Environmental Studies

AEC- 02

SELF LEARNING MATERIAL

DIRECTORATE

OF DISTANCE EDUCATION

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Unit 1

Introduction to environmental studies:

Multidisciplinary nature of environmental studies:-

Environment belongs to all the lining beings and thus is, important for all. Each and every body of whatever occupation he or she may have is affected by environmental issues like global warming, depletion of ozone layer, dwindling forest, energy resources, loss of global biodiversity etc..

Environment study deals with the analysis of the processes in water, air, land, soil and organisms which leads to pollute or degrade environment. It helps us for establishing standard, for safe, clean and healthy natural ecosystem. It also deals with important issues like safe and clean drinking water, hygienic living conditions and clean and fresh air, fertility of land, healthy food and development.

Multidisciplinary Nature of Environmental Studies:

Because, the environment is complex and actually made up of many different environments, including natural, constructed and cultural environments, environmental studies is the inter disciplinary examination of how biology, geology, politics policy studies, law, geology, religion engineering, chemistry and economics combine to inform the consideration of humanity’s effects on the natural world.

This subject educates the students to appreciate the complexity of environmental issues and citizens and experts in many fields. By studying environmental science, students may develop a breadth of the interdisciplinary and methodological knowledge in the environmental fields that enables them to facilitate the definition and solution of environmental problems.

It is essentially a multidisciplinary approach and its components include Biology, Geology, Chemistry, Physics, Engineering, Sociology, Health Sciences, Anthropology, Economics, Statistics and Philosophy. It is essentially a multidisciplinary approach.

An Understanding of the working of the environment requires the knowledge from wide ranging fields. The Table 1.1 below shows a list of topics dealt commonly in air pollution and the related traditional fields of knowledge illustrating the interdisciplinary nature of the subject.

Table 1.1. Interdisciplinary Nature of Environmental Science:

Ex: Air Pollution:

Environmental issue/topics	**Major subject/ Topic knowledge required**
Nature and reaction of air pollutants	Chemistry and Chemical engineering
Effects of air pollutants on human beings, animal and plants	Zoology and botany and various branches of life science. Physics and Chemistry
Effect of air pollutants on materials	Meteorology, Thermodynamics, Geography
Effect of climate on air pollution	Mathematical modeling, etc.
Air pollution control devices	Physics, chemistry and various branches of Engineering
History of air pollution and air	History

pollution episodes	
Economic impacts of air pollution	Economics, Demography
Sociological impacts of air pollution	Sociology
Alternative fuels	Various branches of physical sciences
Conservation of resources and pollution control	Various branches of physical and political sciences
Ozone hole and global warming	Almost all fields under the sun has got something to contribute to the understanding and prevention of these phenomenon.

Components of environment atmosphere

Environment:- Everything that surrounds or affects an organism during its life time is collectively known as its environment or simply put everything surrounding a living organism like people; place and things constitute its environment which can be either natural or man-made. The word environment has been derived from a French word ‘environner’ meaning to encircle or to surround. In the beginning, environment of early man consisted of only physical aspects of the planet earth such as land (lithosphere), air (atmosphere) and water (hydrosphere) along with biotic communities but, with the passage of time and advancement of society man extended his environment to include his social, economic and political functions too. At the organismic level it is essentially physiological interaction which tries to understand that how different organisms are adapted to their environment in terms of not only survival but also reproduction and propagation of their population. All organisms (from virus to man) are obligatorily dependent on the environment for various essential needs such as food, shelter, water, oxygen etc. The surrounding that affects an organism during its lifetime is collectively known as its environment. In another words “Environment is sum total of water, air and land inter-relationships among themselves and also with the human being, other living organisms and material goods”. It comprises all the physical and biological surrounding

and their connections. Environmental studies give an approach towards understanding the environment of our globe and the impact of human life upon the environment and vice-versa. Thus environment is actually universal in nature and it is a multidisciplinary subject counting physics, chemistry, geology, geography, history, economics, physiology, biotechnology, remote sensing, geophysics, soil science and hydrology etc.

Environment belongs to all the biotic and abiotic components and therefore is, vital for all. Consequently, everyone is affected by environmental issues like global warming, depletion of ozone layer, dwindling forest, depleting energy resources, loss of biodiversity etc. Environment also deals with the analysis of the processes in hydrosphere, atmosphere, lithosphere, and organisms which leads to pollute biosphere. Environment helps us for setting benchmark for safe and healthy natural ecosystem.

DEFINITION AND SCOPE: -

The surroundings or settings in which a human being, animal, or plant lives or operates or it is a set of conditions of a living being all the natural forces which provide settings for Definition of Environment: - 'The term environment is used to describe, in the aggregate, all the external forces, influences and conditions, which affect the life, nature behaviour and the growth, development and maturity of living organisms' (Douglas and Holland). 'Environment refers to the sum total of all conditions which surround man at a given point in space and time' (C.C.Park) The entire range of external influence acting on an organism, both the physical and biological, and other organisms, i.e. forces of nature surrounding an individual. (Encyclopedia Britannica) Total environmental system including not only the biosphere, but also his interactions with his natural and man-made surroundings (US Council on Environmental quality). development and growth as well as danger and damage. In a comprehensive form the environment may be defined as "sum total of living, non-living components; influences and events, surrounding an organism." Environment is defined more comprehensively by others 'as a holistic view of the world as its functions at any point of time, with a multitude of spatial elemental and socio-economic systems distinguished by quality and attributes of space and mode of behaviour of abiotic and biotic forms.' (K.R. Dikshit, 1984)

Environment is argued as an inseparable whole and is constituted by the interacting systems of physical, biological and cultural elements, which are interlinked individually as well as collectively in myriad ways. Physical elements (space, landforms, water bodies, climate, soils, rocks and minerals) determine variable character of the human habitat, its opportunities as well as limitations. Biological elements (plants, animals, micro-organisms and man) constitute the biosphere. Cultural elements (economic, social, political) are essentially manmade features which go into the making of cultural milieu (Savindra Singh and A. Dubey, 1983). Thus, environment is defined as '(1) the circumstances and conditions (physical conditions) that surround an organism or group of organisms, or (2) the social and cultural conditions that affect an individual or community. Since human inhabit the natural world as well as the 'built' or technological, social, and cultural world, all constitute part of our environment' (W.P.Cunnigham and M.A. Cunnigham, 2004).

Environmental knowledge is a multidisciplinary knowledge whose fundamental aspects have a direct significance to every segment of the planet. Its main characteristics include:

- Conservation and natural resources.
- Maintenance and management of biological diversity.
- Controlling and managing environmental pollution to permissible limit
- Stabilisation of human population and environment.
- Development of alternate sources of renewable energy systems
- Providing new dimension to nation's security through conservation, protection, management and maintenance of environment

It also deals with vital issues like safe and clean drinking water, hygienic living conditions and pollution free fresh air, fertility of land, healthy food and development of sustainable environmental laws, administration, environmental protection, management and environmental business are coming up as new opportunities for environment protection and managements. The relationship and interaction between organism and environment are highly complex and multidimensional. No organism can live alone without interacting with other organisms or other biotic/abiotic forms. So each organism has other organisms as a part of its environment. Each and everything with which we interact or which we need for our sustenance forms our environment. In fact, environment is visualised in different ways with different angles by different groups of people but it may be safely argued that 'environment is an inseparable whole and is constituted by the interacting system of physical, biological and cultural elements which are interlinked individually as well as collectively in myriad ways. The environment is not static; rather it's a very dynamic entity. Various factors (biotic & abiotic) are in a flux and keep changing the environment continuously.

TYPES OF ENVIRONMENT: -

On the basis of basic structure, the environment may be divided into

- Physical/abiotic environment
- Biotic environment

- Cultural environment

PHYSICAL/ABIOTIC ENVIRONMENT: -

on the basis of physical characteristics and state, abiotic or physical environment is subdivided into:

1. Solid i.e. lithosphere (solid earth)

2. Liquid i.e. hydrosphere (water component)

3. Gas i.e. atmosphere (gaseous component)

These environments can be termed as lithospheric, hydrosspheic, atmospheric environment which can be further broken into smaller units based on different spatial scales like mountain environment, plateau, plain, lake, river maritime, glacier, desert environment etc. The physical environment may also be viewed in terms of climatic conditions providing certain suits of habitat for biological communities like tropical, temperate and polar environment etc.

BIOTIC ENVIRONMENT-:

biotic environment consists of flora and fauna including man as an important factor. Thus the biotic environment may be divided into:

iv. Floral environment

v. Faunal environment

Further all the organisms work to form their social groups and organizations at several levels and thus is formed social environment, where in, the organisms work to derive matter from the physical environment for their sustenance and development. This process generates economic environment. It may be pointed out that of all the organisms man is the most skilled and civilize4d and hence his social organization is most systematic. It is significant to note that three aspects of man, physical, social and economic have different characteristics and functions in the biotic environment. As ‘physical man’ is one of the organismic populations or biological community and thus requires basic elements of physical environment (habitat, air, water, food etc.) like other biological populations and releases wastes into the ecosystem; ‘social man’ establishes social institutions forms social organisations, formulates laws and policies to safeguard his existence, interest and social welfare and ‘economic man’ derives and utilises resource from the physical and biotic environments with his skills and technologies. These may be termed as physical, social and economic functions of man. It is the third function which makes the man and environmental process because he transports matter and energy from one component of the ecosystem to the other. The word lithosphere originated from a Greek word mean "rocky" + "sphere” i.e. the solid outmost

shield of the rocky planet. The Earth is an oblate spheroid. It is composed of a number of different layers. These layers are:

COMPONENTS OF ENVIRONMENT: -

The basic components of the environment are atmosphere or the air, lithosphere or the rocks and soil, hydrosphere or the water, and the living component of the environment or the biosphere.

ATMOSPHERE: -

- the thick gaseous layer surrounding the earth.
- It spreads up to 300 km. above the earth's surface.
- Apart from gases there are water vapor, industrial gases, dust and smoke particles in suspended state, microorganism etc.

LITHOSPHERE: -

The word lithosphere originated from a Greek word mean "rocky" + "sphere" i.e. the solid outmost shield of the rocky planet. The Earth is an oblate spheroid. It is composed of a number of different layers. These layers are:

- The Core which is around 7000 kilometers in diameter (3500 kilometers in radius) and is situated at the Earth's center.
- The Mantle which environs the core and has a thickness of 2900 kilometers.
- The Crust floats on top of the mantle and is composed of basalt rich oceanic crust and granitic rich continental crust.

HYDROSPHERE: -

- The hydrosphere includes all water on or near earth surface and includes oceans, lakes, rivers, wetlands, icecaps, clouds, soils, rock layers beneath surface etc.
- water exist in all three states: solid (ice), liquid (water), and gas (water vapor)
- 71%of planet surface is covered with water
- Freshwater- 2.53%
- Freshwater in glaciers-1.74%

- Water as water vapour in atmosphere-12,900 km3
- living organism contain- 1100 km3

Since the environment includes both physical and biological concept, it embraces both the abiotic (non-living) and biotic (living) components of planet earth. Thus, on account of basic structure the components of environment may be classified into two basic types:

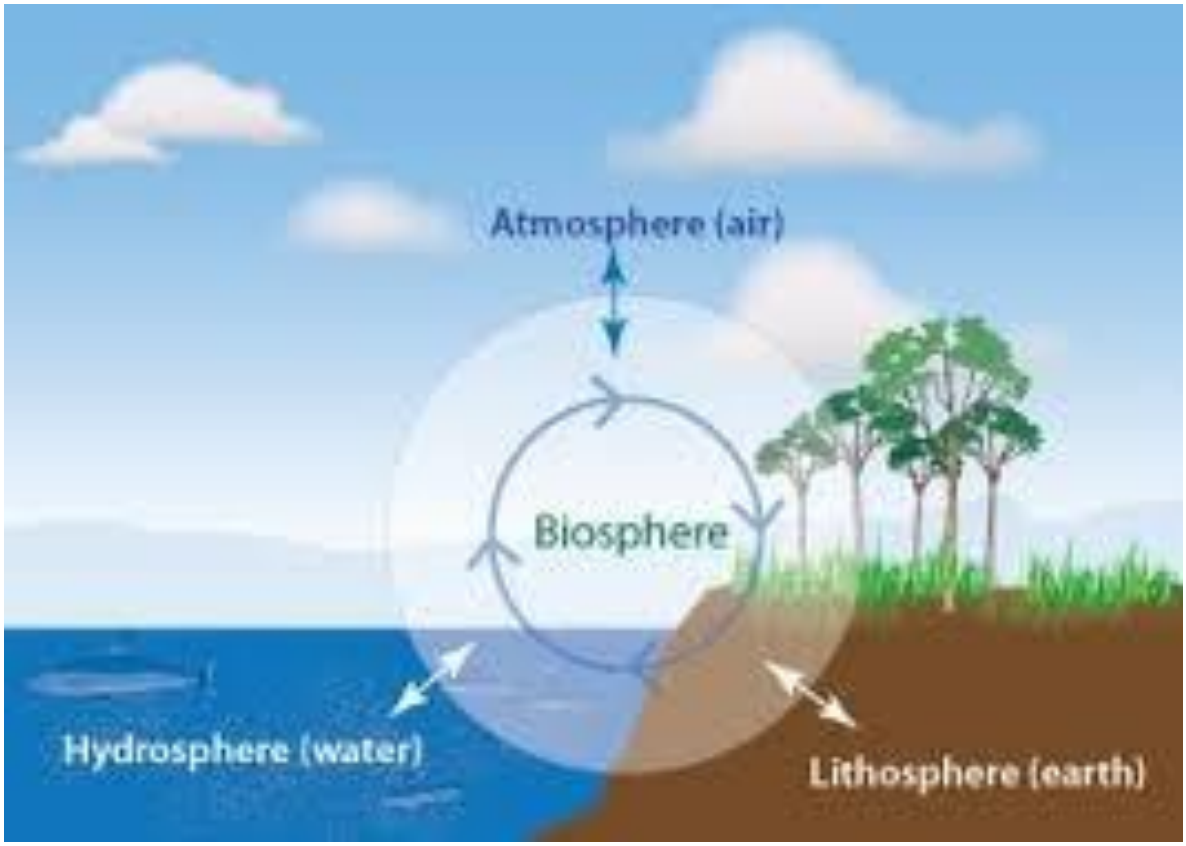

Fig. 1 Components of Environment.

ABIOTIC COMPONENTS (NON-LIVING): -

these are the most important determining factor of where and how well an organism exists in the environment. Although these factors interact with each other, one single factor can limit the range of an organism thus acting as the limiting factor. These factors can be categorised into following groups:

PHYSICAL FACTORS: -

the major components are temperature, Water (Rainfall), Light (Energy), Soil, Atmospheric pressure.

TEMPERATURE: -

Temperature is the most ecologically germane environmental factor. It's a very well-known and an established fact that the average temperature on land varies seasonally, decreasing progressively from the equator towards the poles and from plains to the top of mountains ranging from sub-zero levels to >50˚C in polar areas/high altitudes and tropical deserts in summer respectively. There are, however, unique habitats like thermal springs and deep-sea hydrothermal vents where average temperatures exceed 100˚C. It is commonly known fact that mango trees do not and cannot grow in temperate countries like Canada and Germany, snow leopards are not found in Kerala forests and tuna fish are rarely caught beyond tropical latitudes in the ocean. A few organisms can tolerate and thrive in a wide range of temperatures without having effect on their internal environment (they are called eurythermal), but, a vast majority of them operate within a narrow range of temperatures (such organisms are called stenothermal).

WATER (RAINFALL): -

Subsequent to temperature, water is another most important factor influencing the life of organisms. In fact, genesis of life on earth is attributed to water without which life is unsustainable. Its availability is too scarce in deserts. Due to this scarcity only special adaptations by plants and animals of this region make it possible to survive there in such an unusual living conditions. The productivity and distribution of plants is also profoundly dependent on water. One might believe that organisms living in oceans, lakes, rivers and other water bodies should not face any water-related problems, but it doesn't hold true. For aquatic organisms the quality (chemical composition, pH) of water becomes crucial and one of the most determining factor for their survival. The saline concentration (measured as salinity in parts per thousand), is less than 5 % in inland waters, 30-35 % in the sea and >100 % in some hypersaline lagoons. Some organisms are tolerant to a wide range of salinity (referred as euryhaline) while others are restricted to a much narrow range of salinity (referred as stenohaline). Many freshwater animals cannot survive for long in sea water and vice versa because of the osmotic problems which would subsequently lead to their death.

LIGHT (ENERGY): -

One can quickly and easily understand the importance of light/energy for living organisms, particularly autotrophs since they produce/manufacture food through photosynthesis, a specialised process which is only possible with the availability of sunlight as a source of energy. Many plants are also dependent on sunlight to meet their photoperiodic requirement for flowering. For many animals too, light is essential as they use the diurnal and seasonal variations in light intensity and duration (photoperiod) as cues for timing their searching food, reproductive and migratory activities. The

availability of light on land is in close association with that of temperature since the sun is the source for both. But, deep (>500m) in the oceans, the environment is perpetually dark and its inhabitants are unaware of the existence of a celestial source of energy called Sun.

SOIL: -

The nature and properties of soil in various places vary to a great extent depending upon the climate which includes temperature and humidity, the weathering process, whether soil is transported or sedimentary and how soil development occurred. Various physical characteristics of the soil such as soil composition, grain size and aggregation determine the percolation and water holding capacity of the soil. These features along with chemical parameters such as pH, mineral composition and also topography determine to a large extent the vegetation in any area. This in turn indicates or rather determines the type of animals that can be supported on a particular soil area. Similarly, in an aquatic environment, the sediment-characteristics often determine the type of benthic animals that can thrive there optimally.

RESPONSES TO CHANGE IN ABIOTIC FACTORS: -

Abiotic conditions of many habitats may vary drastically in time, which raises an essential question –how do the organisms living in such changing habitats adapt themselves with stressful conditions? But, prior to delving into answering this inevitable question, one should perhaps ask first why a highly variable and ever changing external environment should create an inconvenience to an organism after all. One would expect that during the course of millions of years of their existence, many species would have evolved a relatively constant internal (within the body) environment that enables all biochemical reactions and physiological functions to progress with maximal efficiency and thus, enhance the overall ‘fitness’ of the species.

REGULATE: -

Some organisms are able to achieve and stabilize homeostasis by physiological (sometimes behavioural also) means which ensures constant body temperature, constant osmotic concentration, etc. All birds and mammals, and a very few lower vertebrate and invertebrate species are indeed capable of such regulation (thermoregulation and osmoregulation). Evolutionary biologists are of the opinion that the mammalian success is largely owing to their ability to adhere to a constant body temperature and thrive successfully whether they live in frigid Antarctica or in the blazing Sahara Desert. The mechanisms used by most mammals to regulate or stabilise their body temperature are similar to those of human beings. We, the humans, maintain a constant body temperature of 37˚C. In summer, when external temperature is more than our body temperature, we sweat profusely resulting in evaporation which leads to external body cooling thus lowering the overall body temperature. Likewise, in winter when the temperature is much lower than 37˚C, we start to shiver, leading to heat generation and thus raising the body temperature and thereby maintaining homeostasis

around 37˚C. Plants, on the other hand, do not possess such mechanisms to maintain internal temperatures and are thus unable to regulate homeostasis.

CONFORM: -

In literal English term it means to obey or agree to something. An overwhelming majority (99%) of animals and nearly all plants are unable to maintain a constant internal environment, thus inefficient in maintaining homeostasis. Their body temperature varies with the ambient temperature, rise with increasing temperature and fall with decreasing temperature most of the times. In aquatic animals, the osmotic concentrations of the body fluids change with that of the ambient water osmolality which itself depends upon the salinity of the surrounding water. Such animals and plants are simply conformers, meaning thereby that they just agree to the surrounding conditions rather than adopting any mechanism to stabilise their internal environment.

MIGRATE: -

The organisms can shift away temporarily from the stressful habitat to a more hospitable area and return when stressful period is over. In human analogy, this strategy is like a person moving from Delhi to Shimla for the duration of summer to avoid the stressful conditions of severe heat and return back to Delhi when temperature is more comfortable. Likewise, many animals, particularly birds, during winter undertake long-distance migrations to more hospitable areas and avoid the frigid conditions of their true environment. Every winter the famed Keoladeo National Park (Bharatpur) in Rajasthan host thousands of migratory birds coming from Siberia and other extremely cold northern regions which become temporarily inhospitable for them. Thus migration is a form of temporary shift of organism from its true habitat to an ecologically friendlier habitat due to more stressful conditions of true habitat.

SUSPEND: -

In bacteria, fungi and lower plants, various types of thick walled spores are formed which help them to survive unfavourable/extreme conditions – which subsequently germinate on availability of suitable environment. In higher plants, seeds and some other vegetative reproductive structures serve as means to resist the periods of stress besides helping in its dispersal – they germinate to form new plants under favorable moisture and temperature conditions. They do so by reducing their metabolic activity and going into a stage of ‘dormancy’.

In animals, the organism, if unable to migrate, might avoid the stress by escaping in time through the two phenomenon. The familiar case of bears going into hibernation during winter is an example of escape in time to avoid extreme of cold.

Some snails and fish go into aestivation (a state of animal dormancy characterized by inactivity and a lowered metabolic rate) to avoid extreme summer heat and desiccation.

Similarly, under unfavorable conditions many zooplankton species in lakes and ponds are known to enter diapause, (a stage of suspended/deferred development). Diapause, when referencing animal dormancy, is the delay in development in response to regularly and recurring periods of adverse environmental conditions.

INORGANIC AND ORGANIC SUBSTANCES: -

Water, Oxygen, Carbon, Nitrogen, Sulphur, Nitrates, Phosphates and ions of various metals etc. are inorganic substances essential for organisms to survive while proteins, Carbohydrates, Lipids etc. are essential Organic substances:

BIOTIC COMPONENTS (LIVING): -

It consists of the living parts of the environment, including the association of a lot of interrelated populations that belong to different species inhabiting a common environment. The populations are those of the animal community, the plant community and the microbial community.

The biotic community is divided into:

a. Autotrophs,

b. Saprotrophs, and

c. Heterotrophs

AUTOTROPHS

(derive from Greek word: auto - self, trophos - feeder) are called producers, transducers or convertors, as well. Those are photosynthetic plants, normally chlorophyll bearing, which synthesize a high-energy complex organic compound (food) from the inorganic raw materials utilizing the aid of the sun, and this process is called photosynthesis. Autotrophs form the core of all biotic systems. In terrestrial ecosystems, autotrophs are usually rooted plants. In the aquatic ecosystems, the floating plants referred to as phytoplankton and the shallow water rooted plants – macrophytes - are the main producers.

HETEROTROPHS

(from Greek: heteros - other; trophs - feeder) are the consumers, normally animals that feed on the other organisms. Consumers are also referred to as phagotrophs (phago - to swallow or ingest) while macroconsumers are normally herbivores and carnivores. Herbivores are called First order or primary consumers, for they feed directly on green plants. For example, Terrestrial ecosystem consumers are cattle, deer, grass hopper, rabbit, etc. Aquatic ecosystem consumers are protozoans, crustaceans, etc.

Carnivores are animals that prey or feed on other animals. Second order consumers or Primary carnivores include those animals that feed on herbivorous animals. For example, fox, frog, smaller fishes, predatory birds, snakes, etc.

Third order consumers or Secondary carnivores are the animals that feed on primary carnivores. For example, wolf, owl, peacock, etc. Some larger carnivores prey on Secondary carnivores. Quaternary consumers or Tertiary carnivores include those animals which feed upon secondary carnivores. For example, the lion, the tiger, etc. Those are not eated by any other animal. The larger carnivores which cannot be preyed on further are also called the top carnivores.

SAPROTROPHS

(from Greek again: sapros - rotten; trophos - feeder) are called the reducers or decomposers or osmotrophs. They break the complex organic compounds in dead matter down (dead plants and animals). Decomposers don't ingest the food. Instead they secrete a digestive enzyme into the dead, decaying plant or animal remains and digest this organic material. The enzymes act on the complex organic compounds in the dead matter. Decomposers absorb a bit of the decomposition products to provide themselves with nourishment. The remaining substance is added as minerals in the process of mineralisation to the substratum. Released minerals are utilised or reused as nutrients by plants - the producers.

Scope and importance

The science of Environment studies is a multi-disciplinary science because it comprises various branches of studies like chemistry, physics, medical science, life science, agriculture, public health, sanitary engineering etc. It is the science of physical phenomena in the environment. It studies of the sources, reactions, transport, effect and fate of physical a biological species in the air, water and soil and the effect of from human activity upon these.

Environment Explained

Literary environment means the surrounding external conditions influencing development or growth of people, animal or plants; living or working conditions etc. This involves three questions:

1. What is Surrounded The answer to this question is living objects in general and man in particular.

2. By what Surrounded

The physical attributes are the answer to this question, which become environment. In fact, the concern of all education is the environment of man. However, man cannot exist or be understood in isolation from the other forms of life and from plant life. Hence, environment refers to the sum total of condition, which surround point in space and time. The scope of the term Environment has been changing and widening by the passage of time. In the primitive age, the environment consisted of only physical aspects of the planted earth' land, air and water as biological communities. As the time passed on man extended his environment through his social, economic and political functions.

3. Where Surrounded The answer to this question. It is in nature that physical component of the plant earth, viz land, air, water etc., support and affect life in the biosphere. According to a Goudie environment is the representative of physical components of the earth where in man is an important factor affecting the environment.

(i) Definitions of Environment : Some important definitions of environment are as under:

1. Boring: ‘A person’s environment consists of the sum total of the stimulation which he receives from his conception until his death.’
It can be concluded from the above definition that Environment comprises various types of forces such as physical, intellectual, economic, political, cultural, social, moral and emotional. Environment is the sum total of all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturation of living organisms.

2. Douglas and Holland: ‘The term environment is used to describe, in the aggregate, all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturity of living organisms.’

(ii) Scope of Environment: The environment consists of four segments as under:

1. **Atmosphere**:

The atmosphere implies the protective blanket of gases, surrounding the earth:

(a) It sustains life on the earth.

(b) It saves it from the hostile environment of outer space.

(c) It absorbs most of the cosmic rays from outer space and a major portion of the electromagnetic radiation from the sun.

(d) It transmits only here ultraviolet, visible, near infrared radiation (300 to 2500 nm) and radio waves. (0.14 to 40 m) while filtering out tissue-damaging ultraviolate waves below about 300 nm.

The atmosphere is composed of nitrogen and oxygen. Besides, argon, carbon dioxide, and trace gases.

2. **Hydrosphere**:

The Hydrosphere comprises all types of water resources oceans, seas, lakes, rivers, streams, reserviour, polar icecaps, glaciers, and ground water.

(i) Nature 97% of the earth's water supply is in the oceans,

(ii) About 2% of the water resources is locked in the polar icecaps and glaciers.

(iii)Only about 1% is available as fresh surface water-rivers, lakes streams, and ground water fit to be used for human consumption and other uses.

3. **Lithosphere**:

Lithosphere is the outer mantle of the solid earth. It consists of minerals occurring in the earth's crusts and the soil e.g. minerals, organic matter, air and water.

4. **Biosphere**:

Biosphere indicates the realm of living organisms and their interactions with environment, viz atmosphere, hydrosphere and lithosphere.

Element of Environment

Environment is constituted by the interacting systems of physical, biological and cultural elements inter-related in various ways, individually as well as collectively. These elements may be explained as under:

(1) Physical elements

Physical elements are as space, landforms, water bodies, climate soils, rocks and minerals. They determine the variable character of the human habitat, its opportunities as well as limitations.

(2) **Biological elements**

Biological elements such as plants, animals, microorganisms and men constitute the biosphere

(3) **Cultural elements**

Cultural elements such as economic, social and political elements are essentially manmade features, which make cultural milieu.

ENVIRONMENT STUDIES: IMPORTANCE

Importance of Environment Studies: The environment studies enlighten us, about the importance of protection and conservation of our indiscriminate release of pollution into the environment.

At present a great number of environment issues, have grown in size and complexity day by day, threatening the survival of mankind on earth. We study about these issues besides and effective suggestions in the Environment Studies. Environment studies have become significant for the following reasons:

1. **Environment Issues Being of International Importance**

It has been well recognised that environment issues like global warming and ozone depletion, acid rain, marine pollution and biodiversity are not merely national issues but are global issues and hence must be tackled with international efforts and cooperation.

2. **Problems Cropped in The Wake of Development**

Development, in its wake gave birth to Urbanization, Industrial Growth, Transportation Systems, Agriculture and Housing etc. However, it has become phased out in the developed world. The North, to cleanse their own environment has, fact fully, managed to move ‘dirty’ factories of South. When the West developed, it did so perhaps in ignorance of the environmental impact of its activities. Evidently such a path is neither practicable nor desirable, even if developing world follows that.

3. **Explosively Increase in Pollution**

World census reflects that one in every seven persons in this planted lives in India. Evidently with 16 per cent of the world's population and only 2.4 per cent of its land area, there is a heavy pressure on the natural resources including land. Agricultural experts have recognized soils health problems like deficiency of micronutrients and organic matter, soil salinity and damage of soil structure.

4. Need for An Alternative Solution

It is essential, specially for developing countries to find alternative paths to an alternative goal. We need a goal as under:

(1) A goal, which ultimately is the true goal of development an environmentally sound and sustainable development.

(2) A goal common to all citizens of our earth.

(3) A goal distant from the developing world in the manner it is from the over-consuming wasteful societies of the “developed” world.

5. **Need To Save Humanity From Extinction**

It is incumbent upon us to save the humanity from exinction. Consequent to our activities constricting the environment and depleting the biosphere, in the name of development.

6. **Need For Wise Planning of Development**

Our survival and sustenance depend. Resources withdraw, processing and use of the product have all to by synchronised with the ecological cycles in any plan of development our actions should be planned ecologically for the sustenance of the environment and development.

7. **Misra’s Report**

Misra (1991) recognized four basic principles of ecology, as under:

(i) Holism

(ii) Ecosystem

(iii) Succession

(iv) Conversation.

Holism has been considered as the real base of ecology. In hierarchical levels at which interacting units of ecology are discussed, are as under:

Individual<population<community<ecosystem<biome

Misra (1991) has recognised four basic requirements of environmental management as under:

(i) Impact of human activities on the environment,

(ii) Value system,

(iii) Plan and design for sustainable development,

(iv) Environment education.

