes or exchange of energy that

take place in various plant and animal communities of different biomes of the world.

For instance, green leaves prepare food and roots absorb nutrients from the soil, herbivores feed on the leaves and the roots and in turn serve as food for the carnivores.

Decomposers execute the functions of breaking down complex organic materials into simple inorganic products, which are used by the producers.

Fundamentally, ecosystem functions are exchange of energy and nutrients in the food chain. These exchanges sustain plant and animal life on the planet as well as the decomposition of organic matter and the production of biomass.

All these functions of the ecosystem take place through delicately balanced and controlled processes.

Food Chain and Food Web

Food chain is a linear sequence of organisms which starts from producer organisms and ends with decomposer species. Food web is a connection of multiple food chains. Food chain follows a single path whereas food web follows multiple paths. From the food chain, we get to know how organisms are connected with each other. Food chain and food web form an integral part of this ecosystem. Let us take a look at the food chain and a food web and the difference between them.

Food Chain

In scientific terms, a food chain is a chronological pathway or an order that shows the flow of energy from one organism to the other. In a community which has producers, consumers, and decomposers, the energy flows in a specific pathway. Energy is not created or destroyed. But it flows from one level to the other, through different organisms.

A food chain shows a single pathway from the producers to the consumers and how the energy flows in this pathway. In the animal kingdom, food travels around different levels. To understand a food chain better, let us take a look at the terrestrial ecosystem.

Food chain in a Terrestrial Ecosystem

The sun is the source of energy, which is the initial energy source. This is used by the producers or plants to create their own food, through photosynthesis and grow. Next up, in this chain is another organism, which is the consumer that eats this food, taking in the energy.

The primary consumers are the organisms that consume the primary producers. In a terrestrial ecosystem, it could be a herbivore like a cow or a goat or it could even be a man. When a goat is consumed by man, he becomes the secondary consumer.

As the energy goes one level up, the food chain also moves up. Each level in the food chain is called a trophic level. The different trophic levels are Primary producers, primary consumers, secondary consumers, tertiary consumers and quaternary consumers.

Example of food chain

Grass (Producer) ––Goat (Primary Consumer) –– Man (Secondary consumer)

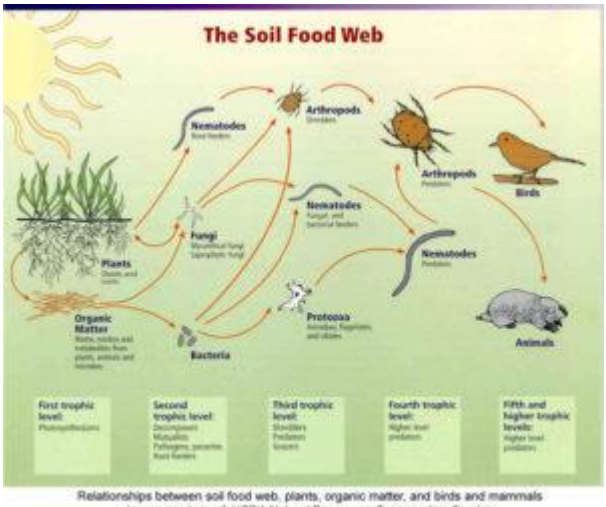
When dead organic matter becomes the starting of a food chain, then it is called the *detritus food chain* (DFC). The decomposers, which are the fungi and bacteria, feed on the organic matter to meet the energy requirements. The digestive enzymes secreted by the decomposers help in the breakdown of the organic matter into inorganic materials.

Food Web

Many interconnected food chains make up a food web. When you look at the larger picture, a food web shows a realistic representation of the energy flow through different organisms in an ecosystem.

Sometimes, a single organism gets eaten by many predators or it eats many other organisms. This is when a food chain doesn't represent the energy flow in a proper manner because there are many trophic levels that interconnect. This is where a food web comes into place. It shows the interactions between different organisms in an ecosystem.

The following diagram shows the energy flow between various organisms through a food web.



Relationships between soil food web, plants, organic matter, and birds and mammals
Image courtesy of USDA Natural Resources Conservation Service
http://soils.usda.gov/sqi/soil_quality/soil_biology/soil_food_web.html

Ecological Pyramid

It is a graphic representation of the relationship between organisms at various trophic levels in a food chain. The basis of an ecological pyramid is the biomass, energy, and number. Just as the name suggests ecological pyramids are in the shape of a pyramid. The concept was first introduced by Charles Elton, the pioneer British Ecologist.

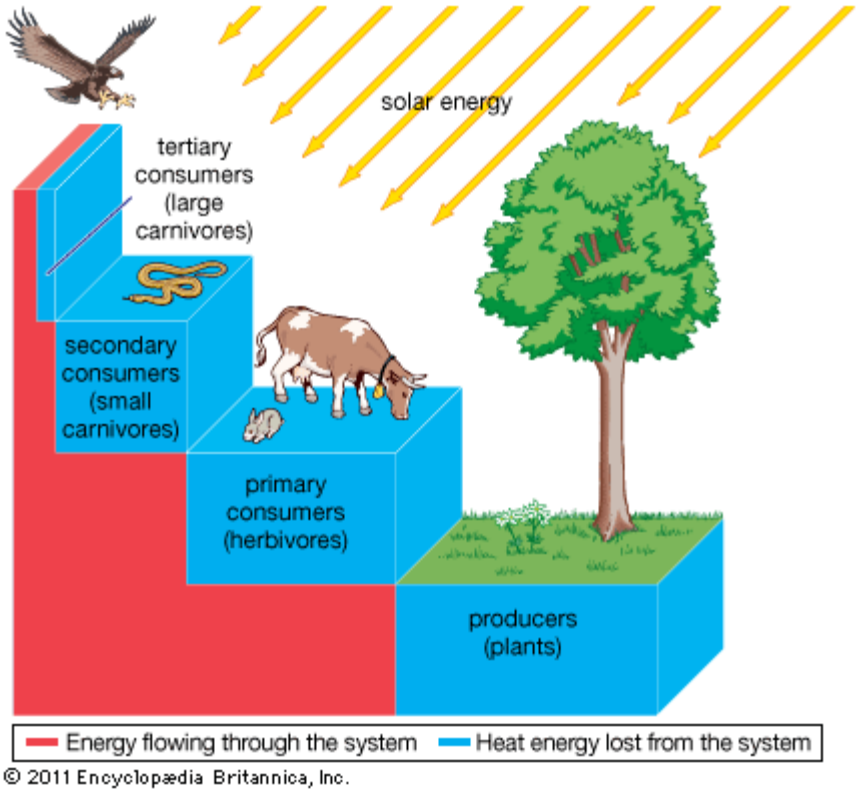
The bottom of an ecological pyramid is the broadest and is occupied the producers, which form the first trophic level. Producers are at the lowest level. Just as in a food chain, the producers are consumed by the primary consumers, in an ecological pyramid; the next level is occupied by the primary consumers. The next level of the pyramid is occupied by the secondary consumers and the last, by the tertiary consumers.

Types of Ecological Pyramids

Depending on the factors that we use to represent an ecological pyramid, there are three types. They are:

- *Pyramid of numbers*– Here the factor that is taken into account is the number of organisms in each trophic level. As we go up the levels of the pyramid, the number of organisms decreases. The producers form the largest number and hence are at the bottom of the pyramid.
- *Pyramid of energy*– This is an upright pyramid that represents the flow of energy from the producers to the final consumers.
- *Pyramid of biomass* – This pyramid represents the amount of biomass of the organisms present at each trophic level. Biomass is nothing but the weight of the organisms.

In general, all ecological pyramids are upright, except in certain cases. For example, in a detritus food chain, the pyramid of numbers is not upright because many organisms feed on one dead plant or animal. The pyramid of biomass in an ocean is also inverted. But a point of note is that the pyramid of energy is always upright as the flow of energy is unidirectional.



(Source – Encyclopedia Britannica)

Ecological Succession

A characteristic feature of biological communities is that their structure and composition changes according to certain changes in environmental conditions. Some of these changes occur in a more predictable and orderly fashion. The phenomenon through which these changes occur in ecological communities is Ecological succession.

This is an important aspect of the study of ecology and forms the core of ecological science. This ecological succession can be triggered by some form of disturbance or even due to the formation of new habitats in the ecosystem.

When the changes create a community that is almost in equilibrium with the environment, it is what we call a climax community. In a given ecological area, the communities change successively. This sequence of communities is a sere. The transitional communities are called seral communities. As the seral communities

progress, there is an increase in diversity of organisms, increased number, and an increased biomass.

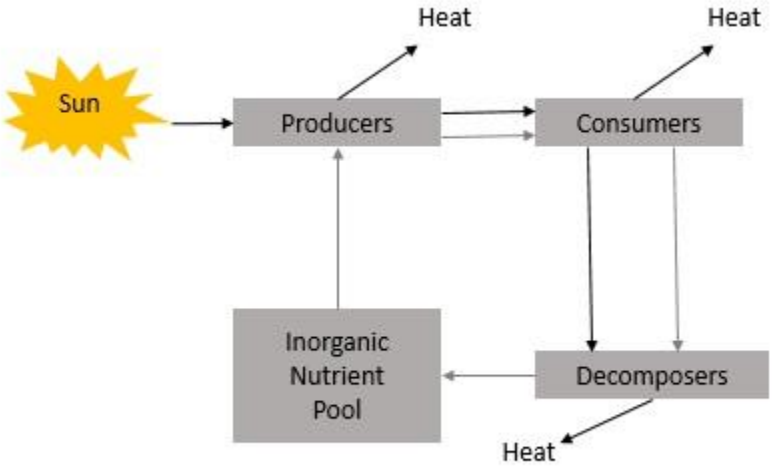
The starting point of ecological succession can be traced back to millions and millions of year back, where living organisms never existed. Slowly, as environmental changes happened, over time, new organisms developed, and the diversity of the planet started showing changes.

Types of Ecological Succession

Ecological succession is mainly of two types- Primary succession and secondary succession. The primary succession is a slow process that initiates in areas where there are no living organisms. Secondary succession begins in areas that were once inhabited but destroyed due to environmental disturbances. This is generally faster, as most of the other factors are already present.

Energy Flow in Ecosystem

Energy moves life. The cycle of energy is based on the flow of energy through different trophic levels in an ecosystem. Our ecosystem is maintained by the cycling energy and nutrients obtained from different external sources. At the first trophic level, primary producers use solar energy to produce organic material through photosynthesis.



The herbivores at the second trophic level, use the plants as food which gives them energy. A large part of this energy is used up for the metabolic functions of these animals such as breathing, digesting food, supporting growth of tissues, maintaining blood circulation and body temperature.

The carnivores at the next trophic level, feed on the herbivores and derive energy for their sustenance and growth. If large predators are present, they represent still higher trophic level and they feed on carnivores to get energy. Thus, the different plants and animal species are linked to one another through food chains.

Decomposers which include bacteria, fungi, molds, worms, and insects break down wastes and dead organisms, and return the nutrients to the soil, which is then taken up by the producers. Energy is not recycled during decomposition, but it is released.

Biogeochemical Cycles

All elements in the earth are recycled time and again. The major elements such as oxygen, carbon, nitrogen, phosphorous, and sulphur are essential ingredients that make up organisms.

Biogeochemical cycles refer to the flow of such chemical elements and compounds between organisms and the physical environment. Chemicals taken in by organisms are passed through the food chain and come back to the soil, air, and water through mechanisms such as respiration, excretion, and decomposition.

As an element moves through this cycle, it often forms compounds with other elements as a result of metabolic processes in living tissues and of natural reactions in the atmosphere, hydrosphere, or lithosphere.

Such cyclic exchange of material between the living organisms and their non-living environment is called Biogeochemical Cycle.

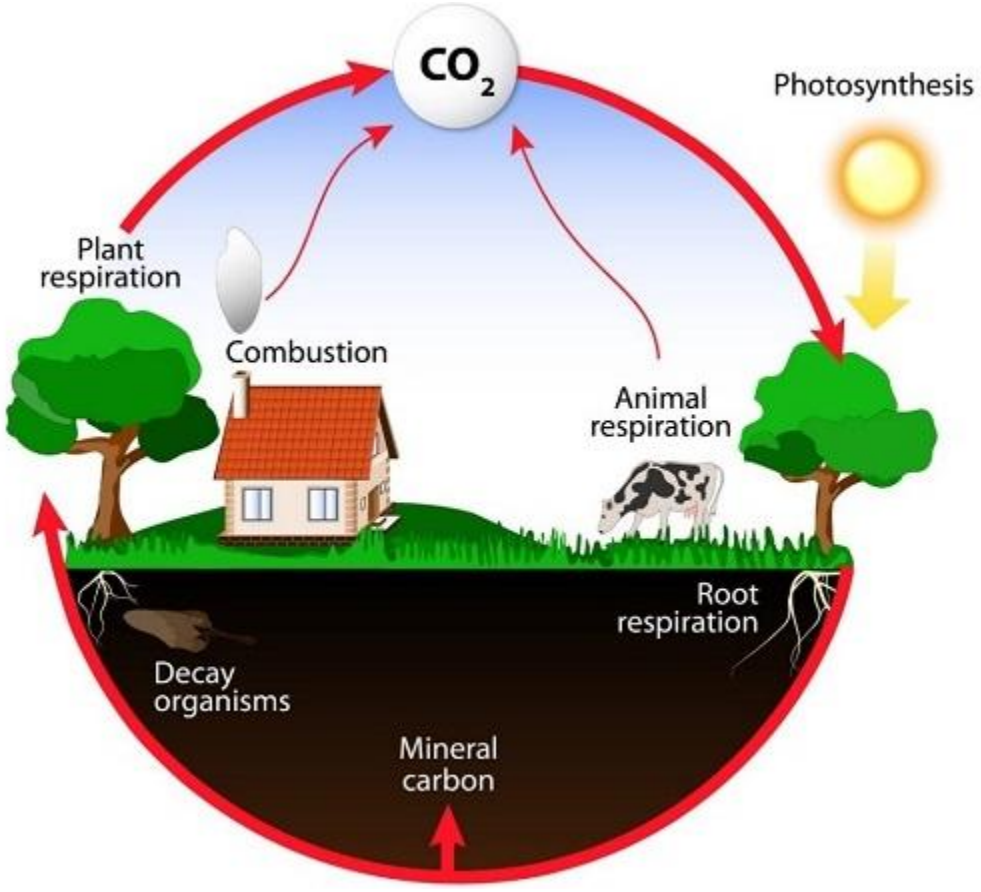
Following are some important biogeochemical cycles −

- Carbon Cycle
- Nitrogen Cycle
- Water Cycle

- Oxygen Cycle
- Phosphorus Cycle
- Sulphur Cycle

Carbon Cycle

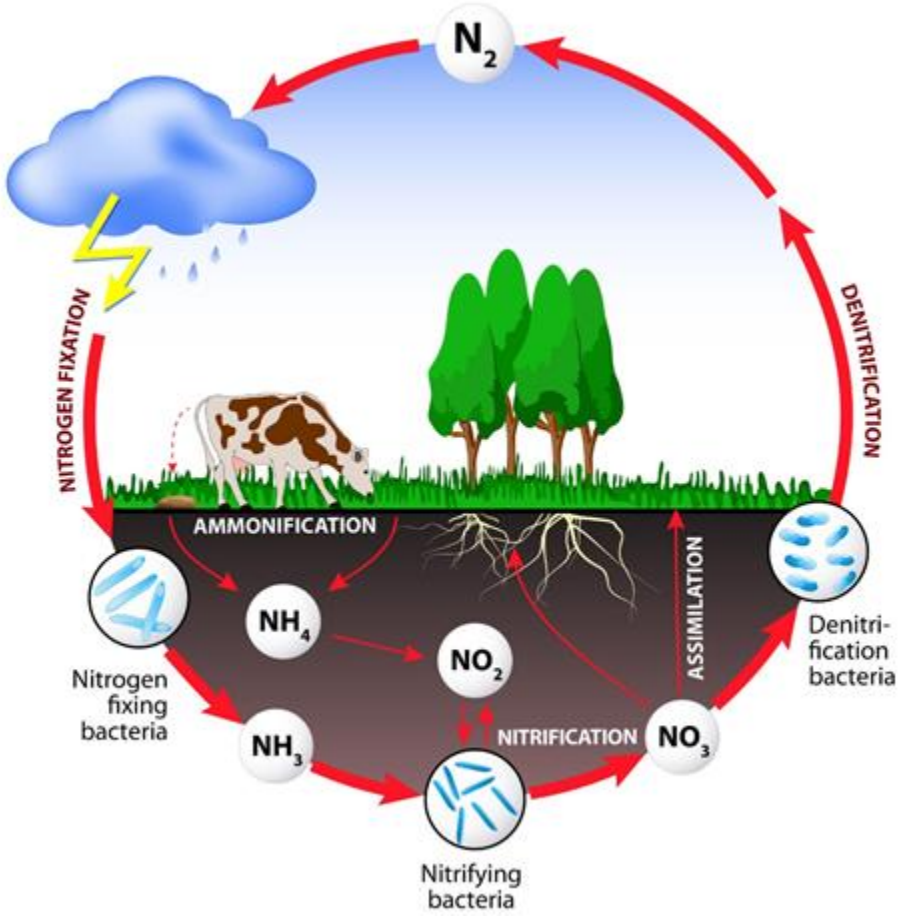
Carbon enters into the living world in the form of carbon dioxide through the process of photosynthesis as carbohydrates. These organic compounds (food) are then passed from the producers to the consumers (herbivores & carnivores). This carbon is finally returned to the surrounding medium by the process of respiration or decomposition of plants and animals by the decomposers. Carbon is also recycled during the burning of fossil fuels.