Keeping in view the of goal of planning for environmentally sustainable development India contributed to the United Nations Conference on Environment and Development

(UNCED), also referred to as “Earth Summit” held at Rio de Janciro, the Capital of Brazil, 3rd-14th June, 1992.

NEED FOR PUBLIC AWARENESS

It is essential to make the public aware of the formidable consequences of the Environmental Degradation, if not retorted and reformative measures undertaken, would result in the extinction of life. We are facing various environmental challenges. It is essential to get the country acquainted with these challenges so that their acts may be eco-friendly. Some of these challenges are as under:

1. **Growing Population**

A population of over thousands of millions is growing at 2.11 per cent every year. Over 17 million people are added each year. It puts considerable pressure on its natural resources and reduces the gains of development. Hence, the greatest challenge before us is to limit the population growth. Although population control does automatically lead to development, yet the development leads to a decrease in population growth rates. For this development of the women is essential.

2. **Poverty**

India has often been described a rich land with poor people. The poverty and environmental degradation have a nexus between them. The vast majority of our people are directly dependent on the nature resources of the country for their basic needs of food, fuel shelter and fodder. About 40% of our people are still below the poverty line. Environment degradation has adversely affected the poor who depend upon the resources of their immediate surroundings. Thus, the challenge of poverty and the challenge environment degradation are two facets of the same challenge. The population growth is essentially a function of poverty. Because, to the very poor, every child is an earner and helper and global concerns have little relevance for him.

3. **Agricultural Growth**

The people must be acquainted with the methods to sustain and increase agricultural growth with damaging the environment. High yielding varities have caused soil salinity and damage to physical structure of soil.

4. **Need to Ground water**

It is essential of rationalizing the use of groundwater. Factors like community wastes, industrial effluents and chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater. It is essential to restore the water quality of our rivers and other water bodies as lakes is an important challenge. It so finding our

suitable strategies for consecration of water, provision of safe drinking water and keeping water bodies clean which are difficult challenges is essential.

5. **Development And Forests**

Forests serve catchments for the rivers. With increasing demand of water, plan to harness the mighty river through large irrigation projects were made. Certainly, these would submerge forests; displace local people, damage flora and fauna. As such, the dams on the river Narmada, Bhagirathi and elsewhere have become areas of political and scientific debate.

Forests in India have been shrinking for several centuries owing to pressures of agriculture and other uses. Vast areas that were once green, stand today as wastelands. These areas are to be brought back under vegetative cover. The tribal communities inhabiting forests respects the trees and birds and animal that gives them sustenance. We must recognize the role of these people in restoring and conserving forests. The modern knowledge and skills of the forest deptt. should be integrated with the traditional knowledge and experience of the local communities. The strategies for the joint management of forests should be evolved in a well planned way.

6. **Degradation of Land**

At present out of the total 329 mha of land, only 266 mha possess any potential for production. Of this, 143 mha is agricultural land nearly and 85 suffers from varying degrees of soil degradation. Of the remaining 123 mha, 40 are completely unproductive. The remaining 83 mha is classified as forest land, of which over half is denuded to various degrees. Nearly 406 million head of livestock have to be supported on 13 mha, or less than 4 per cent of the land classified as pasture land, most of which is overgrazed. Thus, our of 226 mha, about 175 mha or 66 per cent is degraded to varying degrees. Water and wind erosion causes further degradation of almost 150 mha This degradation is to be avoided.

7. Reorientation of Institutions

The people should be roused to orient institutions, attitudes and infrastructures, to suit conditions and needs today. The change has to be brought in keeping in view India’s traditions for resources use managements and education etc. Change should be brought in education, in attitudes, in administrative procedures and in institutions. Because it affects way people view technology resources and development.

8. **Reduction of Genetic Diversity**

Proper measures to conserve genetic diversity need to be taken. At present most wild genetic stocks have been disappearing from nature. Wilding including the Asiatic Lion are facing problem of loss of genetic diversity. The protected areas network like sanctuaries, national parks, biosphere reserves are isolating populations. So, they are

decreasing changes of one group breeding with another. Remedial steps are to be taken to check decreasing genetic diversity.

9. **Evil Consequences of Urbanization**

Nearly 27 per cent Indians live in urban areas. Urbanisation and industrialisation has given birth to a great number of environmental problem that need urgent attention. Over 30 percent of urban Indians live in slums. Out of India's 3,245 towns and cities, only 21 have partial or full sewerage and treatment facilities. Hence, coping with rapid urbanization is a major challenge.

10. **Air and water Population**

Majority of our industrial plants are using outdated and population technologies and makeshift facilities devoid of any provision of treating their wastes. A great number of cities and industrial areas that have been identified as the worst in terms of air and water pollution. Acts are enforced in the country, but their implement is not so easy. The reason is their implementation needs great resources, technical expertise, political and social will. Again the people are to be made aware of these rules. Their support is indispensable to implement these rules.

VARIOUS TYPES OF ENVIRONMENT

According to Kurt Lewin, environment is of three types which influence the personality of an individual as under:

(a) Physical Environment,

(b) Social and Cultural Environment, and

(c) Psychological Environment.

These may be explained as under:

1. Physical Environment

Physical environment, refers to geographical climate and weather or physical conditions wherein and individual lives. The human races are greatly influenced by the climate. Some examples are as under:
(a) In the cold countries i.e. European countries the people are of white colour. Likewise, in Asian and African countries, that is, in hot countries people are of dark complexion.

(b) The physique of an individual depends on climate conditions as the individual tries to adjust in his physical environment.

(c) The human working efficiency also depends on the climatic conditions.

2. Social Environment

Social Environment includes an individual's social, economic and political condition wherein he lives. The moral, cultural and emotional forces influence the life and nature of individual behaviour. Society may be classified into two categories as under:

(i) An open society is very conductive for the individual developement.

(ii) A closed society is not very conductive for the developenment.

3. Psychological Environment

Although physical and social environment are common to the individual in a specific situation. Yet every individual has his own psychological environment, in which he lives. Kurt Lewin has used the term 'life space' for explaining psychological environment. The Psychological environment enables us to understand the personality of an individual. Boththe person and his goal form psychological environment.

If a person is unable to overcome the barriers, he can either get frustrated or completed to change his goal for a new psychological environment. But adopting this mechanism, the individual is helped in his adjustment to the environment.

STRUCTURE OF ENVIRONMENT

Environment is both physical and biological. It includes both living and non-living components.

(i) Physical Environment

The Physical Environment is classified into three broad categories viz.

(i) Solid,

(ii) Liquid

(iii) Gas.

These represent the following spheres:

(i) The lithosphere (solid earth)

(ii) The hydrosphere (water component) and

(iii) The atmosphere

As such, the three basic of physical environment may be termed as under:

(i) Lithospheric Environment

(ii) Hydrospheric Environment

(iii) Atmospheric Environment

The scientists have classified them into smaller units based on different spatial scales, e.g.

(i) Mountain Environment

(ii) Glacier Environment

(iii) Plateau Environment

(iv) Coastal Environment

(ii) Biological Environment

The biological of the environment consists of:

(i) Plants (flora)

(ii) Animals (fauna).

Thus, the biotic environment further be divided into floral environment and faunal environment. All the organisms work to form their social groups and organizations at several levels. Thus, the social environment is formed. In this social environment the organisms work to derive matter from the physical environment for their sustenance and development. This process gives birth to economic environment. Man claims to be most skilled and civilized of all the organisms. This is the reason why his social organisation is most systematic. The three aspects of man, e.g. physical, social and economic, function in the biotic environment as under:

(i) The Physical Man

The ‘Physical Man’ is one of the organisms populations or biological community. He is in need of basic elements of the physical environment like habitat (space), air, water and food. Besides, like other biological populations, he releases wastes into the ecosystem.

(ii) The Social Man

The ‘Social Man’ performs the following functions:

(a) Establishing social institutions,

(b) Forming social organisations,

(c) Formulating laws, principles and policies,

(d) Taking steps to safeguard his existence, interest and social welfare.

(iii) The Economic Man

The economic man derives and utilises resources from the physical and biotic environment with his skills and technologies. The economic function makes the man an environment/ geomorphic process as he transports matter and energy from one component of the ecosystem to the other. There may be any following two situations:

(a) His exploitative functions may be in harmony with the natural environment. Such, functions do not necessarily involve change in the working of the ecosystem.

(b) These functions may exceed the critical limit. Consequently, the equilibrium of the environment/ecosystem is disturbed and a great number of environment and ecological problems crop up. These are determental to man him besides to whole population of human species in a given ecosystem.

Unit 2

Ecosystems & Biodiversity and conservation

What is ecosystem?

An ecosystem, a term very often used in biology, is a community of plants and animals interacting with each other in a given area, and also with their non-living environments. The non-living environments include weather, earth, sun, soil, climate and atmosphere.

The ecosystem relates to the way that all these different organisms live in close proximity to each other and how they interact with each other. For instance, in an ecosystem where there are both rabbits and foxes, these two creatures are in a relationship where the fox eats the rabbit in order to survive. This relationship has a knock-on effect with the other creatures and plants that live in the same or similar areas. For instance, the more rabbits that foxes eat, the more the plants may start to thrive because there are fewer rabbits to eat them.

According to Wikipedia,

“An ecosystem is a community of living organisms in conjunction with the nonliving components of their environment (things like air, water and mineral soil), interacting as a system. These biotic and abiotic components are regarded as linked together through nutrient cycles and energy flows.

As ecosystems are defined by the network of interactions among organisms, and between organisms and their environment, they can be of any size but usually encompass specific, limited spaces (although some scientists say that the entire planet is an ecosystem).”

Ecosystems can be huge, with many hundreds of different animals and plants all living in a delicate balance, or they could be relatively small. In particularly harsh places in the world, such as the North and South Poles, the ecosystems are relatively simple because there are only a few types of creatures that can withstand the freezing temperatures and harsh living conditions.

Some creatures can be found in multiple different ecosystems all over the world in different relationships with other or similar creatures. Ecosystems also consist of creatures that mutually benefit from each other.

For instance, a popular example is that of the clownfish and the anemone – the clownfish cleans the anemone and keeps it safe from parasites as the anemone stings bigger predators that would otherwise eat clownfish.

Structure and function of ecosystem

An organism is always in the state of perfect balance with the environment. The environment literally means the surroundings.

The environment refers to the things and conditions around the organisms which directly or indirectly influence the life and development of the organisms and their populations.

“Ecosystem is a complex in which habitat, plants and animals are considered as one interesting unit, the materials and energy of one passing in and out of the others” – Woodbury.

Organisms and environment are two non-separable factors. Organisms interact with each other and also with the physical conditions that are present in their habitats.

“The organisms and the physical features of the habitat form an ecological complex or more briefly an ecosystem.” (Clarke, 1954).

The concept of ecosystem was first put forth by A.G. Tansley (1935). Ecosystem is the major ecological unit. It has both structure and functions. The structure is related to species diversity. The more complex is the structure the greater is the diversity of the species in the ecosystem. The functions of ecosystem are related to the flow of energy and cycling of materials through structural components of the ecosystem.

According to Woodbury (1954), ecosystem is a complex in which habitat, plants and animals are considered as one interesting unit, the materials and energy of one passing in and out of the others.

According to E.P. Odum, the ecosystem is the basic functional unit of organisms and their environment interacting with each other and with their own components. An ecosystem may be conceived and studied in the habitats of various sizes, e.g., one square metre of grassland, a pool, a large lake, a large tract of forest, balanced aquarium, a certain area of river and ocean.

All the ecosystems of the earth are connected to one another, e.g., river ecosystem is connected with the ecosystem of ocean, and a small ecosystem of dead logs is a part of large ecosystem of a forest. A complete self-sufficient ecosystem is rarely found in nature but situations approaching self-sufficiency may occur.

Structure of Ecosystem:

The structure of an ecosystem is basically a description of the organisms and physical features of environment including the amount and distribution of nutrients in a particular habitat. It also provides information regarding the range of climatic conditions prevailing in the area.

From the structure point of view, all ecosystems consist of the following basic components:

1. Abiotic components

2. Biotic components

1. Abiotic Components:

Ecological relationships are manifested in physicochemical environment. Abiotic component of ecosystem includes basic inorganic elements and compounds, such as soil, water, oxygen, calcium carbonates, phosphates and a variety of organic compounds (by-products of organic activities or death).

It also includes such physical factors and ingredients as moisture, wind currents and solar radiation. Radiant energy of sun is the only significant energy source for any ecosystem. The amount of non-living components, such as carbon, phosphorus, nitrogen, etc. that are present at any given time is known as standing state or standing quantity.

2. Biotic Components:

The biotic components include all living organisms present in the environmental system.

From nutrition point of view, the biotic components can be grouped into two basic components:

(i) Autotrophic components, and

(ii) Heterotrophic components

The autotrophic components include all green plants which fix the radiant energy of sun and manufacture food from inorganic substances. The heterotrophic components include non-green plants and all animals which take food from autotrophs.

So biotic components of an ecosystem can be described under the following three heads:

1. Producers (Autotrophic components),

2. Consumers, and

3. Decomposers or reducers and transformers

The amount of biomass at any time in an ecosystem is known as standing crop which is usually expressed as fresh weight, dry weight or as free energy in terms of calories/metre.

Producers (Autotrophic elements):

The producers are the autotrophic elements—chiefly green plants. They use radiant energy of sun in photosynthetic process whereby carbon dioxide is assimilated and the light energy is converted into chemical energy. The chemical energy is actually locked up in the energy rich carbon compounds. Oxygen is evolved as by-product in the photosynthesis.

This is used in respiration by all living things. Algae and other hydrophytes of a pond, grasses of the field, trees of the forests are examples of producers. Chemosynthetic bacteria and carotenoid bearing purple bacteria that also assimilate CO_2 with the energy of sunlight but only in the presence of organic compounds also belong to this category.

The term producer is misleading one because in an energy context, producers produce carbohydrate and not energy. Since they convert or transduce the radiant energy into chemical form, E.J. Kormondy suggests better alternative terms ‘converters’ or ‘transducers’. Because of wide use the term producer is still retained.

Consumers:

Those living members of ecosystem which consume the food synthesized by producers are called consumers. Under this category are included all kinds of animals that are found in an ecosystem.

There are different classes or categories of consumers, such as:

(a) Consumers of the first order or primary consumers,

(b) Consumers of the second order or secondary consumers,

(c) Consumers of the third order or tertiary consumers, and

(d) Parasites, scavengers and saprobes.

(a) Primary consumers:

These are purely herbivorous animals that are dependent for their food on producers or green plants. Insects, rodents, rabbit, deer, cow, buffalo, goat are some of the common herbivores in the terrestrial ecosystem, and small crustaceans, molluscs, etc. in the aquatic habitat. Elton (1939) named herbivores of ecosystem as “key industry animals”. The herbivores serve as the chief food source for carnivores.

(b) Secondary consumers:

These are carnivores and omnivores. Carnivores are flesh eating animals and the omnivores are the animals that are adapted to consume herbivores as well as plants as their food. Examples of secondary consumers are sparrow, crow, fox, wolves, dogs, cats, snakes, etc.

(c) Tertiary consumers:

These are the top carnivores which prey upon other carnivores, omnivores and herbivores. Lions, tigers, hawk, vulture, etc. are considered as tertiary or top consumers.

(d) Besides different classes of consumers, the parasites, scavengers and saprobes are also included in the consumers. The parasitic plants and animals utilize the living tissues of different plants and animals. The scavengers and saprobes utilize dead remains of animals and plants as their food.

Decomposers and transformers:

Decomposers and transformers are the living components of the ecosystem and they are fungi and bacteria. Decomposers attack the dead remains of producers and consumers and degrade the complex organic substances into simpler compounds. The simple organic matters are then attacked by another kind of bacteria, the transformers which change these organic compounds into the inorganic forms that are suitable for reuse by producers or green plants. The decomposers and transformers play very important role in maintaining the dynamic nature of ecosystems.

Function of Ecosystem:

An ecosystem is a discrete structural, functional and life sustaining environmental system. The environmental system consists of biotic and abiotic components in a habitat. Biotic component of the ecosystem includes the living organisms; plants, animals and microbes whereas the abiotic component includes inorganic matter and energy.

Abiotic components provide the matrix for the synthesis and perpetuation of organic components (protoplasm). The synthesis and perpetuation processes involve energy exchange and this energy comes from the sun in the form of light or solar energy.

Thus, in any ecosystem we have the following functional components:

(i) Inorganic constituents (air, water and mineral salts)

(ii) Organisms (plants, animals and microbes), and

(iii) Energy input which enters from outside (the sun).

These three interact and form an environmental system. Inorganic constituents are synthesized into organic structures by the green plants (primary producers) through

photosynthesis and the solar energy is utilized in the process. Green plants become the source of energy for renewals (herbivores) which, in turn become source of energy for the flesh eating animals (carnivores). Animals of all types grow and add organic matter to their body weight and their source of energy is complex organic compound taken as food.

They are known as secondary producers. All the living organisms whether plants or animals in an ecosystem have a definite life span after which they die. The dead organic remains of plants and animals provide food for saprophytic microbes, such as bacteria, fungi and many other animals. The saprobes ultimately decompose the organic structure and break the complex molecules and liberate the inorganic components into their environment.

These organisms are known as decomposers. During the process of decomposition of organic molecules, the energy which kept the inorganic components bound together in the form of organic molecules gets liberated and dissipated into the environment as heat energy. Thus in an ecosystem energy from the sun, the input is fixed by plants and transferred to animal components.

Nutrients are withdrawn from the substrate, deposited in the tissues of the plants and animals, cycled from one feeding group to another, released by decomposition to the soil, water and air and then recycled. The ecosystems operating in different habitats, such as deserts, forests, grasslands and seas are interdependent on one another. The energy and nutrients of one ecosystem may find their way into another so that ultimately all parts of the earth are interrelated, each comprising a part of the total system that keeps the biosphere functioning.

Thus the principal steps in the operation of ecosystem are as follows:

(1) Reception of radiant energy of sun,

(2) Manufacture of organic materials from inorganic ones by producers,

(3) Consumption of producers by consumers and further elaboration of consumed materials; and.

(4) After the death of producers and consumers, complex organic compounds are degraded and finally converted by decomposers and converters into such forms as are suitable for reutilization by producers.

The principal steps in the operation of ecosystem not only involve the production, growth and death of living components but also influence the abiotic aspects of habitat. It is now clear that there is transfer of both energy and nutrients from producers to consumers and finally to decomposers and transformers levels. In this transfer there is a progressive decrease of energy but nutrient component is not diminished and it shows cycling from abiotic to biotic and vice versa.

The flow of energy is unidirectional. The two ecological processes—energy flow and mineral cycling which involve interaction between biotic and abiotic components lie at the heart of ecosystem dynamics. The principal steps and components of ecosystem are illustrated in Fig. 3.1.

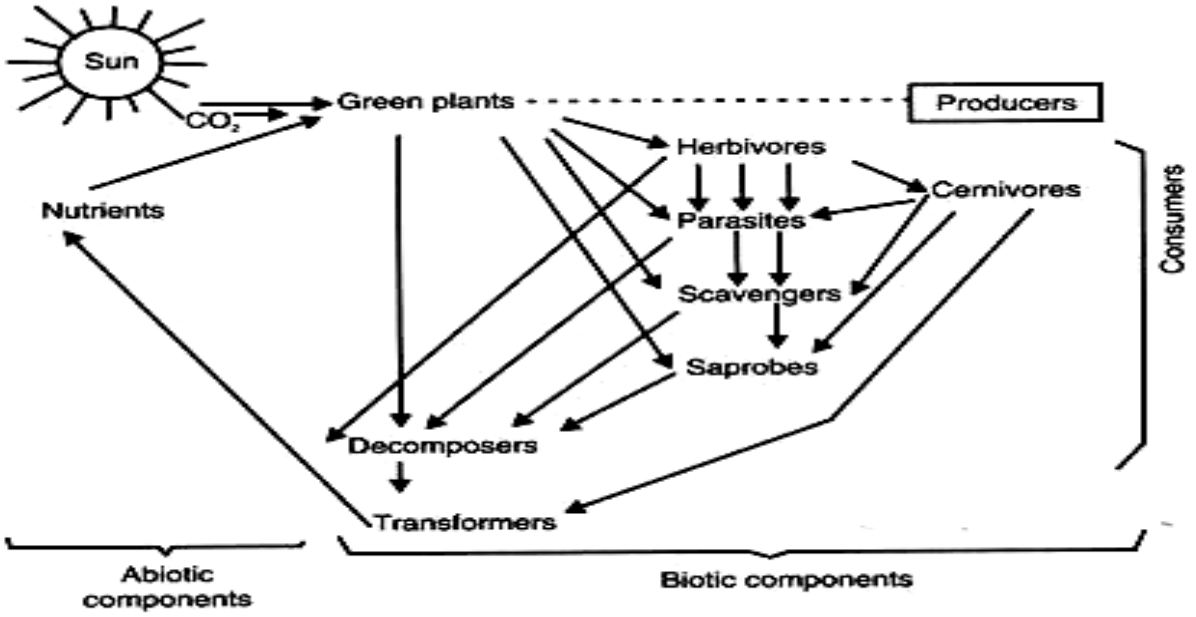

Fig. 3.1. Different components of ecosystem.

Energy flow in ecosystem

Energy has been defined as the capacity to do work. Energy exists in two forms potential and kinetic.

Potential energy is the energy at rest {i.e., stored energy) capable of performing work. Kinetic energy is the energy of motion (free energy).

It results in work performance at the expense of potential energy. Conversion of potential energy into kinetic energy involves the imparting of motion.

The source of energy required by all living organisms is the chemical energy of their food. The chemical energy is obtained by the conversion of the radiant energy of sun.

The radiant energy is in the form of electromagnetic waves which are released from the sun during the transmutation of hydrogen to helium. The chemical energy stored in the food of living organisms is converted into potential energy by the arrangement of the constituent atoms of food in a particular manner. In any ecosystem there should be unidirectional flow of energy.

This energy flow is based on two important Laws of Thermodynamics which are as follows:

(1) The first law of Thermodynamics:

It states that the amount of energy in the universe is constant. It may change from one form to another, but it can neither be created nor destroyed. Light energy can be neither created nor destroyed as it passes through the atmosphere. It may, however, be transformed into another type of energy, such as chemical energy or heat energy. These forms of energy cannot be transformed into electromagnetic radiation.

(2) The second law of Thermodynamics:

It states that non-random energy (mechanical, chemical, radiant energy) cannot be changed without some degradation into heat energy. The change of energy from one form to another takes place in such a way that a part of energy assumes waste form (heat energy). In this way, after transformation the capacity of energy to perform work is decreased. Thus, energy flows from higher to lower level.

Main source of energy is sun. Approximately 57% of sun energy is absorbed in the atmosphere and scattered in the space. Some 35% is spent to heat water and land areas and to evaporate water. Of the approximately 8% of light energy striking plant surface, 10% to 15% is reflected, 5% is transmitted and 80 to 85% is absorbed; and an average of only 2% (0.5 to 3.5%) of the total light energy striking on a leaf is used in photosynthesis and rest is transformed into heat energy.

Energy flow in Ecosystems:

Living organisms can use energy in two forms radiant and fixed energy. Radiant energy is in the form of electromagnetic waves, such as light. Fixed energy is potential

chemical energy bound in various organic substances which can be broken down in order to release their energy content.

Organisms that can fix radiant energy utilizing inorganic substances to produce organic molecules are called autotrophs. Organisms that cannot obtain energy from abiotic source but depend on energy-rich organic molecules synthesized by autotrophs are called heterotrophs. Those which obtain energy from living organisms are called consumers and those which obtain energy from dead organisms are called decomposers (Fig. 3.7).

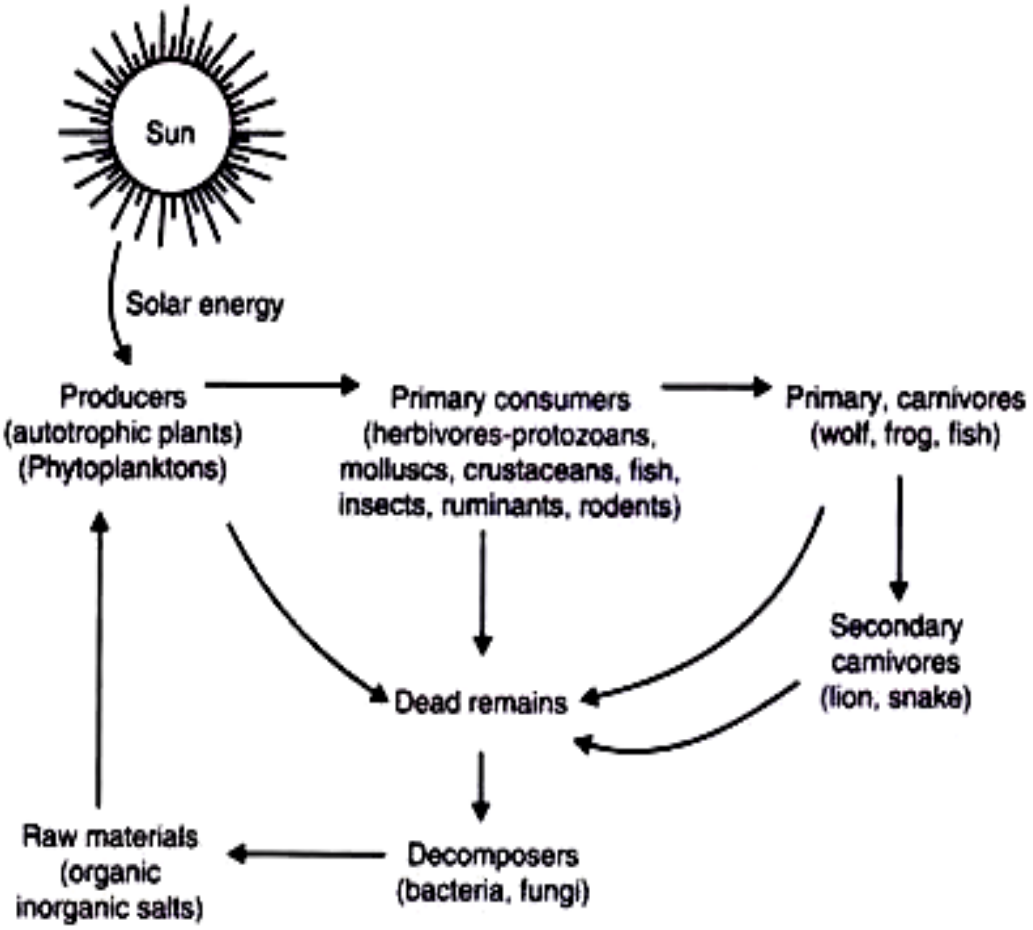

Fig. 3.7. Flow of energy at different levels of ecosystem.

When the light energy falls on the green surfaces of plants, a part of it is transformed into chemical energy which is stored in various organic products in the plants. When the herbivores consume plants as food and convert chemical energy accumulated in plant products into kinetic energy, degradation of energy will occur through its conversion into heat. When herbivores are consumed by carnivores of the first order (secondary

consumers) further degradation will occur. Similarly, when primary carnivores are consumed by top carnivores, again energy will be degraded.

Trophic level:

The producers and consumers in ecosystem can be arranged into several feeding groups, each known as trophic level (feeding level). In any ecosystem, producers represent the first trophic level, herbivores present the second trophic level, primary carnivores represent the third trophic level and top carnivores represent the last level.

Food Chain:

In the ecosystem, green plants alone are able to trap in solar energy and convert it into chemical energy. The chemical energy is locked up in the various organic compounds, such as carbohydrates, fats and proteins, present in the green plants. Since virtually all other living organisms depend upon green plants for their energy, the efficiency of plants in any given area in capturing solar energy sets the upper limit to long-term energy flow and biological activity in the community.

The food manufactured by the green plants is utilized by themselves and also by herbivores. Animals feed repeatedly. Herbivores fall prey to some carnivorous animals. In this way one form of life supports the other form. Thus, food from one trophic level reaches to the other trophic level and in this way a chain is established. This is known as food chain.

A food chain may be defined as the transfer of energy and nutrients through a succession of organisms through repeated process of eating and being eaten. In food chain initial link is a green plant or producer which produces chemical energy available to consumers. For example, marsh grass is consumed by grasshopper, the grasshopper is consumed by a bird and that bird is consumed by hawk.

Thus, a food chain is formed which can be written as follows:
Marsh grass → grasshopper → bird → hawk

Food chain in any ecosystem runs directly in which green plants are eaten by herbivores, herbivores are eaten by carnivores and carnivores are eaten by top carnivores. Man forms the terrestrial links of many food chains.

Food chains are of three types:

1. Grazing food chain

2. Parasitic food chain

Saprophytic or detritus food chain

1. Grazing food chain:

The grazing food chain starts from green plants and from autotrophs it goes to herbivores (primary consumers) to primary carnivores (secondary consumers) and then to secondary carnivores (tertiary consumers) and so on. The gross production of a green plant in an ecosystem may meet three fates—it may be oxidized in respiration, it may be eaten by herbivorous animals and after the death and decay of producers it may be utilized by decomposers and converters and finally released into the environment. In herbivores the assimilated food can be stored as carbohydrates, proteins and fats, and transformed into much more complex organic molecules.

The energy for these transformations is supplied through respiration. As in autotrophs, the energy in herbivores also meets three routes respiration, decay of organic matter by microbes and consumption by the carnivores. Likewise, when the secondary carnivores or tertiary consumers eat primary carnivores, the total energy assimilated by primary carnivores or gross tertiary production follows the same course and its disposition into respiration, decay and further consumption by other carnivores is entirely similar to that of herbivores.

Thus, it is obvious that much of the energy flow in the grazing food chain can be described in terms of trophic levels as outlined below:

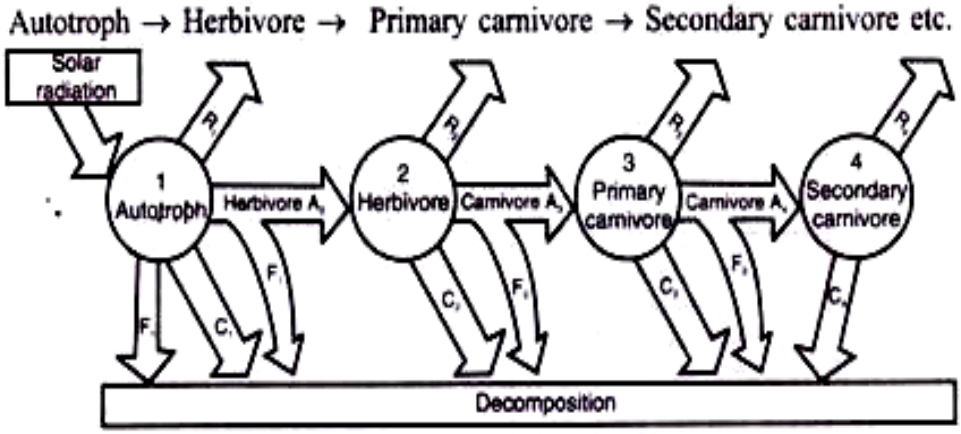

Fig. 3.8. Diagrammatic representation of a grazing food chain showing input and losses of energy at each trophic level. Trophic levels are numbered and used as subscripts to letters indicating energy transfer. A—assimilation of food by the organisms at the trophic level; F—energy lost in the form of faeces and other excretory products; C—energy lost through decay; and R—energy lost to respiration.

A schematic representation of grazing food chain showing input and losses of energy has been presented in Fig. 3.8.

2. Parasitic food chain:

It goes from large organisms to smaller ones without outright killing as in the case of predator.

3. Detritus food chain:

The dead organic remains including metabolic wastes and exudates derived from grazing food chain are generally termed detritus. The energy contained in detritus is not lost in ecosystem as a whole, rather it serves as a source of energy for a group of organisms called detritivores that are separate from the grazing food chain. The food chain so formed is called detritus food chain (Fig. 3.9).

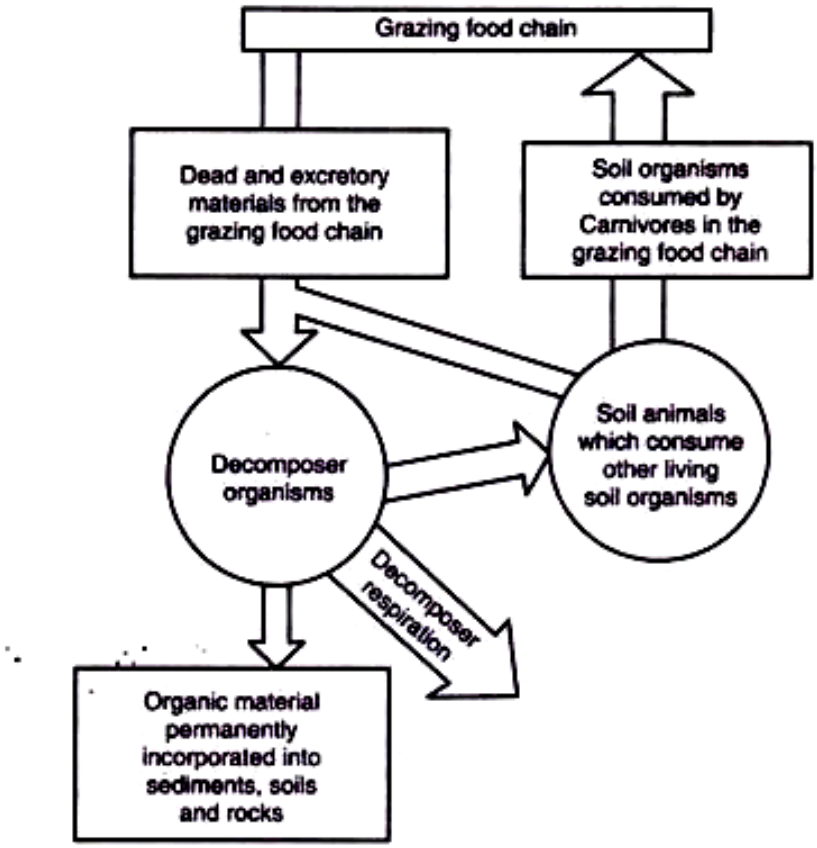

Fig. 3.9. Diagrammatic representation of the detritus food chain showing energy transfers between it and the grazing food chain, as well as energy losses to the detritus food chain.

In some ecosystems more energy flows through the detritus food chain than through grazing food chain. In detritus food chain the energy flow remains as a continuous passage rather than as a stepwise flow between discrete entities. The organisms in the detritus food chain are many and include algae, fungi, bacteria, slime moulds, actinomycetes, protozoa, etc. Detritus organisms ingest pieces of partially decomposed organic matter, digest them partially and after extracting some of the chemical energy in the food to run their metabolism, excrete the remainder in the form of simpler organic molecules.

The waste from one organism can be immediately utilized by a second one which repeats the process. Gradually, the complex organic molecules present in the organic wastes or dead tissues are broken down to much simpler compounds, sometimes to carbon dioxide and water and all that are left are humus. In a normal environment the

humus is quite stable and forms an essential part of the soil. Schematic representation of detritus food chain is given in Fig. 3.9.

Food web:

Many food chains exist in an ecosystem, but as a matter of fact these food chains are not independent. In ecosystem, one organism does not depend wholly on another. The resources are shared specially at the beginning of the chain. The marsh plants are eaten by variety of insects, birds, mammals and fishes and some of the animals are eaten by several predators.

Similarly, in the food chain grass → mouse → snakes → owls, sometimes mice are not eaten by snakes but directly by owls. This type of interrelationship interlinks the individuals of the whole community. In this way, food chains become interlinked. A complex of interrelated food chains makes up a food web. Food web maintains the stability of the ecosystem. The greater the number of alternative pathways the more stable is the community of living things. Fig. 3.10. illustrates a food web in ecosystem.

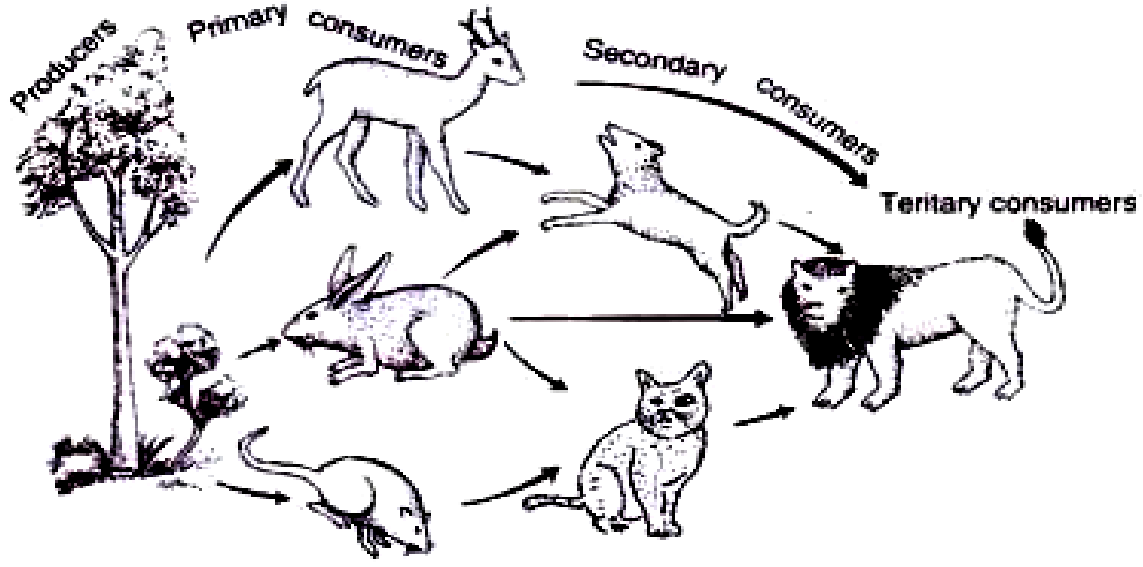

Fig. 3.10. Food web in an ecosystem.

Ecological pyramid:

The trophic structure of an ecosystem can be indicated by means of ecological pyramid. At each step in the food chain a considerable fraction of the potential energy is lost as heat. As a result, organisms in each trophic level pass on lesser energy to the next trophic level than they actually receive. This limits the number of steps in any food chain to 4 or 5. Longer the food chain the lesser energy is available for final members. Because of this tapering off of available energy in the food chain a pyramid is formed that is known as ecological pyramid. The higher the steps in the ecological pyramid the lower will be the number of individuals and the larger their size.

The idea of ecological pyramids was advanced by C.E. Elton (1927). There are different types of ecological pyramids. In each ecological pyramid, producer level forms the base and successive levels make up the apex. Three types of pyramidal relations may be found among the organisms at different levels in the ecosystem.

These are as follows:

1. Pyramid of numbers,

2. Pyramid of biomass (biomass is the weight of living organisms), and

3. Pyramid of energy.

1. Pyramid of numbers:

It depicts the numbers of individuals in producers and in different orders of consumers in an ecosystem. The base of pyramid is represented by producers which are the most abundant. In the successive levels of consumers, the number of organisms goes on decreasing rapidly until there are a few carnivores.

The pyramid of numbers of an ecosystem indicates that the producers are ingested in large numbers by smaller numbers of primary consumers. These primary consumers are eaten by relatively smaller number of secondary consumers and these secondary consumers, in turn, are consumed by only a few tertiary consumers (Fig. 3.11, 3.12a).

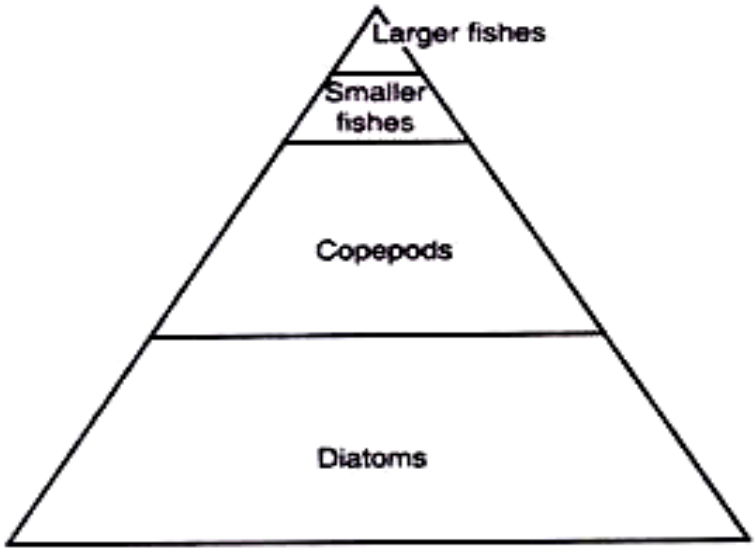

Fig. 3.11. A pyramid of numbers of a lake ecosystem.

This type of pyramid is best presented by taking an example of Lake Ecosystem. In this type of pyramid the base trophic level is occupied by producer elements—algae, diatoms and other hydrophytes which are most abundant. At the second trophic level come the herbivores or zooplanktons which are lesser in number than producers.

The third trophic level is occupied by carnivores which are still smaller in number than the herbivores and the top is occupied by a few top carnivores. Thus, in the ecological pyramid of numbers there is a relative reduction in number of organisms and an increase in the size of body from base to apex of the pyramid. In parasitic food chain starting from tree, the pyramid of numbers will be inverted (Fig. 3.12).

Fig. 3.12 (*a* & *b*). Pyramids of number
(*a*) Fig. 3.12 a & b. Up-right Pyramids of numbers in a grassland and cultivated field
(*b*) Pyramid of numbers (inverted) of diseased tree (Parasitic ecosystem)

Pyramid of biomass of organisms:

The living weights or biomass of the members of the food chain present at any one time form the pyramid of biomass of organisms. This indicates, by weight or other means of measuring materials, the total bulk of organisms or fixed energy present at one time. Pyramid of biomass indicates the decrease of biomass in each tropic level from base to apex, e.g., total biomass of producers is more than the total biomass of the herbivores.

Likewise, the total biomass of secondary consumers will be lesser than that of herbivores and so on (Fig. 3.13, 3.14 a, b). Since some energy and material are lost in each successive link, the total mass supported at each level is limited by the rate at which the energy is being stored below. This usually gives sloping pyramid for most of the communities in terrestrial and shallow water ecosystems. The pyramid of biomass in a pond ecosystem will be inverted as shown in Fig. 3.13 b.

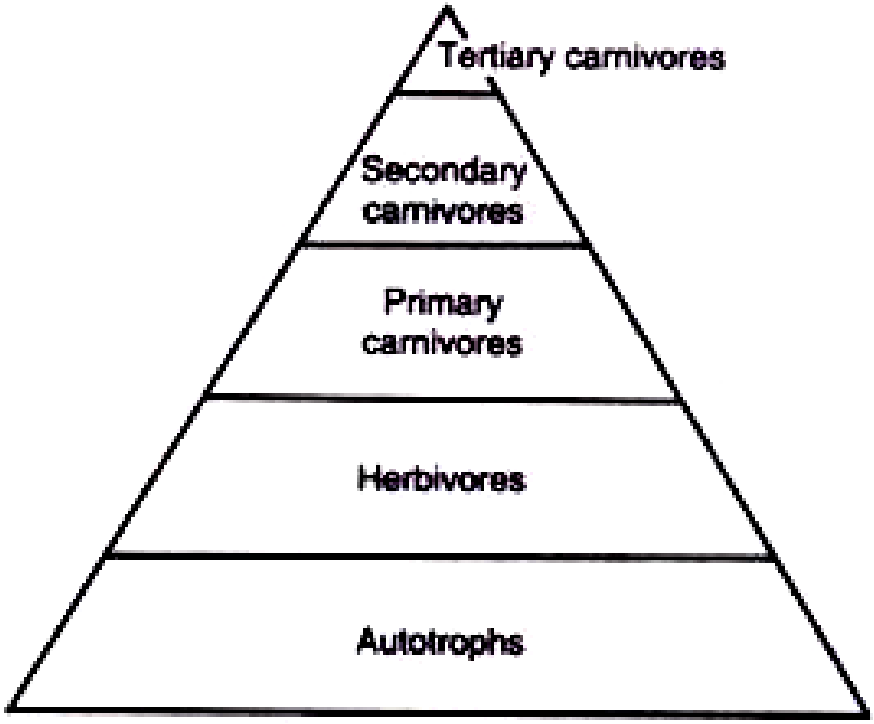

Fig. 3.13. A pyramid of biomass

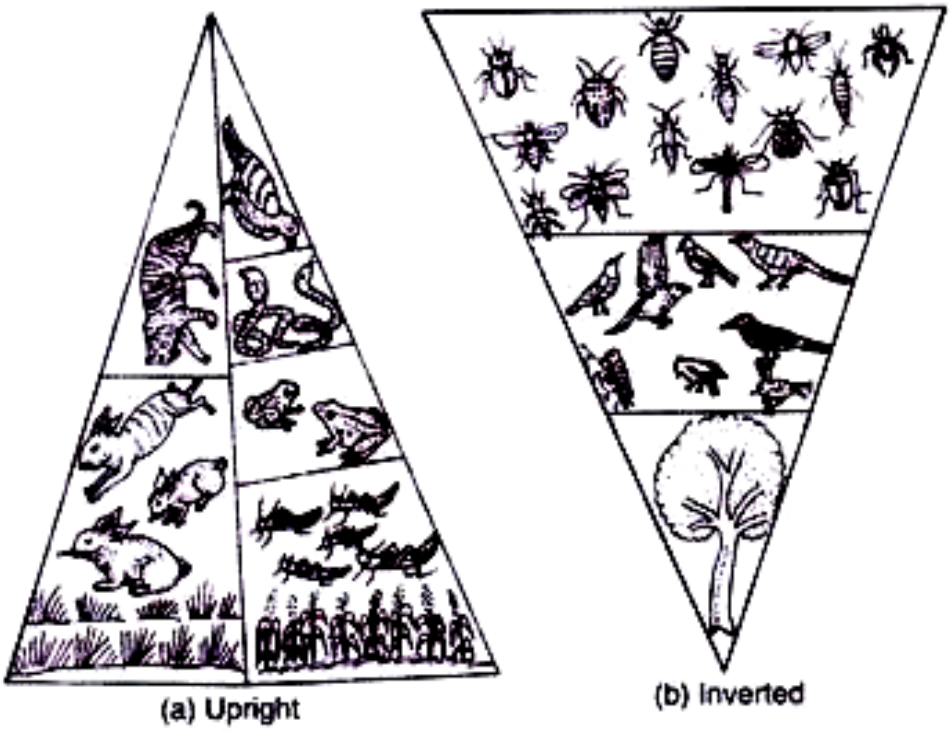

Fig. 3.14. (*a* & *b*). Pyramids of biomass
(*a*) A grassland ecosystems showing upright-triangular
(*b*) Inverted pyramid of biomass of an aquatic ecosystem.

Pyramid of energy:

This depicts not only the amount of total energy utilized by the organisms at each trophic level of food chain but more important, the actual role of various organisms in transfer of energy. At the producer level the total energy will be much greater than the energy at the successive higher trophic level.

Some producer organisms may have small biomass but the total energy they assimilate and pass on to consumers may be greater than that of organisms with much larger biomass. Higher trophic levels are more efficient in energy utilization but much heat is lost in energy transfer. Energy loss by respiration also progressively increases from lower to higher trophic states (Fig. 3.15).

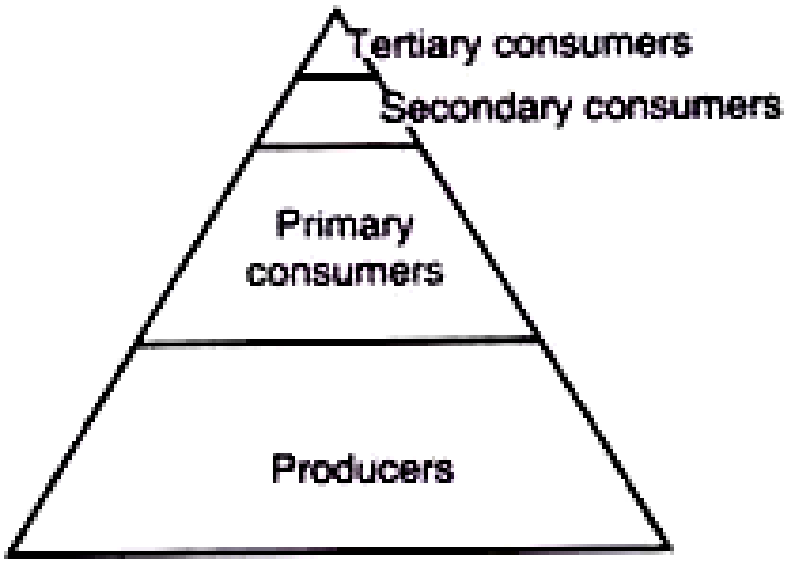

Fig. 3.15. A pyramid of energy

In the energy flow process, two things become obvious. Firstly there is one way along which energy moves i.e. unidirectional flow of energy. Energy comes in the ecosystem from outside source i.e. sun. The energy captured by autotrophs does not go back to the sun, the energy that passes from autotrophs to herbivores does not revert back and as it moves progressively through the various trophic levels, it is no longer available to the previous levels.

Thus due to unidirectional flow of energy, the system would collapse if the supply from primary source, the sun is cut off. Secondly, there occurs a progressive decrease in energy level at each trophic level which is accounted largely by the energy dissipated as heat in metabolic activities.

Productivity:

The relationship between the amount of energy accumulated and the amount of energy utilized within one trophic level of food chain has an important bearing on how much energy from one trophic level passes on to the next trophic level in the food chain. The ratio of output of energy to input of energy is referred to as ecological efficiency.

Different kinds of efficiencies can be measured by the following parameters:

(i) Ingestion which indicates the quantity of food or energy taken by trophic level. This is also called exploitation efficiency.

(ii) Assimilation indicates the amount of food absorbed and fixed into energy rich organic substances which are stored or combined with other molecules to build complex molecules such as proteins, fats etc.

(iii) Respiration which indicates the energy lost in metabolism.

Primary Productivity:

The fraction of fixed energy a trophic level passes on to the next trophic level is called production. Green plants fix solar energy and accumulate it in organic forms as chemical energy. Since it is the first and basic form of energy storage, the rate at which the energy accumulates in the green plants or producers is known as primary productivity.

Primary productivity is the rate at which energy is bound or organic material is created by photosynthesis per unit area of earth's surface per unit time. It is most often expressed as energy in calories / cm^2 / yr or dry organic matter in g / m^2 / yr (g/m^2 x 8.92 = lb / acre). The amount of organic matter present at a given time per unit area is called standing crop or biomass and as such productivity, which is a rate, is quite different from biomass or standing crop.

The standing crop is usually expressed as dry weight in g/m^2 or kg/m^2 or t/ha (metric tons) or 10^6g/hectare. Primary productivity is the result of photosynthesis by green plants including algae of different colours. Bacterial photosynthesis or chemosynthesis, although of small significance may also contribute to primary productivity. The total solar energy trapped in the food material by photosynthesis is referred to as gross primary productivity (G.P.P.).

A good fraction of gross primary production is utilized in respiration of green plants. The amount of energy bound in organic matter per unit area and time that is left after respiration in plants is net primary production (N.P.P.) or plant growth. Only the net primary productivity is available for harvest by man and other animals. Net productivity of energy = gross productivity—energy lost in respiration.

Secondary Productivity:

The rates at which the heterotrophic organisms resynthesize the energy-yielding substances is termed as secondary productivity. Secondary productivities are the productivities of animals and saprobes in communities. The amount of energy stored in the tissues of consumers or heterotrophs is termed as net secondary production and the total plant material ingested by herbivores is grass secondary production. Total plant material ingested by herbivores minus the materials lost as faeces is equal to Ingested Secondary Production.

Environmental factors affecting the production processes in an ecosystem are as follows:

1. Solar radiation and Temperature

2. Moisture. Leaf water potential, soil moisture and precipitation fluctuation and transpiration.

3. Mineral nutrition. Uptake of minerals from the soil, rhizosphere effects, fire effects, salinity, heavy metals, nitrogen metabolism.

4. Biotic activities. Grazing, above ground herbivores, below ground herbivores, predators and parasites, diseases of primary producers.

5. Impact of human population. Pollutions of different sorts, ionizing radiations like atomic explosions, etc.

There are three fundamental concepts of productivity:

1. Standing crop

2. Materials removed

3. Production rate.

1. Standing crop:

It is the abundance of the organisms existing in the area at any one time. It may be expressed in terms of number of individuals, as biomass of organisms, as energy content or in some other suitable terms. Measurement of standing crop reveals the concentration of individuals in the various populations of ecosystem.

2. The materials removed:

The second concept of productivity is the materials removed from the area per unit time. It includes the yield to man, organisms removed from the ecosystem by migration, and the material withdrawn as organic deposit.

3. The production rate:

The third concept of productivity is the production rate. It is the rate at which the growth processes are going forward within the area. The amount of material formed by each link in the food chain per unit of time per unit area or volume is the production rate.

All the three major groups of organisms—producers, consumers and reducers are the functional kingdoms of natural communities. The three represent major directions of evolution and are characterised by different modes of nutrition. Plants feed primarily by photosynthesis, animals feed primarily by ingesting food that is digested and absorbed in the alimentary canal and the saprobes feed by absorption and have need for an extensive surface of absorption. The principal kinds of organisms among saprobes are the unicellular bacteria, yeasts, chytrids or lower fungi and higher fungi with mycelial bodies.

In terrestrial communities as much as 90% of net primary production remains un-harvested and are utilized as dead tissue by saprobes and soil animals. The saprobes have a larger and more essential role than animals in degrading dead organic matter to inorganic forms and in such ecosystems, secondary production by reducers (decomposers) should exceed that by consumers, though the former is even more difficult to measure than the latter.

Biomass of decomposers with their microscopic cells and filaments embedded in food sources is also difficult to measure and that is small in relation to their productivity and

significance for the ecosystem. Small masses of reducers degrade and transform larger masses of organic matter to inorganic remnants. In so doing decomposers disperse back to the environment the energy of photosynthesis accumulated in the organic compounds that are decomposed.

Thus they have a major role in the energy flow of ecosystems. A community or ecosystem, like an organism, is an open energy system. The continuous intake of energy in photosynthesis replaces the energy dissipated to environment by respiration and biological activity and the system does not run-down through the loss of free energy to maximum entropy.

If the amount of energy entrapped is greater than the energy dissipated, the pool of biologically useful energy of organic bonds increases. This results in increase of community biomass and consequently the community grows; such is the case in succession. If energy intake is lesser than energy dissipation, the community biomass will decrease and it must, in some sense, retrogress. If energy intake and loss are in balance, the pool of organic energy is in steady state; such is the case in climax communities.

Three aspects of this steady state may be recognized:

(i) The steady state of population of climax communities in which equal birth and death rates in population keep the number of individuals relatively constant,

(ii) The steady state of energy flow,

(iii) The steady state of the matter of community, where addition of material by photosynthesis and organic synthesis is balanced by loss of material through respiration and decomposition.

Methods of Measuring Primary Production:

There are several parameters for measuring primary production and the methods of measuring primary production are based on those parameters.

The methods are discussed here as under:

1. Harvest method:

It involves removal of vegetation periodically and weighing the material. For measuring above ground production, the above ground plant parts are clipped at ground level, dried to constant weight at 80°C and weighed. The dry weight in g/m^2 /year gives the ground production. Below ground production is estimated by using frequent core sampling technique of Dahlman and Kucera (1965). It is expressed in terms of weight in gm per unit area per year. In terms of energy one gm dry weight of plant material contains 4 to 5 kcal.

The limitations of harvest method are as follows:
(i) The amount of plant material consumed by herbivores and the food oxidized during respiration process of the plants is not accounted.

(ii) Root biomass is neglected.

(iii) Photosynthetic trans located to underground parts of plants are not known.

In spite of these limitations the method is used all over for measuring net assimilation rate (NAR) and relative growth rate (RGR).

2. Carbon dioxide assimilation method:

Utilization of CO_2 in photosynthesis or its liberation during respiration is measured by infrared gas analysis or by passing the gas through Baryta water $Ba(OH)_2$ and titrating the same. The CO_2 removed from incoming gas chamber is taken to be synthesized into organic matter by the green plants. Performing the experiment in light and dark chambers the net and gross production can be measured.
In the lighted chamber photosynthesis and respiration take place simultaneously and the CO_2 coming out from the chamber is the unused gas of the atmosphere plus gas from the respiration of plant parts. In the dark chamber all CO_2 is due to respiration.
Net production = Gross production—Respiration

3. Oxygen production method:

In the aquatic vegetation CO_2 gas analysis method is not used but oxygen evolution method is generally used. The light and dark bottle technique is employed for measuring primary production of aquatic plant. In this method two bottles, one transparent and the other opaque are filled with water at a given depth of lake, closed, maintained at that depth for some time and then brought to laboratory for determination of oxygen content in the water. The decrease of oxygen in dark bottle is due to respiratory activity while increase of O_2 in light bottle is due to photosynthesis. The total increase of O_2 in light bottle plus the amount of O_2 decreased in dark bottle express gross productivity (O_2 value multiplied by 0.375 gives an equivalent of carbon assimilation). Recently, oxygen electrodes have been used for estimating oxygen content in water.

4. Chlorophyll method:

Gesner (1949) pointed out that the amount of chlorophyll/m^2 is almost limited to a narrow range of 0.1 to 3.0 gm regardless of the age of individuals or the species present therein. There is direct correlation between the amount of chlorophyll and dry matter production in different types of communities with varying light conditions.
The relation of total amount of chlorophyll to the photosynthetic rate is referred to as assimilation ratio or rate of production/gm chlorophyll. Total chlorophyll per unit area is greater in land plants as compared to that in aquatic plants. In marine ecosystem the rate of carbon assimilation is 3.7 g/ hr/g of chlorophyll. The relationship between area based chlorophyll and dry matter production in terrestrial ecosystems has been worked out by Japanese ecologists Argua and Monsi (1963).

5. Other methods:

Pandeya (1971), Sharma (1972) and several other ecologists have evolved correlation coefficients for evaluating biomass and productivity in forest trees by measuring their diameter at breast height (DBH), height, canopy cover, etc.

Methods of establishing regression are as below:
(i) Diameter of trees in sample quadrats is measured at breast height and the height repeated is determined for each tree.

(ii) Different diameter and height classes are determined for each species.

(iii) A set of sample trees are cut and subjected to a detailed analysis for dry weight of stems, twigs, leaves and roots.

(iv) Regression values are computed for the sets of trees belonging to each girth class, relating the biomass of each fraction to the diameter at breast height.

(v) The regression values are used to compute the probable biomass and Production each tree in the sample area. These values for each species when pooled give biomass and production rate of trees per unit area in the forest. Age of the trees markedly influences the annual net production.

Food web and ecological succession

Food web

A food web is a detailed interconnecting diagram that shows the overall food relationships between organisms in a particular environment. It can be described as a "who eats whom" diagram that shows the complex feeding relationships for a particular ecosystem.

The study of food webs is important, as such webs can show how energy flows through an ecosystem. It also helps us understand how toxins and pollutants become concentrated within a particular ecosystem. Examples include mercury bioaccumulation in the Florida Everglades and mercury accumulation in the San Francisco Bay. Food webs can also help us study and explain how the diversity of species is related to how they fit within the overall food dynamic. They may also reveal critical information about the relationships between invasive species and those native to a particular ecosystem.

Key Takeaways: What Is a Food Web?

- A food web can be described as a "who eats whom" diagram that shows the complex feeding relationships in an ecosystem.
- The concept of a food web is credited to Charles Elton, who introduced it in his 1927 book, Animal Ecology.
- The interconnectedness of how organisms are involved in energy transfer within an ecosystem is vital to understanding food webs and how they apply to real-world science.

- The increase in toxic substances, like man-made persistent organic pollutants (POPs), can have a profound impact on species within an ecosystem.

- By analyzing food webs, scientists are able to study and predict how substances move through the ecosystem to help prevent the bioaccumulation and biomagnification of harmful substances.

Food Web Definition

The concept of a food web, previously known as a food cycle, is typically credited to Charles Elton, who first introduced it in his book Animal Ecology, published in 1927. He is considered one of the founders of modern ecology and his book is a seminal work. He also introduced other important ecological concepts like niche and succession in this book.