Nitrogen Cycle

Nitrogen is present in the atmosphere in an elemental form and as such it cannot be utilized by living organisms. This elemental form of nitrogen is converted into combined state with elements such as H, C, O by certain bacteria, so that it can be readily used by the plants.

Nitrogen is being continuously expelled into the air by the action of microorganisms such as denitrifying bacteria and finally returned to the cycle through the action of lightening and electrification.



Water Cycle

The evaporation of water from ocean, rivers, lakes, and transpiring plants takes water in the form of vapors to the atmosphere. This vaporized water subsequently cools and condenses to form cloud and water. This cooled water vapor ultimately returns to the earth as rain and snow, completing the cycle.

****

UNIT-2

Environmental Issues

One aspect of it could bring about development while the other side of the coin could be a detrimental effect. These unfavourable changes often lead to environmental issues that affect the natural balance of the environment.

We can define environmental issues as the harmful effects of any human activity on the environment. This includes both the biological and physical aspects of the environment. Air pollution, water pollution, natural environment pollution, garbage pollution etc. are some of the major environmental issues that are causing immense concern.

To tackle these environmental issues, protecting the environment is very vital. This not only helps in preventing the detrimental effects but also helps us to conserve the natural resources and natural environment for the future generations. Protection of the environment is not only a social movement but is also backed by various laws that have been passed to ensure that humans do not misuse the resources any longer.

Different Types of Environmental Issues

Some of the major environmental issues that are causing immense concern are environmental pollution, air pollution, water pollution, garbage pollution, noise pollution, deforestation, resource depletion, climate change etc. Most of these have resulted as a result of human overpopulation and also the indiscriminate of natural resources without conserving them.

Pollution and its Types

Pollution in all forms is a major environmental issue in India. Any undesirable change in the environment, air, water, land, soil, etc. can be termed as pollution. These changes could be in the physical, chemical or even biological changes. The agents that bring about or cause this pollution are called pollutants.

In India, there are many laws that help in curbing pollution. These laws are intended to protect the environment as well as improve its quality. One such act is the Environment (Protection) Act, 1986.

- ***Air Pollution –*** When the atmosphere is filled with toxic gases released as result of industrial or other economic activities, it results in polluting the atmosphere and the air in the environment. This is nothing but air pollution.
- ***Water Pollution –*** With the natural water resources depleting day by day, water is a scarce commodity. But, even in these times, the water sources are polluted by pollutants from various sources, making them unfit for human consumption.
- ***Garbage Pollution –*** When we do not adhere to proper waste disposal mechanisms, waste accumulates, causing garbage pollution. So the only way to address this issue is to ensure a proper waste disposal system that does not contaminate the environment.

Air Pollution

An undesirable change in the physical, chemical and biological characteristics of air that can cause harmful effects on humans and other living organisms is called air pollution. Some of the air pollutants include particulate pollutants such as dust particles, aerosols, soot, smoke etc. and gaseous pollutants such as carbon monoxide, nitrogen dioxide, sulfur dioxide etc.

Causes of Air Pollution

Some of the main causes of air pollution include the following:

- Decomposition of garbage that releases unwanted gases in the air.
- Excessive usage of fossil fuels that increases the particulate matter in the air.
- Smoke coming out from thermal power plants, forest fires etc.
- Usage of leaded petrol in automobiles.

Air Quality Index

Air Quality Index (AQI) is a quantitative measurement of air pollution. Governments and other environmental agencies use this index to track and keep check of the air quality of a region. It also helps us forecast how polluted the air is poised to become. The calculation takes into consideration five air pollutants, namely ground-level ozone, particulate pollution, carbon monoxide, sulphur dioxide and nitrogen dioxide.

Harmful Effects of Air Pollution

Air pollution has some serious side effects. It causes damage to the environment and also the health of the human population. Gases like carbon monoxide can cause headaches, asphyxia, giddiness, cardiovascular malfunction etc. Some gases in the air can trigger asthmatic attacks. Some other gases cause severe respiratory tract diseases like bronchitis and allergic reactions.

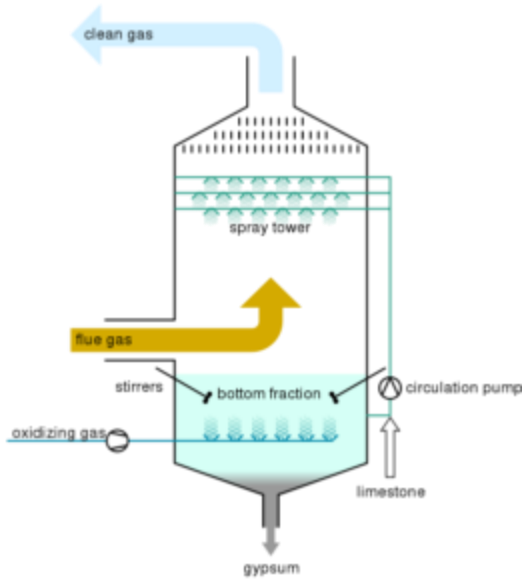
The fine particulate matter that is released by industries can cause breathing problems, damage to the lungs etc. Not only human beings are affected, even plants can be adversely affected by air pollution that results in their decreased growth and yield.

Measures to Control Air pollution

Industries release smoke and other harmful gases into the atmosphere. This causes the air quality index in the surrounding areas to be very poor. A bad air quality index indicates that air is not fit for breathing and can cause many unwanted problems. Therefore, the problem of air pollution has to be tackled at the root level.

Devices like the electrostatic precipitator and scrubber help in removing particulate matter and some harmful gases respectively. The use of electrostatic precipitator is one of the widely used ones to remove the particulate matter that get suspended in the air.

This is mostly used in thermal power plants where the particulate matter concentration is high in exhausts. This device has electrode wires that produce a corona to release electrons. When dust particles are released, these electrons attach to the dust particles, thus giving them a negative charge. There are collecting plates that are grounded, which attract these charged dust particles. The dust particulate matter is thus removed from the smoke coming out of exhausts in thermal power plants.



A ***scrubber*** is an apparatus that removes gases like Sulphur dioxide. In a scrubber, the exhaust goes through a spray of water or lime. This water dissolves the gases and with the reactions of lime and sulfur dioxide, precipitates are formed. Clean air then comes out, as it is now devoid of the harmful gases.

Usage of unleaded petrol in automobiles is also recommended. To reduce the emissions of poisonous gases like carbon monoxide and nitrogen dioxide, automobiles are also fitted with catalytic converters.

Water Pollution

Water pollution is an undesirable change in the water caused due to certain pollutants, which affects the activities of living organisms including humans. We know that water is a natural source that is too precious. We have to safeguard this precious source, whatever is remaining of it.

When humans dump everything and anything into the water bodies, they are damaging an important lifeline of all living organisms. They

must take measures to stop water pollution. In fact, the government of India has also passed an act under the *Prevention and Control of Pollution Act, 1974* to help safeguard the water resources.

Some of the common water pollutants are Industrial Effluents and Domestic Sewage, Pesticides, Fertilizers, Plankton blooms, Silt, Oils, etc. These cause immense harm to the water. When the causes of water pollution are tackled, we can reduce the effects of water pollution. There are some serious side effects of water pollution. Let us know more about them

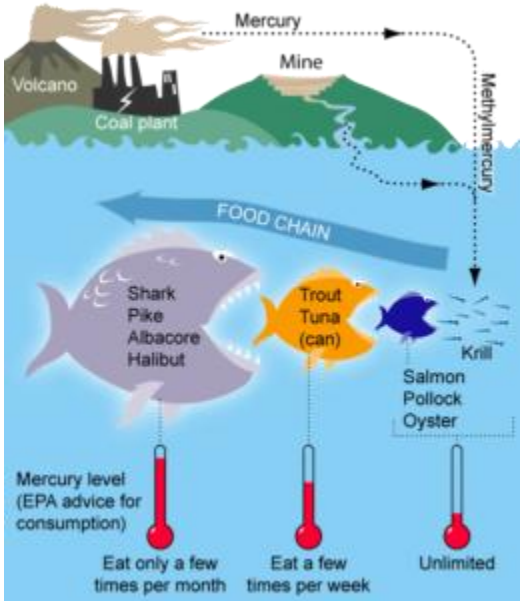
Effects of Water Pollution

Biomagnification

An increase in the concentration of toxicants or pollutants in different trophic levels is called biological magnification. At successive trophic levels, the levels of the toxicants keep on increasing. The most common example is the concentration of heavy metals like Mercury and the pesticide called DDT, in water.

When you look into the aquatic food chain, these toxic materials that are ingested by the organisms cannot be metabolized or excreted. And,

therefore they are passed on to the other trophic levels. Gradually as you go higher up the trophic levels, the concentration of these toxicants increases; thereby causing immense damage to the organisms. The concentration of DDT in fish-eating birds disturbs the calcium metabolism, thereby leading to thinner egg shells and a gradual decline in the bird population.



Eutrophication

The natural ageing of a water body like a lake due to nutrient enrichment is called eutrophication. Water in a young lake is cold and devoid of many nutrients. As other water bodies drain into it, they bring along nutrients and minerals like phosphorus, nitrogen etc. This increases in the population of organisms in the aquatic body.

With the deposition of the organic remains at the bottom of the lake, the water slowly becomes warmer. Floating plants also develop. This process slowly increases the conversion into the land. There are many factors like climate, size of the lake etc. that affect the natural ageing of the water body. But water pollutants from homes and industrial

effluents increase the rate at which this ageing occurs. This is accelerated or cultural eutrophication.

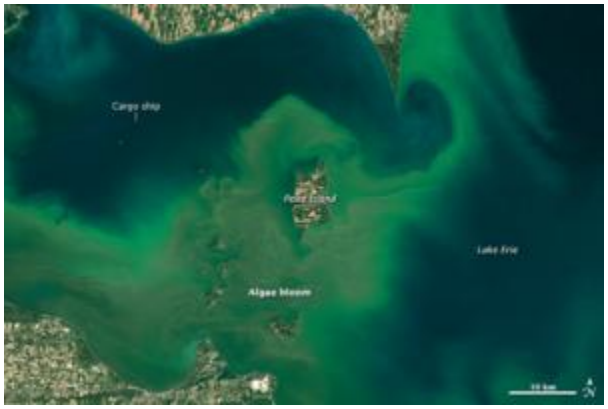
Biological Oxygen Demand (BOD)

It is also called as biochemical oxygen demand. BDO is the measure of oxygen that is used by the microorganisms to oxidize (decompose) the organic matter in water. It is very important because it is a parameter that shows the water quality. Any discharged wastewater or pollutants have an undesirable effect which increases the plant growth and decay in the aquatic body unnaturally.

The BOD is an index of the effects of the discharged wastewater. So, a higher BOD level means that there is a greater amount of organic matter available for the oxygen-consuming bacteria. This results in lesser dissolved oxygen for other living organisms, which may eventually lead to the decline of fish and other living aquatic creatures.

Excessive Algal Bloom

Excessive algal bloom is harmful. Some algae are toxic to human beings and living organisms. Large amounts of nutrients in the water are the main cause of harmful planktonic growth. They ultimately cause the deterioration of water quality along with the decline in fish population.



Noise Pollution

Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms. According to the World Health Organization, sound levels less than 70 dB are not damaging to living organisms, regardless of how long or consistent the exposure is. Exposure for more than 8 hours to constant noise beyond 85 dB may be hazardous. If you work for 8 hours daily in close proximity to a busy road or highway, you are very likely exposed to traffic noise pollution around 85dB.

This type of pollution is so omnipresent in today's society that we often fail to even notice it anymore:

- street traffic sounds from cars, buses, pedestrians, ambulances etc.
- construction sounds like drilling or other heavy machinery in operation
- airports, with constant elevated sounds from air traffic, i.e. planes taking off or landing
- workplace sounds, often common in open-space offices
- constant loud music in or near commercial venues
- industrial sounds like fans, generators, compressor, mills
- train stations traffic
- household sounds, from the television set to music playing on the stereo or computer, vacuum cleaners, fans and coolers, washing machines, dishwashers, lawnmowers etc.
- events involving fireworks, firecrackers, loudspeakers etc.
- conflicts generate noise pollution through explosions, gunfire etc. The dysfunctions, in this case, are likely caused by the conflict and insecurity and less by the noise pollution in itself, although that compounds stress levels too.

Human Diseases Caused by Noise Pollution

Whether we realize we are subjected to it or not, noise pollution can be hazardous to our health in various ways.

- **Hypertension** is, in this case, a direct result of noise pollution caused elevated blood levels for a longer period of time.

- **Hearing loss** can be directly caused by noise pollution, whether listening to loud music in your headphones or being exposed to loud drilling noises at work, heavy air or land traffic, or separate incidents in which noise levels reach dangerous intervals, such as around140 dB for adult or 120 dB for children.
- **Sleep disturbances** are usually caused by constant air or land traffic at night, and they are a serious condition in that they can affect everyday performance and lead to serious diseases.
- **Child development**. Children appear to be more sensitive to noise pollution, and a number of noise-pollution-related diseases and dysfunctions are known to affect children, from hearing impairment to psychological and physical effects. Also, children who regularly use music players at high volumes are at risk of developing hearing dysfunctions. In 2001, it was estimated that 12.5% of American children between the ages of 6 to 19 years had impaired hearing in one or both ears
- Various **cardiovascular dysfunctions**. Elevated blood pressure caused by noise pollution, especially during the night, can lead to various cardiovascular diseases.
- **Dementia** isn't necessarily caused by noise pollution, but its onset can be favored or compounded by noise pollution.
- **Psychological dysfunctions** and noise annoyance. Noise annoyance is, in fact, a recognized name for an emotional reaction that can have an immediate impact.

Effects of Noise Pollution on Wildlife and Marine Life

Our oceans are no longer quiet. Thousands of oil drills, sonars, seismic survey devices, coastal recreational watercraft and shipping vessels are now populating our waters, and that is a serious cause of noise pollution for marine life. Whales are among the most affected, as their hearing helps them orient themselves, feed and communicate. Noise pollution thus interferes with cetaceans' (whales and dolphins) feeding habits, reproductive patterns and migration routes, and can even cause hemorrhage and death.

Other than marine life, land animals are also affected by noise pollution in the form of traffic, firecrackers etc., and birds are especially affected by the increased air traffic.

Social and Economic Costs of Noise Pollution

The World Health Organization estimates that one out of three people in Europe is harmed by traffic noise. More than the purely medical effects of noise pollution on the individual, there is a significant social and economic impact. Since noise pollution leads to sleep disturbance, it affects the individual's work performance during the day, it leads to hypertension and cardiovascular disease and costs the health system additional time and money, and it negatively affects school performance in children.

Tips for Avoiding Noise Pollution

- Wear earplugs whenever exposed to elevated noise levels
- Maintain a level of around 35 dB in your bedroom at night, and around 40 dB in your house during the day
- If possible, choose your residential area as far removed from heavy traffic as you can
- Avoid prolonged use of earphones, especially at elevated sound levels
- If possible, avoid jobs with regular exposure to elevated sound levels

Thermal Pollution:-

The Main Cause of Thermal Pollution:

Many human and natural factors contribute to the problem of thermal pollution. The single biggest cause of thermal pollution is probably cooling for industrial machinery and power plants. Water is an excellent, and free, cooling agent. This is why many industrial operations pull in relatively cool water to cool their machinery and let the relatively warm water flow back into the river or lake or sea.

Thermal pollution also has some natural causes. Geothermal vents and hot springs introduce excess heat into bodies of water. Soil erosion, deforestation, and runoff from paved areas are other artificial sources of hot water. Deforestation eliminates shade, which exposes the water to sunlight. Water on hot paved surfaces gets hot, then runs off into nearby bodies of water, raising the water temperature. Retention ponds can also be a source of thermal shock because the relatively small and shallow bodies of water can absorb quite a bit of heat energy from the sun.

Pumping that water directly into a river, lake, or bay causes a significant temperature increase, just like pouring a hot pitcher of water into a bathtub full of water causes the water to jump a few degrees Fahrenheit.

The Effects of Thermal Pollution:

The effects of thermal pollution are diverse, but in short, thermal pollution damages water ecosystems and reduces animal populations. Plant species, algae, bacteria, and multi-celled animals all respond differently to significant temperature changes. Organisms that cannot adapt can die of various causes or can be forced out of the area. Reproductive problems can further reduce the diversity of life in the polluted area.

However, thermal pollution can be beneficial to some species. Bacteria and algae tend to benefit from the excess heat. Some larger animals also benefit from the warmer water. In Florida, manatees spend the winter near power plants, where the cooling water they use warms up the shallow salt water. On balance, thermal pollution is a negative force for many reasons.

***Decreased Dissolved Oxygen: ***

Warm water holds less oxygen than cool water. If the oxygen level drops animals that cannot move to another area may begin to die. In deeper bodies of water, the injection of warm water can keep oxygen from dispersing into deep water, which is potentially good for bacteria but dangerous for aquatic animals. The decreased oxygen can cause algae blooms that pose a threat to aquatic plants and animals. This algae bloom problem is probably the most common and best-known side effect of thermal pollution.

Migration:

Fish and amphibians may move away from the warm water to a more-suitable location, disrupting the ecosystem for animals that remain. Birds may also be forced to leave in search of areas with more food. Plants and certain animals will be stuck in the area, which can lead to huge losses. Migration away from the polluted area

contributes to a dramatic loss of biodiversity at sites where thermal pollution happens.