In a food web, organisms are arranged according to their trophic level. The trophic level for an organism refers to how it fits within the overall food web and is based on how an organism feeds. Broadly speaking, there are two main designations: autotrophs and heterotrophs. Autotrophs make their own food while heterotrophs do not. Within this broad designation, there are five main trophic levels: primary producers, primary consumers, secondary consumers, tertiary consumers, and apex predators. A food web shows us how these different trophic levels within various food chains interconnect with one another as well as the flow of energy through the trophic levels within an ecosystem.

Trophic Levels in a Food Web

Primary producers make their own food via photosynthesis. Photosynthesis uses the sun's energy to make food by converting its light energy into chemical energy. Primary producer examples are plants and algae. These organisms are also known as autotrophs.

Primary consumers are those animals that eat the primary producers. They are called primary as they are the first organisms to eat the primary producers who make their own food. These animals are also known as herbivores. Examples of animals in this designation are rabbits, beavers, elephants, and moose.

Secondary consumers consist of organisms that eat primary consumers. Since they eat the animals that eat the plants, these animals are carnivorous or omnivorous. Carnivores eat animals while omnivores consume both other animals as well as plants. Bears are an example of a secondary consumer.

Similar to secondary consumers, **tertiary consumers** can be carnivorous or omnivorous. The difference being that secondary consumers eat other carnivores. An example is an eagle.

Lastly, the final level is composed of **apex predators**. Apex predators are at the top because they do not have natural predators. Lions are an example.

Additionally, organisms known as **decomposers** consume dead plants and animals and break them down. Fungi are examples of decomposers. Other organisms known as **detritivores** consume dead organic material. An example of a detrivore is a vulture.

Energy Movement

Energy flows through the different trophic levels. It begins with the energy from the sun that autotrophs use to produce food. This energy is transferred up the levels as the different organisms are consumed by members of the levels that are above them. Approximately 10% of the energy that is transferred from one trophic level to the next is converted to biomass. **Biomass** refers to the overall mass of an organism or the mass of all the organisms that exist in a given trophic level. Since organisms expend energy to move around and go about their daily activities, only a part of the energy consumed is stored as biomass.

Types of Food Webs

There are a number of different types of food webs, which differ in how they are constructed and what they show or emphasize in relation to the organisms within the particular ecosystem depicted. Scientists can use connectance and interaction food webs along with energy flow, fossil, and functional food webs to depict different aspects of the relationships within an ecosystem. Scientists can also further classify the types of food webs based on what ecosystem is being depicted in the web.

Connectance Food Webs

In a connectance food web, scientists use arrows to show one species being consumed by another species. All of the arrows are equally weighted. The degree of strength of the consumption of one species by another is not depicted.

Interaction Food Webs

Similar to connectance food webs, scientists also use arrows in interaction food webs to show one species being consumed by another species. However, the arrows used are weighted to show the degree or strength of consumption of one species by another. The arrows depicted in such arrangements can be wider, bolder, or darker to denote the strength of consumption if one species typically consumes another. If the interaction between species is very weak, the arrow can be very narrow or not present.

Energy Flow Food Webs

Energy flow food webs depict the relationships between organisms in an ecosystem by quantifying and showing the energy flux between organisms.

Fossil Food Webs

Food webs can be dynamic and the food relationships within an ecosystem change over time. In a fossil food web, scientists attempt to reconstruct the relationships between species based on available evidence from the fossil record.

Functional Food Webs

Functional food webs depict the relationships between organisms in an ecosystem by depicting how different populations influence the growth rate of other populations within the environment.

Food Webs and Type of Ecosystems

Scientists can also subdivide the above types of food webs based on the type of ecosystem. For example, an energy flow aquatic food web would depict the energy flux relationships in an aquatic environment, while an energy flow terrestrial food web would show such relationships on land.

Importance of the Study of Food Webs

Food webs show us how energy moves through an ecosystem from the sun to producers to consumers. This interconnectedness of how organisms are involved in this energy transfer within an ecosystem is a vital element to understanding food webs and how they apply to real-world science. Just as energy can move through an ecosystem, other substances can move through as well. When toxic substances or poisons are introduced into an ecosystem, there can be devastating effects.

Bioaccumulation and biomagnification are important concepts. **Bioaccumulation** is the accumulation of a substance, like a poison or contaminant, in an animal. **Biomagnification** refers to the buildup and increase in concentration of said substance as it is passed from trophic level to trophic level in a food web.

This increase in toxic substances can have a profound impact on species within an ecosystem. For example, man made synthetic chemicals often do not break down easily or quickly and can build up in an animal's fatty tissues over time. These substances are known as persistent organic pollutants (POPs). Marine environments are common examples of how these toxic substances can move from phytoplankton to zooplankton, then to fish that eat the zooplankton, then to other fish (like salmon) who eat those fish and all the way up to orca who eat salmon. Orcas have a high blubber content so the POPs can be found at very high levels. These levels can cause a number of issues like reproductive problems, developmental issues with their young as well as immune system issues.

By analyzing and understanding food webs, scientists are able to study and predict how substances may move through the ecosystem. They are then better able to help prevent

the bioaccumulation and biomagnification of these toxic substances in the environment through intervention.

Ecological succession

Succession is the order of colonization of species in an ecosystem from a barren or destroyed area of land. Mosses and lichens are the first species that inhabit an area. They make the area suitable for the growth of larger species such as grasses, shrubs and finally trees.

Table of Contents

Read on to explore what is ecological succession and its types.

Ecological Succession Definition

“Ecological succession is a series of changes that occur in an ecological community over time.”

What is Ecological Succession?

Ecological succession is the steady and gradual change in a species of a given area with respect to the changing environment. It is a predictable change and is an inevitable process of nature as all the biotic components have to keep up with the changes in **our environment.**

The ultimate aim of this process is to reach equilibrium in the ecosystem. The community that achieves this aim is called a climax community. In an attempt to reach this equilibrium, some species increase in number while some other decreases.

In an area, the sequence of communities that undergo changes is called sere. Thus, each community that changes is called a seral stage or seral community.

All the communities that we observe today around us have undergone succession over the period of time since their existence. Thus, we can say that evolution is a process that has taken place simultaneously along with that of ecological succession. Also, the initiation of life on earth can be considered to be a result of this succession process.

If we consider an area where life starts from scratch by the process of succession, it is known as primary succession. However, if life starts at a place after the area has lost all the life forms existing there, the process is called secondary succession.

It is obvious that primary succession is a rather slow process as life has to start from nothing whereas secondary succession is faster because it starts at a place which had already supported life before. Moreover, the first species that comes into existence during primary succession is known as pioneer species.

Types of Ecological Succession

There are the following types of ecological succession:

Primary Succession

Primary succession is the succession that starts in lifeless areas such as the regions devoid of soil or the areas where the soil is unable to sustain life.

When the planet was first formed there was no soil on earth. The earth was only made up of rocks. These rocks were broken down by microorganisms and eroded to form soil. The soil then becomes the foundation of plant life. These plants help in the survival of different animals and progress from primary succession to the climax community.

If this primary ecosystem is destroyed, secondary succession takes place.

Also Read: Soil Profile

Secondary Succession

Secondary succession occurs when the primary ecosystem gets destroyed. For eg., a climax community gets destroyed by fire. It gets recolonized after the destruction. This is known as secondary ecological succession. Small plants emerge first, followed by larger plants. The tall trees block the sunlight and change the structure of the organisms below the canopy. Finally, the climax community arrives.

Also Read: Ecosystem

Cyclic Succession

This is only the change in the structure of an ecosystem on a cyclic basis. Some plants remain dormant for the rest of the year and emerge all at once. This drastically changes the structure of an ecosystem.

Seral Community

“A seral community is an intermediate stage of ecological succession advancing towards the climax community.”

A seral community is replaced by the subsequent community. It consists of simple **food webs** and food chains. It exhibits a very low degree of diversity. The individuals are less in number and the nutrients are also less.

There are seven different types of seres:

Types of Seres	Explanation
Hydrosere	Succession in aquatic habitat.
Xerosere	Succession in dry habitat.
Lithosere	Succession on a bare rock surface.
Psammosere	Succession initiating on sandy areas.
Halosere	Succession starting in saline soil or water.
Senile	Succession of microorganism on dead matter.
Eosere	Development of vegetation in an era.

Examples of Ecological Succession

Following are the important examples of ecological succession:

Acadia National Park

This national park suffered a huge wildfire. Restoration of the forest was left on to nature. In the initial years, only small plants grew on the burnt soil. After several years, the forest showed diversity in tree species. However, the trees before the fire were mostly evergreen, while the trees that grew after the fire were deciduous in nature.

Ecological Succession of Coral Reefs

Small coral polyps colonize the rocks. These polyps grow and divide to form coral colonies. The shape of the coral reefs attracts small fish and crustaceans that are food for the larger fish. Thus, a fully functional coral reef exists.

Frequently Asked Questions

What are the main causes of ecological succession?

The main causes of ecological succession include the biotic and climatic factors that can destroy the populations of an area. Wind, fire, soil erosion and natural disasters include the climatic factors.

What is the importance of ecological succession?

Ecological succession is important for the growth and development of an ecosystem. It initiates colonization of new areas and recolonization of the areas that had been destroyed due to certain biotic and climatic factors. Thus, the organisms can adapt to the changes and learn to survive in a changing environment.

Case studies of these following ecosystems:-

1. **Forest ecocystem**
2. **Grassland ecosystem**
3. **Desert ecosystem**
4. **Aquatic ecosystems (ponds, streams, lakes and rivers)**

1. **Forest ecocystem**

Types and Characteristic Features:

(a) Temperate Forest Ecosystem:

The temperate forest ecosystem is very important on Earth. Temperate forests are in regions where the climate changes a lot from summer to winter. Tropical rain forests are in regions where the climate stays constant all year long. Temperate forests are almost always made of two types of trees, deciduous and evergreen. Deciduous trees are trees that lose their leaves in the winter.

Evergreens are trees that keep them all year long, like pine trees. Forests can either be one or the other, or a combination of both. A fourth kind of forest is a temperate rain forest. These are found in California, Oregon and Washington in the United States.

These forests are made of redwoods and sequoias, the tallest trees in the world. The amount of rainfall in an area determines if a forest is present. If there is enough rain to support trees, then a forest will usually develop. Otherwise, the region will become grasslands.

(b) The Tropical Rain Forest Ecosystem:

Tropical rain forests are one of the most important areas on Earth. These special ecosystems are homes to thousands of species animals and plants. Contrary to popular belief, rain forests are not only densely packed plants, but are also full of tall trees that form a ceiling from the Sun above. This ceiling keeps smaller plants from growing. Areas where sunlight can reach the surface are full of interesting plants.

Do you know where rain forests get their name? They are so named because they receive a lot of rain – an average of 80 inches a year. The temperature doesn't change very much during the year. It is always warm and muggy. The famous Amazon jungle is located in Brazil, in South America. This particular forest is called the Neotropics. Other large blocks are located in Central and West Africa.

(i) Insects of the Tropical Rain Forest:

The most feared and well known spider in the world resides in the jungle. Tarantulas are one of the creepiest animals you will ever see. Most species of tarantula have poisonous fangs for killing prey and for protection.

Although some are life-threatening to humans, others are harmless. Army ants are just one species of ant in the rain forest. They are called army ants because they march in a long, thick line through the jungle. They only stop when the young larvae reach pupil stage. Once the queen lays its eggs, the ants start marching again.

Beautiful butterflies fill the forest, but at one time these insects weren't so pretty. Butterflies start out as caterpillars, which tend to be a tad on the ugly side. They go through metamorphosis, which is the process of changing into a butterfly. Centipedes aren't so lucky. They don't turn into butterflies, but instead roam the forest looking for food. Some centipedes use poison to kill their prey.

(ii) Tropical Rain Forest Birds:

The birds of the rain forest are the most beautiful in the world. A wide range of colors can be seen darting through the trees as the forest tops come to life. Many species of tropical birds are kept as pets because of their looks.

Hundreds of species of parrot live in the rain forest. The scarlet macaw is just one of these. It is also one of the longest, stretching to a length of 3 feet from its head to the tip of its tail. When these macaws eat a poisonous fruit, they eat a special type of clay that neutralizes the poison.

Toucans are also very interesting birds. They have large beaks that they use to reach fruit they can't get to. Scientists estimate there are 33 species of toucan in the rain forest. Not every tropical bird was blessed with looks. The hoatzin looks more like a peacock without the pretty tail.

Hoatzins are terrible flyers – crash landings are common practice. The brown kiwi is a flightless bird that looks more like a rodent with a long beak and feathers. Kiwis live on

the ground instead of the trees. They have special claws used for running, digging and defence.

(iii) Tropical Rain Forest Mammals:

Birds aren't the only creatures that fly through the rain forests. Several species of flying mammals live in the jungle. From the harmless fruit bat to the unique flying squirrel, the tropical rain forests are full of surprises.

The Indian flying fox is one of the largest bats in the world. Its wings can spread out to 5 feet in width. Unlike bats in other parts of the world, these bats do not live in caves. They prefer to .hang in trees during the day. Hundreds or even thousands of bats can be spotted in a single tree.

Vampire bats live in the Amazon jungle in South America. The famous stories of blood-sucking bats probably originated here. These bats do in fact drink the blood of their victims. They usually attack farm animals, but have also enjoyed the blood of humans. But vampire bats only drink a very small amount of fluid.

(iv) Tropical Rain Forest Reptiles:

The tropical rain forests of the world are full of reptiles. Reptiles are cold blooded, which means their body temperature depends on their environment. So, it is important for them to stay in warm climates. Snakes are reptiles, and the rain forests are home to many. The mamba family is the most poisonous of all. They kill their prey by injecting poison with their sharp fangs.

Anacondas make up another snake family. They are some of the longest creatures in the world, as they can reach 30 feet in length. Anacondas prefer to wrap themselves around their prey and squeeze, rather than inject poison. Anacondas swallow their prey whole and sleep while the food is digesting. Chameleons are interesting lizards that can change color.

This enables them to blend in with their surroundings. Not only is this a great disguise from predators, it is also an easy way to sneak up on their prey. Chameleons only eat insects. Geckos are very neat creatures. The flying gecko can glide from tree to tree to escape from predators. Their grip is so strong, that if you tried to pull one off a window, the glass would break before the gecko would let go.

(v) Tropical Rain Forest Primates:

Monkeys and their cousins are all primates. Humans are also primates. There are many species of monkeys in the tropical rain forests of the world. Monkeys can be divided into two groups: new world monkeys and old world monkeys. New world monkeys live only in South and Central America. Spider monkeys live in the rain forests in the Andes Mountains.

They look very strange with their long noses. Spider monkeys eat mostly fruit and nuts, so they are called frugivores. They are joined by the howler monkeys. These primates are so named because they have a special sac that makes their sounds louder.

Old world monkeys live only in Africa and Asia. The colobus monkey is one such kind. These monkeys are called foliovores because they eat leaves. They live in small groups of 15, but other primates live in larger groups of up to 200. There are too many species. Chimpanzees, orangutans and gorillas are all called pongids. These primates are more famous than the others. Gorillas are too big to climb trees, so they are found on the forest floor.

(c) Boreal or Taiga Forests:

The boreal forest ecosystem is the contiguous green belt of conifer and deciduous trees that encircles a large portion of the Northern Hemisphere. In North America, the boreal forest stretches across most of northern Canada and into Alaska. It has long been identified as one of the world's great forest ecosystems.

This forest ecosystem covers roughly 35% of Canada's land mass and is the single largest land based ecosystem in North America. It also contains a significant proportion of Canada's biodiversity and has long been recognized as an important global carbon sink.

Although the boreal is relatively unknown, it is important as the "great lung" of North America, "breathing in" carbon dioxide and "exhaling" oxygen into the atmosphere. In short, the boreal forest manages to do what the rain forest of the Amazon does but with only the fraction of the flora and fauna.

This forest ecosystem houses the largest and smallest mammal species (wood bison & pygmy shrews) of the North American continent. The Boreal forest has many things: great lakes and northern rivers; vast bogs, fens and other organic wetlands. The rich wildlife diversity of the Boreal is a joy to behold: woodland caribou and lynx; whooping

cranes and wood bison; northern owls; woodpeckers with three rather than four toes; colorful wood warblers.

The Boreal has more than 5,000 species of conspicuous and colorful fungi, celebrated far more in Scandinavia and Siberia than in North America. Then there are the precious old-growth forests, the richest and most biologically diverse of the Boreal forest communities that are essential for so many Boreal species.

Structure of Forest Ecosystems:

Different organisms exist within the forest layers. These organisms interact with each other and their surroundings. Each organism has a role or niche in sustaining the ecosystem.

Some provide food for other organisms; others provide shelter or control populations through predation:

Producers:

All living organisms' intake energy in order to survive. In a forest ecosystem, trees and other plants get their energy from sunlight. Plants produce their own food, in the form of carbohydrates. Plants are, therefore, called the primary producers, since they produce the basic foodstuffs for other organisms within food chains and food webs. Photosynthesis is the chemical reaction that allows plants to produce their own food.

Consumers:

Animals cannot produce their own food. They must consume food sources for die energy they need to survive. All animals, including mammals, insects, and birds, are called consumers. Consumers rely on plants and other animals as a food source. Details of these animals in a forest ecosystem have been given earlier.

Primary consumers only eat plants and are referred to as herbivores. Secondary consumers are referred to as carnivores and feed on herbivores. Tertiary consumers are carnivores that feed on other carnivores. Omnivores eat both plant and animal matter.

Decomposers:

Leaves, needles, and old branches fall to the forest floor as trees grow. Eventually all plants and animals die. So what happens to all of this plant and animal material? Does it

sit on the forest floor forever? Thankfully no. These materials are decomposed by worms, microbes, fungi, ants, and other bugs.

Decomposers break these items down into their smallest primary elements to be used again. Decomposers are important in that they sustain the nutrient cycle of ecosystems.

Humans are part of Forest Ecosystem:

Humans are consumers. We get food and materials from forests. Because of this, we are a part of the forest ecosystem. Human consumption alters forest ecosystems. Human intervention may be necessary to sustain forest communities under the increased pressure of human use.

2. **Grassland ecosystem**

   Grasslands are areas where the vegetation is dominated by grasses (Poaceae), however it may be associated with plants from other families also. Grasslands occur naturally on all continents ecoregions of the earth except Antarctica. The structure and function of the world's grasslands makes them one of the most vulnerable to global climate changes of any terrestrial ecosystem. Grasslands—as highly dynamic ecosystems—provide goods and services to support flora, fauna, and human populations world-wide. Grasslands have been goldmines of plants used for food. Many of our food grains—wheat, corn, rice, rye, millet, and sorghum—have originated in grasslands. Many types of grassland remain the primary source of genetic resources for improving our crops and for increasing the number of pharmaceuticals. Grass-lands produce forage for domestic livestock, which in turn support human livelihoods with meat, milk, wool, and leather products. Grasslands provide habitat for breeding, migrating, and wintering birds; ideal conditions for many soil fauna; and range-lands for wild herbivores. These ecosystems cycle water and nutrients, and build and maintain stabilization mechanisms for soil. Grassland vegetation, above and below ground, as well as the soil, serve as large storehouses for carbon, helping to limit global warming. Grasslands also supply energy from fuel, wood and wind generated from wind farms. These largely open-air landscapes support recreational activities such as hunting, wildlife-watching, and tourism more generally, and offer aesthetic and spiritual gratification.

   Definitions for grasslands vary. Some studies classify grasslands by vegetation while others characterize them by climate, soils, and human use of the ecosystem. Bailey (1989) presents a map of ecosystem units or eco-regions of

the continents—including dry savanna or steppe, grassy savanna, prairie, and shrub savanna—using climate and vegetation as indicators of the extent of each unit. He qualifies this method by stating that: The delineation of eco-regions should properly be based upon the distinctiveness and distribution of various ecological associations. Savannas often have been described as forming a continuum between tropical forests and grasslands.

Several major studies have presented estimates of the extent of the world's land area in grasslands. These estimates vary, in part, because of differences in land cover characterizations of grasslands. The estimates range from approximately 41 to 56 million km2 , or 31 to 43 percent of the earth's surface (Whittaker and Likens 1975; Atjay et al. 1979; Olson et al. 1983)

Types of grasslands

There are two broad types of grasslands in the world: Tropical and Subtropical Grassland (Savannah) and Temperate Grassland.

Tropical Savannah

Tropical Savannahs are close to the equator and remain warm year round with marked dry and wet seasons that discourage the creation of forests. Tropical Savannah occurs in Africa, India, Australia, South America and Indonesia– typically have well-drained soils with only a thin layer of humus, often located in the transitional region between rainforest and desert. Rainfall of 50 to 130 centimeters a year is concentrated in six to eight months with drought the rest of the year. Soils are usually very thin, supporting only grasses and forbs (flowering plants), with only scattered trees and shrubs. Differences in climate and soils create many variations in the plant communities and animal species throughout the Savannah. In many areas, the grasslands have been burned to maintain a healthy grass crop for grazing animals. In some areas the Savannah has been expanded by cutting the forest and burning the area each year to prevent the return of trees. Flooded grasslands are also located at subtropical and tropical latitudes, which are flooded seasonally or year-round. They are also known as swamp. Desert grassland is composed of sparse grassland eco-regions located in the deserts and xeric shrub lands biome

Temperate grasslands

Temperate grasslands have less rainfall (25 to 90 centimeters) than tropical grasslands and a much greater range of temperatures from winter to summer than Savannah. They undergo hot summers and cold winters with moderate rainfall. These interior grasslands are distinguished by deep-rooting, perennial tall grasses, flowers and herbs with very few shrubs and trees. Due to their rich, fertile soils and favorable climate, many of these ecosystems have been converted to agricultural production or ranching. There are two broad types of grasslands in temperate latitudes: Prairie and Steppe

Prairie grasslands

Prairie grasslands are found across the globe. They have a variety of names in other parts of the world: pampas in South America, veldt in South Africa and puszta in Hungary. These areas have deep, rich soils and are dominated by tall grasses; trees and shrubs are restricted to river valleys, wetlands and other areas with more moisture. Over the years the native grass species on the extensive areas of level ground have been ploughed and fields seeded. Many of these grasslands have been lost to cereal crops.

Steppe grasslands

Steppe grasslands receive only 25 to 50 centimeters of rainfall each year and the grasses are much shorter than those on prairie grasslands. They are also not as widespread, occurring only in Central and Eastern Europe, Northern Eurasia and Western North America. Montane grasslands are located above the tree line. The biome includes high altitude (montane, subalpine, and alpine) grasslands and shrub lands around the world. Similar to montane grasslands, polar arctic tundra can have grasses, but high soil moisture means that little tundra is grass-dominated today. However, during the Pleistocene ice ages, a polar grassland known as steppe-tundra occupied large areas of the Northern hemisphere.

The various components of a grassland ecosystem are as follows—

1. Abiotic substances:

These include the nutrients present in the soil and the aerial environment. The elements required by plants are hydrogen, oxygen, nitrogen, phosphorous and sulphur. These are supplied by the soil and air in the form of CO_2, water,

nitrates, phosphates and sulphates. In addition to these some trace elements are also present in the soil.

2. Primary producers:

Autotrophic producers are green plants that are capable of structural institutions and their internal processes to bind the primary global bodies, transporting it, save and reused for the stability of the ecosystem. These are mainly grasses of the family, Poaceae, a large variety of herbs, some shrubs and scattered trees.

3. Consumers:

Herbivores such as grazing mammals (e.g., cows, sheep, deer, rabbit, buffaloes, etc), insects (e.g., Dysdercus, Coccinella, Leptocorisa, etc), some termites and millipedes are the primary consumers.

The animals like fox, jackals, snakes, frogs, lizard, birds etc., are the carnivores feeding on the herbivores. These are the secondary consumers of the grassland ecosystem. Hawks occupy the tertiary tropic level as these feed on the secondary consumers.

4. Decomposers:

These include bacteria of death and decay, moulds and fungi (e.g., Mucor, Penicillium, Aspergillus, Rhizopus, etc) [1-3]. These bring the minerals back to the soil to be available to the producers again.

3. Desert ecosystem

Desert ecosystem is a sensitive ecosystem that is mainly composed of sand. The atmosphere is dry and lacks humidity. To qualify as a desert, a place should receive less than 10 inches of water a year. It is a highly specialized ecosystem that hosts certain species that are unique and can survive only in this habitat. Clouds are very scarce in deserts, because of which deserts are dry and have hot days and cold nights. Clouds are supposed to bring rain and block the sun, absence of which makes the desert dry. Clouds also prevent the heat from escaping the atmosphere at night, absence of which makes the desert cold at nights.

Types

Mainly deserts are of very fine red sand type that inhabits its own flora and fauna. Some of the deserts consist of sand mixed with pebbles and rocks. In general, a dry place which receives precipitation below potential evapotranspiration (but not extremely) is called a semi-arid place (steppe climate). Desertification is a type of land degradation in which a relatively dry land region becomes increasingly arid, typically losing its bodies of water as well as vegetation and wildlife. It is caused by a variety of factors, such as climate change and human activities. Desertification process converts such semi-arid places to deserts. Deserts start out as a rock, years of wind and water had caused weathering of these rocks has led to the formation of dunes.

Characteristic features

- Receives very less rainfall with which many plants and animals will not sustain. Composed of dry sand, and some pebbles and rocks.
- Has very little water bodies (oasis is found in few places)
- Temperature during daytime is very high leading to a hot climate.
- Temperature during night is very less leading to a cold climate.
- Vegetation is very poor as only certain plants will be able to survive.
- Very few animals are found in the desert.

Structure and function:

The different structural components of the desert can be classified as abiotic and biotic components.

Abiotic components

The abiotic components of the desert include the nutrients in the soil. The soil lacks organic matter and also there is scarcity of water.

Biotic components

There are three biotic components in a desert ecosystem, they are, producers, consumers and decomposers.

Producers – Succulent plants are the ones that are found predominantly in the deserts. Succulent plants store water and during daytime transpiration are very less. These plants have a thick waxy layer that protects them from the hot sun. Many plants have beautiful flowers but also possess poisonous thorns.

Consumers – Many insects and reptiles are found in the deserts. Of the many insects that are found in the desert the ants are the most abundant species. Certain ants are capable of deflecting sunlight and are called as silver ants. The insects generally come out at night when the temperature is less. Snakes and certain poisonous lizards are found in the desert which is part of the rare species.

Also the desert inhabits certain rodents, birds and some mammalian vertebrates. Rats are the most common rodents, accompanied by hamsters and burrowers. The most important animal in the desert is the camel which is called as the car of the desert. Travelling in the desert happens mainly on camels. Two types of camels, one hump and two humps camel are found in the deserts.

Decomposers – A few thermophilic bacteria and fungi are the common decomposers that are found in the desert. They are less in number because the amount of dead organic matter is very less.

Biodiversity

Biodiversity is short for “biological diversity.” Biodiversity is “the variety of all living things, and the systems which connect them.” This includes all the planet’s different plants, animals and micro organisms, plus the genetic information they contain and the ecosystems of which they are a part. It is the result of millions of years of evolution.

So why is biodiversity so important? Everything in the natural world is connected. This means that everything we do as humans affects biodiversity, and biodiversity affects us. In the world of which we are a part, the more variety the better. This provides protection against things going wrong. Diverse ecosystems, and therefore diverse species and genes, make for a healthier, more resilient planet.

Biodiversity enhances an ecosystem's ability to do these essential ecological processes:

- oxygen production
- form and build healthy soils
- filter water on its way to the sea
- pollinate crops and plants generally
- store and recycle nutrients
- resist feral invasion

A lessening of biodiversity in an ecosystem weakens the ability of that system to survive and perform the ecosystem services that we as humans benefit so much from. Basically, there are three types of biodiversity: species, ecosystem and genetic diversity.

Species Diversity

Suggested student activity: Unit of Work on "Birds" Yr ¾ upwards. This includes every organism great and small – from amoebas to elephants – that currently exist, or have ever existed on our planet. This includes plants, fungi, insects, fish, reptiles & amphibians, birds and mammals, plus molluscs, worms, spiders, algae and other micro organisms. So far scientists have identified more than 1.4 million living species, with millions more yet to be discovered!

Note: species' diversity also refers to the differences within species as well as the variety (total number) of species. For instance, …

Ecosystem Diversity

An ecosystem is a community of organisms (living things) which depend upon each other for their existence. For example, you might expect to find kangaroos, or emus, or echidnas, in grassy woodland, but not in Antarctica, because these animals need the plants or bugs in the woodland, and conversely the plants need them: plants are tippruned by kangaroos, emus disperse and help germinate

seed in their scats, and echidnas till the soil which also aids in germination of some seeds.

Examples of some local SA ecosystems are: woodland of the Mt Lofty Ranges, grasslands of the mid-North, mallee scrub, Port Adelaide mangroves, the Port Noarlunga reef, Murray River system, ponds, caves. On a more global scale, some examples are: oceans, the polar and Antarctic ice sheets, rainforests and deserts.

Genetic Diversity

Genes are simply traits that we inherit from our parents and can pass on to our children, for example, traits such as hair colour, eye colour, curly or straight hair and whether you can curl your tongue and so on.

Genes are the basic units of life on Earth. They are responsible for both the similarities and the differences between organisms, eg the changes in colour and markings of birds within a particular species. “Genetic diversity is the variety of genes within a species.

Each species is made up of individuals that have their own particular genetic composition. This means a species may have different populations, each having different genetic compositions. To conserve genetic diversity, different populations of a species must be conserved.”

Because our environment is constantly changing, we need a diverse range of genes to be able to adapt. Preserving variety within populations of species is essential for preserving the ability of that species to cope with environmental change. An organism’s ability to adapt to environmental change will determine how well it survives in the long run. The greater the diversity of genes in a population, the greater the chances that some individuals will possess the genes needed to survive under conditions of environmental stress (such as climate change, drought, fire, famine, introduction of a new predator etc).

4. **Aquatic ecosystem**

An ecosystem is a complex web of relationships between living and non-living things. The study of ecosystems is known as ecology. The biotic parts of an ecosystem are the living components, such as the communities of plants and animals, including humans. The abiotic parts are the nonliving components, including sunlight, air, water, temperature, and minerals.

Each part of an ecosystem is connected to and depends on all the others parts. It takes all the parts interacting in a balanced fashion to make the system work. Changes to any part of an ecosystem can affect many others, which in turn may affect many more. A healthy, balanced ecosystem provides for the needs of the communities of life that are part of the ecosystem.

Kinds of aquatic ecosystems

Ecosystems organized around bodies of water are called aquatic ecosystems. Texas has six kinds of aquatic ecosystems (Fig. 6.1):

Aquifers and springs

Rivers and streams

Lakes and ponds

Wetlands

Bays and estuaries

Ocean (Gulf of Mexico)

Aquifers and springs

Aquifers are underground reservoirs and rivers of water. The water they contain is called groundwater. Aquifers form where water seeps into the ground over time. Sometimes this water is ancient, having fallen on the land thousands of years ago.

Most of Texas's land surface sets over aquifers, some large and some small. About half of the water we use in Texas is pumped from these aquifers by manmade wells drilled deep into the Earth. Aquifers need water seeping back into the ground to replenish the water that is pumped or drained out. These areas are called "**recharge** zones." A recharge zone is the area of land above an aquifer where surface water soaks back into the ground or travels through cracks or fractures between rocks deep into the Earth. Aquifers are very important to Texas' economy and one of the reasons why people are able to live, ranch, and farm throughout the state.

Springs are the points where, because of the underground geology, groundwater travels to the surface and emerges from the ground. Springs can be a slow seep or spring water can bubble up in pools and ponds. Springs sometimes form the headwaters of streams and rivers. Texas is home to over 3,000 springs, including some of the largest in the United States.

Rivers and streams

Rivers and streams are flowing water with a measurable current. The current flows between the stream banks and over an underwater streambed or riverbed. The word “stream” can be used to describe all flowing natural waters. “Rivers” are just large streams. Streams are ever-changing systems that move and store water. They also move and store sediment and organic matter, such as leaves that fall into the water.

Texas has different kinds of streams that vary from one end of the state to the other. Streams have different sizes, shapes, lengths, flow rates, plants, animals, water quality, and streambed composition (for example, rocks or sand). Regardless of their size, shape, or location, all healthy Texas streams and rivers share a common feature: they are diverse ecosystems. The plants and animals living in them exist in balance with the processes that recycle nutrients, or chemicals in the water organisms need to grow. The healthiest streams are those that flow freely and have natural banks and streambeds.

Streams and rivers are important to people both ecologically and economically. They have been used from the earliest times by humans for travel and commerce. They carry the water humans need for life, and they often are used to carry away their wastes, as well. Streams and rivers contain fish and attract wildlife used by people for food. They are the means by which **freshwater** is carried to the ocean, forming ecologically important **wetlands** and **estuaries** along the way. They also provide places for recreation important to Texas’ economy, including paddle sports, fishing, wildlife watching, and hunting.

Lakes and ponds

Lakes and ponds are among Texas’ most well-known and popular aquatic ecosystems. Lakes and ponds are bodies of standing (not flowing) water. You may be surprised to learn that Texas actually has only one natural lake. (Fig. 6.2)

The many lakes and ponds in Texas have been built by humans by placing **dams** across rivers or streams. These range from small ranch and farm ponds of less than the size of a football field, to large lakes such as Lake Fork near Dallas and Lake Travis near Austin. The largest of these lakes **impounded** by dams are usually called reservoirs**.** There are over 200 major reservoirs and over 5,000 smaller ones in Texas.

Texas lakes and ponds are used to hold water for use by people for drinking, production of electric power, recreation, and use in agriculture, such as watering crops and for ranch animals. Boating, fishing, water skiing, and other outdoors experiences add billions of dollars to the state’s economy each year as people buy equipment for these recreational experiences and pay to travel and stay at outdoor locations.

Small ponds are formed by trapping water in valleys or other low spots in a watershed. Ponds are usually shallow enough that if the water is clear, sunshine can reach the bottom, allowing rooted plants to grow completely across it. A pond's water temperature changes with air temperature and is about the same from one end to another and from top to bottom. There is little wave action, and the bottom is usually covered with mud. Lakes are bigger than ponds, so they are often too deep for light to reach the bottom and grow plants much beyond the shoreline. While lakes and ponds have much in common, a lake's larger size and greater depth create differences in physical and chemical characteristics, including changes in **dissolved oxygen** and the temperature from top to bottom.

Wetlands

Wetlands are the "in-between" places, where water meets land. These are lands covered with shallow water at least part of the year. They can be present along the edges of rivers or lakes as the transitional zone between uplands and deep water, or wetlands can be individual bodies isolated or connected to other water bodies by groundwater. Think of wetlands as giant sponges laid out on the ground. When it rains, these are places where water collects and is held or where water slowly drains away over time. Wetlands can be big or small, full of tiny floating plants or massive trees. They are found from mountain top to estuary. They are coastal shorelines, **marshes**, stream banks, and swamps. Life gathers around wetlands, and wetlands give life.

Wetlands are among the most productive ecosystems in the world. Texas has many large and ecologically important coastal wetlands. These kind of wetlands are situated in Texas' estuaries and bays. Up to 90% of Texas' coastal saltwater fish species depend on wetlands for food, spawning, and places where their young can hatch and grow up.

Yet wetlands have a bad reputation to some people. There are those who think these shallow waters are nothing more than stinky, bug-infested wastelands. Some people even think wetlands should be drained and used for other purposes. The truth is, healthy wetlands are very important to us. They help maintain water quality, recharge aquifers, reduce flooding, provide habitat, and are great places to go paddling, hunting, fishing, and wildlife watching.

Wetlands are dependent on the presence of water for all or part of the time. Because of this, wetlands that do not have water in them year-round can sometimes be difficult to recognize and protect. Sadly, Texas has lost over half its wetlands. Many have been lost as a result of human alterations, draining and filling. Many of the wetlands that are left have been partially filled in, polluted, or altered to the point they no longer function

naturally. Taking care of the wetlands that are left and restoring them are among the biggest challenges facing **natural resource** managers today.

Bays and estuaries

Although use of the terms estuary and bay are often interchanged, estuaries are where one or more rivers flow into a partially enclosed area on the coast, mixing freshwater with the ocean's **saltwater**. This water is called **brackish**. Bays are also partially enclosed by land, but bays open directly to the ocean. A bay's water can be brackish or saltwater.

Freshwater moves from land to the ocean in various ways — as flowing rivers and streams, as runoff from land near the coast, and as spring flow from aquifers. At the ocean's edge these freshwater inflows mix with saltwater to create Texas' many brackish (a mix of freshwater and saltwater) estuaries. This "freshwater inflow" delivers essential nutrients and sediments along with the freshwater.

Salinity is a measure of how much salt is in the water and is affected by how much freshwater reaches the coast. Salinity plays a critical role in the health of fish and other coastal plants and wildlife. Too little freshwater allows the estuaries to become too salty for many plants, fish, and wildlife to survive.

This dynamic mixing of freshwater and saltwater produces nutrient rich, dark colored, and turbid waters. These waters feed estuary and bay habitats upon which 90% of all the commercially and recreationally important fish and shellfish of the Gulf of Mexico depend. The mud and sand bottoms of Texas' estuaries and bays are dominated by extensive seagrass beds and benthic communities, including numerous oyster reefs. This essential habitat is being lost. About 60% of Texas' shoreline is eroding away and almost half of Texas' original coastal wetlands are gone.

Coastal barrier islands run along the entire coast. These long, narrow islands block direct flow of freshwater to the ocean, creating productive estuaries and helping protect bays and shorelines during hurricanes and storm surges. Barrier islands host fascinating, yet sometimes fragile, ecosystems.

Ocean (Gulf of Mexico)

The Gulf of Mexico is the ninth largest body of water in the world. It's formed like a giant wide-brimmed bowl with the edge full of shallow bays and estuaries. (Fig. 6.3) Starting from the coastline and moving out into the ocean, the Gulf has wide and shallow shelfs that gradually slope into the deeper Gulf waters. The floor of the Gulf is mostly a vast expanse of undulating soft mud bottom. The freshwaters that flow into the Gulf greatly affect the health of the aquatic life there. For example, the water flowing from the

Mississippi River along the Louisiana coast has created a hypoxic zone, often called the dead zone. This is a vast area deficient in dissolved oxygen where many organisms become stressed or can't survive. This environmental threat comes from excessive nutrients and wastes carried into the Gulf by the Mississippi River, which collects water from 41% of the continental US.

All of these factors combine to support one of the most productive, yet ecologically threatened bodies of water in the world. The Gulf is a place of incredible **biodiversity** with over 15,000 species calling it home. Commercial fisheries annually catch over 1.5 billion pounds of food. Shrimp are the predominant species caught for food for people. Gulf shrimp and oysters account for 70% of all the shrimp and oysters that go into our grocery stores and restaurants across the US. Recreational fishing is also important, providing employment and tourist dollars in coastal communities. (Fig. 6.4)

Over the last 90 years, the Gulf and US coastline has changed dramatically. Fifty percent of our Coastal wetlands are gone, up to 60% of the seagrass beds have been lost, and over 50% of our oyster reefs have disappeared. In Texas, reduced freshwater flowing into estuaries and bays reduces the amount of certain kinds of habitat needed by many of the Gulf's most important species to people and the aquatic ecosystem.

Texas' aquatic systems are all connected

Life in healthy aquatic ecosystems is constantly progressing toward a state of balance, but balance does not mean a lack of change. Ecosystems are always changing. Change comes in response to natural or human-caused events. For example, heavy rains can force a river to change course, leaving the old channel and forming a new one. A human activity such as straightening a stream speeds up erosion and cuts out curves that shelter fish and other aquatic life. Changes may destroy habitat for some species and create habitat for others.

Whether changes are good or bad depends on how they affect the ecosystem's biodiversity. This term refers to the variety and number of different species and populations. The more closely the biodiversity in an ecosystem matches that of a completely natural system, the healthier, more sustainable and better balanced it is. Some human activities that can reduce aquatic biodiversity are draining a wetland, damming a river, or pumping so much water out of an aquifer that springs no longer flow. These activities destroy habitat, which is the main cause of species decline. Therefore, protecting and restoring a wide variety of aquatic habitats helps keep species from becoming endangered or extinct.

Levels of biological diversity

Genetic

Genetics is a field of biology that studies genes, heredity, and genetic variation. Genetic variation includes how genes become mutated or are involved in disease and aging. Environmental genetics examines how environmental factors interact with genes to cause disease, or enhance the adaptation of a species to its environment.

A geneticist is a science who studies genes, including how they are inherited, mutated, activated, or inactivated. They often study the role that genes play in disease and health. Environmental geneticists specialize in studying the interactions between genes and environmental factors that lead to adverse health effects, disease, and aging.

What Does a Geneticist Do?

Geneticists study the inheritance of traits. They may focus on these events at the molecular, organism, or population level. Some treat people with genetic disorders. Many environmental geneticists try to understand how environmental factors or exposures interact with genes to cause disease.

Environmental genetics often deals with epigenetics - the process by which parts of the genome can be "turned on" or "turned off" by external environmental factors. While many traits are set in stone by genes, others are more flexible and may or may not end up being expressed. For example, if you're predisposed to a certain condition or trait due to your genetic makeup, you may or may not develop it on your own. However, being exposed to certain environmental factors such as diet and stress may cause that part of your genome to activate and be expressed. For example, genetics may make some people more susceptible to adverse health effects related to environmental factors like air pollution. Many environmental geneticists study how these interactions work.

Others study ecological genetics to expand our understanding of the role genetics plays in species' adaptations to changing environments. Ecological geneticists use population genetics for the conservation, management, and genetic improvement of species. For example, they calculate the reproduction and survival rates of a species or community. They use their knowledge of genetics to identify at-risk species and increase their genetic diversity. Some research how to genetically engineer plants that can adapt to climate change.

Regardless of specialty, most geneticists perform many of the same tasks. For example, they plan or conduct genetic research on gene expression and other topics. They keep laboratory notebooks that record their research methodology, procedures, and results. They review and interpret lab results using mathematical and statistical methods. Geneticists must keep up with scientific literature to learn about new methods, tools, and results in the field, and use that information to inform their own research. They often write grants or attend fundraising events to fund their research projects.

They share their research results by writing academic journal articles and presenting at professional conferences.

Species and ecosystem diversity

Biodiversity, a combination of the words biological and diversity, refers to variability of forms of life in a specific area. Ecologists define three levels of biodiversity: genetic biodiversity, species biodiversity, and ecosystem biodiversity. Genetic biodiversity refers to variability in the gene pool of a community. Species biodiversity, which is the form of biodiversity most often discussed, refers to the number of species living in an area. Ecosystem biodiversity refers to the number of ecosystems in a certain area. Ecosystems are all of the animals, plants, bacteria, and fungi as well as the physical components of the area. An ecosystem can be as large as an entire forest or as small as a clump of moss that provides a habitat for plants, microscopic invertebrates, and bacteria.

Biodiversity is important to humans for a number of reasons. It represents a significant resource of chemical and biological products including food, fibers, and medicine. It produces in clean air, clean water, and fertile soils. Ecologically, biodiversity contributes to ecosystem stability, which allows ecosystems to effectively withstand environmental perturbations.

Historical Background and Scientific Foundations

The variation among organisms on Earth is called biological diversity, or biodiversity. Biodiversity most often refers to the number of species in a certain area, or the species diversity. Individuals that belong to the same species are able to mate and produce offspring that are fertile. Increased species biodiversity is also known as species richness. An ecosystem that has greater species biodiversity contains more ecological niches. An ecological niche is the collection of biological and physical requirements necessary for an organism to grow and reproduce. A coral reef with its many nooks and caves for hiding and influx of light from above contains many ecological niches and the species biodiversity is extremely high. On the other hand, the deep ocean, with its relatively homogeneous topography and lack of light, has low species biodiversity.

A second form of biodiversity is genetic biodiversity, which refers to the variability in the genetic material of the individuals in a certain population or community. Genetic biodiversity influences how well a species can adapt to environmental pressures. For example, suppose a population is impacted by a severe environmental stress, such as a drought or a fire. If the population has high genetic biodiversity, some of the individuals are likely to have adaptations that allow them to survive the impact. On the other hand, if genetic diversity is low, it is possible that the entire population will be adapted to a narrow range of ecological conditions; a more specialized ecological niche. If environmental conditions become extreme, the entire population will be threatened. The idea of genetic biodiversity extends beyond populations to communities. A community

with more species will have a more genetic variation than one with fewer species. The genetic biodiversity of a community with more species is larger and there are likely to be populations within that community that can withstand environmental perturbations, should they occur.

An ecosystem is the community of living organisms as well as the physical components of an environment such as water, soil, and climate. Another level of biodiversity refers to ecosystem biodiversity. Ecosystem biodiversity has two related meanings and these two meanings also relate to species and genetic biodiversity. The first definition of ecosystem biodiversity refers to the number of ecosystems found in a certain area. Therefore, California, which includes temperate forests, prairies, deserts, temperate lakes, chaparral, kelp forests, beach

WORDS TO KNOW

BIODIVERSITY:

Literally, “life diversity”: the wide range of plants and animals that exist within any given geographical region.

COMMUNITY:

All of the populations of species living in a certain environment.

GENETIC:

Having to do with the genetic material, or DNA, in an organism.

SPECIES:

A biological classification group ranked below genus, consisting of related organisms capable of interbreeding.

ecosystems, estuaries, alpine forests, and rocky shorelines has greater ecosystem diversity than does Kansas, which primarily consists of prairies, rivers, and lake ecosystems. In general, places with more varied terrain tend to have more ecosystems than places where topography is more homogeneous. Because California has numerous types of landforms and climates (mountains, flat areas, ocean coasts, and lakes), it has more ecosystem biodiversity than Kansas, which is for the most part, a plain.

A second definition of ecosystem biodiversity refers to the number of ecological interactions among organisms in a certain area. For example, a coral reef ecosystem, composed of coral, sea stars, worms, sea slugs, snails, kelp, sea grass, fish, crabs, sharks, seals, whales, and plankton has much greater ecosystem diversity than the open ocean near Antarctica, which has an ecosystem composed primarily of phytoplankton, krill, fish, and whales. This form of ecosystem biodiversity is a measure of the complexity of an ecosystem. A more diverse ecosystem has more ecological

niches, more feeding relationships among organisms, more organisms that capture energy, and more species that recycle organic nutrients into inorganic forms.

To a large extent, the various definitions of biodiversity overlap. An area that contains numerous ecosystems will contain a high diversity of interactions among organisms. A region with numerous interactions among organisms likely has a large number of species and high species biodiversity. If a region has high species biodiversity, it has a lot of genetic variability in the organisms that make up the ecosystem.

Numerous factors influence ecological biodiversity. Ecological biodiversity is greater in places where ecological resources are abundant. Where the topography is more varied, there are more places for shelter and more places to escape predation. In places where rainfall and sunlight are abundant, photosynthesis is greater and plants grow rapidly, providing a source of food for other organisms. In places where the climate is more stable, more species can adapt to the more reliable conditions. Places where extreme weather occurs often tend to have less ecological biodiversity. As a result, the tropics have more ecological biodiversity than the poles; rain forests and temperate forests have more ecological biodiversity than deserts; coral reefs have more ecological biodiversity than does the open ocean.

Finally, the history of a location influences the ecological diversity. For example, Greenland was covered by glaciers until about 10,000 years ago. The diversity on Greenland is low because there has been little time for species to immigrate and adapt to the environment and complex ecological interactions have not had a lot of time to develop.

Impacts and Issues

Biodiversity in all of its forms—ecological, species, and genetic—is important for numerous reasons. Humans rely on ecosystems for many functions. Ecosystems produce the food humans eat and the fiber that humans used for clothing and shelter. The diversity of plants in the many ecosystems is the source for medicines that humans use to treat disease. Coastal ecosystems, in particular, play a major role in scrubbing water of pollutants and producing clean water that can be used for drinking and washing. All of the oxygen on the planet results from photosynthesis from plants in forests and phytoplankton in the oceans.

When ecosystems are more diverse, they are better able to withstand environmental perturbations. When a more ecologically complex ecosystem is impacted by human activities and environmental pressures, there are likely to be organisms and interactions among organisms that can continue to exist despite the impact. For example, before word processing programs had automatic back up features, the only way to save a document was for the user to provide the save command to the program. More modern programs have automatic save features and computers themselves have back up features. If something happens to one of the save processes, the document will still likely be saved using a different process. In the same way, an ecosystem with more

diversity will likely be able to continue functioning even if something happens to a portion of it because of an environmental perturbation.

As human activity impacts the environmental conditions on the planet, by changing the climate, removing natural habitat for development, and through pollution, the diversity of ecosystems are negatively impacted in numerous ways. More organisms are currently undergoing extinction than at any other time in Earth's history because of habitat loss to human development, pollution, and climate change. This has immediate impacts on the species biodiversity of an ecosystem. If a top predator is removed from an ecosystem, the entire ecosystem

is impacted. Ecologist R T. Paine showed that the removal of starfish, the top predator in rocky intertidal ecosystems, decreased diversity throughout the entire area causing a collapse of the ecosystem.

Pollution is a serous threat to ecosystem diversity. Toxic pesticides and fertilizers are spread on agricultural crops and their impact is rarely confined to agricultural pests. For example, the European red mite became a significant pest in orchards because pesticides likely removed its competitors. Climate change threatens the biodiversity of many ecosystems. Currently, corals are dying at a rapid rate throughout the world. One probable reason for this is the warming of ocean temperatures as a result of global climate change. Coral reefs are one of the most diverse ecosystems on the planet, not only home to countless species, but a place of enormous forms of interactions among species. When the corals die, the many ecosystems that occur in the reefs diminish in biodiversity.

Biogeography zone of India

Our country can be divided into ten major regions based on the geography,

climate and pattern of vegetation seen and the communities of mammals, birds, reptiles, ambhibians, insects and other invertebrates that live in them. Each of these regions contain a variety of ecosystems such as forests, grass lands, lakes, rivers, mountains and hills which have specific plant and animals species.

India's Biogeographic Zones are given below :

1. The cold mountainous snow covered Trans-Himalayan region of ladakh

2. The Himalayan ranges and valleys of Kashmir, Himachal Pradesh, Uttarakhand, Assam and other North eastern States.

3. The Terai, the low land where the Himalayan rivers flow into the plains

4. The Gangetic and Brahmaputra plains.

5. The Thar Desert of Rajastan

6. The semi- arid grassland region of the Deccan plateau, Gujarat, Maharashtra,Andhra Pradesh, Karnataka and Tamilnadu

7. The North eastern States of India

8. The Western Ghats in Maharastra, Karnataka and Kerala

9. The Andaman and Nicobar Islands

10. The long western and eastern coastal belt with sandy beaches, forests and mangroves.

THREATS TO BIODIVERSITY:

Habitat loss is mainly due to human population growth, industrialization and changes in the land use patterns, poaching of wild life and man wildlife conflicts. Man has begin to overuse or misuse most of these natural ecosystems. Due to unsustainable resource-use, once productive forests and grasslands have been turned into deserts and wastelands have been increased all over world. Scientists have estimated that human activities are likely to eliminate approximately 10 million species by the year 2050.

Human population growth, industrialization and changes in the land use patterns:

Around 1.8 million species of plants and animals are known to science. The actual number of species have been existing is more than 10x1.8millions. Though new species have been continually identified, the rate of extinction is very high (10-20,000 species per year i.e.,1000 to 10,000 times faster rate). Human actions are expected to exterminate 25% of world's species in next 20-30 years. The mega extinction spasm is related to human population growth, industrialization and changes in the land use patterns in India. The reasons are:

Forests and grasslands are changed to agricultural land. Encroachments are being repeatedly legalized.

Natural wetlands are drained to establish crop lands leading to loss of aquatic species.

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

Grasslands are changed to other forms, degraded by overgrazing. Loss to cattle, goat and sheep.

Natural forests are being deforested for timber and replanted for teak, sal etc. Such monoculture does not support biodiversity as in forests which has closed canopy and

rich undergrowth. Excess collection of fire wood by lopping of branches of trees canopy is opened up altering the local biodiversity.

Foraging cattle retard regeneration of forest as young seedlings are trampled.

Ever increasing population gradually decrease buffer zones and forested areas. A prime example is Gir national park, the last bastion of Asiatic lion with a meter gauge railway line, state expressway and 3 temples.

Repeated fires by local grazers to increase growth of grass ultimately reduce regeneration of grasses.

Introduction of exotic weeds eg. lantana bushes, Eupatorium shrubs and ‘congress’ grass are invading at the expense of indigenous undergrowth species. Following traditional farming techniques like slash and burn in Himalayas, and rab, lopping of tree branches for making wood ash fertilizer in Western ghats

are now leading to loss of biodiversity.

Over harvesting of fish by large trawling boats is leading to depletion of fish stocks.

Marine turtles caught in the net are massacred of the coast of Orissa. The rare whale shark, a highly endangered species, is being killed off the coast of Gujarat.

Poaching:

Specific threats to certain animals are related to large economic benefits. The skin and bones from tigers, ivory from elephants, horns from rhinos and perfume from the musk deer are extensively used abroad. Bears are killed for their gall bladders. Corals and shells are also collected for export or sold on the beaches of Chennai, Kanyakumari and the Andaman and Nicobar islands. Tortoises, exotic birds and other small animals are packed into tiny containers and smuggled abroad for the pet trade. A variety of wild plants with real or sometimes, dubious medicinal values are being overharvested. The commonly collected plants include Rauwolfia, Nux vomica, Datura, etc. The garden plants collected for illegal trade include orchids, ferns and mosses.

Man wild life conflicts:

Conflicting situations with wild life starts causing immense damage and danger to man. Ex: In Sambalpur, Orissa 195 humans are killed in last 5 years by elephants and in retaliation villagers killed 98 elephants and badly injured more than 30 elephants. Similar incidents with tigers, leopards etc. are in news. Shrinking forest cover, human encroachment, ill and weak animals, lack of food (one adult elephant needs 200 kg green fodder and 150 kg of clean water) for animals, protecting villagers by putting

electric fence are the main reasons for such happenings. As the compensation by government. is not enough, conflicts occur between forest department and villagers.

Global biodiversity hot spots

There are currently 36 recognized biodiversity hotspots. These are Earth’s most biologically rich—yet threatened—terrestrial regions.

To qualify as a biodiversity hotspot, an area must meet two strict criteria:

- Contain at least 1,500 species of vascular plants found nowhere else on Earth (known as "endemic" species).
- Have lost at least 70 percent of its primary native vegetation.

Many of the biodiversity hotspots exceed the two criteria. For example, both the Sundaland Hotspot in Southeast Asia and the Tropical Andes Hotspot in South America have about 15,000 endemic plant species. The loss of vegetation in some hotspots has reached a startling 95 percent.

WHY DOES CEPF WORK ONLY IN BIODIVERSITY HOTSPOTS?

The extinction crisis is vast, and conservation funds are limited, so focus is a critical element of CEPF's approach. Biodiversity hotspots are home to thousands of irreplaceable species that are facing multiple, urgent threats. These are places where CEPF's relatively small investments can help move the needle in a meaningful way toward sustainable conservation.

WHO LIVES IN THE BIODIVERSITY HOTSPOTS?

The 36 biodiversity hotspots are home to around 2 billion people, including some of the world's poorest, many of whom rely directly on healthy ecosystems for their livelihood and well-being.

The hotspots provide crucial ecosystem services for human life, such as provision of clean water, pollination and climate regulation.

These remarkable regions also hold some of the highest human population densities on the planet, but the relationship between people and biodiversity is not simply one where more people lead to greater impacts on biodiversity. Much of human-biodiversity impacts lies not in human density but rather in human activity.

Conservation in the hotspots promotes sustainable management of these essential natural resources and supports economic growth, which also reduces drivers of violent conflict.

CEPF works with civil society in the hotspots to protect biodiversity.

HOW DID THE CONCEPT OF BIODIVERSITY HOTSPOTS BEGIN?

In 1988, British ecologist Norman Myers published a seminal paper identifying 10 tropical forest “hotspots.” These regions were characterized both by exceptional levels of plant endemism and serious levels of habitat loss.

Conservation International, one of CEPF's global donor organizations, adopted Myers’ hotspots as its institutional blueprint in 1989. In 1996, the organization made the decision to undertake a reassessment of the hotspots concept, including an

examination of whether key areas had been overlooked. Three years later an extensive global review was undertaken, which introduced quantitative thresholds for the designation of biodiversity hotspots and resulted in the designation of 25.

In 2005, an additional analysis brought the total number of biodiversity hotspots to 34, based on the work of nearly 400 specialists.

In 2011, the Forests of East Australia was identified as the 35th hotspot by a team of researchers from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) working with Conservation International.

Researchers have identified a new biodiversity hotspot, one of only 36 in the world. The North American Coastal Plain biodiversity hotspot, which stretches from northern Mexico to southern Maine, runs along the coast and includes areas within major U.S. cities, most notably New York City and Washington, D.C.

The hotspot is home to 1,816 species of plants, 51 species of birds and 114 species of mammals that are found nowhere else in the world.

Among the notable endemic species are the Florida yew (Taxus floridana), an evergreen shrub/small tree; the Florida bonneted bat (Eumops floridanus); and a fish species known as broadspotted molly (Poecilia latipunctata). These three species are listed as Critically Endangered by the International Union for the Conservation of Nature.

The threats to the hotspot’s biodiversity have been overlooked for a long time because until recently, people didn’t realize how much biodiversity the area truly held.

“Sometimes something precious is right under your nose, but goes unnoticed,” said Reed Noss, Provost’s Distinguished Research Professor with the University of Central Florida’s Department of Biology “Such it is that a region long explored by botanists and zoologists – the North American Coastal Plain (NACP) – was recognized only recently as meeting the criteria for a global biodiversity hotspot.”

Biodiversity hotspots are the world’s most biologically rich yet threatened terrestrial areas. To qualify as a hotspot, a region has to meet two criteria: it has to contain at least 1,500 species of vascular plants as endemics and it has to have 30 percent or less of its original vegetation remaining.

India as a mega-biodiversity nation

India has a very rich diversity of wild plants and animals, and is considered to be one of the mega-diversity country. Its share of the global biodiversity is about 8.6% of wild plant animal species respectively. Estimates for the number of micro-organism species are not available. Parallel to this enormous diversity in domesticated animal such as buffalo, goat, sheep, pig, poultry, horse, ponies, camels, and yak. As per American standards, the productivity of these animals is very poor, but having undergone periods of rigorous selection, race are hardy, adaptable to heat and parasitic stresses and can survive o poor roughage. A great variety also exists among our crops. For example, Indian farmers probaly grew over 30,000 varieties of rice aloe.

Both plant and animal species are under threat of extinction primarily due to modification, degradation and loss of their habitats, causes by various developmental projects like industries, urban housing complexes, rail, road, and other communication networks, over exploitation, introduction of exotic species, pollution and global warming. Estimates show that about 50 species are being drawn to extinction every day, and at this rate about 25% of present day biodiversity is likely to become extinct during the next 20-30 years if appropriate are not taken for its conservation. It is therefore, the prime responsibility of all scientists and technocrats to ensure that developmental activities promoted by them cause no/ minimal loss to biodiversity of an area.

Endangered and endemic species of India

Endangered species, any species that is at risk of extinction because of a sudden rapid decrease in its population or a loss of its critical habitat. Previously, any species of plant or animal that was threatened with extinction could be called an endangered species. The need for separate definitions of “endangered” and “threatened” species resulted in the development of various categorization systems, each containing definitions and criteria by which a species can be classified according to its risk of extinction. As a rule, a range of criteria must be analyzed before a species can be placed in one category or another.

Often such categorization systems are linked directly to national legislation, such as the United States Endangered Species Act (ESA) or the Canadian Species at Risk Act (SARA). In addition, regional agreements, such as the European Union’s Habitats Directive (Council Directive 92/43/EEC), and international conservation agreements, such as the Convention on the Conservation of Migratory Species of Wild Animals (CMS) or the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), are connected to species-assessment systems. One of the most-recognized independent international systems of species assessment is the Red List of Threatened Species, created by the International Union for Conservation of Nature (IUCN).