Increased Toxins:

Toxins in the water are more a side effect of dumping waste water than a direct effect of thermal pollution. Chemical pollution is an almost inevitable side effect of using water for cooling. Solvents, fuel oil, and dissolved heavy metals end up in the lake or river where the cooling water gets dumped. Nuclear power plants can also release slightly radioactive cooling water. The chemicals may have a range of toxic effects on plants and animals, from fatal poisoning to mutations and sterilization.

Loss of Biodiversity:

The sudden heating can kill off vulnerable organisms or drive them away. This is one of many serious issues for threatened and endangered animal species. This loss can come from organisms dying from the hot water, being unable to reproduce as effectively as before, or simply leaving the area. We usually think of animals as casualties of water pollution, but multi-celled aquatic plants are also at risk when thermal pollution changes the local aquatic ecosystem.

Ecological Impacts:

The local aquatic ecosystem can be damaged by thermal pollution, especially if it is dramatic, as in copious amounts of warm water being dumped into a chilly pond or bay or river. “Thermal shock” can kill off insects, fish, and amphibians. This sudden loss of life causes further issues with the ecosystem. Key food sources are no longer adequate. A threatened or endangered local population may be wiped out or put under even more pressure. Coral reef bleaching has also been observed when a power plant or factory is dumped into coastal water. Coral bleaching happens when the coral organisms die.

Reproductive Effects:

A significant temperature increase in the water can cause reproductive problems. Warmer water can reduce the fertility of some organisms. Other species may suffer birth defects or lay deformed eggs because of chemical changes in the body caused by warmer water. Defective eggs and birth defects hurt the overall reproductive fitness of the animal population and can reduce the population. Thermal pollution can change the biology of aquatic organisms in a variety of ways.

Increased Metabolic Rate:

Warmer water may be good for cold-blooded fish and amphibians, but only for a limited time. One of many real problems that warm water may cause is faster metabolism, which means animals need more food. The local ecosystem may not be able to support a significant increase in food consumption. Worse still, the warmer water gives an advantage to certain organisms while it puts stress on others. The more-adaptable organisms may unbalance the ecosystem simply by out-competing other organisms and by eating them or driving them to starvation.

Population Explosion in India

In term of population, India stands second in world which neutralizes whatever economic progress the country makes and lowers the per capita income.

So to raise the economic standard of the country, the birth rate should be lowered. Let us discuss some important reasons for high population growth in India.

(i) The large size of the population (58%) are in the reproductive age group.

(ii) About 50% of the girls marry too early i.e., below the Legal age of marriage (below the age of 18).

(iii) The population explosion in due to unmet need for contraception. So urgent steps should be taken to make contraception more widely available, accessible and affordable.

(iv) The high birth rate may be due to high infant mortality rate.

(v) The people residing in rural and remote areas are mostly poor and illiterate. The sexual relation is one of their main source of enjoyment which results in high birth rate in rural areas.

(vi) Because of illiteracy and ignorance, the rural peoples do not adopt family welfare programmes easily.

Family, welfare programme:

To reduce the birth rate to the extent necessary for the stabilization of the population, the national Family Welfare Programme was launched in India in 1951. The objective of the programme is to promote responsible and Planned Parenthood through voluntary and free choice of family planning methods, best suited to individual acceptors.

Attempts are also made to involve local self government including voluntary organizations (HQO) and opinion leaders to promote the programme. The mass media (AIR, Television etc.) and interpersonal communications are used for highlighting the benefit of small family norm and removal of socio-cultural barriers for the adoption of family limitation programmes.

The family welfare programme is given top priority by the constitution of India. During first and second five year plans, clinical approach was adopted but subsequently (after 1961), this approach was replaced by “Extension and Education approach which emphasized expansion of service facilities along with spread of message of small family norm.

In rural areas, the family welfare programme is implemented through primary health centres (PHCs), community health centres (CHCs) etc. In urban areas, the programme is operated through hospitals and dispensaries. By adopting national family.

Welfare programme, India has achieved the following targets:
(i) The crude birth rate has been reduced from 40.8 (1951) to 26.4 (1998, SRS).

(ii) The infant mortality rate has been reduced from 146 per 1000 live births (1951) to 72 per 1000 live births (1998).

(iii) The death rate has been reduced from 25% (1951) to 9.0% (1998, SRS)

(iv) The life expectancy has been raised from 37 years to 62 years.

(v) The need for and methods of family planning have given wide publicity.

(vi) The total fertility rate has been reduced from 6.0 (1951) to 3.3 (1997, SRS).

Population variation among nations:

About 20 of the available land area is conducive to human settlement. Most of the population prefer to live in coastal areas and river basin. As per statistics, about 40% of world's population resides with in 100 km of the coast.

About 99% of all population increase is seen in developing countries while population size is either static or declining in industrial nations. Amongst the major, industrial nations only USA has significant population growth mainly due to immigration.

The population status of ten most populous countries in the world is shown in the table given below:

Table 13.1: Population Status Op Ten Most Populous Countries During 2004

Rank	Name of Country	Population in millions
1.	China	1300
2.	India	1087
3.	USA	294
4.	Indonesia	219
5.	Brazil	179
6.	Pakistan	159

7.	Russia	144
8.	Bangladesh	141
9.	Nigeria	137
10.	Japan	128

The average crude birth rate and death rate during 2002 is shown in table given below:

Table 13.2: Average Crude Birth Rate and Death Rates in Different Parts of World During 2002.

Sl. No.	Area	Crude Birth Rate	Crude Death Rate
1.	World	21	09
2.	Industrial Countries	11	10
3.	Developing Countries	24	08
4.	Africa	38	14
5.	Latin America	23	06
6.	Asia	20	07
7.	north America	14	09
8.	Europe	10	11

Environment and Human Health

Environment and Human Health Explained

The interconnectedness of life on earth means that nothing we put into the ecosystem simply disappears. **In other words, what we do to the planet, we do to ourselves.** Pollutants reach humans through the food we eat, the water we drink, and the air we breathe and endanger our health in both immediate and long-lasting ways. Outdoor air pollution alone is associated with more than one million deaths and countless illnesses each year across the globe. Children and the elderly – the most vulnerable members of our society – are especially susceptible to toxins like mercury and pesticides.

Why Environmental Health Matters

Food

Pesticides and other chemicals used in food production don't disappear when they hit the store shelves: they go directly into the food we eat. Not only do these modern additives degrade the soil quality of our farmland and harm the pollinators that help grow our food, they can lead to cancer and antibiotic resistance in the people who eat them. **Of the more than 80,000 chemicals currently used in the United States, most haven't been adequately tested for their effects on human health**.

Water

The human body is mostly water – up to 70% water, in fact. Add that to the reality that only 2.5% of water on the planet is drinkable and it becomes clear why protecting our water supply is so important. Although the Clean Water and Safe Drinking Water Acts are meant to keep toxins out of our water, many still slip by both our policy safeguards and our physical filtration systems. Currently, many of the protections America put in place to ensure clean, safe water **are under threat**. Fracking for natural gas, which has contaminated groundwater, has led to health problems in communities where those resources are being extracted. Polluted runoff from cities and farms flows into the rivers we draw much of our drinking water from and ends up in our bodies.

Air

Motor vehicle and industrial emissions impact human health too, as these sources contain dangerous pollutants like mercury and sulfur dioxide. The American Lung Association found that **too many Americans live in areas that have unhealthy levels of air pollution**and are at risk of illnesses like lung and heart disease, cancer, and asthma. Rising global temperatures from climate change worsen pollution. Indoor air can be dangerous as well, given the presence of chemicals from building materials, household products and mold. Illnesses caused by air

pollution keep children out of school and adults out of work and lead to an estimated 35,700 premature deaths in the U.S. per year.

Cleaning – general procedures

Cleaning is important for infection control – particularly in work areas – because deposits of dust, soil and microbes on surfaces can transmit infection. Contaminated areas such as operating rooms or isolation rooms must be cleaned after each session, and spot cleaned after each case or thoroughly cleaned as necessary.

The following basic principles should be followed:

- written cleaning protocols should be prepared, including methods and frequency of cleaning; protocols should include policies for the supply of all cleaning and disinfectant products
- standard precautions (including wearing of personal protective equipment [PPE], as applicable) should be implemented when cleaning surfaces and facilities (see 'Standard and additional precautions')
- cleaning methods should avoid generation of aerosols
- all cleaning items should be changed after each use and cleaned and dried before being used again. They should also be changed immediately following the cleaning of blood or body fluid/substance spills. Single-use cleaning items are preferred, where possible, such as lint-free cleaning cloths
- sprays should not be used, because they can become contaminated and are difficult to clean. Sprays are not effective, as they do not touch all parts of the surface to be cleaned
- detergents should not be mixed with other chemicals
- all cleaning solutions should be prepared fresh before use.

Cleaning – specific procedures

Surface cleaning

Floors in hospitals and day-care facilities should be cleaned daily or, as necessary, with a vacuum cleaner fitted with a particulate-retaining filter. The filter should be changed in accordance with the manufacturer's instructions.

The exhaust air should be directed away from the floor to avoid dust dispersal.

A ducted vacuum cleaning system can also be used, as long as safe venting of the exhaust air is ensured.

Damp dusting using a lint-free cloth is essential. Brooms disperse dust and bacteria into the air, and should not be used in patient or clinical areas. Dust-retaining mops, which are specially treated or manufactured to attract and retain dust particles, do not increase airborne counts as much as ordinary brooms and remove more dust from surfaces. However, brooms and dust-retaining mops should not be used in clinical areas where there is a high risk of infection associated with dust (for example, burns units).

The procedure for routine surface cleaning is as follows:

- All cleaning solutions should be prepared immediately before use.
- Work surfaces should be cleaned (wiped over) with a neutral detergent and warm water solution, rinsed and dried before and after each session, or when visibly soiled. Spills should be cleaned up as soon as practical.
- When a disinfectant is required for surface cleaning, the manufacturer's recommendations for use, and workplace health and safety instructions should be followed.
- Buckets should be emptied after use, washed with detergent and warm water, rinsed in hot water and stored dry (turned upside down).
- Mops should be laundered or cleaned in detergent and warm water, rinsed in hot water, then stored dry. Mop heads should be detachable or stored with the mop head up.

Specialised areas

Isolation rooms and ensuite bathrooms should be cleaned at least twice daily, depending on the type of microorganism.

Operating rooms and day procedure rooms, including endoscopy rooms, should be cleaned after each operating session and when visibly soiled. Thorough cleaning of the operating suite should be performed daily in addition to the cleaning performed after each operating session.

Obstetric areas, particularly delivery suites, should be cleaned after each delivery, when visibly soiled and at least daily.

Oncology areas should be cleaned twice daily.

Sterilising processing departments should be cleaned at least twice daily and when visibly soiled.

Wet areas

The following should be cleaned at least daily and more frequently as required:

- toilets, sinks, washbasins, baths and shower cubicles
- all fittings attached to showers, baths and handbasins
- surrounding floor and wall areas.

Walls and fittings

Walls and screens should be cleaned quarterly or if visibly soiled.

Blinds and curtains should be cleaned quarterly or if visibly soiled.

Carpets should be vacuumed daily and other floor surfaces washed daily and when soiled.

Bed and examination screens should be changed weekly and when visibly soiled.

Cleaning Creutzfeldt-Jakob disease infectious agents

Spills of central nervous system tissue or cerebrospinal fluid should be absorbed with paper towels and disposed of by incineration. The surface should then be soaked with one molar sodium hydroxide or 2.0–2.5 per cent sodium hypochlorite, left for 1 hour and cleaned again with paper towels that are disposed of by incineration.

Cleaning other infectious disease agents

Spills of blood or other body fluids and tissues should be cleaned using standard spills management procedures. PPE used when cleaning contaminated surfaces should be incinerated after use. Reusable eye protection should be cleaned as above.

Maintenance of cleaning equipment

Cleaning items (including solutions, water, buckets, cleaning cloths and mop heads) should be changed after each use. They should also be changed immediately following the cleaning of blood or body substance spills.

These items should be washed in detergent and warm water, rinsed and stored dry between uses. Mops with detachable heads should be laundered between uses.

Spills of laboratory cultures of human pathogens

Spills of laboratory cultures should be absorbed with paper towels and disposed of as clinical waste. The contaminated surfaces should be treated with 2.0–2.5 per cent sodium hypochlorite, left for 1 hour and cleaned again with paper towels that are disposed of as clinical waste.

Laboratories should also refer to *AS/NZS 2243.3:2002: Safety in laboratories – microbiological aspects and containment facilities*.

Waste disposal

All healthcare facilities should have policies and procedures in place for the correct management of all waste generated. The Environmental Protection Authority (EPA) has clear guidelines on how waste should be managed. The National Health and Medical Research Council (NHMRC) also has guidelines on the management of waste generated in healthcare facilities.

Waste is classified into three main groups of waste:

- general
- clinical
- pharmaceutical.

All waste should be stored in secure areas until collected. Waste disposal companies licensed with the EPA will collect all clinical and pharmaceutical waste for disposal in specialised waste disposal facilities, which are also licensed by the EPA.

Waste should be removed from clinical areas at least three times each day and more frequently as needed, such as from specialised areas. Waste bags should be tied before removing from the area.

General waste disposal

Place in general waste bin for removal.

Clinical waste disposal

Place in biohazard bags as soon as possible. Biohazard bags have a biohazard symbol and are currently coloured yellow.

Single-use sharps should be placed (by the user) into a sharps container that meets the Australian and New Zealand Standards AS 4031:1992 and AS/NZS 4261:1994.

Pharmaceutical waste disposal

When uncertain about how to dispose of leftover pharmaceuticals, they should be returned to pharmacy for correct disposal.

Most disinfectants can be disposed of through the sewer system by running cold water into the sink before pouring the disinfectant into the sink. Leaving the cold water running for a few moments after the disinfectant has been disposed of dilutes the disinfectant.

****

Referenes:-

https://www.toppr.com/
https://www.environmentalpollutioncenters.org/
https://blog.arcadiapower.com/
http://www.environmentalpollution.in/
https://www.earthshare.org/health/
https://www2.health.vic.gov.au/

UNIT-3

Water Resources

Water is a vital elixir for all living beings. Although it is a renewable resource, scarcity of quality water is felt in many parts of the world. We need water to grow food, keep clean, generate electricity, control fire, and last but not the least, we need it to stay alive.

World Ocean water covers about 75 percent of the surface of the earth. Therefore, the earth is called the water planet. Ocean water is saline and not fit for human consumption. Fresh water is just about 2.7 percent of the total water. Global warming and perpetuating water pollution have made a considerable part of available freshwater unfit for human consumption. As a result, water is very scarce.

Steps need to be taken to conserve water. Water is renewable, but its overuse and pollution make it unfit for use. Sewage, industrial use, chemicals, etc. pollute water with nitrates, metals, and pesticides.

Use of Water Resources

Water resources are used for agricultural, industrial, domestic, recreational, and environmental activities. Majority of the uses require fresh water.

However, about 97 percent of water found on the earth is salt water and only three percent is fresh water. A little over two-thirds of the available fresh water is frozen in glaciers and polar ice caps. The remaining freshwater is found mainly as groundwater and a negligible portion of it is present on the ground or in the air.

Following is a brief account of how water is used in different sectors.

Agricultural Use

Agriculture accounts for 69 percent of all water consumption basically in agricultural economies like India. Agriculture, therefore, is the largest consumer of the Earth’s available freshwater.

By 2050, the global water demand of agriculture is estimated to increase by a further 19% due to irrigational needs. Expanding irrigation needs are likely to put undue pressure on water storage. It is still inconclusive whether further expansion of irrigation, as well as additional water withdrawals from rivers and groundwater, will be possible in future.

Industrial Use

Water is the lifeblood of the industry. It is used as a raw material coolant, a solvent, a transport agent, and as a source of energy. Manufacturing industries account for a considerable share in the total industrial water consumption. Besides, paper and allied products, chemicals and primary metals are major industrial users of water.

Worldwide, the industry accounts for 19 percent of total consumption. In industrialized countries, however, industries use more than half of the water available for human use.

Domestic Use

It includes drinking, cleaning, personal hygiene, garden care, cooking, washing of clothes, dishes, vehicles, etc. Since the end of World War II there has been a trend of people moving out of the countryside to the ever-expanding cities. This trend has important implications on our water resources.

Government and communities have had to start building large water-supply systems to deliver water to new populations and industries. Of all water consumption in the world, domestic use accounts for about 12 percent.

Use for Hydropower Generation

Electricity produced from water is hydropower. Hydropower is the leading renewable source of electricity in the world. It accounts for about 16 percent of total electricity generation globally. There are many opportunities for hydropower development throughout the world.

Today, the leading hydropower generating countries are China, the US, Brazil, Canada, India, and Russia.

Use for Navigation and Recreation

Navigable waterways are defined as watercourses that have been or may be used for transport of interstate or foreign commerce. Agricultural and commercial goods are moved on water on a large scale in a number of regions in the world.

Water is also used for recreational purposes such as boating, swimming, and sporting activities. These uses affect the quality of water and pollute it. Highest priority should be given to public health and drinking water quality while permitting such activities in reservoirs, lakes, and rivers.

Overutilization of Surface and Ground Water

Water scarcity has become a burning global issue. The UN has held several conventions on water in recent decades. Continuous overutilization of surface and ground water has led to virtual water scarcity in the world today.

The depleting sources for high growth in human population over the centuries and increased man-induced water pollution across the world have created unforeseen water scarcity around the globe. As a result, there has been continuous overutilization of the existing water sources due to mammoth growth in world population.

Groundwater is the major source of water in many parts of the world. However, there has been continuous depletion of this source due to its overexploitation by rising human population and the rapid rise in industrialization and urbanization in modern times.

Consequences of Overutilization

Water scarcity now becomes an important topic in international diplomacy. From village to the United Nations, water scarcity is a widely-discussed topic in decision making.

Nearly three billion people in the world suffer from water scarcity. International, intrastate and regional rivalries on water are not new to world. The ongoing Jordan River conflict, Nile River conflict, and Aral Sea conflict are cases in point. The intra-state issues such as Cauvery Water dispute in South India, 2000 Cochabamba protests in Bolivia is still a

simmering cauldron causing periodic tension at the national and regional levels.

According to World Health Organization (WHO) sources, a combination of rising global population, economic growth and climate change means that by 2050 five billion (52%) of the world's projected 9.7 billion people will live in areas where fresh water supply is under pressure. Researchers expect about 1 billion more people to be living in areas where water demand exceeds surface-water supply.

Climate Change

Scientists, environmentalists, and biologists worldwide are now alarmed that climate change can have an impact on the drainage pattern and hydrological cycle on the earth thereby severely affecting the surface and groundwater availability.

Climate change is believed to rise the global temperature at an increasing pace. Temperature increase affects the hydrological cycle by directly increasing evaporation of available surface water and vegetation transpiration.

As a result, precipitation amount, timing and intensity rates are largely affected. It impacts the flux and storage of water in surface and subsurface reservoirs.

Floods & Draughts

Floods and droughts are two well-known natural hazards in the world. The former is due to excess in water flow and the latter is due to scarcity of water.

The amount of rainfall received by an area varies from one place to another depending on the location of the place. In some places it rains almost throughout the year whereas in other places it might rain for only few days. India records most of its rainfall in the monsoon season.

Heavy rains lead to rise in the water level of rivers, seas, and oceans. Water gets accumulated in the coastal areas, which results in floods. Floods bring in extensive damage to crops, domestic animals, property and human life.

During floods, many animals get carried away by the force of water and eventually die.

On the other hand, droughts set in when a particular region goes without rain for a long period of time. In the meantime, the soil will continuously lose groundwater by the process of evaporation and transpiration. Since this water is not brought back to earth in the form of rains, the soil becomes very dry.

The level of water in the ponds and rivers goes down and in some cases water bodies get dried up completely. Ground water becomes scarce and this leads to droughts. In drought conditions, it is very difficult to get food and fodder for the survival. Life gets difficult and many animals perish in such conditions.

Frequent floods and droughts are mostly due to climate change and global warming. Various environmental organizations world over are of the view that climate change is a long-term change in weather patterns, either in average weather conditions or in the distribution of extreme weather events.

Natural Resources

Resources obtained from nature, i.e. from the earth are called **natural resources**. These resources occur naturally, and humans cannot make them. The raw materials used in artificial or man-made resources are natural resources.

Classification of Natural Resources

Classification of natural resources can be done in several ways based on their origin, level of development and uses, stock or deposits, and their distribution.

On the basis of their origin, natural resources can be classified into living or biotic and non-living or abiotic resources.

Living or Biotic Resources

If natural resources come from living things or organic materials, they are termed as living or biotic resources. Biotic resources include plants, animals

and fossil fuels. Fossil fuels such as coal, oil and natural gas are classified as biotic resources as they are formed from the decay of organic matter over millions of years.

Non-living or Abiotic Resources

On the other hand, if the resources are derived from nonliving or inorganic materials, they are termed as abiotic resources. For instance, air, sunlight, and water are abiotic natural resources. Minerals are also considered abiotic.

On the basis of deposit or stock, natural resources can be classified as renewable and non-renewable.

Renewable Natural Resources

Resources that can be used without any risk of its ending up are called renewable resources. They exist in unlimited quantity. Sun, water, wind, biomass, tides, geothermal energy, etc. are renewable resources. These are infinite sources of energy.

Non-renewable Natural Resources

Those natural resources, on the other hand, that cannot be replenished after their depletion is called non-renewable resources. Most fossil fuels, such as coal, petroleum and natural gas are considered nonrenewable resources. Nonrenewable resources take billions of years for their formation, hence, their cautious and economic use is the only option left for mankind.

On the basis of development of resources, natural resources can be classified as **actual** and **potential resources**.

Actual Resources

An actual resource is one which is used in current times. We know their approximate quantity, for example: coal deposit.

Potential Resources

A potential resource is one whose utility is not known at present or is not used despite having the same. Instead, it may be useful at some time in future. In other words, such resources have the potential to have utility,

although it does not have any today. For example, uranium deposit in Ladakh in India.

Land Resources

Land is a naturally occurring finite resource. It provides the base for survival of living beings. It holds everything that constitutes terrestrial ecosystems. Increased demand on land in modern times due to the rise in human population and resultant activities has resulted in degradation of land quality and quantity, decline in crop production, and competition for land.

Land and Land Resources refer to a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near-surface climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes and swamps), the near-surface sedimentary layers and associated groundwater and geo-hydrological reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc.)

Forest Resources

Forests are the dominant terrestrial ecosystem of Earth, and are distributed across the globe. Forests account for 75% of the gross primary productivity of the Earth's biosphere, and contains 80% of the Earth's plant biomass.

A forest constitutes many components that can be broadly divided into two categories that are biotic (living) and abiotic (non-living) components. Forest is made up of many layers such as forest floor, understory, canopy, and emergent layer.

Forests can be classified in various ways such as Boreal, Temperate, Tropical types with their numerous subtypes. Due to increasing population and consequential expansion of modern civilization, there has been continuous depletion of natural forests over the centuries.

In 1990, the world had 4128 million ha of forest; by 2015 this area had decreased to 3999 million ha. This is a change from 31.6 percent of global

land area in 1990 to 30.6 percent in 2015. Average per capita forest area declined from 0.8 ha to 0.6 ha per person from 1990 to 2015.

Over the past 25 years, global carbon stocks in forest biomass have decreased by almost 11 gigatonnes (Gt). This reduction has been mainly driven by conversion to other land uses and to a lesser extent by forest degradation.

Usefulness of Forest Resources

- Forest is an important natural resource. Forests are vital for the ecological balance and play an important role in temperature regulation in the atmosphere.
- Forests are natural and vast reservoir of food and shelter for animals. They provide natural habitats for numerous species of plants, animals and micro-organisms.
- Forests provide timber, bamboo, canes, leaves, grass, oil, resins, gums, shellac, tanning materials, dyes, hides, fur, fruits, nuts, roots, tubers and other useful things for human beings.
- Forests provide raw materials for forest-based industries.
- Forests are the natural home to medicinal herbs and plants.
- Forest directly or indirectly affects the climate (temperature, precipitation, moisture, underground water-table).
- Forests prevent floods and soil erosion, land degradation and improve the quality of air and water.
- Forests help in purifying air, water, and soil pollution.

Mineral Resources

Minerals are naturally occurring elements or compounds that have been formed through slow inorganic processes. Modern civilization is based on the use and exploitation of mineral resources. Minerals can be metallic and non-metallic.

Minerals are not evenly distributed in the Earth. Some countries are rich in mineral deposits whereas others are devoid of it.

Use of mineral resources is an integral part and one of the key premises of development worldwide. With rapid increase in population and a more rapid increase in society's development needs, the requirements for minerals have grown and diversified manifold.

Extraction of minerals is carried out through mining. Minerals are extracted from beneath the surface, processed, and used for different purposes.

Mineral resources, however, are exhaustible and finite, which means excessive use may affect their availability in the future.

Exploitation of Mineral Resources

Exploitation of mineral refers to the use of mineral resources for economic growth. Exploitation of mineral resources at a mindless speed to meet the growing needs of modern civilization has resulted in many environmental problems.

Although, the exploitation of minerals began at a slow pace during the industrial revolution in Western countries, during the 20^{th} century, the exploitation of some minerals, especially the fossil fuels increased exponentially to meet the growing energy need. Today, about 80% of the world's energy consumption is sustained by the extraction of fossil fuels, which consists of oil, coal, and gas.

Consequences of Exploitation of Mineral Resources.

Excessive exploitation of mineral resources has led to the following severe problems.

- Deforestation and desertification
- Extinction of species
- Rapid depletion of high grade minerals
- Forced migration
- Wastage of upper soil layer and vegetation
- Soil erosion and oil depletion
- Ozone depletion
- Greenhouse gas increase

- Environmental pollution
- Natural hazards, etc.

Energy Resources

Energy is defined by physicists as the capacity to do work. Energy is found on our planet in a variety of forms, some of which are immediately useful to do work, while others require a process of transformation. The sun is the primary energy source in our lives. Besides, water, fossil fuels such as coal, petroleum products, water, nuclear power plants are sources of energy.

Growing Energy Needs

Energy has always been closely linked to man's economic growth and development. Present strategies for development that have focused on rapid economic growth have used energy utilization as an index of economic development. This index, however, does not take into account the long-term ill effects on society of excessive energy utilization.

For almost 200 years, coal was the primary energy source fueling the industrial revolution in the 19th century. At the close of the 20th century, oil accounted for 39% of the world's commercial energy consumption, followed by coal (24%) and natural gas (24%), while nuclear (7%) and hydro/renewable (6%) accounted for the rest.

Industrialization, urbanization, and unbelievable rise in human settlements have multiplied the energy requirement by several times. Modern lifestyle and man's growing dependence on machines and equipment for his personal and professional work has added to the energy demand. Global oil demand continues to grow until 2040, mostly because of the lack of easy alternatives to oil in road freight, aviation and petrochemicals, according to WEO-2016, published by International Energy Agency.

Renewable Energy Resources

Renewable energy systems use resources that are constantly replaced and are usually less polluting. Examples include hydropower, solar, wind, and geothermal (energy from the heat inside the earth). We also get renewable energy from burning trees and even garbage as fuel and processing other plants into bio-fuels.

Wind Energy

The moving air or wind has huge amounts of kinetic energy, and it can be transferred into electrical energy using wind turbines. The wind moves the blades, which spins a shaft, which is further connected to a generator, which generates electricity. An average wind speed of 14 miles per hour is needed to convert wind energy into electricity. Windgenerated electricity met nearly 4% of global electricity demand in 2015, with nearly 63 GW of new wind power capacity installed.

Solar Energy

Solar energy is the light and heat procured from the sun. It is harnessed using an everevolving technologies. In 2014, global solar generation was 186 terawatt-hours, slightly less than 1% of the world's total grid electricity. Italy has the largest proportion of solar electricity in the world. In the opinion of International Energy Agency, the development of affordable, inexhaustible, and clean solar energy technologies will have longer-term benefits.

Biomass Energy

When a log is burned we are using biomass energy. As plants and trees depend on sunlight to grow, biomass energy is a form of stored solar energy. Although wood is the largest source of biomass energy, agricultural waste, sugarcane wastes, and other farm byproducts are also used to produce energy.

Hydropower

Energy produced from water is called hydropower. Hydroelectric power stations both big and small are set up to produce electricity in many parts of the world. Hydropower is produced in 150 countries, with the Asia-Pacific region generating 32 percent of global hydropower in 2010. In 2015, hydropower generated 16.6% of the world's total electricity and 70% of all renewable electricity.

Tidal and Wave Power

The earth's surface is 70% water. By warming the water, the sun creates ocean currents and the wind that produces waves. It is estimated that the

solar energy absorbed by the tropical oceans in a week could equal the entire oil reserves of the world – 1 trillion barrels of oil.

Geothermal Energy

It is the energy stored within the earth ("geo" for earth and "thermal" for heat). Geothermal energy starts with hot, molten rock (called magma) deep inside the earth which surfaces at some parts of the earth's crust. The heat rising from the magma warms the underground pools of water known as geothermal reservoirs. If there is an opening, hot underground water comes to the surface and forms hot springs, or it may boil to form geysers. With modern technology, wells are drilled deep down the surface of the earth to tap into geothermal reservoirs. This is called direct use of geothermal energy, and it provides a steady stream of hot water that is pumped to the earth's surface.

****

UNIT-4

Biodiversity, a shortened form of **Biological diversity**, refers to the existence of number of different species of plants and animals in an environment.

The Convention on Biological Diversity (1992) of the United Nations gives a formal definition of biodiversity in its Article 2: "Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."

Biodiversity is also defined as the existence of variability among living organisms on the earth, including the variability within and between species, and within and between ecosystems.

Species Diversity

Species diversity refers to the variety of different species of plants, animals, fungi, and organisms that are present in a region. It is estimated that there are above 30 million species on the earth. Species diversity is a part of diversity. Even within a small pond, we can notice a great variety of species. Species diversity differs from ecosystem to ecosystem. For example, in a tropical ecosystem more diversity is found than in temperate ecosystem. The most diverse group of species is invertebrates - animals without backbones.

At present, conservation scientists have been able to identify and categorize about 1.8 million species on earth. Many new species are being identified. Areas that are rich in species diversity are called ‘hotspots’ of diversity.

Genetic Diversity

It is the variation in genes that exists within a species. Genetic diversity corresponds to the variety of genes contained in plants, animals, fungi, and micro-organisms. It occurs within a species as well as between species. For example, poodles, German shepherds and golden retrievers are all dogs, but they all are different in look, color, and abilities. Each human being is different from all others. This genetic variability is essential for a health breeding of a population of species.

The diversity in wild species make the ‘gene pool’ from which crops and domestic animals have been developed over thousands of years.

Ecosystem Diversity

It is the diversity of ecosystems, natural communities, and habitats. In other words, ecosystem diversity refers to the variety of ways that species interact with each other and their environment. Tropical or temperate forests, grasslands, hot and cold deserts, wetlands, rivers, mountains, and coral reefs are instances of ecosystem diversity.

Each ecosystem corresponds to a series of complex relationships between biotic (living) and abiotic (non-living) components.

Value & Productive Use of Biodiversity

The importance of biodiversity is second to none. It boosts the ecosystem of productivity where each species, irrespective of their size, have an important role to play. Greater diversity in species ensure natural sustainability for all life forms. Hence, there is a need to preserve the diversity in life on the earth.

According to the UN sources at least 40 percent of the world’s economy and 80 percent of the needs of the poor are derived from biological resources. In addition, the richer the diversity of life, the greater the opportunity for medical discoveries, economic development, and adaptive response to such new challenges as climate change.

Significance of Biodiversity

Environmental services from species and smooth running cycles of ecosystems are necessary at global, regional, and local levels.

Biodiversity is essential for maintaining the water cycles, production of oxygen, reduction in carbon dioxide, protecting the soil, etc. It is also essential for preserving ecological processes, such as soil formation, circulation of and cleansing of air and water, global life support, fixing and recycling of nutrients, maintaining hydrological balance within ecosystems, maintaining rivers and streams throughout the year, etc.

Biodiversity has many values such as consumptive use value, productive use value, social values, ethical and moral values.

A healthy biodiversity offers many valuable services as follows.

- The more a region is rich in terms of biodiversity, better is the regulation of the different cycles. For example, forests regulate the amount of carbon dioxide in the air by releasing oxygen as a by-product during photosynthesis, and control rainfall and soil erosion.
- Protects water resources from being depleted, contaminated, or polluted.
- Helps in soil formation and protection.
- Helps in nutrient storage and recycling.
- Helps check pollution.
- Contributes to climate stability.
- Helps an ecosystem in recovery from unpredictable events.
- Provides biological resources such as food, medicinal resources, and pharmaceutical drugs, wood products, ornamental plants, breeding stocks, etc.
- Provides recreation and tourism facilities.
- Helps in research, education, and monitoring.
- Preservation of biological resources is essential for the well-being and long-term survival of mankind.

Productive Use Value of Biodiversity

Productive Use Value refers to the commercial value of products that are commercially harvested for exchange in formal markets.

Modern civilization is invariably a gift of biodiversity. The food we eat, the medicine we take in, the furniture we use, the industries, for example, are derivatives of biological diversity.

The agricultural crops of the present day have originated from wild varieties. Biotechnologists use the wild plants for developing new, high-yielding, and pest or diseaseresistant varieties. Biodiversity is home to original stock from which new varieties are being developed.

Similarly, all our domesticated animals came from their wild-living ancestral species. With the help of scientific breeding techniques, animals giving better yield of milk, meat, etc. are being developed. The animal products used by modern society come from the advances made in the fields of poultry farming, pisciculture, silviculture, dairy farming, etc.

Fossil fuels, considered to be pivotal in modern society, such as coal, petroleum, and natural gas are gifts of biodiversity from the geological past.

Most of the pharmaceutical drugs and medicines used in the present time are extracted from different plants.

Biodiversity provides rich storehouse for industrialists and entrepreneurs to develop new products. It provides agricultural scientists and biotechnologists with ample scope for developing new and better crops. New crop varieties are being developed using the genetic material found in wild relatives of crop plants though biotechnology.

The need of the hour is the preservation of biodiversity for industrial, economic, and above all, environmental safety. This is called **'biological prospecting'**.

Biodiversity Hotspots

The Earth's biodiversity is evenly distributed across its surface. There are over a thousand major eco-regions in the world. It is estimated that there are about 200 richest, rarest and most distinctive natural areas in the world. These are referred to as the Global 200.

Hotspots of biodiversity refer to bio-geographic regions where significant levels of biodiversity with richness and unusual concentration of endemic species are found, however, they are threatened with mindless exploitation and destruction.

A biodiversity is termed as a hotspot if –

- It has at least 1,500 vascular plants as endemic.
- It must be threatened or under threat of destruction to a considerable extent.

Across the world, about 35 areas are marked as hotspots of biodiversity and they represent 2.3 percent of the Earth's land surface but they support more than half of the world's endemic plant species and almost half of birds, mammals, reptiles, and amphibians as endemic.