Human Beings And Endangered Species

Roughly 99 percent of threatened species are at risk because of human activities alone. By the early 21st century it could be said that human beings (Homo sapiens) are the greatest threat to biodiversity. The principal threats to species in the wild are:

Although some of these hazards occur naturally, most are caused by human beings and their economic and cultural activities. The most pervasive of these threats is habitat loss and degradation—that is, the large-scale conversion of land in previously undisturbed areas driven by the growing demand for commercial agriculture, logging, and infrastructure development. Because the rates of loss are highest in some of the most biologically diverse regions on Earth, a perpetual battle is waged to manage destructive activities there while limiting the impact that such restrictions may have on the well-being of local communities. The relative importance of each threat differs within and among taxa. So far, incidental mortality from ecological disturbance, temporary or limited human disturbance, and persecution have caused limited reductions in the total number of species; however, these phenomena can be serious for some susceptible groups. In addition, global warming has emerged as a widespread threat, and much research is being conducted to identify its potential effects on specific species, populations, and ecosystems.

Conflicts between human activities and conservation are at the root of many of these phenomena. Such controversies are often highly politicized and widely publicized in the global press and through social media. For example, habitat loss and species loss have resulted from the unregulated exploitation of coltan (the rare ore for tantalum used in consumer electronics products such as mobile phones and computers) in Kahuzi-Beiga National Park, one of the Democratic Republic of the Congo's premier forest parks. The park is also home to much of the population of the threatened Eastern Lowland gorilla (Gorilla beringei graueri). Mining has increased gorilla mortality by reducing the animal's food resources and leading many people displaced by the mining to kill gorillas for their meat. In addition, the mountain gorilla (G. beringei beringei), a close relative of the Eastern Lowland gorilla, is also at risk of extinction. However, authorities cite poaching, disease, and crossfire between warring political groups in the vicinity of Virunga National Park as the primary sources of its population decline.

Another example of a widely publicized wildlife controversy involves the relatively recent declines in amphibian populations. Known to be important global indicators of environmental health, amphibians have experienced some of the most serious population declines to date of all groups that have been assessed globally through the IUCN Red List process (see below). Amphibians (a group that includes salamanders, frogs, toads, and caecilians [wormlike amphibians]), being particularly sensitive to environmental changes, are severely threatened by habitat destruction, pollution, the spread of a disease called amphibian chytridiomycosis, and climate change.

Beyond these notable examples, many of the world's birds are also at risk. The populations of some bird species (such as some albatrosses, petrels, and penguins) are declining because of longline fishing, whereas those of others (such as certain cranes, rails, parrots, pheasants, and pigeons) have become victims of habitat destruction. On many Pacific islands, the accidental introduction of the brown tree snake (Boiga irregularis) has wreaked havoc on many bird

Many fishes and other forms of aquatic and marine life are also threatened. Among them are long-lived species that have life history strategies requiring many years to reach sexual maturity. As a result, they are particularly susceptible to exploitation. The meat and fins of many sharks, rays, chimaeras, and whales fetch high prices in many parts of the world, which has resulted in the unsustainable harvest of several of those species.

Moreover, freshwater habitats worldwide are progressively threatened by pollution from industry, agriculture, and human settlements. Additional threats to freshwater ecosystems include introduced invasive species (such as the sea lamprey [Petromyzon marinus] in the Great Lakes), the canalization of rivers (such as in the streams that empty into the Everglades in Florida), and the overharvesting of

freshwater species (as in the case of the extinct Yunnan box turtle [Cuora yunnanensis] in China). While an estimated 45,000 described species rely on freshwater habitats, it is important to note that humans are also seriously affected by the degradation of freshwater species and ecosystems.

Against this backdrop of threats related to urban expansion and food production, the unsustainable harvest of animal and plant products for traditional medicine and the pet trade is a growing concern in many parts of the world. These activities have implications for local ecosystems and habitats by exacerbating population declines through overharvesting. In addition, they have cross-border repercussions in

IUCN Red List Of Threatened Species

One of the most well-known objective assessment systems for declining species is the approach unveiled by the International Union for Conservation of Nature (IUCN) in 1994. It contains explicit criteria and categories to classify the conservation status of individual species on the basis of their probability of extinction. This classification is based on thorough, science-based species assessments and is published as the IUCN Red List of Threatened Species, more commonly known as the IUCN Red List. It is important to note that the IUCN cites very specific criteria for each of these categories, and the descriptions given below have been condensed to highlight two or three of the category's most salient points. In addition, three of the categories (CR, EN, and VU) are contained within the broader notion of "threatened." The list recognizes several categories of species status:

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.

Habital loss

Habitat loss has significant, consistently negative effects on biodiversity. Habitat loss negatively influences biodiversity directly through its impact on species abundance, genetic diversity, species richness, species distribution, and also indirectly. For example, habitat loss has been shown to decrease population growth rate, which was supported by findings from Donovan and Flather (2002) who demonstrated that species with declining trends in abundance globally had a higher probability of occurring in regions with high levels of habitat loss than those exhibiting stable or increasing trends. Habitat loss has also been found to lessen the number of large, specialist species, disrupt species interactions, reduce trophic chain length, diminish dispersal ability and breeding success, and alter predation rate, and components of animal behavior related to success rates in foraging (Fahrig, 2003).

There are additional important effects that changes in spatial configuration due to fragmentation of remaining habitat has, however, which act independently of strict habitat loss (Tscharntke et al., 2002; Fahrig, 2003).

Poaching of wildlife

Wildlife poaching has negative side-effects that affect local communities, wildlife populations, and the environment. It is a crime fueled by a lucrative black market trade of animal parts. The animal parts are sold as novelty items and are sold for their “medicinal” properties. Environmental groups, animal rights groups, government agencies, and even the Duke of Cambridge are calling for an end to wildlife poaching. The United States Fish and Wildlife Service (USFWS), The World Wildlife Fund for Nature (WWF), and The International Anti-Poaching Foundation (IAPF) are leading international efforts to end wildlife poaching.

Poachers kill for profit. For example, bear gall bladders and big horned sheep antlers are worth top dollar for their so-called medicinal properties. This past November, at the National Wildlife Property Repository in Colorado, the wildlife service destroyed six tons of ivory confiscated at U.S. borders. Elephants are killed for their tusks because, while it is possible to remove the tusks without killing the elephant, they are too dangerous to remove when they are alive. The international community is responding. China recently increased its prosecutions of ivory smugglers, sentencing eight citizens to jail for bringing in over 3 tons of ivory between 2010 and 2012.

Man-wildlife conflicts

Human interactions with wildlife are a defining experience of human existence. These interactions can be positive or negative. People compete with wildlife for food and resources, and have eradicated dangerous species; co-opted and domesticated valuable species; and applied a wide range of social, behavioral, and technical approaches to reduce negative interactions with wildlife. This conflict has led to the extinction and reduction of numerous species and uncountable human deaths and economic losses. Recent advances in our understanding of conflict have led to a growing number of positive conservation and coexistence outcomes. I summarize and synthesize factors that contribute to conflict, approaches that mitigate conflict and encourage coexistence, and emerging trends and debates. Fertile areas for scholarship include scale and complexity, models and scenarios, understanding generalizable patterns, expanding boundaries of what is considered conflict, using new tools and technologies, information sharing and collaboration, and the implications of global change. The time may be ripe to identify a new field, anthrotherology, that brings together scholars and practitioners from different disciplinary perspectives to address human–wildlife conflict and coexistence.

Defining Human–Wildlife Conflict and Coexistence

Human–wildlife conflict is commonly described as conflict that occurs between people and wildlife (**2**); actions by humans or wildlife that have an adverse effect on the other (**4**); threats posed by wildlife to human life, economic security, or recreation (**6**); or the perception that wildlife threatens human safety, health, food, and property (**7**). The term wildlife is defined broadly as nondomesticated plants and animals (**8**), although domesticated and feral animals are sometimes included in the human–wildlife conflict literature. Wildlife damage management is defined as the science and art of diminishing the negative consequences of wildlife while maintaining or enhancing their positive aspects (**8**), and is often synonymous with human–wildlife conflict mitigation (**2**, **8**).

Numerous scholars point out that the notion of human–wildlife conflict is complicated by underlying tensions from human–human conflicts over conservation and resource use (2, 7, 9, 10). Another complication is that human interactions with wildlife are often framed negatively even if important positive benefits—recreational, educational, psychological, and ecosystem services—exist (11). As a result, there is a growing convergence around the phrase human–wildlife conflict and coexistence to connote the recognition of both problems and solutions (2, 10, 12), although some authors question whether coexistence is more precisely co-occurrence (13).

Importance of Conflict

Human–wildlife conflict has significant consequences for human health, safety, and welfare, as well as biodiversity and ecosystem health. Impacts on humans can be direct or indirect. Human injury and death can result when animals bite, claw, gore, or otherwise directly attack people; during collisions between animals and automobiles, trains, planes, boats and ships, and other vehicles; and from the transmission of a zoonotic disease or parasite (4). Conflict with wildlife can cause direct material and economic damage to crops, livestock, game species, and property (2, 14–16). Indirect impacts of conflict, more difficult to measure, include opportunity costs to farmers and rangers associated with guarding crops or livestock, diminished psychosocial wellbeing, disruption of livelihoods, and food insecurity (2, 12, 14, 15, 17, 18).

Human–wildlife interactions vary on a continuum from positive to negative, in intensity from minor to severe, and in frequency from rare to common (11; see also Figure 2). Attacks on people by apex predators such as tigers, lions, and sharks are now relatively infrequent but the attacks can be lethal and lead to strong public reactions (2). Conversely, conflict between people and common garden pests or birds such as geese may be more common but provoke less concern. Conflict frequency can also be highly variable within and among geographic regions. Some households or farms within a community may suffer little damage whereas neighbors may experience a surplus killing event in which a predator may kill many animals in one attack (12), or some properties may be better protected than others.

The most extreme biological impact is extinction. Hundreds of terrestrial and marine vertebrate species have become extinct in recorded history, and populations of many remaining species have declined in abundance (19). The decline of large, predatory animals in particular has resulted in cascading ecological consequences for other species and ecosystem services (20), and many of these declines are linked to conflict with humans.

Biological invansions

Biological invasions are a major force of change, affecting many dimensions of life on Earth. Invasions result when species colonize new geographic regions, which are disjunct (isolated) from existing populations. Humans have dramatically altered invasion dynamics, especially with the global expansion of trade in modern times.

Historically, geographic barriers such as oceans and continents have shaped the dispersal, distribution and evolution of organisms. These types of barriers were sometimes breached by shifting land masses and sea level over geologic time, as well as by episodic or rare events, such as storm- and tsunami-induced rafting or dispersal of organisms through the air. But in recent times, human activities increasingly transfer organisms across these barriers, altering the magnitude and tempo of dispersal and the types (diversity) of organisms moved around the world.

Today, new invasions are dominated by human-aided dispersal, where global trade can move species across continents and ocean basins in days or even hours. Transportation and the movement of organisms by humans—both intentional and unintentional—has greatly accelerated the baseline rate of invasions for marine, freshwater and terrestrial habitats throughout the world, allowing many species transfers that would never occur otherwise. From the poles to the equator, no global region is immune to human-mediated invasions. These invasions are strongly affecting process within populations, processes within ecosystems, disease dynamics, and goods and services to society.

SERC is a world leader in research on biological invasions, with diverse research programs that explore (a) the underlying mechanisms that lead to invasions, (b) changing spatial and temporal patterns of non-native species occurrence, (c) the ecological, social and conservation consequences of invasions, and (d) the effects of management and policy on invasion dynamics and impacts. As a cross-cutting theme that affects many ecological processes, SERC invasion research is conducted across marine, freshwater and terrestrial habitats at the population, community and ecosystem levels.

Conservation of biodiversity

The following measures should be taken to conserve biodiversity

1. Illegal hunting and trade of animals and animal products should be stopped immediately

2. People-at-large should boycott purchasing coats, purse or bags made of animal skin

3. Bio-diversity laws should be strengthened.

4. Adequate crop and cattle compensation schemes must be started

5. Solar powered fencing must be provided with electric current proof trenches to prevent animals from entering fields.

6. Cropping pattern should be changed near the forest borders

7. Adequate food and water should be made available for wild animals within forest zones.

8. Development and construction work in and around forest region must be stopped.

Biodiversity is one of the important tools for sustainable development. The commercial, medical, genetic, aesthetic, and ecological importance of biodiversity emphasizes the need for its conservation.

FACTORS AFFECTING BIODIVERSITY:

1. Biodiversity is disturbed by human activity

2. Poaching of animals, over-exploitation of natural sources and degradation of habitats affect biodiversity.

3. Marine ecosystems are disturbed due to oil spills and discharge of effluents

4. Climatic factors like global warming, ozone depletion and acid rain also affect biodiversity

NEED FOR BIODIVERSITY

1. It provides recreation and tourism

2. Drugs, herbs, food and other important raw materials are derived from plants and animals

3. It preserves the genetic diversity of plants and animals

4. It ensures sustainable utilization of life supporting systems on earth

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5. It needs to conservation of essential ecological diversity and life supporting systems

6. Loss of biodiversity leads to ecological and environmental deterioration

There are two types of biodiversity conservation:

1. In-situ conservation and
2. Ex-situ conservation

IN-SITU CONSERVATION

In-situ conservation involves protection of flora and fauna within its natural habitat. The natural habitats or ecosystems under in-situ conservation are called "protected areas".

1. Biosphere reserves
2. National parks
3. Wildlife sanctuaries
4. Gene sanctuaries

Biosphere reserves cover large areas (>5000 sq.km.) They are normally used to protect species for a long time. The roles of biosphere reserves are listed below:

1. Long-term survival of evolving ecosystem
2. Protect endangered species
3. Protect maximum number of species and communities
4. Serve as site of recreation and tourism
5. May also be used for educational and research purposes

Biosphere reserves function as an open system and changes in land use are not allowed. No tourism and explosive activities are allowed in biosphere reserves.

A national park is an area dedicated for the conservation of wildlife along with its environment. It covers an area ranging from 100 to 500 sq.km. One or more national parks may exist within a biosphere reserve.

A national park is used for enjoyment through tourism, without affecting the environment.

It is used to protect, propagate and develop wildlife.
Grazing domestic animals inside national parks is prohibited
All private rights and forestry activities are prohibited inside a national park

Wildlife sanctuary is an area that is reserved for the conservation of animals only.

1. It protects animals only

2. It allows operations such as harvesting of timber, collection of forest products, private ownership rights and forestry operations, provided it does not affect animals adversely

Gene sanctuary is an area where plants are conserved.

Other projects for the conservation of animals are Project Tiger, Gir Lion Project, Crocodile breeding project, project elephant etc

Advantages of in-situ conservation

1. It is cheap and convenient

2. Species get adjusted to natural disasters like drought, floods, forest fires etc.

Disadvantages of in-situ conservation

1. A large surface area of earth is required to preserve biodiversity

2. Maintenance is not proper due to shortage of staff and pollution

Ex-situ conservation

Ex-situ conservation involves protection of flora and fauna outside their natural habitats. This type of conservation is mainly done for conservation of crop varieties and wild relatives of crops.

1. Ex-situ conservation involves maintenance and breeding of endangered plant and animal species under controlled conditions

2. It identifies those species that are at a high risk of extinction

3. It prefers species that are important for man in the near future among the endangered species.

Important centers of ex-situ conservation:

1. Botanical gardens
2. Seed banks
3. Microbial culture collections
4. Tissue and cell cultures
5. Museums and
6. Zoological gardens

Methods of ex-situ conservation

National Bureau of Plant Genetic Resources (NPBGR) It is located in New Delhi and uses the Cryopreservation Technique to preserve agricultural and horticultural crops. Cryopreservation technique involves using liquid nitrogen at -196 C. Varieties of rice, turnip, radish, tomato, onion, carrot, chilli, tobacco have been successfully preserved for years using this technique.

National Bureau of Animal Genetic Resources (NPAGR) It is located in Karnal, Haryana and preserves the semen of domesticated bovine animals.

National Facility for Plant Tissue Culture Repository (NFPTCR) In this facility, conservation of varieties of crop plants or trees is done using tissue culture. This facility has been created within the NPBGR.

Advantages of Ex-situ conservation

1. Survival of endangered species is increasing due to special care and attention

2. In captive breeding the animals are assured of food, water, shelter and security thereby have a longer life span

3. It is carried-out in cases of endangered species that do not have any chance of survival in the wild

Disadvantages of Ex-situ conservation

1. It is an expensive method

2. Freedom of wildlife is lost

3. Animals cannot survive in the natural environment

In- situ and Ex- situ conversation of biodiversity

Biodiversity mainly refers to the variety and variability of life existing on the planet Earth. The term biodiversity usually refers to the process of measuring the variation at the genetic, species, and ecosystem level. Biodiversity plays a vital role in boosting the ecosystem. The factors responsible for the cause of changes in biodiversity are:

- Pollution
- Invasive species
- Overexploitation
- Change in the climatic conditions

We all need to conserve biodiversity, as it leads to the conservation of essential ecological diversity to preserve the continuity of food chains. In-situ and Ex-situ conservation are the two strategies practised for the preservation of a variety of living species globally.

Also read: Biodiversity

What is In-situ Conservation?

It is the methods of conserving all the living species, especially the wild and **endangered species** in their natural habitats and environment. In-situ conservation of Biodiversity includes biosphere reserves, national parks, wildlife sanctuaries, etc.

Also Read: National Parks and Sanctuaries.

What is Ex-situ Conservation?

It is the methods of conserving all the living species in the artful habitats that reflect their natural living habitats. Ex-situ Conservation of Biodiversity comprises of aquariums, botanical gardens, **Cryopreservation**, DNA banks, zoos, etc.

Also Read: Vegetative Propagation

This was brief information to the Biodiversity, their types and the importance. Stay tuned with BYJU'S to explore more about this topic.

Articles to Explore:

- What is an endothermic animal?
- How does human affect the environment?
- How many types of ecosystems are there?
- How many types of environment are there?

- Why should we conserve biodiversity short answer?
- What are the six different major levels of an organization?

Ecosystem and biodiversity services:

Ecological

Ecology is the study of the relationships between living organisms, including humans, and their physical environment; it seeks to understand the vital connections between plants and animals and the world around them. Ecology also provides information about the benefits of ecosystems and how we can use Earth's resources in ways that leave the environment healthy for future generations.

Who are Ecologists?

Ecologists study these relationships among organisms and habitats of many different sizes, ranging from the study of microscopic bacteria growing in a fish tank, to the complex interactions between the thousands of plant, animal, and other communities found in a desert.

Ecologists also study many kinds of environments. For example, ecologists may study microbes living in the soil under your feet or animals and plants in a rain forest or the ocean.

The Role of Ecology in Our Lives

The many specialties within ecology, such as marine, vegetation, and statistical ecology, provide us with information to better understand the world around us. This information also can help us improve our environment, manage our natural resources, and protect human health. The following examples illustrate just a few of the ways that ecological knowledge has positively influenced our lives.

Improving Our Environment

Pollution from Laundry Detergents & Fertilizers
In the 1960s, ecological research identified two of the major causes of poor water quality in lakes and streams-phosphorous and nitrogen-which were found in large amounts in laundry detergents and fertilizers. Provided with this information, citizens were able to take the necessary steps to help restore their communities' lakes and streams-many of which are once again popular for fishing and swimming.

Non-Native or Introduced Species Invasions

Some non-native species (plants, animals, microbes, and fungi not originally from a given area) threaten our forests, croplands, lakes, and other ecosystems. Introduced species, such as the kudzu vine shown here, do this by competing with plants and animals that were originally there, often damaging the environment in the process. For example, the gypsy moth, a native of Europe and Asia, wreaks havoc on great swaths of forest lands by defoliating, or eating the leaves off of trees. At first, highly toxic chemicals, which also poisoned other animals, were the only methods available to control this introduced pest. By targeting vulnerable stages in the moths' life cycle, ecologists devised less toxic approaches to control their numbers.

Public Health

Ecologists have discovered that marshes and wetlands filter toxins and other impurities from water. Communities can reap the benefit of this ecological service. Leaving some of these filtering ecosystems intact can reduce the burden on water treatment plants that have been built to perform the same service. By using natural filtering systems, we have the option to build fewer new treatment plants.

Economic

Economics is a social science concerned with the production, distribution, and consumption of goods and services. It studies how individuals, businesses, governments, and nations make choices about how to allocate resources. Economics focuses on the actions of human beings, based on assumptions that humans act with rational behavior, seeking the most optimal level of benefit or utility. The building blocks of economics are the studies of labor and trade. Since there are many possible applications of human labor and many different ways to acquire resources, it is the task of economics to determine which methods yield the best results.

Economics can generally be broken down into macroeconomics, which concentrates on the behavior of the economy as a whole, and microeconomics, which focuses on individual people and businesses.

KEY TAKEAWAYS

- Economics is the study of how people allocate scarce resources for production, distribution, and consumption, both individually and collectively.
- Two major types of economics are microeconomics, which focuses on the behavior of individual consumers and producers, and macroeconomics, which examine overall economies on a regional, national, or international scale.

- Economics is especially concerned with efficiency in production and exchange and uses models and assumptions to understand how to create incentives and policies that will maximize efficiency.

- Economists formulate and publish numerous economic indicators, such as gross domestic product (GDP) and the Consumer Price Index (CPI).

- Capitalism, socialism, and communism are types of economic systems.

Understanding Economics

One of the earliest recorded economic thinkers was the 8th-century B.C. Greek farmer/poet Hesiod, who wrote that labor, materials, and time needed to be allocated efficiently to overcome scarcity. But the founding of modern Western economics occurred much later, generally credited to the publication of Scottish philosopher Adam Smith's 1776 book, An Inquiry Into the Nature and Causes of the Wealth of Nations.[1]

The principle (and problem) of economics is that human beings have unlimited wants and occupy a world of limited means. For this reason, the concepts of efficiency and productivity are held paramount by economists. Increased productivity and a more efficient use of resources, they argue, could lead to a higher standard of living.

Despite this view, economics has been pejoratively known as the "dismal science," a term coined by Scottish historian Thomas Carlyle in 1849.[2] He used it to criticize the liberal views on race and social equality of contemporary economists like John Stuart Mill, though some commentators suggest Carlyle was actually describing the gloomy predictions by Thomas Robert Malthus that population growth would always outstrip the food supply.

Types of Economics

The study of economics is generally broken down into two disciplines.

Microeconomics focuses on how individual consumers and firms make decisions; these individual decision making units can be a single person, a household, a business/organization, or a government agency. Analyzing certain aspects of human behavior, microeconomics tries to explain how they respond to changes in price and why they demand what they do at particular price levels. Microeconomics tries to explain how and why different goods are valued differently, how individuals make financial decisions, and how individuals best trade, coordinate, and cooperate with one another. Microeconomics' topics range from the dynamics of supply and demand to the efficiency and costs associated with producing goods and services; they also include how labor is divided and allocated; how business firms are organized and function; and how people approach uncertainty, risk, and strategic game theory.

Macroeconomics studies an overall economy on both a national and international level, using highly aggregated economic data and variables to model the economy. Its focus can include a distinct geographical region, a country, a continent, or even the whole world. Its primary areas of study are recurrent economic cycles and broad economic growth and development. Topics studied include foreign trade, government fiscal and monetary policy, unemployment rates, the level of inflation and interest rates, the growth of total production output as reflected by changes in the Gross Domestic Product (GDP), and business cycles that result in expansions, booms, recessions, and depressions.

Micro- and macroeconomics are intertwined. Aggregate macroeconomic phenomena are obviously and literally just the sum total of microeconomic phenomena. However these two branches of economics use very different theories, models, and research methods, which sometimes appear to conflict with each other. Integrating the microeconomics foundations into macroeconomic theory and research is a major area of study in itself for many economists.

Schools of Economic Theory

There are many competing, conflicting, or sometimes complementary theories and schools of thought within economics.

Economists employ many different methods of research from logical deduction to pure data mining. Economic theory often progresses through deductive processes, including mathematical logic, where the implications of specific human activities are considered in a "means-ends" framework. This type of economics deduces, for example, that it is more efficient for individuals or companies to specialize in specific types of labor and then trade for their other needs or wants, rather than trying to produce everything they need or want on their own. It also demonstrates trade is most efficient when coordinated through a medium of exchange, or money. Economic laws deduced in this way tend to be very general and not give specific results: they can say profits incentivize new competitors to enter a market, but not necessarily how many will do so. Still, they do provide key insights for understanding the behavior of financial markets, governments, economies—and human decisions behind these entities.

Other branches of economic thought emphasize empiricism, rather than formal logic—specifically, logical positivist methods, which attempt to use the procedural observations and falsifiable tests associated with the natural sciences. Some economists even use direct experimental methods in their research, with subjects asked to make simulated economic decisions in a controlled environment. Since true experiments may be difficult, impossible, or unethical to use in economics, empirical economists mostly rely on simplifying assumptions and retroactive data analysis. However, some economists argue economics is not well suited to empirical testing, and that such methods often generate incorrect or inconsistent answers.

Two of the most common in macroeconomics are monetarist and Keynesian. Monetarists are a branch of Keynesian economics that argue that stable monetary policy is the best course for managing the economy, and otherwise often have generally favorable views on free markets as the best way to allocate resources. In contrast, other Keynesian approaches favor fiscal policy by an activist government in order to manage irrational market swings and recessions and believe that markets often don't work well at allocating resources on their own.

Economic Indicators

Economic indicators are reports that detail a country's economic performance in a specific area. These reports are usually published periodically by governmental agencies or private organizations, and they often have a considerable effect on stocks, fixed income, and forex markets when they are released. They can also be very useful for investors to judge how economic conditions will move markets and to guide investment decisions.

Below are some of the major U.S. economic reports and indicators used for fundamental analysis.

Gross Domestic Product (GDP)

The Gross Domestic Product (GDP) is considered by many to be the broadest measure of a country's economic performance. It represents the total market value of all finished goods and services produced in a country in a given year or another period (the Bureau of Economic Analysis issues a regular report during the latter part of each month).[3] Many investors, analysts, and traders don't actually focus on the final annual GDP report, but rather on the two reports issued a few months before: the advance GDP report and the preliminary report. This is because the final GDP figure is frequently considered a lagging indicator, meaning it can confirm a trend but it can't predict a trend. In comparison to the stock market, the GDP report is somewhat similar to the income statement a public company reports at year-end.

Retail Sales

Reported by the Department of Commerce during the middle of each month, the retail sales report is very closely watched and measures the total receipts, or dollar value, of all merchandise sold in stores.[4] The report estimates the total merchandise sold by taking sample data from retailers across the country—a figure that serves as a proxy of consumer spending levels. Because consumer spending represents more than two-thirds of GDP, this report is very useful to gauge the economy's general direction. Also, because the report's data is based on the previous month sales, it is a timely indicator. The content in the retail sales report can cause above normal volatility in the market, and information in the report can also be used to gauge inflationary pressures that affect Fed rates.

Industrial Production

The industrial production report, released monthly by the Federal Reserve, reports on the changes in the production of factories, mines, and utilities in the U.S. One of the closely watched measures included in this report is the capacity utilization ratio, which estimates the portion of productive capacity that is being used rather than standing idle in the economy.[5] It is preferable for a country to see increasing values of production and capacity utilization at high levels. Typically, capacity utilization in the range of 82–85% is considered "tight" and can increase the likelihood of price increases or supply shortages in the near term. Levels below 80% are usually interpreted as showing "slack" in the economy, which might increase the likelihood of a recession.

Employment Data

The Bureau of Labor Statistics (BLS) releases employment data in a report called the non-farm payrolls, on the first Friday of each month.[6] Generally, sharp increases in employment indicate prosperous economic growth. Likewise, potential contractions may be imminent if significant decreases occur. While these are general trends, it is important to consider the current position of the economy. For example, strong employment data could cause a currency to appreciate if the country has recently been through economic troubles because the growth could be a sign of economic health and recovery. Conversely, in an overheated economy, high employment can also lead to inflation, which in this situation could move the currency downward.

Consumer Price Index (CPI)

The Consumer Price Index (CPI), also issued by the BLS, measures the level of retail price changes (the costs that consumers pay) and is the benchmark for measuring inflation. Using a basket that is representative of the goods and services in the economy, the CPI compares the price changes month after month and year after year.[7] This report is one of the more important economic indicators available, and its release can increase volatility in equity, fixed income, and forex markets. Greater-than-expected price increases are considered a sign of inflation, which will likely cause the underlying currency to depreciate.

Types of Economic Systems

Societies have organized their resources in many different ways through history, deciding how to use available means to achieve individual and common ends.

Primitivism

In primitive agrarian societies, people tend to self-produce all of their needs and wants at the level of the household or tribe. Families and tribes would build their own dwellings, grow their own crops, hunt their own game, fashion their own clothes, bake their own bread, etc. This economic system is defined by very little division of labor and

resulting low productivity, a high degree of vertical integration of production processes within the household or village for what goods are produced, and relationship based reciprocal exchange within and between families or tribes rather than market transactions. In such a primitive society, the concepts of private property and decision-making over resources often apply at a more collective level of familial or tribal ownership of productive resources and wealth in common.

Feudalism

Later, as civilizations developed, economies based on production by social class emerged, such as feudalism and slavery. Slavery involved production by enslaved individuals who lacked personal freedom or rights and were treated as the property of their owner. Feudalism was a system where a class of nobility, known as lords, owned all of the lands and leased out small parcels to peasants to farm, with peasants handing over much of their production to the lord. In return, the lord offered the peasants relative safety and security, including a place to live and food to eat.

Capitalism

Capitalism emerged with the advent of industrialization. Capitalism is defined as a system of production whereby business owners (entrepreneurs) organize productive resources including tools, workers, and raw materials to produce goods for sale in order to make a profit and not for personal consumption. In capitalism, workers are hired in return for wages, owners of land and natural resources are paid rents or royalties for the use of the resources, and the owners of previously created wealth are paid interest to forgo the use of some of their wealth so that the entrepreneurs can borrow it to pay wages and rents and purchase tools for hired workers to use. Entrepreneurs apply their best judgement of future economic conditions to decide what goods to produce, and are earn a profit if they decide well or suffer losses if they judge poorly. This system of market prices, profit, and loss as the selection mechanism as to who will decide how resources are allocated for production is what defines a capitalist economy

These roles (workers, resource owners, capitalists, and entrepreneurs) represent functions in the capitalist economy and not separate or mutually exclusive classes of people. Individuals typically fulfill different roles with respect to different economic transactions, relationships, organizations, and contracts which they are a party to. This may even occur within a single context, such as a employee-owned co-op where the workers are also the entrepreneurs or a small business owner-operator who self-finances his firm out of personal savings and operates out of a home office, and thus acts as simultaneously as entrepreneur, capitalist, land owner, and worker.