List of Biodiversity Hotspots in the World

North and Central America – California Floristic Province, Madrean pine-oak woodlands, Mesoamerica

The Caribbean – Caribbean Islands

South America – Atlantic Forest, Cerrado, Chilean Winter Rainfall-Valdivian Forests, Tumbes-Chocó-Magdalena, Tropical Andes

Europe – Mediterranean Basin

Africa – Cape Floristic Region, Coastal Forests of Eastern Africa, Eastern Afromontane, Guinean Forests of West Africa; Horn of Africa; Madagascar and the Indian Ocean Islands; Maputaland-Pondoland-Albany; Succulent Karoo

Central Asia – Mountains of Central Asia

South Asia – Eastern Himalaya, Nepal; Indo-Burma, India and Myanmar; Western Ghats, India; Sri Lanka

South East Asia and Asia-Pacific – East Melanesian Islands; New Caledonia; New Zealand; Philippines; Polynesia-Micronesia; Southwest Australia; Sundaland; Wallacea

East Asia – Japan; Mountains of Southwest China

West Asia – Caucasus; Irano-Anatolian

About 1.8 million species are known to mankind at present. Scientists, however, have estimated that the number of species of plants and animals on the earth can go up to 20 billion. It means a majority of species still remain undiscovered.

World's most prolific bio-rich nations are in the south. On the other hand, the majority of the countries capable of exploiting biodiversity are the

developed Northern countries. These countries have very low level of biodiversity.

Developed nations want to consider biodiversity as 'global resources'. However, nations rich in biodiversity like India don't want to compromise their sovereignty over their biological diversity unless there is a revolutionary change in global thinking about sharing of all types of natural resources such as rare minerals as uranium, oil, or even intellectual and technological resources.

India is home to rich biodiversity. Countries with diversities higher than India are located in South America such as Brazil, and South East India countries such as Malaysia and Indonesia.

Biological diversities are now being increasingly appreciated as being of unimaginable value. International initiatives such as World Heritage Convention, Biodiversity Action Plan (BAP) aims for the protection and support of biologically rich natural areas and address threatened species and habitats to protect and restore biological systems.

Convention in the Trade of Endangered Species (CITES) is intended to reduce the utilization of endangered plants and animals by controlling trade in their products and in pet trade.

India as a Mega Diversity Region

A **mega diversity region** or country is one that harbors majority of the Earth's species and is therefore considered extremely bio-diverse. India is rich in biodiversity from north to south and from east to west. Geological events in the landmass of India, different climatic regions across the country and its special geographical position between a couple of distinct biological evolution and radiation of species are responsible for India's rich and varied biodiversity.

India is one among the top 10 countries with rich biodiversity and one among the 12 Mega biodiversity regions in the world. Around 18 biosphere reserves have been set up in India.

India is home to 350 different mammals (rated highest in the world), 1, 200 species of birds, 453 species of reptiles and 45, 000 plant species. India is

home to 50, 000 known species of insects, that include 13, 000 butterflies and moths. It is estimated that the number of unnamed species could be much higher than the existing number.

More than 18 percent of Indian plants are endemic (native to a particular region) to the country and found nowhere else in the world.

India has 27 indigenous breeds of cattle, 40 breeds of sheep, 22 breeds of goats and 8 breeds of buffaloes.

Among the amphibians found in India, 62 percent are unique to this country. High endemism has also been recorded in various flowering plants, insects, marine worms, centipedes, mayflies, and fresh water sponges.

Apart of noticeable diversity in Indian wild plants and animals, there is also a great diversity of cultivated crops and breeds of domestic livestock. The traditional cultivars (a plant variety that has been produced in cultivation by selective breeding) include about 50,000 varieties of rice and a number of cereals, vegetables, and fruits. The highest diversity of cultivars is found concentrated in the high rainfall areas of Western Ghats, Eastern Ghats, Northern Himalayas. and North-Eastern hills.

Threats to Biodiversity

Biodiversity is a paramount factor for the survival of the living world in general and mankind in particular. The fewer species (animals and plants) we have, the fewer people we will have on the earth. During the last few decades, loss of biodiversity is on the rise. Following are the major causes of threat to biodiversity.

Habitat Loss

Today, major loss to biodiversity in the world has been done by man. Man has begun to overuse or misuse most of these natural ecosystems.

Due to mindless and unsustainable resource use, once productive forest and grasslands have been turned into deserts, and wastelands have increased all over the world. Rapid industrialization, urbanization, and growth in population have resulted in massive deforestation and consequential habitat loss around the world.

For instance, mangroves have been cleared for fuel-wood and prawn farming, which has led to a decrease in the habitat essential for breeding of marine fish.

Forests all over the world, in particular tropical rainforests such as the Amazon, are under unforeseen threat largely from conversion to other land-uses.

Scientists have estimated that human activities are likely to eliminate approximately10 million species by the year 2050. It is also estimated that at the present rate of extinction about 25 percent of the world's species will undergo extinction fairly rapidly. Rich biodiversities such as tropical forests, wetlands, and coral reefs world over will constitute the major part of this extinction.

Poaching of Wildlife

Poaching of wildlife for trade and commercial activities has been on the rise for the last many decades. It has been a significant cause of the extinction of hundreds of species and the endangerment of many more, such as whales and many African large mammal, Asian tigers, etc. Most extinction over the past several hundred years is mainly due to overharvesting for food, fashion, and profit.

Illicit trade in wildlife in current times is driving many species of wild animals and plants to extinction. Elephants are poached for ivory; tigers and leopards for their skin; pangolins for meat and scales; and rare timber is targeted for hardwood furniture.

The global illegal wildlife trade is estimated to be between $7 billion and $23 billion in illicit revenue annually. It is now considered the most lucrative global crime after drugs, humans, and arms.

In 2015, the United Nations General Assembly unanimously adopted a resolution for tackling illicit trafficking in wildlife. The Sustainable Development Goals has laid down specific targets to combat poaching and trafficking of protected species.

Man-Wildlife Conflict

Man-wildlife conflict refers to the interaction between wild animals and people and the consequential negative impact on both of them. Human population growth and the resultant destruction of wildlife habitat for human habitation and economic prosperity create reduction of resources or life to some people and wild animals.

World Wide Fund for Nature (WWF) defines this conflict as "any interaction between humans and wildlife that results in a negative impact on human social, economic, or cultural life, on the conservation of wildlife population, or on the environment."

Although man-wildlife conflict is as old as human civilization, in modern times the degree of conflict has been on the rise due to high rise in human population in the past several centuries.

Since human populations expand into wild animal habitats, natural wildlife territory is displaced. Reduction in the availability of natural prey/food sources leads to wild animals seeking alternate sources. Alternately, new resources created by humans draw wildlife resulting in conflict. Competition for food resources also occurs when humans attempt to harvest natural resources such as fish and grassland pasture.

There are many consequences of man versus wildlife conflicts. The major consequences are –

- Destruction of wildlife habitat
- Injury and loss of life of both humans and wildlife
- Crop damage and livestock depredation
- Damage to human property
- Decrease in wildlife population and reduction in geographic ranges
- Trophic cascades

Apart from the above, there are other causes of threat to biodiversity. Factors such as climate change, invasion of non-native species also add to biodiversity losses in some or the other.

Conversation of Biodiversity

Considering the degree of threat to biodiversity around the world and the vital importance of biodiversity for living beings of which mankind is a major part, there is an urgent need to conserve biodiversity in the world. Further, we should be concerned about saving biodiversity because of the benefits it provides us – biological resources and ecosystem services, and the social and aesthetic benefits.

There are two main methods for the conservation of biodiversity.

In-situ Conservation

In-situ or on-site conservation refers to the conservation of species within their natural habitats. This is the most viable way of biodiversity conservation. It is the conservation of genetic resources through their maintenance within the environment in which they occur.

Examples – National Parks, Wild Life sanctuaries, Biosphere Reserves, Gene Sanctuaries

Ex-situ Conservation

Ex-situ conservation means the conservation of components of biological diversity outside their natural habitats. In this method, threatened or endangered species of animals and plants are taken out of their natural habitat and placed in special settings where they can be protected and provided with natural growth.

In ex-situ conservation methods, the plants and animals taken away from their habitats are taken care of in an artificially created environment.

Examples – Captive Breeding, Gene Banks, Seed Banks, Zoos, Botanical gardens, Aquaria, In vitro fertilization, Cryopreservation, Tissue Culture.

National Biodiversity Act

National Biodiversity Act in India draws from the objectives of Convention of Biodiversity (CBD). It aims at conservation of biodiversity, sustainable use and equitable sharing of the benefits of such use.

To achieve its objectives, it has put in place a three-tier institutional structure such as –

- National Biodiversity Authority based in Chennai
- State Biodiversity Board (SBBs) in every state
- Biodiversity Management Committee (BMCs) at Panchayat/Municipality levels

The Ministry of Environment and Forestry (MoEF) is the nodal agency.

Main Provisions of the Act

- Prohibition on transfer of Indian genetic material outside the country without specific approval of the Indian Government.
- Prohibition of anyone claiming an IPR such as a patent over biodiversity or related knowledge without the permission of Indian Government.
- Regulation of collection and use of biodiversity by Indian national, while exempting local communities from such restrictions.
- Measures from sharing of benefits from the use of biodiversity including transfer of technology, monitory returns, joint research and development, joint IPR ownership, etc.
- Measures to conserve sustainable use of biological resources including habitat and species protection projects, integration of biodiversity into the plans and policies of the various departments and sectors.
- Provisions for local communities to have a say in the use of their resources and knowledge and to charge fees for this.
- Protection of indigenous or traditional laws such as registration of such knowledge.
- Regulation of the use of the genetically modified organisms.
- Setting up of national, state and local biodiversity funds to be used to support conservation and benefit sharing.
- Setting up of Biodiversity Management Committees (BMC) at local village levels. State Biodiversity Boards at state level and National Biodiversity Authority.

UNIT-5

Environment and disasters At the global level, there is a need for having consensus around linking Disaster Risk Reduction with environmental management. As Disaster management highlights the interdependence of the economy, environment and inclusive development. While the Hyogo Framework for Action (HFA) calls for efforts to "encourage the sustainable use and management of ecosystems, through better land-use planning and development activities to reduce risk and vulnerabilities." The framework promotes the implementation of "integrated environmental and natural resource management approaches that incorporate disaster risk reduction, including structural and non-structural measures, like the integrated flood management and appropriate management of fragile ecosystems." In view of the Hyogo Framework of Action (HFA), the UN-ISDR Global Joint Work programme for 2008-2009 sought to ensure that "national and local authorities are better equipped to protect environmental services in coastal areas, flood and fire-sensitive basins and mountain ecosystems"(UNEP & UNISDR, 2010).

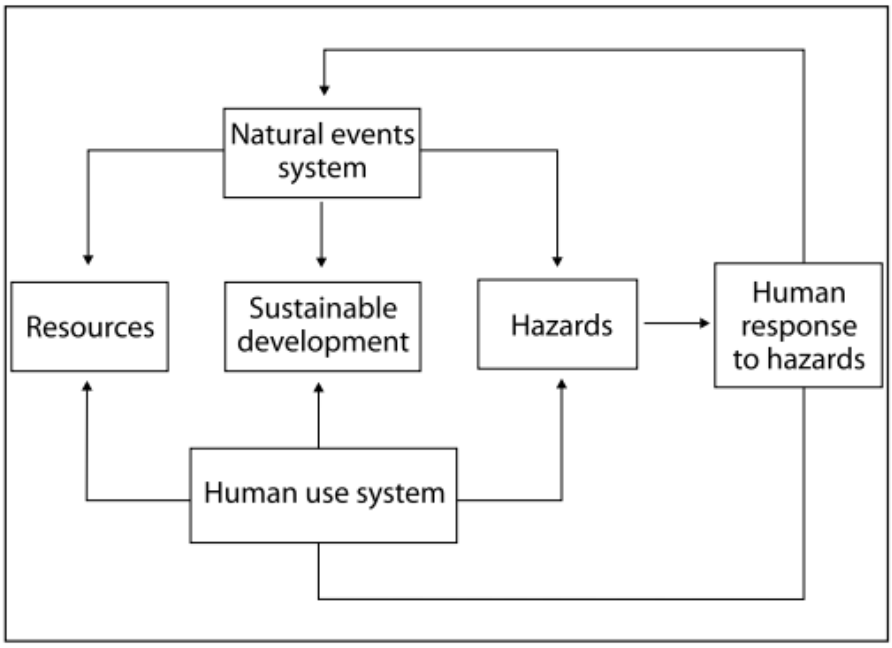


Figure 1: Environmental hazards and interface of natural events system with human use system (Burton et al., 1993)

Hazards and disasters are two sides of the same coin; neither can be fully understood or explained from the standpoint of either physical science or social science alone; and are inextricably linked to the ongoing environmental changes at global, regional and local levels. Environmental hazards exist at the interface between the natural events and human systems. Human responses to hazards can modify both the natural events, and the human use of, the environment (Figure 1. Burton et. al.1993). Environmental degradation is a process that reduces the capacity of the environment for meeting the social and ecological objectives, and related needs. The potential effects of degradation varies, and may contribute to increase in vulnerable

conditions along and intensity in occurrence of natural hazards. Some examples include: land degradation, deforestation, desertification, wildland fires, loss of biodiversity, land, water and air pollution, climate change, sea level rise and ozone depletion etc. Disasters are events of environmental extremes which are inevitable entities of this living world. The major environmental changes driving hazards and vulnerabilities to disasters are climate-change, land-use changes and degradation of natural resource (Gupta and Nair, 2011). Environmental causes consequences of disasters are illustrated in Figure 2.

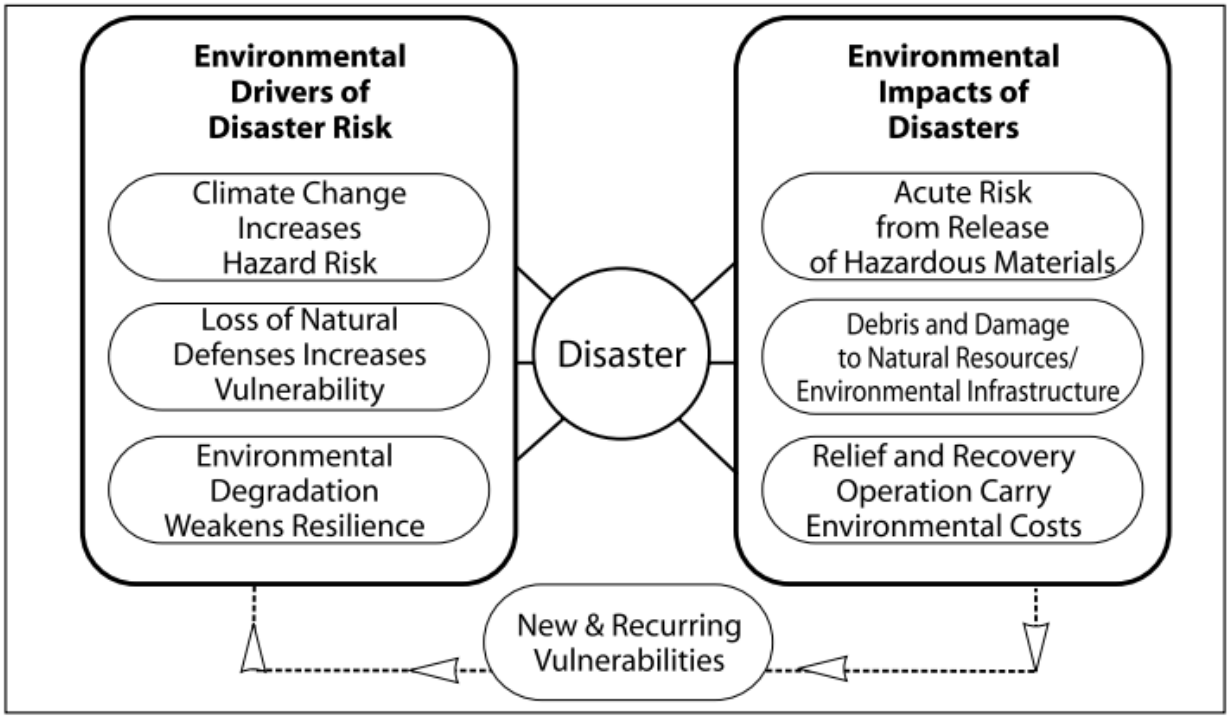


Figure 2: Environmental causes and consequences of disasters (UNEP, 2010).

'In many countries and regions, mangrove deforestation is contributing to fisheries decline, degradation of clean water supplies, salinisation of coastal soils, erosion, and land subsidence, as well as release of carbon dioxide into the atmosphere.'
Professor Edward Barbier & Dr. Mark Cox

Photo 1: Degraded mangroves in Vietnam. Source: aquaculturehub.org

The inter-relationship between environment and disasters is now widely recognized in terms of the following interfaces (GDRC).:

a. Environmental degradation leading to disasters: Environmental changes are known to generate or aggravate disasters especially of hydro-meteorological origin.

b. Environmental degradation causes vulnerability: Environmental degradation causes vulnerability: People are going to be

Photo 2: Desertification, land degradation and drought are major environmental threats with serious impacts on human well-being © S.Manfredi. Source: http://ies.jrc.ec.europa.eu/

worsely affected due to decline in ecosystem services, i.e. the provisional, recreational, regulatory and supporting services. Environment degradation reduces biomass productivity, impacts livelihoods, water, food, health, housing and the overall economy, jeopardizing the coping mechanism and capacity of communities. Low survival capacities result in high exposure to hazardous locations, social unrest and conditions that increase disaster impacts.

c. **Disasters impact environment and ecology:** Disasters cause primary and secondary impacts on the environment, affecting natural processes, resources and ecosystems, thereby creating conditions for future disasters or for a complex environment related emergency.

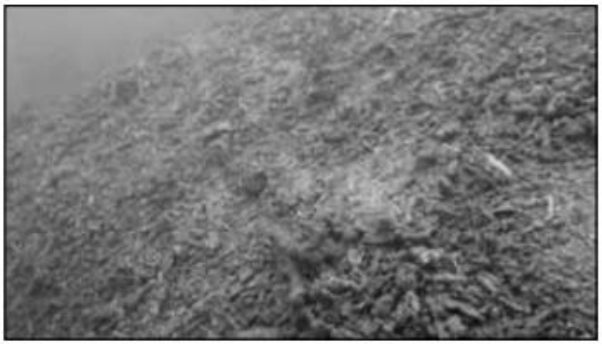


Photo 3: Photo of the National Park Service shows a coral reef in Faga'alu Bay, American Samoa that was flattened by a tsunami September 2009. Source : *Paul Brown / AP*

d. Relief & Recovery compromise environmental sustainability: Aspects related to Environment is compromised during the event of an disaster management operation and recovery process. Due to improper disposal of disaster and relief waste, there is a mis-management of natural resources such as water, or land, inappropriate use or management of land- mostly ecological sensitive zones or natural hazard prone zones –flood plains, and landscape modifications in the case of sanctuaries, national parks, bio-reserves with introduction of alien species or substances including organisms.

Environmental management and disaster management cycle

Environment concerns are crucial in all phases of disaster management and vice versa. Environmental services like shelter, water, food security, sanitation, waste management and disease control form crucial components of emergency relief. Considering disaster risk reduction as important aspect in all stages of environmental management is crucial in order to focus on disaster prevention and reduce risk from hazards, minimization of impacts, rehabilitation and overall leading to sustainability. Opportunities for integration also exist in planning and decision making tools, and in regulatory provisions pertaining to environmental governance and disaster management.

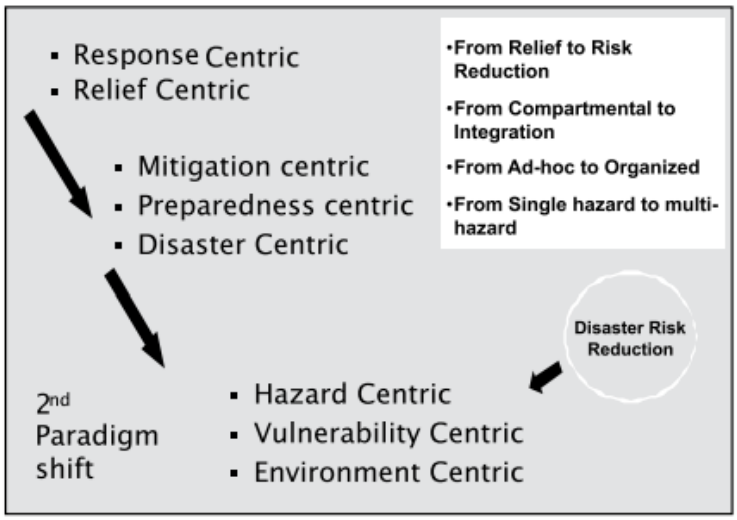


Figure 3 : Second Paradigm shift driven by awareness on climate change and sustainability concerns

BOX 1: Environmental classification of disasters

1) **Environmental disasters**
   - Hydro-meteorological, forest fire, geophysical, geochemical, biological e.g. epidemics, pest infestation…., etc.
2) **Technological disasters**
   - Industrial (chemical, electrical, mechanical), nuclear/radiological, aviation, dam break, mining, structural collapse …., etc.
3) **Civil disasters and conflicts**
   - Civil unrest, strike, war, sabotage, mass poisoning, bomb blast, stampede, transport accidents.... etc.

* environmental disasters may be of natural origin or human-induced / man-made and can also trigger a technological disaster or civil strife. On other hand, a technological mishap or civil disaster may trigger environmental calamity.

However, in order to facilitate a strategic and functional understanding of the linkages between the two, a cross-examination and interpretation of environmental tools and legislation towards disaster management is necessary. Globally, disaster management has voiced a paradigm shift from being 'response & relief' centric' approach to becoming a 'mitigation and preparedness' approach. As lessons are drawn from UN-IDNDR a 2nd paradigm shift is underway, driven by climate-change awareness and sustainability concerns in disaster management (Figure 3, Gupta et. al, 2009). This has resulted in a wider acceptance of the 'Disaster Risk Reduction' as a concept over 'Disaster Management', and giving recognition to the 'environmental approach that includes disaster risk reduction and management', which is now of a prime concern in disaster management strategies world over. Environmental management for disaster risk reduction does not exist as a formal field of practice. Instead, its scope is largely defined by the goals set by organizations working on related issues, such as ecosystem conservation, , disaster risk reduction and climate change adaptation and mitigation, etc. Monitoring and observing environmental factors that signal the onset of a hazard are fundamental to early warning systems. Environmental monitoring and assessment play an important role in generating relevant information that assists in identifying risks, vulnerabilities and opportunities to promote community resilience (UNEP-UNISDRPEDRR,2010). Environmental governance includes policies, legal and regulatory frameworks and institutional structures, and offers important opportunities for mainstreaming disaster risk reduction into environmental management, and for strengthening the environmental components of disaster risk reduction. Policy or regulatory frameworks often specify levels of environmental protection and establish the means for monitoring and enforcing protection.

Environmental approach to disaster risk management aims at utilizing environmental knowledge and practices in all stages of the risk-cycle so as to reduce the risk from disaster, and to ensure sustainability in reconstruction and recovery process. It starts with the under-standing of the environmental basis of disasters, or in other words – recognizing disasters as 'environmental events'(Box 1). "Human societies cannot be dissociated from the environment that they shape and which in turn influence their

development and livelihoods. Together they form a comprehensive system with intrinsic levels of vulnerability and inherent coping mechanisms. The less degraded the environmental component of this system, the lower its overall vulnerability and the higher its coping capacity" (OECD, 2010). The principles set out in the Hyogo Framework are acknowledged by the UN-ISDR, which defines ten opportunities for environment in the context of disaster prevention or reduction (UNEP, 2010):

1. Engage environmental managers fully in national disaster risk management mechanisms;

2. Include risk reduction criteria in environmental regulatory frameworks;

3. Assess environmental change as a parameter of risk;

4. Utilize local knowledge in community-based disaster risk management;

5. Engage the scientific community to promote environmental research and innovation;

6. Protect and value ecosystem services;

7. Consider environmental technologies and designs for structural defences;

8. Integrate environmental and disaster risk considerations in spatial planning;

9. Prepare for environmental emergencies; and,

10. Strengthen capacities for environmental recovery.

In addressing the relationship between social and environmental vulnerability and the occurrence of disasters, Wilches-Chaux (1993) states, "There is no doubt those natural forces play an important role in the initiation of several disasters, however it is no longer the case that they can be considered the main cause of such disasters. There seem to be three fundamentals causes that dominate the disaster processes in the developing world, which is precisely where their incidence is the largest". Environmental and natural resource management are other key elements in vulnerability reduction; it is essential to place continuous emphasis on implementing long-term environmental measures (IADB, 1999).

Disaster management law and environment

Country examples South Africa's Disaster Management Act, 2003, predated both the World Conference on Disaster Reduction and the Hyogo Framework for Action (2005), has generated particular interest as an example of international best practice – especially in profiling the role of legislation in driving integration of DRR action across multiple sectors and disciplines (BCPR, 2004). India's National Disaster Management Act, 2005, Chapter 1, Section 2(d) has recognized '…substantial damage to life, human suffering…property…and degradation of environment…' as a 'disaster' and considered the flora and fauna including microbes (damages and losses to life), ecosystems-services, biodiversity, sustainability, environmental-health (human sufferings), natural resources (property), and environmental quality,

climate, bio-productivity (environment) while evolving the definition of 'disaster' (Box 2). Simultaneously, interpretation of the coping capacity contexts 'community' as group of populations that shall include all life forms of the area affected.

Environmental legislation

National legislation
a. Constitutional provisions
b. Common laws
c. Statutory laws
d. Customary laws
International law (treaty and conventions) Taking example of India, environmental laws can also be broadly grouped as below.
a. Laws on environment protection and conservation
b. Laws on pollution and waste management
c. Laws on safety and emergency preparedness
The laws on environmental protection (conservation, pollution and waste management), are now becoming more relevant in Disaster Risk Reduction (DRR) in the wake of paradigm shift in disaster management to pre-disaster risk reduction and post-disaster sustainable recovery processes. Whereas the safety and emergency preparedness provide for proper risk assessment, emergency planning and response organization aims at minimizing the impacts of a disaster event. The growing emphasis on 'greening disaster response' calls for greater role of environmental law, and related standards and codes ensure preventive environmental-health (food safety and shelter provisions, water and sanitation, waste management and control of disease outbreak) so as to avoid secondary disasters and complex emergencies.

National laws

a. Constitutional provisions Several countries across the world, constitution contains provisions that establish environmental rights and duties with regard to conserving natural resources and for prevention of harm to life and health. Indian constitution has many such provisions related to environment and human rights. Article 21 of the Indian constitution states "No person shall be deprived of his life or personal liberty except according to procedure established by law". The right to life has been employed in a diversified manner in India. Besides the mere right to survive as a species, quality of life, the right to live with dignity and the right to live-
lihood etc. are also with the purview of Article 21. The Constitution of India provides that all are equal before the law and shall be accorded equal protection of the law. Article 14 states that "The State shall not deny to any person equality before the law or the equal protection of the laws within the territory of India. Article 14 can be used to challenge government sanctions for mining and other activities with high stakes on human rights and environmental impact, where the permissions are arbitrarily granted without adequate consideration of environmental impacts. The Constitution Act of 1976 (Forty Second Amendment) explicitly incorporated environmental protection and improvement as a part of state policy. Article 48 A provides that the state shall endeavour to protect and improve the environment and safeguard the forests and wildlife of the country. Article 51A (g) imposes a similar responsibility on every citizen to protect and improve the natural

environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures. Thus, protection of natural environment and compassion for living creatures was made the positive fundamental duty of every citizen. Section 11 of chapter 2 of the South African constitution deals with the right to life, a non-derogable right. Under section 24 of chapter 2 of the South African constitution, everyone has the right to an environment that is not harmful to health or well-being. Section 24 adds that the government must act reasonably to protect the environment by preventing pollution and ecological degradation, promoting conservation, and securing ecologically sustainable development, while building the economy and society. Section 24 demonstrates that the right to a healthy environment is part of the socio-economic right of people of South Africa applied by the courts to give a meaningful interpretation to the right to life similar to India.

Substantive procedural right to a clean environment is contained in article II, section 16, of the Philippine Constitution, which states that "The State shall protect and advance the right of the people to a balanced and healthful ecology in accord with the rhythm and harmony of nature". Article 50 of the Constitution of the Ukraine, adopted in 28 June 1996, is another good example. It states: "Every person has the right to a safe and healthy environment and to compensation for damages resulting from the violation of this right".

Common laws

The term "Common" is derived from the Latin word 'Lex Communis' the body of customary law of England, which is based upon the judicial decisions. The Common law continues to be in force in India under Article 372 of the constitution so far and is not yet altered, modified or repealed by statutory laws. Under the Common Law, an action might lie for causing pollution of environment, viz., air, water, or noise if it would amount to private or public nuisance. The common law remedies against environmental pollution are available under the law of Torts. Tort is a civil wrong other than a breach of trust or contract. The most important tort liabilities for environmental pollution are under the heads of nuisance, trespass, negligence and strict liability. The Indian Penal Code formulated by the British during the British Raj in 1860, forms the backbone of criminal law in India. The Code of Criminal Procedure, 1973 governs the procedural aspects of the criminal law. Indian Penal Code (IPC), 1860 makes various acts affecting environment as offences (Chapter XIV, section 268 and 294 A). Public health, safety, convenience, decency and morals are dealt under these sections. IPC also cover the negligent handling of poisonous substances, combustive and explosive materials. Criminal Procedure Code, 1973 (CrPc) can also be invoked to prevent pollution. Chapter X, Part B sections 133 to 143 provides the most effective and speedy remedy for preventing and controlling public nuisance. Section 133 can be used against municipalities and government bodies.

Statutory laws

In 2005, the Hyogo Framework for Action (2005–2015) called for nation states and the international community to ensure that DRR is a national and local priority with a strong institutional basis for implementation. The framework identified legislation as a critical component in moving towards a comprehensive and mainstreamed DRR approach. 'Adopt, or modify where necessary, legislation to support disaster risk reduction, including regulations and mechanisms that encourage compliance and that promote incentives for undertaking risk reduction and mitigation

activities' (UN-ISDR, 2005). Many countries do not have specific legislation for DRR (at least till recently). Several countries enacted such legislation in last one decade. e.g. India, Sri Lanka, Pakistan etc. However, these countries have a number of sectoral environmental policies and laws which need to be taken into account in the DRR framework. Key environment policies and law may include agriculture, forests and wildlife, habitat, water, land-use, sanitation, wildfire, etc. Failure to acknowledge pre-existing sectoral policies with a bearing on DRR can lead to the alienation of those working in these policy sectors, generating perceptions of resource competition that can slow down or stop progress. For example, Kenya has wildfire management legislation that contributes to prevention, but is not recognized as such in disaster legislation (Pelling and Holloway, 2006). Environmental laws and policies in India provide significantly for DRR in the context of natural disasters, but the environment sector (narrowly recognized for chemical accidents management only), and rarely represented in the membership of the National Disaster Management Authority or the Board of the National Institute of Disaster Management, the two statutory entities on DRR capacity development under the Disaster Management Act, 2005 which otherwise provides significant consideration of 'environment' while defining a 'disaster' (Box 2). Definition of environment as per the Environmental Protection Act (Section 2(a)). "Environment includes water, air and land and the interrelation ship which exists among and between water, air and land and human beings and other living creatures, plants, micro organism and property". Environmental legislation have been contributing to risk reduction aspects of disaster management and now are emerging to be relevant for disaster preparedness, relief and recovery strategies due to growing recognition of ecosystem functions, livelihood issues, water and sanitation, waste management and environmental health issues, within the DRR agenda in general, and in particular, while integrating climate-change adaptation. A list of laws and policies for environmental protection in India is given in Box 3.

Box 3: Laws and Policies for Environmental Protection in India

ACTS

- The Indian Forest Act, 1927
- Factories Act, 1948
- Factories Amendment Act, 1987
- Wildlife (Protection) Act, 1972
- The Water (Prevention and Control of Pollution) Act, 1974
- Forest (Conservation), Act, 1980
- The Air (Prevention and Control of Pollution) Act, 1981
- Environment (Protection) Act, 1986
- The Public Liability Insurance Act, 1991
- Biological Diversity Act 2002
- Forest Rights Act, 2006 (Ministry of Tribal Affairs)
- The Cultural Heritage Conservation Bill 2010 (draft)
- Mine and Mineral Act 2010
- National Green Tribunal Act, 2010

RULES

- The Manufacture, Storage and Import of Hazardous Chemicals Rules,1989
- Manufacture, Use, Import, Export and Storage of Hazardous Micro-organisms, Genetically Engineered Organisms or Cells Rules, 1989
- Emergency Preparedness, Planning and Response to Chemical Accidents Rules, 1996
- Dumping and disposal of fly ash discharged from coal or lignite based thermal power plants on land, Rules, 1999.
- Bio-Medical Waste (Management and Handling) Rules, 1998
- The Hazardous Wastes (Management and Handling) Rules,1989
- Environment (siting for industrial projects) Rules, 1999
- The Noise Pollution (Regulation and Control) (Amendment) Rules, 2000
- The Municipal Solid Waste (Management & Handling) Rules, 2000
- Hazardous Waste (Management, Handling and Trans-boundary) Rules, 2008
- Wetlands (Conservation and Management) Rules, 2010
- Guidelines for diversion of forests lands for non-forest purposes under the Forest (Conservation) Act, 1980
- Plastic Waste (Management and Handling) (Amendment) Rules, 2011

Notifications

- Coastal Regulation Zone (CRZ) Notification (revised 2011)
- EIA Notification 1994 (revised 2006)

Policies

- National Forest Policy, 1988
- National Water Policy, 2002
- National Agricultural Policy, 2000
- National Environment Policy 2006
- National Disaster Management Policy, 2009

Other laws

Disaster Management Act, 2005. (recognises damage /destruction of environment as disaster)

Law relating to land use zoning, land acquisition, land pooling, resettlement and rehabilitation also have provisions for environmental protection.

BOX 4: Environmental laws in the United States

- ***Food Quality Protection Act (1996)*** is to ensure that food quality meets strict standards for public health protection. Under this law, the Environmental Protection Agency is required to better protect infants and children from pesticides in food and water, and from indoor exposure to pesticides.
- ***Food, Agriculture, Conservation, and Trade Act (1990)*** contains a title on the conservation of environment intended to protect soil and water resources, a conservation plan (FACTA90) and includes the Conservation Reserve Program, the Wetlands Reserve Program and the Environmental Easement Program to remove agricultural production in environmentally sensitive areas, including highly erodible cropland, wetlands, and areas which threaten surface and groundwater quality.
- ***Water Quality Act (1987),*** Section 404, have specific provisions for regulating the discharge into waters including marshes and wetlands, which are associated with activities, such as port development; channel construction and maintenance; development sites; and water resource projects, such as dams, jetties, and levies; land-clearing and soil deposition, which lead to the change the hydrology; flow or circulation

of waters, and affect the wetland area.