The United States and much of the developed world today can be described as broadly capitalist market economies.

Socialism

Socialism, like feudalism, is a form of a command economy.. Socialism is a system of production where there is no private ownership of the means of production (or other property) and the system of prices, profits, and losses is not used to determine who will decide what to produce and how to produce it. Production decisions are instead made through some sort of political or other collective decision making process or by a central planner who takes and holds power over resources and factors of production. Socialism is similar to primitivism in that collective notions of ownership and control over resources are at least nominally observed, though in practice it more closely resembles a feudal or slave-based economy, where those who can gain and maintain control of political power act as a privileged elite class over the workers. Communism is a variant of socialism that also involves the violent overthrow of a capitalist economy and the imposition of socialist economic policy by force, and is particularly prone to resemble a slave-based economy where the leaders of the revolution become the new overlords or slave masters.

Social

Social science, any branch of academic study or science that deals with human behaviour in its social and cultural aspects. Usually included within the social sciences are cultural (or social) anthropology, sociology, psychology, political science, and economics. The discipline of historiography is regarded by many as a social science, and certain areas of historical study are almost indistinguishable from work done in the social sciences. Most historians, however, consider history as one of the humanities. In the United States, focused programs, such as African-American Studies, Latinx Studies, Women, Gender, and Sexuality Studies, are, as a rule, also included among the social sciences, as are often Latin American Studies and Middle Eastern Studies, while, for instance, French, German, or Italian Studies are commonly associated with humanities. In the past, Sovietology was always considered a social science discipline, in contrast to Russian Studies.

Beginning in the 1950s, the term behavioral sciences was often applied to the disciplines designated as the social sciences. Those who favoured this term did so in part because these disciplines were thus brought closer to some of the sciences, such as physical anthropology and physiological psychology, which also deal with human behaviour.

Strictly speaking, the social sciences, as distinct and recognized academic disciplines, emerged only on the cusp of the 20th century. But one must go back farther in time for the origins of some of their fundamental ideas and objectives. In the largest sense, the origins go all the way back to the ancient Greeks and their rationalist inquiries into human nature, the state, and morality. The heritage of both Greece and Rome is a powerful one in the history of social thought, as it is in other areas of Western society. Very probably, apart from the initial Greek determination to study all things in the spirit of dispassionate and rational inquiry, there would be no social sciences today. True,

there have been long periods of time, as during the Western Middle Ages, when the Greek rationalist temper was lacking. But the recovery of this temper, through texts of the great classical philosophers, is the very essence of the Renaissance and the Enlightenment in modern European history. With the Enlightenment, in the 17th and 18th centuries, one may begin.

Ethical

From Volkswagen's emissions fiasco to Wells Fargo's deceptive sales practices to Uber's privacy intrusions, corporate wrongdoing is a continuing reality in global business. Unethical behavior takes a significant toll on organizations by damaging reputations, harming employee morale, and increasing regulatory costs—not to mention the wider damage to society's overall trust in business. Few executives set out to achieve advantage by breaking the rules, and most companies have programs in place to prevent malfeasance at all levels. Yet recurring scandals show that we could do better.

Interventions to encourage ethical behavior are often based on misperceptions of how transgressions occur, and thus are not as effective as they could be. Compliance programs increasingly take a legalistic approach to ethics that focuses on individual accountability. They're designed to educate employees and then punish wrongdoing among the "bad apples" who misbehave. Yet a large body of behavioral science research suggests that even well-meaning and well-informed people are more ethically malleable than one might guess. When watching a potential emergency unfold, for example, people are much more likely to intervene if they are alone than if other bystanders are around—because they think others will deal with the situation, believe that others are more qualified to help, or fail to recognize an emergency because others don't look alarmed. Small changes to the context can have a significant effect on a person's behavior. Yet people in the midst of these situations tend not to recognize the influence of context. In Stanley Milgram's famous obedience experiments, participants who were told by an authority figure to deliver increasingly powerful electric shocks to another person progressed to a much higher voltage than other people predicted they themselves would deliver. Context is not just powerful, researchers have learned; it is surprisingly powerful.

Pillars of an Ethical Culture

Creating an ethical culture thus requires thinking about ethics not simply as a belief problem but also as a design problem. We have identified four critical features that need to be addressed when designing an ethical culture: explicit values, thoughts during judgment, incentives, and cultural norms.

Explicit values

Strategies and practices should be anchored to clearly stated principles that can be widely shared within the organization. A well-crafted mission statement can help achieve this, as long as it is used correctly. Leaders can refer to it to guide the creation of any new strategy or initiative and note its connection to the company's principles when addressing

employees, thus reinforcing the broader ethical system. Employees should easily be able to see how ethical principles influence a company's practices. They're likely to behave differently if they think the organization is being guided by the ethos of Mr. Rogers, the relentlessly kind PBS show host, versus that of Gordon Gekko, the relentlessly greedy banker in the film Wall Street. Indeed, in one experiment, 70% of participants playing an economic game with a partner cooperated for mutual gain when it was called the Community Game, but only 30% cooperated when it was called the Wall Street Game. This dramatic effect occurred even though the financial incentives were identical.

Even well-meaning people are more ethically malleable than one might guess.

A mission statement should be simple, short, actionable, and emotionally resonant. Most corporate mission statements today are too long to remember, too obvious to need stating, too clearly tailored for regulators, or too distant from day-to-day practices to meaningfully guide employees. A statement can't be just words on paper; it must undergird not only strategy but policies around hiring, firing, promoting, and operations so that core ethical principles are deeply embedded throughout the organization. Patagonia's mission statement, for instance, is "Build the best product, cause no unnecessary harm, use business to inspire and implement solutions to the environmental crisis." Its Worn Wear initiative implements its mission by enabling employees to help consumers repair or recycle their products. Patagonia also developed a standardized metric, posted on its website, to evaluate the environmental impact of its entire supply chain. Zappos says its number one core value is to "Deliver WOW through service" to customers, according them respect and dignity. It implements this value by not measuring the average length of customer service calls (the industry standard), so employees can spend as much time with customers as necessary. Mission statements like these help keep an organization's values crystal clear in employees' minds.

Thoughts during judgment.

Most people have less difficulty knowing what's right or wrong than they do keeping ethical considerations top of mind when making decisions. Ethical lapses can therefore be reduced in a culture where ethics are at the center of attention. You might know that it's wrong to hurt someone else's chances of being hired but fail to think of the harm you cause to unknown applicants when trying to help a friend, a family member, or a business school classmate land a job. Behavior tends to be guided by what comes to mind immediately before engaging in an action, and those thoughts can be meaningfully affected by context. Should someone remind you that helping a friend necessarily hurts the chances of people you don't happen to know, you might think twice about whether your advocacy efforts are appropriate.

Incentive programs must provide a variety of rewards to be effective.

Several experiments make this point. In one, people were more likely to tell the truth when an honor code came at the beginning of a form—thereby putting ethics top of mind as they completed the form—than when it was posted at the end. In a large field

experiment of approximately 18,000 U.S. government contractors, simply adding a box for filers to check certifying their honesty while reporting yielded $28.6 million more in sales tax revenue than did a condition that omitted the box. And in a simulation that asked MBA students to play the role of financial adviser, having them complete an ethics checklist before recommending potential investment funds significantly decreased the percentage who recommended what turned out to be the Madoff feeder fund. When ethics were top of mind, the students were more alert to the possibility that the fund was too good to be true.

As a counterexample, Enron was notorious for its constant focus on stock price, even posting it in the elevators. Reflecting on his own misdeeds, its former CFO Andy Fastow said, “I knew it was wrong…. But I didn’t think it was illegal…. The question I should have asked is not what is the rule, but what is the principle.” People working in an ethical culture are routinely triggered to think, Is it right? rather than Is it legal?

Incentives

It is a boring truism that people do what they’re incentivized to do, meaning that aligning rewards with ethical outcomes is an obvious solution to many ethical problems. That may sound simple (just pay people for acting ethically), but money goes only so far, and incentive programs must provide a variety of rewards to be effective.

Aesthetic and Informational value

Beauty is something we perceive and respond to. It may be a response of awe and amazement, wonder and joy, or something else. It might resemble a “peak experience” or an epiphany. It might be watching a sunset or taking in the view from a mountaintop—the list goes on. Here we are referring to a kind of experience, an aesthetic response that is a response to the thing’s representational qualities, whether it is man-made or natural (Silverman). The subfield of philosophy called aesthetics is devoted to the study and theory of this experience of the beautiful; in the field of psychology, aesthetics is studied in relation to the physiology and psychology of perception.

Aesthetic analysis is a careful investigation of the qualities which belong to objects and events that evoke an aesthetic response. The aesthetic response is the thoughts and feelings initiated because of the character of these qualities and the particular ways they are organized and experienced perceptually (Silverman).

The aesthetic experience that we get from the world at large is different than the art-based aesthetic experience. It is important to recognize that we are not saying that the natural wonder experience is bad or lesser than the art world experience; we are saying it is different. What is different is the constructed nature of the art experience. The art experience is a type of aesthetic experience that also includes aspects, content, and

context of our humanness. When something is made by a human– we know that there is some level of commonality and/or communal experience.

Why aesthetics is only the beginning in analyzing an artwork

We are also aware that beyond sensory and formal properties, all artwork is informed by its specific time and place or the specific historical and cultural milieu it was created in (Silverman). For this reason we analyze artwork through not only aesthetics, but also, historical and cultural **contexts**.

How we engage in aesthetic analysis

Often the feelings or thoughts evoked as a result of contemplating an artwork are initially based primarily upon what is actually seen in the work. The first aspects of the artwork we respond to are its sensory properties, its formal properties, and its technical properties (Silverman). Color is an example of a sensory property. Color is considered a kind of form and how form is arranged (e.g., color) is a formal property. What medium (e.g., painting, animation, etc.) the artwork is made of is an example of a technical property. These will be discussed further in another module. As Dr. Silverman, of California State University explains, the sequence of questions in an aesthetic analysis could be: what do we actually see? How is what is seen organized? And, what emotions and ideas are evoked as a result of what has been observed?

How We Assign Value to Art

The word art is often used to apply judgments of value, as in expressions like “that meal was a work of art” (implying that the cook is an artist) or “the art of deception” (the advanced, praiseworthy skill of deceiving). It is this use of the word as a measure of high value that gives the term its flavor of subjectivity.

Does It Have to Be Visually Pleasing or Not?

Making judgments of value requires a basis for criticism. At the simplest level, deciding whether an object or experience is considered art is a matter of finding it to be either attractive or repulsive. Though perception is always colored by experience, and is necessarily subjective, it is commonly understood that what is not somehow visually pleasing cannot be art. However, “good” art is not always or even regularly visually pleasing to a majority of viewers. In other words, an artist’s prime motivation need not be the pursuit of a pleasing arrangement of form. Also, art often depicts terrible images made for social, moral, or thought-provoking reasons.

For example, the painting pictured above, by Francisco Goya, depicts the Spanish shootings on the third of May, 1808. It is a graphic depiction of a firing squad executing several pleading civilians. Yet at the same time, the horrific imagery demonstrates

Goya's keen artistic ability in composition and execution, and it produces fitting social and political outrage. Thus, the debate continues as to what mode of aesthetic satisfaction, if any, is required to define "art." The revision of what is popularly conceived of as being visually pleasing allows for a re-invigoration of and a new appreciation for the standards of art itself.

Art is often intended to appeal to and connect with human emotion. It can arouse aesthetic or moral feelings, and can be understood as a way of communicating these feelings. Art may be considered an exploration of the human condition or what it is to be human.

Factors Involved in the Judgment of Art

Seeing a rainbow often inspires an emotional reaction like delight or joy. Visceral responses such as disgust show that sensory detection is reflexively connected to facial expressions and to behaviors like the gag reflex. Yet disgust can often be a learned or cultural response, too; as Darwin pointed out, seeing a smear of soup in a man's beard is disgusting even though neither soup nor beards are themselves disgusting.

Artistic judgments may be linked to emotions or, like emotions, partially embodied in our physical reactions. Seeing a sublime view of a landscape may give us a reaction of awe, which might manifest physically as increased heart rate or widened eyes. These unconscious reactions may partly control, or at least reinforce, our judgment in the first place that the landscape is sublime.

Likewise, artistic judgments may be culturally conditioned to some extent. Victorians in Britain often saw African sculpture as ugly, but just a few decades later, those same audiences saw those sculptures as being beautiful. Evaluations of beauty may well be linked to desirability, perhaps even to sexual desirability. Thus, judgments of art can become linked to judgments of economic, political, or moral value. In a contemporary context, one might judge a Lamborghini to be beautiful partly because it is desirable as a status symbol, or we might judge it to be repulsive partly because it signifies for us over-consumption and offends our political or moral values.

Judging the value of an artwork is often partly intellectual and interpretative. It is what a thing means or symbolizes for us that is often what we are judging. Assigning value to artwork is often a complex negotiation of our senses, emotions, intellectual opinions, will, desires, culture, preferences, values, subconscious behavior, conscious decision, training, instinct, sociological institutions, and other factors. Watch the video below to hear discussion on these factors in value judgement.

Unit-3

Natural Resources:

Renewable and Non-renewable Resources

Natural resources are materials or things that people use from the earth. There are two types of natural resources. The first are renewable natural resources. They are called renewable because they can grow again or never run out. The second are called nonrenewable natural resources. These are things that can run out or be used up. They usually come from the ground.
Renewable natural resources

Let's look more closely at renewable natural resources. They are the ones that can grow again. Trees are a good example. If cut down, they can regrow from seeds and sprouts. Animals are another example. Baby animals are born and grow up. They replace older animals that die.

Trees are one of the most useful renewable natural resources. We use trees to produce almost 8,000 different things, like this cardboard box. Wood is used to make most of these products. Tree wood is in our homes, furniture, paper, and on and on. Tree chemicals are also used to produce things like rayon cloth, food, medicine, and rubber.

By-products are things made out of leftovers. For example, when a tree is cut down and sawn up for wood, the leftover sawdust can be used for fuel, making particle board like in the picture, or animal bedding. These are by-products. Another by-product from harvesting trees is bark mulch for gardens.

Air and water are renewable natural resources too. They don't regrow like trees or have babies like animals. But, they are always being renewed. They move in cycles. They go from one place to another, and often back where they started, again and again. This is a good thing, because all living things need air and water to survive. There is one other type of renewable natural resource. It includes sources of power like sun and wind energy. These are never ending. Finally, remember this: renewable resources can regrow or be replaced within a person's lifespan.

Nutrients are chemicals that living things need. They are renewable natural resources. They move round and round in cycles and never run out. When an animal like this cow eats a plant, it takes in nutrients. The nutrients are used in the animal's body and then many come out as waste, which returns the nutrients to the soil. When the animal dies, nutrients will return to the soil as well. Plants take up the nutrients in the soil and continue the cycle.

Nonrenewable natural resources

Now, let's look at nonrenewable natural resources. They are found in the ground. There are fixed amounts of these resources. They are not living things, and they are sometimes hard to find. They don't regrow and they are not replaced or renewed. They include the fossil fuels we burn for energy (natural gas, coal, and oil). Minerals, used for making metals, are also nonrenewable natural resources. Nonrenewable natural resources are things that take longer than a person's lifespan to be replaced. In fact, they can take millions of years to form.

Fossil fuels such as oil, coal, and gas will not last forever. They are nonrenewable. People are trying hard to find new fuels that are clean and will provide the power we need. Wind, solar, and hydrogen power are renewable resources that offer hope for the future.

People use both types of natural resources to produce the things they need or want. Our homes, clothing, plastics, and foods are all made from natural resources. Let's look at each one of these to be sure.

Your home is in a building. Buildings are made out of wood and minerals. Wood is from trees. Minerals are mined from the ground. Bricks, cement, and metals are made from minerals. How about your clothes? Most of your clothing is made from cotton, polyester, or nylon. Cotton comes from cotton plants. Polyester and nylon are made from oil. Plastics are made from oil too. How about your food? People eat grains, fruits, and other parts of plants. You may also enjoy dairy products and meat from animals. Everything we have or use is made from a natural resource. Which of those mentioned here are renewable? Which are nonrenewable?

- Are ears of corn a renewable or nonrenewable resource?
- What about coal? Is it renewable or nonrenewable?
- Are rocks and minerals renewable or nonrenewable resources?
- Is wood a renewable or a nonrenewable resource?

All natural resources should be used wisely. We must conserve natural resources. Conserve means to not use up, spoil, or waste things. This is especially true for the nonrenewable resources. However, even some renewable natural resources can run out if they are all killed or overused. We must also protect our natural resources from pollution. Pollution occurs when people put harmful chemicals and other things into nature. Oil spilled in water, toxic chemicals in the air, or garbage dumped on the side of the road are examples of this problem.

So what can you do to take care of natural resources?

You can reduce, reuse, and recycle! For example, turn off the lights when you are not in a room. This will reduce the use of fossil fuel used to make electricity. Ride your bicycle and walk more, to reduce the amount of gasoline used to transport you. You can reuse things. Things like plastic jugs, jars, paper, and bags can be reused. Each time you reuse something, you conserve the natural resources that would have been used to make new ones.

Finally, you can recycle. Recycle means to reuse a natural resource or product to make something new. It also means to collect and send these things for reuse. Items that can be easily recycled include: glass, some plastics, paper, cardboard, aluminum, and steel. Some plastics and metals are hard to recycle. They are often made from mixtures of materials. Mixtures can be hard to separate. Try to buy and use things that you can recycle.

Where does your garbage go when you throw it away? One place it goes is to a landfill. A landfill is a place made for safely putting garbage. Garbage must stay closed in the landfill so it doesn't pollute the ground, air, or water. Another place that garbage can go is into an incinerator. An incinerator is a large oven that burns garbage down to ashes. The ashes are then put in a landfill. A third place that some types of garbage can go is into a compost pile. A compost pile is made from natural garbage such as food scraps, leaves, and grass clippings. Compost piles help this garbage rot. After it rots, it can be put back on the earth to fertilize plants. The movement of garbage from a home or community to one of these places, like a landfill, is called the waste stream.

Land Resources and land use change

Land use is obviously constrained by environmental factors such as soil characteristics, climate, topography, and vegetation. But it also reflects the importance of land as a key and finite resource for most human activities including agriculture, industry, forestry, energy production, settlement, recreation, and water catchment and storage. Land is a fundamental factor of production, and through much of the course of human history, it has been tightly coupled to economic growth (Richards 1990). As a result, control over land and its use is often an object of intense human interactions.

Human activities that make use of, and hence change or maintain, attributes of land cover are considered to be the proximate sources of change. They range from the initial conversion of natural forest into cropland to on-going grassland management (e.g., determining the intensity of grazing and fire frequency) (Schimel et al. 1991; Hobbs et al. 1991; Turner 1989).

Such actions arise as a consequence of a very wide range of social objectives, including the need for food, fibre, living space, and recreation; they therefore cannot be understood independent of the underlying drivingforces that motivate and constrain

production and consumption. Some of these, such as property rights and the structures of power from the local to the international level, influence access to or control over land resources. Others, such as population density and the level of economic and social development, affect the demands that will be placed on the land, while technology influences the intensity of exploitation that is possible. Still others, such as agricultural pricing policies, shape land-use decisions by creating the incentives that motivate individual decision makers.

Interpretations of how these factors interact to produce different uses of the land in different environmental, historical, and social contexts are controversial in both policymaking and scholarly settings. Furthermore, there are many theories regarding which factors are the most important determinants. Particular controversy arises in assessing the relative importance of the different forces underlying land-use decisions in specific cases (e.g., Kummer 1992). For example, apparent dryland degradation could be the result of: overgrazing by increasingly numerous groups of nomadic cattle herders; an unintended consequence of a "development" intervention such as the drilling of bore holes which increases stress on land close to the wells; or the political clout of groups that, through governmental connections, are able to over-exploit land belonging to the state or local communities (Pearce 1992; NERC 1992). Identifying a particular cause may have implications for the rights of competing user groups or the formulation of policy responses.

Candidate Driving Forces of Land-Use Change

The possible forces driving land-use and land-cover changes can be grouped into six categories: population; level of aMuence; technology; political economy; political structure; and attitudes and values (e.g., Turner and Meyer 1991; Stern et al. 1992).

The first three have been linked to environmental change in the I = PAT relationship that considers environmental impact (I) to be a function of population (P), affluence (A), and technology (T) (Commoner 1972). The relationships of these three categories of driving forces with environmental change have been statistically analyzed. Some of this work specifically addresses land-use and land-cover change (Ambio 1992; Meyer and Turner 1992) and suggests measures for each category: respectively, population density, GNP or GDP per capita, and energy consumption per capita.

Of these three categories of driving forces, population produces the most controversy. It is, however, one of the few variables for which worldwide data of reasonable accuracy are available, providing a basis for statistical assessments of its role in various kinds of environmental change (e.g., Ambio 1992). At the global level of aggregation, the neoMalthusian and "comucopian" positions use the same data to reach opposite conclusions: that population growth is or is not a cause of environmental damage (Boserup 1965, 1981; Ehrlich and Ehrlich 1990; Ehrlich and Holdren 1988; Simon 1981). At the regional scale, several studies relate population growth and deforestation in developing countries in the tropics (e.g., Allen and Barnes 1985; Palo 1990; Rudel 1989), although their findings and methods have been questioned (Kummer 1992).

Comparative assessments of population and land use suggest that: (i) population growth is positively correlated with the expansion of agricultural land, land intensification, and deforestation, but (ii) these relationships are weak and dependent on the inclusion or exclusion of statistical outliers (Bilsborrow and Geores 1991; Bilsborrow and Okoth-Ogendo 1992). Sub-continental comparisons for Africa have led Zaba (1991) to conclude that population density and growth ranked below environmental endowment and economy as factors in environmental degradation. Population density was found to be related to agricultural expansion and intensification everywhere, but only in some regions to deforestation. Detailed studies of specific regions for example, modelling exercises with Amazonian data likewise indicate subtle and varying relationships aones and O'Neill 1992; Skole 1992).

The interactions of population, affluence, and technology as causes of environmental change have been explored extensively (for implications appropriate for land-use, see Lee 1986), but research on the direct association of affluence or technology with landuse change is not as common. This is because of the paucity of globally comparative data for statistical assessments and because of the common assumption that level of affluence or technology do not by themselves govern human-environment relationships but must be considered within a larger set of contextual variables.

Nonetheless, some historical assessments associate high levels of affluence and industrial development (and thus the ability to draw resources from elsewhere) with the return of forest cover (Williams, 1989; Hagerstrand and Lohm 1990; Pfister and Messerli 1990). Global comparisons indicate that afforestation is largely a phenomenon of advanced industrial societies, which are both affluent and have high technological capacity (Young et al. 1990). Wealth, however, also increases per capita consumption, bringing about environmental change through higher resource demands, although these higher demands can be reduced by advanced technologies available to wealthy societies. Poverty is often associated with environmental degradation (IDRC and SAREC, 1992), although recent research shows that this relationship is strongly influenced by other factors as well (Kates and Haarman 1992). These mixed conclusions indicate the importance of further studies of the relationship between level of affluence and environmental change.

The role of technology as a potential cause of past and prospective changes in land use and land cover also requires further study. It is obvious that technological development alters the usefulness and demand for different natural resources. The extension of basic transport infrastructure such as roads, railways, and airports, can open up previously inaccessible resources and lead to their exploitation and degradation. Technological developments and their application (such as improvements in methods of converting biomass into energy; use of information-processing technologies in crop and pest management; and the development of new plant and animal strains through research in biotechnology) may lead to major shifts in land use in both developed and developing countries during the coming decades (Brouwer and Chadwick, 1991).

To these three sets of candidate forces, three others have been added: political economy, which includes the systems of exchange, ownership, and control; political structure, involving the institutions and organization of governance; and attitudes and values of individuals and groups. The candidate driving forces grouped within these categories have received much less attention than population growth. They do not yet encompass clearly defined variables and causal relationships, but comprise similar explanations of relationships of societal and environmental change (Blaikie and Brookfield 1987). Changes in land tenure (an institution in socio-economic terms) have direct impacts on land use, as does the move from non-market to market exchange of resources (political economy). Changes in attitudes and values may add a dimension to environmental change that cannot be explained otherwise, such as impact on land use of the "green" movement. Identifying the key variables within each set of potential driving forces and developing proxy measures for them will be one of the objectives of the IGBP-HDP project on land-use and land-cover change.

Detailed examinations link all of these candidate forces (e.g., Scott et al. 1990). For example, the model of socio-economic and environmental interactions with land use developed at Oak Ridge National Laboratory explores the interrelated effects of changes in technology, political economy, and political structure in Amazonia (Jones and O'Neill 1992). Improved transport facilities are expected to exacerbate land degradation if the region in question is small, but its impact on larger regions will vary by circumstance. Additional comparative studies are needed to address the interactions of different driving forces with their environmental context.

Finally, environmental transformations - whether potential climate change or localized impacts such as soil depletion - themselves affect land use. Assessments of the impacts of climate change on land use and land cover (e.g., Glantz 1989; Parry, Carter and Konjin 1988; Riebsame 1991) rely on assumptions about land-use change that can only be improved through studies of the dynamics of land use. For example, a study in Oaxaca, Mexico, indicates that local deforestation has caused a drop in the local water table and/or a reduction in local rainfall, and that the local population has responded by expanding the area under cultivation to maintain production (Liverman 1990). Crosson (1990) calls for a better understanding of the interactions of soil depletion, landuse systems, and environmental changes.

Relatively few global aggregate or regional comparative studies have explicitly investigated the role of these proposed driving forces, either independently or as a group. Still fewer have investigated statistical relationships among them. In contrast, many regional or smaller-scale case studies have been undertaken that offer detailed insights into specific cases that cannot necessarily be generalized. Thus the literature is rich in insights and "stories", but weak in comparative assessments that illuminate the causes and courses of land cover change. As a result, research is driven by subjective interpretations and assumptions rather than by attempts to test different hypotheses.

Knowns and Unknowns

* The major categories of driving forces have been identified

The six categories (above) have both empirical bases and theoretical rationales. We are not certain, however, which specific variables would best represent themes implied in the category, nor which forces are dominant and under which conditions.

* Many candidate driving forces are associated with environmental change over the long ter?n and at a global level

Globally, population, technological capacity, and affluence have all increased, just as the Earth's land cover has been transformed. At the same time, social organization, attitudes, and values have also undergone profound changes. The specific role of any of the proposed driving forces is extremely difficult to demonstrate at this global scale of analysis, however, because of their complex interrelationships, and interactions with other factors such as social organization, attitudes, and values, which have also undergone profound changes.

* Global-level aggregate relationships are difficult to dernonstrate at sub-global scales of analysis

A number of empirical relationships between driving forces and changes at a global scale have been documented for the modern period (20th century) (e.g., Newell and Marcus 1987). Comparative regional assessments, however, show considerable variability among these variables and environmental impacts (Young et al. 1990).

* Regional studies suggest the existence of generic relationships between the causes of landuse change and changes in land cover

Comparative studies suggest that common situations exist (e.g., rapid growth in population and international commodity demand in frontier forest areas) and that classifying them will improve our understanding and modelling of land-use change (Clark 1989).

* Integrated theories of the relationships between the human causes of land-use change and resulting changes in land-cover are not suitably developed for testing or comparison

While empirical assessments should provide strong clues about driving forces, experience suggests that "inductive" assessments will not be sufficient. Further insights will follow from tests of theories that specify the processes and relationships in question.

A Schema for Relating Land Use and Changes in Land

To understand global land-cover change as an element of global environmental change, it will be necessary to specify the links between human systems generating changes both in land use and in the physical systems that are affected by the resulting changes in land covers. This understanding is facilitated through a simple systems description of the basic states, processes, and flows involved .

In this schema, a land cover (physical system) exists in a systemic relationship with human uses (land use) and the causes of those uses. Driving forces interact among themselves and lead to different land uses depending on the social context in which they operate. At time t,, the underlying human driving forces lead to actions precipitating demand for land use #l (# corresponds to which requires the manipulation of the land cover by means of technology employed in human activities such as clearing, harvesting, or adding nutrients (proximate sources of change). This manipulation is directed either to changing the existing land cover (#I to #2 or #3) or to maintaining a particular cover (#1). In the former, the existing cover is changed to a new state that must be maintained in the face of natural processes that would alter it (physical maintenance loop).

Changes to a new state of land cover are of at least two kinds: modification as in land cover #2 (e.g., fertilization of cropland or planting exotic grasses in pastures) and conversion as in land cover #3 (e.g., forest to cropland or dryland to paddy agriculture). Maintenance processes sustain the land-cover conversion (#3) or modification (#2). Therefore, proximate sources can be seen as those of conversion, modification, or maintenance.

The environmental consequences of uses of land cover (changes in the state of cover) affect the original driving forces through the environmental impacts feedback loop. Likewise these land-cover changes (#2 and #3) can be repeated elsewhere such that they reach a global magnitude that triggers climate change, which, in turn, feeds back on the local physical system, affecting land cover and, ultimately, the driving forces through the environmental impact loop. Regardless of the stimuli - local or global environmental impacts or the interaction of the driving forces in their social context - changes in driving forces at time t2 may trigger a new land use (#2), with new consequences for the land-use/cover system.

This perspective indicates that understanding of global environmental change must consider the conditions and changes in land cover engendered by changes in land use; the rates of change in the conversion-modification-maintenance processes of use; and the human forces and societal conditions that influence the kinds and rates of the processes.

Land degradation

An Old Problem with New Urgency

Land degradation has been advanced as ‘the single most pressing current global problem’ (O'Riordan 2000). Yet, it is an old problem (e.g., Jacks and Whyte 1939), that has undergone a series of often-emotive revivals every decade since the Dust Bowl era in the mid-West USA (e.g., Osborn 1948, Carson 1962, Commoner 1972; Blaikie and Brookfield 1986). The historical stereotype of land degradation is that it is a process ruining the planet, and a destruction caused by ignorant peasants, who will in short time reap the folly of their degrading activities. Hailey's (1938) African Survey called it the ‘scourge of Africa,’ providing the reader with images of sediment-choked rivers and barren hillsides. Concern about degradation, particularly the processes of soil erosion, has fuelled many campaigns to combat it, and spawned numerous institutions to address it. In colonial Africa, for example, the Federation of the Rhodesias and Nyasaland funded the largest ever soil conservation research program on the continent between 1953 and 1965 to investigate rates of erosion and runoff, as well as the effectiveness of conservation and types of land use. In Southern Rhodesia, research evidence of the potential seriousness of erosion directly led to the formation of the Department of Conservation and Extension (CONEX), which carried out major conservation planning and design works throughout the country. A somewhat different institutional base was set in Malawi in response to perceived land degradation. The Land Husbandry Branch was formed in 1960 to undertake land use planning. This led to the more holistic concept of ‘land husbandry,’ including all farm-level production activities, argued as being a more effective tool for delivering conservation than technical, often structural, measures such as earth bunds (contour embankments to intercept runoff and sediment).