- ***Emergency Planning and Community Right-to-Know Act (1986)*** requires companies to disclose information about toxic chemicals they release into the air and water and dispose off on the land.
- ***Comprehensive Environmental Response, Compensation, and Liability Act (CERC***LA) (1980) commonly called as the Superfund Law, requires cleanup of releases of hazardous materials in air, surface and groundwater, and on land. The legislation established a trust fund to pay for cleaning up the environment and the liability for cleanup costs.
- ***Surface Mining Control and Reclamation Act (1977)*** is intended to ensure that coal mining activity is conducted with sufficient protection of the public and the environment, and provides for the restoration of abandoned mining areas to beneficial use.
- ***Fisheries Conservation and Management Act (1976)*** governs the management and control of U.S. marine fish populations, and is intended to maintain and restore healthy levels of fish stocks and prevent over harvesting.
- ***Federal Land Policy and Management Act (1976)*** provides for protection of the scenic, scientific, historic and ecologic values of federal lands and for public involvement in their management.
- ***Resource Conservation and Recovery Act as Amended (RCRA) (1976)*** to regulate the disposal of all types of solid wastes, with emphasis on hazardous waste disposal. Under the law, EPA lists substances that are considered hazardous when disposed of on land. Act provides the requirements for treatment, storage, and disposal of the waste.
- ***Safe Drinking Water Act (1974)*** establishes drinking water standards for tap water safety, and requires rules for groundwater protection from underground injection; amended in 1986 and 1996, added a fund, and included public "right to know" requirements to inform consumers about their tap water.
- ***Endangered Species Act (1973)*** is to protect and recover endangered and threatened species of fish, wildlife and plants in the United States and beyond. The law works in part by protecting species habitats.
- ***Coastal Zone Management Act (1972)*** provides a partnership structure allowing states and the federal government to work together for the protection of U.S. coastal zones from environmentally harmful overdevelopment. The program provides federal funding to participating coastal states and territories for the implementation of measures

that conserve coastal areas.

- ***Marine Mammal Protection Act (1972)*** seeks to protect the species of marine mammals, many of which remain threatened or endangered. The law requires wildlife agencies to review any activity that has the potential to "harass" or kill these animals in the wild. The law is the nation's leading instrument for the conservation of these species, and is an international model for such laws.
- ***National Environmental Policy Act (1970)*** was the first of the modern environmental statutes. NEPA created environmental policies and goals for the country, and established the President's Council on Environmental Quality. It's most important feature is its requirement that federal agencies conduct thorough assessments of the environmental impacts of all major activities undertaken or funded by the federal government.

There are several other legislation, for example, Solid Wastes Disposal (State) Act of US, which provide for protection of drainage systems and low lying areas from being affected by garbage, dirt or otherwise. Other laws of concern are the Atomic Energy Act (1954), Oil Pollution Act (1990), Clean Air Act (1970), Clean Water Act (1972), etc.

Environmental litigation can take many forms, including civil actions based on tort, contract or property law, criminal prosecutions, public interest litigation, enforcement of constitutional rights, international law, and also involve dealing with trans-boundary issues (Shelton and Kiss, 2005). Necessary integration of DRR and development goals have been recognized at national Government level in Nepal in its National Development Planning, National Policy on Environmental Adaptation to Climate Change, and National Strategy for Disaster Risk Management recognizing their interrelatedness (NSET, 2008). In Nepal, the Water Resources Act, 1993 contains provisions to minimize environmental impacts, including soil erosion, floods and landslides. This provision calls for carrying out an EIA study prior to project implementation (Section 20). The Electricity Act, 1993 also contains provisions to minimize soil erosion, floods, air pollution and damage to the environment (Section 24). The Electricity Rules, 1993 stresses environmental analysis, which should include environmental mitigation measures to minimize adverse impacts (Rule 12 and 13). Environmental governance and its development in Nepal have contributed towards disaster risk reduction and climate-change adaptation framework as well. The Environment Protection Act, 1996 (Nepal) envisaged for the 'Development of Environmental Action Plans' at various levels of governance has provided an umbrella framework to the 'disaster prevention and mitigation' and it's mainstreaming into developmental planning. Decision-making, plans and programmes

Box 5: Policies related to environment and natural resources in Nepal

- National Conservation Strategy, 1988
- Nepal Environmental Policy and Action Plan, 1993
- Tourism Policy, 1995
- Solid Waste Management Policy, 1996
- Hydropower Development Policy, 2001
- Nepal Biodiversity Conservation Strategy, 2002
- National Wetland Policy, 2003
- Irrigation Policy, 2003

for environmental protection and natural resource management, and thereby inducted provisions for disaster mitigation and resilience in Nepal, are guided by a number of environment-related policies(Box 5).

Box 6: Acts and rules on environment in Sri Lanka

- National Environmental Act No. 47 of 1980 (broad framework on environmental protection including Environmental Impact Assessment)
- Forest Ordinance No. 16 of 1907
- State Lands Ordinance No. 8 of 1947 (lands and management of resources, including lakes, rivers and streams)
- Irrigation Ordinance No. 32 of 1946 (environmental aspects of water, irrigation and land use in agriculture)
- Water Resources Board Act No. 29 of 1964 (afforestation, pollution of

rivers, streams and other water courses, use of water resources)

- Coast Conservation Act No. 57 of 1981 as amended (Coastal Zones and activities within such zones)
- Soil Conservation Act No. 25 of 1951 (conservation of soil resources, mitigation of soil erosion and the protection of lands against flood and drought)
- Plant Protection Act No. 35 of 1999 (plant diseases, pests, wild plants and invasive species)
- Felling of Trees (Control) Act No. 9 of 1951
- Flood Protection Ordinance No. 4 of 1924 as amended (protection of areas from flood damage and declare a flood area).
- Urban Development Authority Law No. 41 of 1978.

In Sri Lanka, Acts and Rules on environment significantly provide for disaster risk mitigation and ecological sustainability in disaster management actions. Important environmental laws of Sri Lanka are given in Box 6.

Customary Law

Customary law is an important source of international environmental law. These are norms and rules that countries and communities follow as a matter of custom and they are so prevalent that they bind the states. When a principle becomes customary law is not clear cut and many arguments are put forward by states not wishing to be bound. Examples of customary international law relevant to the environment include the duty to warn other states promptly about icons of an environmental nature and environmental damages to which another state or states may be exposed, and Principle 21 of the Stockholm Declaration ('good neighbourliness' or sic utere).

Customary law, by definition, is a non-state legal system that parallels the substantive and procedural functions of the state made laws. Unlike State laws, these emerge from within the community and command social acceptance and observance. Statutory law is uniform whereas customary law is an adaptive, flexible, evolving body of norms and rules governing the behaviour of communities. While the former is for the community latter is in the community. Recognition of the importance of customary laws in India is evident from the enactment of The Provisions of the Panchayat (Extension to Scheduled Areas) Act, 1996 (PESA) and the Forest Rights Act (2006). The provisions of the Panchayat have been extended to the Scheduled Areas with exceptions and modifications as specified in the Extension Act. One of the important features of PESA is that it acknowledges the competence of Gram Sabha, the formal manifestation of a village community, to 'safeguard and preserve the traditions and customs of the people, their cultural identity, community resources and the customary mode of dispute resolutions. A good example of speedy and flexible redressal under customary law can be found in the Nishi case from Arunachal Pradesh, India. The village headmen had constituted a volunteer force to monitor any illegal activities in the community forest.

International law

International law is considered the supreme body of law by international tribunals and in international relations. International law may be considered persuasive in interpreting constitutional or statutory provisions. The jurisprudence of international tribunals also can be considered in this context. In Andhra Pradesh Pollution Control BoardII v. Prof. M.V. Nayudu & Others [2001] 4 LRI 657, Sup. Ct. India, the Court referred to the Declaration of the United Nations Water Conference, the International Covenants on Civil and Political and Economic, Social and Cultural Rights, and the Rio Declaration on Environment and Development as persuasive authority in implying a right of access to drinking water as part of the right to life in the Indian Constitution. The main principles of international environmental law are found in treaty law (The Brundtland Commission). 'Legal regimes are rapidly outdistanced by the accelerating pace and scale of impacts on the environmental base of development.' Law must be reformulated to keep human activities in harmony with the unchanging and universal laws of nature (Brundtland, 1987). On occasion, courts have looked to treaties for the meaning of undefined terms in national law. In Ramiah and Autard v. Minister of the Environment and Quality of Life (Mar. 7, 1997), the Mauritius Environment Appeal Tribunal looked to the Ramsar Convention for a definition of wetlands, even though the convention had not yet been ratified by Mauritius. The Ministry of Environment agreed that the Convention provided guidance on the issue. The sources of international law that may become domestic law through incorporation generally include those sources as listed under Article 38 of the Statute of the International Court of Justice. The Statute refers to (a) international conventions, (b) international custom, (c) general principles of law, and, (d) judicial decisions and doctrine, as subsidiary persuasive sources.

- Among all the components of the environment air and water are necessary to fulfill the basic survival needs of all organisms. So, to protect them from degradation the following acts have been passed.

1. **Water Acts**
2. **Air Acts**
3. **Environment Act**

- A few important legislations of each category with brief description are given below:

The Water (Prevention and Control of Pollution) Act of 1974 and Amendment, 1988

- The main objective of this act is to provide prevention and control of water pollution.

Some important provisions of this Act are given below:

- The Act vests regulatory authority in **State Pollution Control Boards** to establish and enforce effluent standards for factories.
- A **Central Pollution Control Board** performs the same functions for Union Territories and formulate policies and **coordinates** activities of different State Boards.
- The Act grants power to SPCB and CPCB to test equipment and to take the sample for the purpose of analysis.
- Prior to its amendment in 1988, enforcement under the Act was achieved through criminal prosecutions initiated by the Boards.
- The 1988 amendment act empowered SPCB and CPCB to close a defaulting industrial plant.

The Water (Prevention and Control of Pollution) Cess Act of 1977

- The Water Cess Act was passed to generate financial resources to meet expenses of the Central and State Pollution Boards.
- The Act creates **economic incentives** for pollution control and requires local authorities and certain designated industries to pay a cess (tax) for water effluent discharge.
- The **Central Government**, after deducting the expenses of collection, pays the central board and the states such sums, as it seems necessary.
- To encourage capital investment in pollution control, the Act gives a polluter a 70% rebate of the applicable cess upon installing effluent treatment equipment.

The Air (Prevention and Control of Pollution) Act of 1981 and amendment, 1987

- To implement the decisions taken at the **United Nations Conference on the Human Environment** held at Stockholm in June 1972, Parliament enacted the nationwide Air Act.
- The main objectives of this Act are to improve the quality of air and to prevent, control and abate air pollution in the country.

Important provisions of this Act are given below:

- The Air Act's framework is **similar** to that of the Water Act of 1974.
- The Air Act expanded the authority of the central and state boards established under the Water Act, to include air pollution control.
- States not having water pollution boards were required to set up air pollution boards.
- Under the Air Act, all industries operating within designated air pollution control areas must obtain a "consent" (**permit**) from the **State Boards**.
- The states are required to prescribe emission standards for industry and automobiles after consulting the central board and noting its ambient air quality standards.
- The Act grants power to SPCB and to test equipment and to take the sample for the purpose of analysis from any chimney, fly ash or dust or any other.
- Prior to its amendment in 1988, enforcement under the Act was achieved through criminal prosecutions initiated by the Boards.
- The 1988 amendment act empowered SPCB and CPCB to close a defaulting industrial plant.
- Notably, the 1987 amendment introduced a citizen's suit provision into the Air Act and extended the Act to include **noise pollution**.

Environment and Biodiversity Related Acts

- The most important legislation in this category is The Environment (Protection) Act of 1986.
- Through this Act **Central Government** gets full power for the purpose of protecting and improving the quality of the environment.

Environment (Protection) Act of 1986

- In the wake of the **Bhopal tragedy**, the government of India enacted the Environment (Protection) Act of 1986.
- The purpose of the Act is to implement the decisions of the **United Nations Conference on the Human Environment** of 1972, in so far as they relate to the protection and improvement of the human environment and the prevention of hazards to human beings, other living creatures, plants and property.

- The Act is an "umbrella" for legislations designed to provide a framework for Central Government, coordination of the activities of various central and state authorities established under previous Acts, such as the Water Act and the Air Act.
- In this Act, main emphasis is given to "Environment", defined to include water, air and land and the inter-relationships which exist among water, air and land and human beings and other living creatures, plants, micro-organisms and property.
- "Environmental pollution" is the presence of pollutant, defined as any solid, liquid or gaseous substance present in such a concentration as may be or may tend to be injurious to the environment.
- "Hazardous substances" include any substance or preparation, which may cause harm to human beings, other living creatures, plants, microorganisms, property or the environment.

The main provisions of this Act are given below

- The Act empowers the **center** to "take all such measures as it deems necessary".
- By virtue of this Act, **Central Government** has armed itself with considerable powers which include,

1. coordination of action by state,
2. planning and execution of nationwide programmes,
3. laying down environmental quality standards, especially those governing emission or discharge of environmental pollutants,
4. placing restriction on the location of industries and so on.
5. authority to issue direct orders, included orders to close, prohibit or regulate any industry.
6. power of entry for examination, testing of equipment and other purposes and power to analyze the sample of air, water, soil or any other substance from any place.

- The Act explicitly prohibits discharges of environmental pollutants in excess of prescribed regulatory standards.
- There is also a specific prohibition against handling hazardous substances except those in compliance with regulatory procedures and standards.

- The Act provides provision for penalties. For each failure or contravention the punishment included a prison term up to five years or fine up to Rs. 1 lakh, or both.
- The Act imposed an additional fine of up to Rs. 5,000 for every day of continuing violation.
- If a failure or contravention occurs for more than one year, offender may be punished with imprisonment which may be extended to seven years.
- Section 19 provides that any person, in addition to authorized government officials, may file a complaint with a court alleging an offence under the Act.
- This "Citizens' Suit" provision requires that the person has to give notice of not less than 60 days of the alleged offence of pollution to the Central Government.

The Genetic Engineering Appraisal Committee (GEAC) is the apex body constituted in the Ministry of Environment and Forests under 'Rules for Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/Genetically Engineered Organisms or Cells 1989', under the Environment Protection Act, 1986. The Rules of 1989 also define five competent authorities i.e. the Institutional Biosafety Committees (IBSC), Review Committee of Genetic Manipulation (RCGM), Genetic Engineering Approval Committee (GEAC), State Biotechnology Coordination Committee (SBCC) and District Level Committee (DLC) for handling of various aspects of the rules

Genetic Engineering Approval Committee (GEAC)

1. **Biosafety concerns** have led to the development of regulatory regime in India.
2. The **MoEFCC** has notified the Rules for Manufacture, Use/Import/ Export & Storage Of Hazardous Micro Organisms/Genetically Engineered Organisms or Cells, 1989 ['Rules 1989']
3. Aim of 'Rules 1989' is to protect environment, nature and health in connection with application of gene technology and micro-organisms.
4. These rules cover areas of research as well as large scale applications of GMOs and their products including experimental field trials and seed production.
5. The Rules 1989 also define the competent authorities and composition of such authorities for handling of various aspects of the Rules.

Presently there are six committees

1. **Recombinant DNA Advisory Committee (RDAC):** The functions are of an advisory nature. It recommends safety regulations for India in recombinant research, use and applications.
2. **Review Committee on Genetic Manipulation (RCGM)** established under the Department of Biotechnology, **ministry of Science** and technology is to monitor the safety related aspects in respect of on-going research projects.
3. **Genetic Engineering Appraisal Committee (GEAC)**
4. **State Biotechnology Coordination Committee (SBCC's)** have a major role in monitoring. It also has powers to inspect, investigate and take punitive action in case or violations of statutory provisions.
5. **District Level Committees (DLCs)** have a major role in monitoring the safety regulations in installations engaged in the use of genetically modified organisms/hazardous microorganisms and its applications in the environment.
6. **Institutional Biosafety Committee (IBSC)** is established under the institution engaged in GMO research to oversee such research and to interface with the RCGM in regulating it.

Genetic Engineering Appraisal Committee (GEAC)

- The Genetic Engineering Appraisal Committee (GEAC) is the apex body constituted in the **Ministry of Environment and Forests** under 'Rules for Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/Genetically Engineered Organisms or Cells 1989', under the **Environment Protection Act, 1986.**

The Genetic Engineering Appraisal Committee is constituted under the

a. Food Safety and Standards Act, 2006
b. Geographical Indications of Goods (Registration and Protection) Act, 1999
c. Environment (Protection) Act, 1986
d. Wildlife (Protection) Act, 1972

Answer: c)

The Ozone Depleting Substances Rules

- The rules are framed under the jurisdiction of **Environment (Protection) Act**.
- These Rules set the deadlines for phasing out of various ODSs, besides regulating production, trade import and export of ODSs and the product containing ODS.
- These Rules prohibit the use of CFCs in manufacturing various products beyond 1st January 2003 except in metered dose inhaler and for other medical purposes.
- Similarly, use of halons is prohibited after 1st January 2001 except for essential use.
- Other ODSs such as **carbon tetrachloride** and **methylchoroform** and CFC for metered dose inhalers can be used upto 1st January 2010.
- Further, the use of **methyl bromide** has been allowed upto 1st January 2015.
- Since **HCFCs** are used as interim substitute to replace CFC, these are allowed up to 1st January 2040.

National Ganga River Basin Authority (NGRBA)

- National Ganga River Basin Authority (NGRBA) is a financing, planning, implementing, monitoring and coordinating authority for the Ganges River, functioning under the **Ministry of Water Resources**.
- The mission of the organization is to safeguard the drainage basin which feeds water into the Ganges by protecting it from pollution or overuse.
- In 2014, the NGRBA has been transferred from the Ministry of Environment and Forests to the **Ministry of Water Resources, River Development & Ganga Rejuvenation**.
- It was established by the Central Government of India, in 2009 under Section 3(3) of the **Environment Protection Act, 1986**, which also declared Ganges as the '**National River**' of India.

Composition of NGRBA

- The **Prime Minister** the chair of the Authority.

Members belonging to the government sector are as follows:

- Prime Minister of India
- Minister of Environment and Forests (Union Minister)
- Minister of Finance
- Minister of Urban Development
- Minister of Water Resources
- Minister of Power
- Minister of Sciences and Technology
- Chief Ministers of **Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal**
- Ministry Of Environment and Forests (state minister)
- Ministry Of Environment and Forests, secretary

Wild Life (Protection) Act of 1972 and Amendment, 1982

- In 1972, Parliament enacted the Wild Life Act (Protection) Act.
- The Wild Life Act provides for

1. state wildlife advisory boards,
2. regulations for hunting wild animals and birds,
3. establishment of sanctuaries and national parks,
4. regulations for trade in wild animals, animal products and trophies, and
5. judicially imposed penalties for violating the Act.

- Harming **endangered** species listed in **Schedule 1** of the Act is prohibited throughout India.
- Hunting species, like those requiring special protection (Schedule II), big game (Schedule III), and small game (Schedule IV), is regulated through licensing.
- A few species classified as **vermin (Schedule V)**, may be hunted without restrictions.
- Wildlife wardens and their staff administer the act.
- An amendment to the Act in 1982, introduced a provision permitting the capture and transportation of wild animals for the scientific management of animal population.

Forest (Conservation) Act of 1980

- First Forest Act was enacted in 1927.
- Alarmed at India's rapid deforestation and resulting environmental degradation, Centre Government enacted the Forest (Conservation) Act in1980.
- It was enacted to consolidate the law related to forest, the transit of forest produce and the duty livable on timber and other forest produce.
- Forest officers and their staff administer the Forest Act.
- Under the provisions of this Act, prior approval of the Central Government is required for diversion of forestlands for non-forest purposes.
- An Advisory Committee constituted under the Act advises the Centre on these approvals.
- The Act deals with the four categories of the forests, namely reserved forests, village forests, protected forests and private forests.

Reserved forest

- A state may declare forestlands or waste lands as reserved forest and may sell the produce from these forests.
- Any unauthorized felling of trees quarrying, grazing and hunting in reserved forests is punishable with a fine or imprisonment, or both

Village forests

- Reserved forests assigned to a village community are called village forests.

Protected forests

- The state governments are empowered to designate protected forests and may prohibit the felling of trees, quarrying and the removal of forest produce from these forests.
- The preservation of protected forests is enforces through rules, licenses and criminal prosecutions.

Biodiversity Act 2000

- India's richness in biological resources and indigenous knowledge relating to them is well recognized.
- The legislation aims at **regulating access to biological resources** so as to ensure **equitable sharing of benefits**arising from their use.
- The Biological Diversity Bill was introduced in the Parliament in 2000 and was passed in 2002.

Salient features of the biodiversity legislation

- The main intent of this legislation is *to protect India's rich biodiversity and associated knowledge against their use by foreign individuals and organizations without sharing the benefits arising out of such use*, and to **check biopiracy**.
- This bill seeks to check biopiracy, protect biological diversity and local growers through a three-tier structure of central and state boards and local committees.
- The Act provides for setting up of a **National Biodiversity Authority (NBA)**, **State Biodiversity Boards (SBBs)** and **Biodiversity Management Committees (BMCs)** in local bodies. The NBA will enjoy the power of a **civil court**.
- BMCs promote conservation, sustainable use and documentation of biodiversity.
- NBA and SBB are required to consult BMCs in decisions relating to use of biological resources.
- All foreign nationals or organizations require prior approval of NBA for obtaining biological resources and associated knowledge for any use.
- Indian individuals/entities require approval of NBA for transferring results of research with respect to any biological resources to foreign nationals/organizations.
- Collaborative research projects and exchange of knowledge and resources are exempted provided they are drawn as per the policy guidelines of the Central Government.
- However, Indian citizens/entities/local people including vaids and hakims have free access to use biological resources within the country for their own use, medicinal purposes and research purposes.

- While granting approvals, NBA will impose terms and conditions to secure equitable sharing of benefits.
- Before applying for any form of IPRs (Intellectual Property Rights) in or outside India for an invention based on research on a biological resource obtained from India, prior approval of NBA will be required.
- The monetary benefits, fees, royalties as a result of approvals by NBA will be deposited in **National Biodiversity Fund**.
- NBF will be used for conservation and development of areas from where resource has been accessed, in consultation with the local self-government concerned.
- There is provision for notifying **National Heritage Sites** important from standpoint of biodiversity by State Governments in consultation with local self-government.
- There also exists provision for notifying items, and areas for exemption provided such exclusion does not violate other provisions. This is to exempt normally traded commodities so as not to adversely affect trade.

How does National Biodiversity Authority (NBA) help in protecting the Indian agriculture?

1. NBA checks the biopiracy and protects the indigenous and traditional genetic resources.
2. NBA directly monitors and supervises the scientific research on genetic modification of crop plants.
3. Application for intellectual Property Rights related to genetic / biological resources cannot be made without the approval of NBA.

Which of the statements given above is/are correct?

a. 1 only
b. 2 and 3 only
c. 1 and 3 only
d. 1, 2 and 3

The top biotech regulator in India for Genetically Modified Organisms is **Genetic Engineering Appraisal Committee (GEAC)**.

Answer: c) 1 and 3 only

The Scheduled Tribes And Other Traditional Forest Dwellers (Recognition Of Forest Rights) Act, 2006

- Forest Rights Act, 2006 provides for the restitution of deprived forest rights across India.
- The Act is provides scope of integrating conservation and livelihood rights of the people.

FRA is tool

- To empower and strengthen the local self-governance
- To address the livelihood security of the people
- To address the issues of Conservation and management of the Natural Resources and conservation governance of India.

For the first time Forest Rights Act recognizes and secures

- Community Rights in addition to their individual rights
- Right to protect, regenerate or conserve or manage any community forest resource which the communities have been traditionally protecting and conserving for sustainable use.
- Right to intellectual property and traditional knowledge related to biodiversity and cultural diversity
- Rights of displaced communities & Rights over developmental activities

Salient Features

- Nodal Agency for the implementation is Ministry of Tribal Affairs (MoTA).
- This Act is applicable for Tribal and Other Traditional Forest Dwelling Communities.
- The Act provides for recognition of forest rights of **other traditional forest dwellers** provided they have for at least three generations prior to 13.12.2005 primarily resided in and have depended on the forests for bonafide livelihood needs.
- The maximum limit of the recognizing rights on forest land is **4 ha.**

- **National Parks** and **Sanctuaries** have been included along with Reserve Forest, Protected Forests for the recognition of Rights.
- The Act recognizes the right of ownership access to collect, use, and dispose of minor forest produce by tribals.
- Minor forest produce includes all non-timber forest produce of plant origin, including bamboo, brush wood, stumps, cane, tussar, cocoons, honey, wax, lac, leaves, medicinal plants and herbs, roots, tubers and the like.
- The rights conferred under the Act shall be heritable but not alienable or transferable.
- As per the Act, the **Gram Sabha** has been designated as the competent authority for initiating the process of determining the nature and extent of individual or community forest rights.

National Green Tribunal Act, 2010

- Act of the Parliament of India which enables creation of **NGT** to handle the expeditious disposal of the cases pertaining to environmental issues.
- It was enacted under India's constitutional provision of **Article 21**, which assures the citizens of India the **right to a healthy environment**.
- The specialized architecture of the NGT will facilitate **fast track resolution of environmental cases** and provide a boost to the implementation of many sustainable development measures.
- NGT is mandated to dispose the cases within **six months** of their respective appeals.

Origin

- During the Rio de Janeiro summit of United Nations Conference on Environment and Development in June 1992, India vowed the participating states to provide **judicial and administrative remedies** for the victims of the pollutants and other environmental damage.

Members

- The sanctioned strength of the tribunal is currently 10 expert members and 10 judicial members although the act allows for up to 20 of each.

- The Chairman of the tribunal who is the administrative head of the tribunal also serves as a judicial member.
- Every bench of tribunal must consist of at least one expert member and one judicial member.
- The Chairman of the tribunal is required to be a **serving or retired Chief Justice of a High Court or a judge of the Supreme Court of India**.

Jurisdiction

- The Tribunal has Original Jurisdiction on matters of "substantial question relating to environment" (i.e. a community at large is affected, damage to public health at broader level) & "damage to environment due to specific activity" (such as pollution).
- The term "substantial" is not clearly defined in the act.

Notable orders

- Ban on decade old Diesel vehicles at Delhi NCR
- NGT cleared three-day World Culture Festival (Art of Living) on the floodplains of the Yamuna in March but imposed a fine of Rs 5 crore as an interim compensation.

The National Green Tribunal Act, 2010 was enacted in consonance with which of the following provisions of the Constitution of India?

1. Right to healthy environment, construed as a part of part of Right to life under Article 21.
2. Provision of grants for raising the level of administration in the Scheduled Areas for the welfare of Scheduled Tribes under Article 275(1)

Which of the statements given above is/are correct ?

a. 1 only
b. 2 only
c. Both 1 and 2
d. Neither 1 nor 2

Answer: a)

Acts for Protecting Coastal Environment and Wetlands

Coastal Regulation Zone (CRZ)

- The coastal stretches of seas, bays, estuaries, creeks, rivers and back waters which are influenced by tidal action are declared "Coastal Regulation Zone" (CRZ) in 1991.
- India has created institutional mechanisms such as **National Coastal Zone Management Authority (NCZMA)** and State Coastal Zone Management Authority (SCZMA) for enforcement and monitoring of the CRZ Notification.
- These authorities have been delegated powers under Section 5 of the **Environmental (Protection) Act, 1986** to take various measures for protecting and improving the quality of the coastal environment and preventing, abating and controlling environmental pollution in coastal areas.

Classification Criteria and Regulatory Norms

- The coastal regulation zone has been classified for the purpose of regulation of the permitted activities.

CRZ-I:

- Ecological sensitive area and the area between High Tide Line (HTL) and Low Tide Line (LTL).
- **No new construction** is permitted **except** for a few specified most essential activities like support activities for Atomic Energy Plants and Defense requirements, facilities required for disposal of treated effluents and other port related water front activities.

CRZ-II:

- The area that have been developed up to or close to the shore line which includes the designated urban areas that are substantially built up.

- Buildings permitted only on the landward side of the existing authorized structures as defined in the notification.

CRZ-III:

- The areas that are relatively undisturbed and those which do not belong to either CRZ-I or CRZ-II which includes mainly the rural area and those not substantially built up within designated urban areas.
- The area up to 200 meters from HTL is earmarked as "No Development Zone".
- No construction is permitted within this zone except for repairs to the existing authorized structures.
- Development of vacant plots between 200 and 500 meters of HTL is permitted in CRZ III for the purpose of construction of dwelling units and **hotels/beach resorts** subject to certain conditions.

CRZ-IV

- The activities impugning on the sea and tidal influenced water bodies will be regulated except for traditional fishing and related activities undertaken by local communities.
- No untreated sewage, effluents, pollution from oil drilling shall be let off or dumped.

Wetlands (Conservation And Management) Rules 2010

- MoEF has notified the rules in order to ensure that there is no further degradation of wetlands.
- The rules specify activities which are harmful to wetlands such as industrialization, construction, dumping of untreated waste and reclamation and prohibit these activities in the wetlands.
- Other activities such as harvesting and dredging may be carried out in the wetlands but only with prior permission from the concerned authorities.
- Under the Rules, wetlands have been classified for better management and easier identification.
- **Central Wetland Regulatory Authority** has been set up to ensure proper implementation of the Rules.

Animal Welfare Board of India

- **Statutory advisory body** advising the Government of India on animal welfare laws, and promotes animal welfare in the country of India.
- It works to ensure that animal welfare laws in the country are followed; provides grants to Animal Welfare Organizations; and considers itself "the face of the animal welfare movement in the country."
- It was established in 1960 under Section 4 of **The Prevention of Cruelty to Animals Act,1960.**
- Well-known humanitarian **Rukmini Devi Arundale** was instrumental in setting up the board.
- The subject of Prevention of Cruelty to Animals is under **MoEF**.

Role of Information Technology in Environment:

The important roles of information technology in environment are as follows:

1. Remote Sensing:

Remote sensing technique through satellite can be used to assess ongoing changes in the environment and to predict natural calamities like droughts, floods and volcanic eruptions etc. The technique is of great use in exploring the possible availability of crude oils, mineral deposits and location of geothermal power sources.

2. Database:

Database is the collection of inter-related data on various subjects. It is usually in computerized form and can be retrieved whenever required. There are several Distribution Information Centres (DICs) in our country that are linked with each other and with the central information network having access to international database.

The Ministry of Environment and Forests, Government of India has taken up the task of compiling a database on issues like wildlife, forest cover, wastelands etc.

3. Environmental Information System (ENVIS):

ENVIS established in 1982 aims on providing environmental information to decision makers, policy planners, engineers and scientists all over the country. ENVIS centres work for generating a network of database in areas like pollution control, clean technologies, biodiversity, renewable energy, wildlife, environmental management and remote sensing.

Objectives of ENVIS:

a. To build up a repository and dissemination centre in Environmental Science and Engineering.

b. To gear up modern technologies of acquiring, processing, storage, retrieval and dissemination of information of environmental nature.

c. To promote research, development and innovation in environmental information technology.

d. To provide national environmental information service relevant to meet the future needs.

ENVIS Network:

ENVIS has a network of several participating institutions forming a number of nodes, known as ENVIS centres, which work with a Focal Point in the Ministry of Environment and Forests. Due to its compact network, ENVIS has been designed as the National Focal Point (NFP) for INFOTERRA, a global environmental information network of United Nations Environment Programme (UNEP).

a. ENVIS India is in process of establishing 85 ENVIS nodes of which 81 have already been established which include government departments, institutions and NGO's.

b. ENVIS nodes are supposed to create websites on specific environment related areas, establishes linkages with all information

sources, create database on selected parameters and publish bulletins. They serve as interface for the users on the assigned subject.

4. National Management Information System (NMIS):

NMIS of the Department of Science and Technology has compiled a database on Research and Development projects along with information about research scientists and personnel involved.

5. Geographical Information System (GIS):

GIS has proved to be a very effective tool in environmental management. GIS is a technique of superimposing various thematic maps using digital data on a large number of inter-related or inter-dependent aspects. Different thematic maps containing digital information on a number of aspects like water resources, forest land, soil type, crop land, industrial growth, human settlement etc. are superimposed in a layered form in computer using soft-wares.

Applications of GIS:

GIS is very useful for future land use planning and for interpretating polluted zones and degraded lands.

a. GIS also provides information of atmospheric phenomenon like approach of monsoon, ozone layer depletion, smog and inversion phenomenon etc.

b. Planning for locating suitable areas for industrial growth is now being done using GIS by preparing Zoning Atlas.

c. GIS and remote sensing play a key role in resource mapping, environmental conservation and environmental impact assessment.

Role of Information Technology in Human Health:

Information technology is playing a major role in bioinformatics, genome sequencing, biotechnology, gene engineering, online medical transcription and in maintaining DTA databases for a better human health. It also helps in identifying several disease-infected areas which are prone to some vector-borne diseases like malaria, schistosomiasis etc. based upon mapping of such areas.

Bioinformatics, an emerging field of it is used in curing severe diseases like osteoporosis and in human genome project (HGP) by developing a computer programme that helps in completing the genome sequencing. The aim of HGP is to create a map of entire set of genes (genome) in the human cell by decoding the three billion units of human DNA.

Online Information on Health:

It provides vast quantum of information on different subjects including human health and environment. The patient can seek help of a super-specialist doctor placed at far off distance. The National Institute of Occupational Health provides computerized information on occupational health of people working in various hazardous and non-hazardous industries and safety measures etc.

Recently, an American Company M-square started Home Medican Transcription System (Hometrans) under which a medical online service can be started from home. The person interested in it needs to have a computer, telephone, helpline, voice script software and an internet for operating medical transcription.

World Wide Web (www):

A vast quantum of current data is available on World Wide Web. One of the most important online learning centre with power web is **www dot mhhe dot com** which provides current information on environmental science.

Other important websites of organisations and publications in the field of environment are:

Organisations/Publications	Websites
Centre for Science and Environment (CSE), India.	www.cseindia.org
Centre for Environmental Information, New York.	www.awa.com/nature/cei
Bombay Natural History Society (BNHS).	www.bhns.org
Centre for Environment Education (CEE), India	www.education.vsnl.com/cee/india.html
Defenders for Wildlife.	www.defenders.org
Envirolink Network.	www.envirolink.org
Environment Protection Agency	www.epa.gov
Greenpeace	www.greenpeace.org
Natural Resource Conservation Service, USDA.	www.nrcs.usda.gov
World Wide Fund for Nature, India.	www.wwfindia.org
World Watch Institute.	www.worldwatch.org
Population Reference Bureau.	www.prb.org/prb/
Kalpavriksh, Pune, India.	www.kalpavriksh.tripod.com

Information technology is expanding rapidly with increasing applications and new avenues are being opened with effective role in education, management and planning in the field of environment and health.

****