In the US, worries about land degradation supported by pictures of (usually) wind erosion engulfing farmhouses and fields, triggered massive expenditure on research and new institutions. The Soil Conservation Service (now the Natural Resources Conservation Service) was the largest single section of the US Department of Agriculture. Farmers were obliged by law to comply with conservation planning regulations and procedures. Compliance involved using research outputs such as the ‘Universal Soil Loss Equation’ which calculated rates of soil loss for various planned land uses, comparing these with a benchmark known as the ‘tolerable soil loss,’ a rate at which it was said that future production would not be jeopardized. Some of the science underpinning these procedures is now known to be flawed (Stocking 1996a). Yet, there is no doubt that the sustained research and institutional effort in the US, spurred originally by the Dust Bowl era, has not only raised awareness of land degradation but also done much to conserve that nation's soils today.

At international level, there is now a new urgency in addressing land degradation. While the World Commission on Environment and Development (Brundtland 1987) highlighted sustainable development, land degradation was only then seen as a shadowy adversary in achieving long-term productive agriculture. It was an insidious enemy, often masquerading under other names (see Desertification). The series of Sahel droughts in the mid-1980s illustrates the image problem of land degradation. Headlined ‘drought,’ its main impact came through widespread crop and grazing land failure due to the reduced capability of the degraded soils to support plant growth. The water-holding capacity of a degraded soil is only a fraction of a virgin soil. Land degradation therefore increases the vulnerability of marginal environments and societies.

Nevertheless, in the search for sustainable global futures, land degradation has once again come to the fore. The 1992 United Nations Conference on Environment and Development in Rio de Janeiro revived interest. However, it was not until 1998 that enough signatories drew their pens to ratify the Convention to Combat Desertification, the major components of which are national and international proposals to combat land degradation. Today, the fastest-growing section of the global funding mechanism (the Global Environment Facility, GEF), which supports the incremental cost of developing countries' efforts to comply with the international environment-development conventions, is for land degradation projects. The driving force for the renewed interest comes from new data from international projects such as the Dutch-based Global Assessment of Soil Degradation (see Table 1). The International Food Policy Research Institute uses such data to show that, while food production may largely be maintained by ever-increasing inputs, there are ‘hotspots’ of serious land degradation in vulnerable places such as north-east Thailand, northern China, and many African drylands (Scherr and Yadav 1996).

Siol erosion and desertification

Soil erosion is a gradual process of movement and transport of the upper layer of soil (topsoil) by different agents – particularly water, wind, and mass movement – causing its deterioration in the long term.

In other words, soil erosion is the removal of the most fertile top layer of soil through water, wind and tillage.

What Is Soil Erosion? A Soil Erosion Scientific Definition

According to a **Pereira and Muñoz-Rojas (2017)** synthesis, soil erosion is one of the major causes, evidence of, and key variables used to assess and understand **land degradation**. Soil erosion is a consequence of unsustainable land use and other disturbances, such as fire, mining, or intensive agricultural uses. The loss of soil may

have serious impacts on the quantity and quality of soil ecosystem services, with serious economic, social, and political implications.

Different Soil Erosion Causes

Soil erosion is a complex process that depends on soil properties, ground slope, vegetation, and rainfall amount and intensity. According to **Montgomery**, modifications in land use are one of the most impactful ways of accelerating soil erosion. These changes then have a cascade effect as the loss of fertile topsoil cover sends millions of tons of sediments into lakes and reservoirs, changing **ecosystems** and impacting agricultural production and water quality. This has been **the case with the Bo River in Vietnam**.

According to **Al-Kaisi from Iowa State University**, there are 5 main types of natural soil erosion:

- 1) Sheet erosion by water;
- 2) Wind erosion;
- 3) Rill erosion – happens with heavy rains and usually creates smalls rills over hillsides;
- 4) Gully erosion – when water runoff removes soil along drainage lines
- 5) Ephemeral erosion that occurs in natural depressions.

Despite these types of soil erosion, as we have briefly mentioned above, if it wasn't for human activities, today's soils would be less susceptible to erosion and more **resilient**. What are the human causes behind soil erosion then?

The Main Causes And Impacts Of Soil Erosion

The most effective way of minimizing erosion is to guarantee a permanent surface cover on the soil surface, such as trees, pasture, or meadow. However, compared to original forest soils, soils in pasture fields and croplands have less capacity to hold up and are more susceptible to erosion. These soils also have less capacity to absorb water, which makes flooding (and its economic, social, and environmental impacts) more common.

1. Deforestation for Agriculture Is One of the Top Causes of Soil Erosion

The increasingly high demand of a growing population for commodities such as **coffee**, soybean, **palm oil** or wheat is clearing land for agriculture. Unfortunately, clearing autochthonous trees and replacing them with new tree crops that don't necessarily hold onto the soil increases the risks of soil erosion. With time, as topsoil (the most nutrient-rich part of the soil) is lost, putting agriculture under threat.

2. Soil Erosion is Also Caused by Overgrazing, Which Causes Floods too

Overgrazing is caused by intensive cattle raising. As plants don't have the recovery period they need, they end up being crushed and compacted by cattle. In this process, topsoil sediments are transported elsewhere. As for the remaining soil, it can lose its infiltration capacity, which means more water getting lost from the **ecosystem** and a harder time for new plants to grow.

3. Agrochemicals Cause Soil Erosion and Degradation

The use of chemicals under the form of pesticides and fertilizers on (often) monocultural crops is a very usual way of helping farmers improve their yields. However, the excessive use of phosphoric chemicals ends up causing an imbalance of microorganisms in the soil moisture, stimulating the growth of harmful bacteria. As the soil gets degraded, the risk of erosion increases and the sediments sweep (via the actions of water and wind) into rivers and nearby regions, possibly contaminating nearby ecosystems.

At the same time, tillage techniques (that turn over crops and forages) commonly used by farmers to prepare seedbeds by incorporating manure and fertilizers, leveling the soil and taking out invasive seeds also have a large impact. Because it fractures the soil's structure, tillage ends up accelerating surface runoff and soil erosion.

4. Construction and Recreational Activities

Setting up buildings and roads also have their share of responsibility when it comes to soil erosion as they don't allow for the normal circulation of water. Instead, it runs off to flood nearby lands, speeded up erosion in these areas. Moreover, motor-based activities such as motocross also have the potential to disturb ecosystems and change (even if at a smaller scale compared with other causes) and erode the soil.

The Importance of Soil, Especially Topsoil

Soil is a very important resource that allows the production of food, fiber, or forages. Despite it being a renewable resource, it renews slowly – generating three centimeters of topsoil takes 1,000 years. Therefore, protecting it is very important to bet on long-term, sustainable agricultural practices since one of the main issues associated with soil erosion is that it comes along a decrease in soil productivity. These productivity losses reduce the quantity and quality of the food we eat.
A **study** based on the results of 40 soil associations reported that the effects of soil erosion on soil productivity were mostly the result of subsoil properties such as soil water availability, root growth or plow layer fertility – which impact yield results. In the end, with an unfavorable subsoil, erosion is easier and yields and productivity are more greatly affected.

Deforestation :

Cause and impacts due to mining

Coal mining, the first step in the dirty lifecycle of coal, causes deforestation and releases toxic amounts of minerals and heavy metals into the soil and water. The effects of mining coal persists for years after coal is removed.

Dear Readers, please refer to this latest article regarding the serious effects of Acid Mine Drainage on the environment and human lives in South Africa. This Harvard report was just recently released in October, 2016 and is extremely in depth on the issues of the serious effects of mining on the environment and human health.

Destruction and poison linger

Bad mining practices can ignite coal fires, which can burn for decades, release fly ash and smoke laden with greenhouse gasses and toxic chemicals. Furthermore mining releases coal mine methane, a greenhouse gas 20 times more powerful than carbon dioxide. Coal dust inhalation causes black lung disease among miners and those who live nearby, and mine accidents kill thousands every year. Coal mining displaces whole communities, forced off their land by expanding mines, coal fires, subsidence and contaminated water supplies.

There are two widely used ways of mining: strip mining and underground mining.

Strip mining

Strip mining (also known as open cast, mountaintop or surface mining) involves scraping away earth and rocks to get to coal buried near the surface. In many cases, mountains are literally blasted apart to reach thin coal seams within, leaving permanent scars on the landscape as a result.

Strip mining accounts for about 40 percent of the world’s coal mines but in some countries, such as Australia, open cast mines make up 80 percent of mines. Even though it’s highly destructive, industry often prefers strip mining as it requires less labour and yields more coal than underground mining.

Impacts of strip mining:

- Strip mining destroys landscapes, forests and wildlife habitats at the site of the mine when trees, plants, and topsoil are cleared from the mining area. This in turn leads to soil erosion and destruction of agricultural land.
- When rain washes the loosened top soil into streams, sediments pollute waterways. This can hurt fish and smother plant life downstream, and cause disfiguration of river channels and streams, which leads to flooding.

- There is an increased risk of chemical contamination of ground water when minerals in upturned earth seep into the water table, and watersheds are destroyed when disfigured land loses the water it once held.
- Strip mining causes dust and noise pollution when top soil is disrupted with heavy machinery and coal dust is created in mines.

The result of all this is barren land that stays contaminated long after a coal mine shuts down.

Although many countries require reclamation plans for coal mining sites, undoing all the environmental damages to water supplies, destroyed habitats, and poor air quality is a long and problematic task. This land disturbance is on a vast scale. In the US, between 1930 and 2000, coal mining altered about 2.4 million hectares [5.9 million acres] of natural landscape, most of it originally forest. Attempts to re-seed land destroyed by coal mining is difficult because the mining process has so thoroughly damaged the soil. For example, in Montana, replanting projects had a success rate of only 20-30 percent, while in some places in Colorado only 10 percent of oak aspen seedlings that were planted survived.

In China, coal mining has degraded the quality of land of an estimated 3.2 million hectares, according to a 2004 estimate. The overall restoration rate (the ratio of reclaimed land area to the total degraded land area) of mine wasteland was only about 10–12 percent.

Underground mining

The majority of the world's coal is obtained through underground mines. While underground mining, which allows coal companies to extract deeper deposits of coal, is viewed as less destructive than strip mining, the effects of mining widespread damage to the environment. In room-and-pillar mines, columns of coal are left to support the ground above during the initial mining process, then they are often taken out and the mine is left to collapse, which is known as subsidence. In longwall mines, mechanical shearers strip the coal from the mines. Support structures that enable the shearers' access to the mine are eventually removed, and the mine collapses. It is these effects of mining that nobody sees but are the most troubling of all.

Impacts of underground mining

Underground mining causes huge amounts of waste earth and rock to be brought to the surface – waste that often becomes toxic when it comes into contact with air and water.

It causes subsidence as mines collapse and the land above it starts to sink. This causes serious damage to buildings.

It lowers the water table, changing the flow of groundwater and streams. In Germany for example, over 500 million cubic metres of water are pumped out of the ground every

year. Only a small percentage of this is used by industry or local towns – the rest is wasted. What's worse is that removing so much water creates a kind of funnel that drains water from an area much larger than the immediate coal-mining environment.

Coal mining produces also greenhouse gas emissions.

Coal mine methane

Coal mine methane, less prevalent in the atmosphere than CO2, but 20 times as powerful as a greenhouse gas, forms during the geological formation of coal, and is released during the coal mining process. Most coal mine methane come from underground mines. While this methane is often captured and used as town fuel, industrial fuel, chemical feedstock and vehicle fuel, it's very rare that it all gets used.[vii] Methane is also used in power generation projects. However, despite big investment in research, only about 50 such projects exist worldwide.

In China, which mines more than 95 percent of its coal underground, about 300 of the state-owned mines are classified as methane-outburst prone. The effects of mining coal in China have become increasingly clear in modern times.

Worldwide emissions are expected to increase by 20 percent in the next 12 years.

Coal fires

Coal fires – burning or smouldering coal seams, coal storage piles or coal waste piles – are a significant environmental problem in many countries, including China, Russia, the US, Indonesia, Australia and South Africa. Underground coal fires can burn for centuries, filling the atmosphere with smoke laden with carbon-monoxide (CO), carbon-dioxide (CO2), methane (CH4), sulphur dioxide (SO2), nitrous oxides (NOx) and other greenhouse or toxic gases – as well as fly ash from vents and fissures.

Other effects of coal fires include rising surface temperatures and contamination of groundwater, soil and air.

Although coal fires can be caused by thunderstorm lightning, and forest or peat fires, they are often caused by mining accidents and improper mining techniques. In Indonesia, the same fires that are used to clear large tracts of rainforest have ignited over 300 coal fires since the 1980s.

China has the world's most coal fires, while India accounts for the world's greatest concentration. In China, between 15 and 20 million tons of coal burn uncontrollably each year, accounting for between 0.1 percent and 1 percent of the world's human-induced CO2 emissions, (Although coal fires are significant, emissions from power plants are far higher.)

Acid mine drainage

Acid mine drainage is created when water mixes with coal and other rocks unearthed during mining, taking on toxic levels of minerals and heavy metals. This toxic water leaks out of abandoned mines to contaminate groundwater, streams, soil, plants, animals and humans. As a result an orange colour can blanket the river, estuary or sea bed killing plants and making surface water unusable as drinking water. Acid Mine Drainage is one of the biggest effects of mining being felt around the world, especially in South Africa where the problem has been ignored for over 100 years. A well known organisation in South Africa, the Federation for a Sustainable Environment, spearheaded by Ms Mariette Liefferink has been fighting the issue of the effects of mining and Acid Mine Drainage with government and mining companies for 2 decades.

Sources of acid mine drainage can remain active for decades or centuries after a mine closes.

Common health threats posed by coal mining:

- Pneumoconiosis, aka black lung disease or CWP, is caused when miners breathe in coal dust and carbon, which harden the lungs. Estimates show that 1,200 people in the US still die from black lung disease annually. The situation in developing countries is even worse.
- Cardiopulmonary disease, chronic obstructive pulmonary disease, hypertension, lung disease, and kidney disease have been found in higher-than-normal rates among residents who live near coal mines, according to a 2001 US study.
- Toxic levels of arsenic, fluorine, mercury, and selenium are emitted by coal fires, entering the air and the food chain of those living nearby.
- Mine collapses and accidents kill thousands of workers around the world every year. Chinese coal mine accidents killed 4,700 people in 2006.

Dam building on environment

A 27-year-old hermit in Haridwar, Swami Atmabodhanand, has broken his 194-day fast in protest against sand mining and the upcoming dams on key rivers that feed the Ganga.

What is the environmental impact of Dams?

- **Habitat fragmentation:** Unless specifically engineered to allow fish to pass through them, **dams present a barrier** to fish that need to migrate to spawn and reproduce downstream and upstream along a river. This not only impacts the populations of the fish themselves, but it can negatively impact other species in the food chain that either eat that fish or are preyed upon by that fish.

- **Flooding and the destruction of surrounding habitat:** Dammed rivers **create a reservoir upstream** from the dam, which spills out into the surrounding environments and floods ecosystems and habitats that once existed there. Such flooding can kill or displace many different organisms, including plants, wildlife, and humans.
- **Greenhouse gases:** The flooding of surrounding habitat around dams kills trees and other plant life that then decomposes and releases large amounts of **carbon** into the atmosphere. Because the river is no longer flowing freely, the water becomes stagnant and the bottom of the reservoir becomes becomes depleted of oxygen. This lack of oxygen creates a situation where **methane** (a very potent greenhouse gas) is produced from the decomposition of the plant materials at the bottom of the reservoir that eventually gets released into the atmosphere, contributing to global climate change.
- **Sediment builds up behind the dam:** Because a dammed river no longer flows freely, the sediment that would have otherwise been deposited naturally downstream begins to build up behind the dam, forming new riverbanks, river deltas, alluvial fans, braided rivers, oxbow lakes, levees and coastal shores. These changes in sedimentation can lead to dramatic alterations in plant life and animal life and how they are distributed.
- **Downstream sediment erosion:** Due to the restrictions in the sediment flow above a dam, the lack of sediment that would have once flowed downstream ultimately leads to a **deficiency in sediment load**, and therefore, leads to an **increase in downstream erosion.** This lack of sediment load causes the riverbed to deepen and narrow over time, a compromised water table, the homogenization of the river's flow, reduced wildlife support, and a reduction in sediment that reaches coasts and deltas.
- **Negative impacts on local fish populations:** Typically, local fish species **will not be adapted to the new environment** that is present after a dam is built and do not survive, leading to the extirpation of local populations. Many factors impact their survival, including the blockage of migration routes, a disconnection from the river's flood plain, changes in a river's flow, changes in temperature, turbidity, dissolved oxygen, and changes in local plant life.
    - Organic materials from within and outside the river that would normally wash downstream get built up behind dams and start to consume a large amount of oxygen as they decompose. In some cases this triggers algae blooms which, in turn, create oxygen-starved "**dead zones**" incapable of supporting river life of any kind.
    - Also, **water temperatures in dam reservoirs can differ** greatly between the surface and depths, further complicating survival for marine life evolved to handle natural temperature cycling. And when dam operators release oxygen-deprived water with unnatural temperatures into the river below, they harm downstream environments as well.

- **Production of methyl-mercury:** The stagnant water in reservoirs creates a situation where the decomposition of organic matter from decaying plants can transform inorganic mercury into methy-mercury. Unfortunately, methyl-mercury tends to bio-accumalate and cause toxic effects in humans and wildlife that eat the fish in reservoirs.

Forests

Forests and terrestrial ecosystems more broadly are critical not only to flora and fauna but also to communities that depend on them, contributing to poverty reduction, economic growth and employment. They also generate essential ecosystem services that sustain key sectors such as agriculture, energy, and water.

Forest goods provide an important “hidden harvest” for rural populations, keeping many people out of extreme poverty. About 350 million people who live within or close to dense forests depend on them for their subsistence and income. Forests are an important aspect of rural livelihoods, with rural households living near forested areas deriving as much as 22 percent of their income from forest sources according to the Poverty and Environment Network (PEN). This contribution is greater than that of wage labor, livestock, self-owned businesses or any other category aside from crops.

Forests support rural economies in many countries and create jobs and wealth for populations with few alternative off-farm employment options. Forests produce more than 5,000 types of wood-based products, and generate an annual gross value add of just over US$ 600 billion, about 1% of global GDP (in some countries that contribution is much higher, reaching for example 6% of GDP in Cameroon).

Healthy forests provide critical ecosystem services important to people and economies such as habitat for biodiversity, provision of drinking water, water and climate cycle regulation, erosion prevention, crop pollination, soil fertility, and flood control. For instance, more than three-quarters of the world’s food crops rely at least in part on pollination by insects and other animals, and up to US$577 billion worth of annual global food production relies directly on pollinators.

Biodiversity is essential to ecosystem health and the provision of these services. However, according to the IPBES, the rate of species extinctions is accelerating, with severe impacts on people worldwide. About one million animal and plant species are now threatened with extinction, many within decades. Clearing of forests for agriculture, extractive industries, urbanization and other land uses leads to the loss of habitat and brings humans and wildlife into closer contact, increasing the risk of spillover of infectious diseases such as COVID-19, Ebola and HIV from animals to humans as humans and wildlife come into close contact.

Forests provide a critical carbon sink to slow climate change, however deforestation and forest degradation contribute about 12% of the world’s greenhouse gas emissions. The 2019 IPCC special report on Climate Change and Land affirmed that planting forests

and protecting existing forests is key to all pathways for limiting global warming to 1.5^{o}C or well below 2^{o}C increase. Investment in planting trees and forest conservation is urgently needed as many of the world's remaining forests are under increasing threat due to agriculture expansion, timber extraction, fuelwood collection and other activities. The IPBES estimates that investment in better land stewardship could contributes about 37 percent of the climate change mitigation needed by 2030 to keep global temperatures below a 2^{o}C increase.

Biodiversity and tribal populations

The human race has been dependent on plants for both material and emotional needs for millions of years. This has enabled them to evolve a unique system of knowledge on the utilization and conservation of plant genetic resources. The majority of the human population depends on just 100 to 150 plant species for most of their requirements. In contrast, the tribal people living in southern India use 1†000 to 1†500 species of plants. Nearly ten species of food plants, which were hitherto unreported, came to light during ethnobotanical studies on six tribal communities in the state of Andhra Pradesh in southern India. There is a lesson here that, by widening our dietary habits to include a greater diversity of plant products, our dependence on and extensive cultivation of a few species can be reduced.

Medicinal properties of plants have been recognized and utilized by tribal communities for thousands of years. The tribal elders possess a great deal of knowledge about medicinal plants and medicines for curing certain life-threatening diseases.

The farming practices of tribal people are truly sustainable in many ways. Their subsistence life style, local diet habits and dependence on rainfed irrigation have influenced them to cultivate and conserve the traditional cultivars or land races. The tribal communities practice a unique method of farming, known as the mixed cropping system in limited areas depending on monsoon rain. Seed material for sowing and the grains for consumption are preserved in traditional granaries in which the seeds remain viable until they are used next time.

Due to the practices described above, these people were able to conserve genetic strains for a long period of time. However, today, the genetic material conserved by the tribes is under threat. In order to prevent this genetic erosion, the traditional cultivars need to be conserved as they form basic raw material for further crop improvement.

Observations on the conservation and sustainable utilization practices of 15 tribal communities are discussed in the paper.

INTRODUCTION

Biological diversity and cultural diversity

Biological diversity that is seen today is the result of millions of years of evolutionary process. Diversity is measured in terms of genetic diversity (diversity within the species), species diversity (diversity at species level), and ecosystem diversity. Conservation of Biological diversity is essential in order to sustain the life of human beings as well as other forms of life. Human race has been dependent on plants both for their material needs and emotional needs for millions of years. All over the world people have developed intimate relationship with the surrounding vegetation? Such a close interaction prevails among various tribal communities throughout the world even today. The interaction has enabled to evolve a unique system of knowledge on the utilization and conservation of plant genetic resources.

Cultural diversity in terms of ethnic groups gives us knowledge on the value of plant resources. The knowledge of ethnic groups on the cultural, spiritual, social and economic values of plants can be of immense use to the entire humankind. It can provide many valuable genes for developing the crop plants that are extensively cultivated today. It can equip the humankind with several new chemicals for combating many human ailments. We have examples from throughout the world where the ethnic knowledge has contributed for the betterment of the modern world. A modern drug has been developed and marketed for retention of memory from the semi aquatic herb Bacopa monnieri that has been traditionally used in India for enhancing the memory power. Similarly several new drugs have been developed from the plants used by the Amazon tribals (Schultes, 1991). All these examples clearly give a message that the cultural diversity is the prime source of the utilitarian aspects of plants. The very existence of cultural diversity is directly dependent on biological diversity. This traditional ecological knowledge of ethnic groups is not confined to mere sustenance only since the tribal communities depend upon biological resources for their spiritual, religious and cultural needs too. The tribal communities understand all these as life sustaining resources. There fore they not only utilise them but also conserve them. Erosion of either of this diversity would greatly affect the humankind. Hence, both the biological and cultural diversity should be considered as a unit for a meaningful conservation. In this paper, observations on the conservation and sustainable utilization practices of few southern Indian tribal communities namely Gonds, Kolams, Pardhans, Koyas, Naikpods, Konda Reddys and Lambadis of Andhra Pradesh and Irulas, Kadars, Malasar, Malaimalasar, Malayalis, Muthuvans, Paliyars and Pulayars of Tamilnadu are discussed. This documentation has made an impact on the tribal communities in the sense that the tribes particularly the younger generation could re-realize their knowledge potential on the plants and helped in starting joint ventures towards the conservation, sustainable utilization and equitable sharing of the plant genetic resources.

Materials and Methods

Tribal areas located deep inside the forest areas were selected to ensure less contact with the so called civilized society. Reconnaissance surveys were done to select tribal communities and hamlets in order to work with people who still practice forest depended lifestyles, living in rich forests. After selecting the tribal areas camp sites were established in the tribal huts or tribal schools and each stay was for 30 - 35 days for developing good rapport and also to collect data on socio-cultural aspects of tribal which are the during forces of biodiversity conservation. Field surveys were conducted to collect plant specimens in flowering and truthing to establish correct identification of the plant species and the local name. Herbarium was prepared as per Fosberg and Sachet and the voucher specimens are deposited in national herbarium and the identification was done with standard floras. Nomenclature is followed as per International Code of Botanical Nomenclature.

The Ethnobotanical and ethnogricultural data was crosschecked with different individuals in different areas across the study area in different seasons to establish greater validity of the data. The data was collected in local Telugu and Tamil languages using tape recorders to avoid the disturbing the knowledge sharers as it was also found easy in the field as we can simultaneously concentrate on floristics, vegetation and population study of the area.

The data thus collected was referred using available literature, which is resulted in the discovery of many unreported uses to the world.

OBSERVATIONS

Unique Aspects of Plant Utilization by Tribal Communities

In southern India certain interesting characteristics accompany the tribal utilization of plants. Often many plants are used for a single purpose although other parts of the plants may have potential utility values. For example Bridelia retusa, Canthium dicoccum, Ficus racemosa, Madhuca longifolia var. latifolia, Palaqium ellipticum, Phyllanthus emblica, Polyalthia cerasoides, Premna tomentosa, Scleichera oleosa, Terminalia bellerica and Xylia xylocarpa are used almost exclusively for their edible fruits and seeds. These plants are not used even for construction or making agricultural implements and similar uses.

Tribal use of plants is also characterized by diversity in choice. The majority of the human population depends on just 100 - 150 plant species for most of their requirements. In contrast, the tribals living in southern India use 1,000 - 1,500 species of plants. Thus a variety of plants are used as edible greens: Allmania nodiflora, Cansjeera rheedii, Colocasia esculenta, Lycianthes laevis, Mukia maderaspatana, Portulaca oleracea, Rhaphidphora pertusa, Talinum cuneifolium and Trichosanthes nervifolia. Similarly they eat fruits of many plant species to name a few, like Carissa carandas, Cordia obliqua and Memecylon edule.

This approach not only increases the choice of plants and hence the nutritional values but also prevents over exploitation of any single or a few species. Nearly 10 species of food plants, which were hitherto unreported, came into light during the Ethnobotanical studies on six tribal communities in the state of Andhra Pradesh in southern India. A knowledge that is totally unknown to the majority of people in the country. There is a lesson here for all human beings, namely, that by enlarging the dietary habits to include a greater diversity of plant products our dependence and extensive cultivation of a few species can be reduced. Tribes also use a plenty of non-timber forest produce for their day to day subsistence: For example oil from Madhuca longifolia var. latifolia, gum from Sterculia urens, fragrant resin from Boswellia serrata and edible fruits and fibre form Grewia teliaefolia.

Tribal communities show prudence and ecological wisdom in resource utilisation. “Kadars” of Tamil Nadu for example select only mature plants of the yam Dioscorea for harvesting the tubers. They first examine the vine and choose only those whose leaves are yellow which is an indication of maturity. Tubers of young green vines are never dug out. After harvesting the mature yams they cut off the upper portion of the tuber along with the vine and replant it in the pit. They cover the pit with loose soil for the tuber to grow again in the coming season for whoever may harvest it in the future. The community as a whole shares the harvest thus avoiding over exploitation. Part of the collection is stored for consumption during the off - season. This is a unique example of community co-operation in plant utilities and conservation of resources.

Traditional Knowledge of tribes on medicinal plants

Medicinal properties of plants have been recognized and practiced by tribal communities as a tradition for thousands of years. Knowledge on some common medicinal plants of their locality is available with all the members of the community. However, the elderly members possess a great deal of knowledge of medicinal plants as well as on medicines for curing certain life threatening diseases. Tribal people use plants solely or in combination. Same plant may be used for different disorders: for example Calotropis gigantea is used as vermicide and for chest pain, Centella asiatica used for gynaecological problems and for jaundice, Dodonaea viscosa used for headache, stomach pain and piles, Wrightia tinctoria for treating mumps and as lactagogue. In certain cases a combination of different plants are used in the treatment for e.g. Albizia lebbec together with Cassia fistula and Euphorbia hirta is used for urinary disorder. And Capparis zeylanica with Pongamia pinnata, Cissus quandrangularis and Toddalia asiatica is used for venereal disease. Each tribe has its own method of collecting the plants as well as the preparation of medicines. Dosage and duration of medication depends on the age of the patient and the intensity of disease. The tribes collect the plant part used for medicine at a particular time like, either before flowering or fruiting, or in a particular season.

Traditional agricultural practices of tribal communities

The knowledge of tribal people in traditional agriculture is invaluable. Their farming practices are truly sustainable in many ways. Tribal communities namely Irulas, Malayalis and Muthuvas inhabiting Tamil Nadu have been cultivating the traditional cultivars viz. paddy, millets, pulses and vegetable crops. Their subsistence life style, local diet habits and dependence on rain fed irrigation have influenced them to cultivate and conserve the traditional cultivars or land races. Many crops such as Panicum miliaceum, Echinocloa colona, Paspalum scrobiculatum and Setaria italica are now cultivated and conserved only by the tribal people in many parts of southern India. By selecting and conserving the seeds from one season to the next, they have been able to sustain and continue to be self-reliant. For

e.g. healthy cobs are left in the field so as to allow it to dry to the maximum days to make sure that no moisture is left in the seeds. The selection of large and healthy seeds and also the selection based on the color of the seeds (e.g. in case of Castor seeds) have also helped them select more viable seeds. The tribal communities prefer to continue the cultivation of traditional cultivars, as these are ecologically suitable and economically viable and valuable. The traditional cultivars and land races cultivated by tribes are also drought and pest tolerant and disease resistant. The tribes also have practical reason for cultivating these cultivars, which satisfy their high calorie requirements that are required for their hard life. Pesticides and fertilizers are not required.

The tribal communities practice a unique method of farming namely mixed cropping system (MCS). The MCS enables them to cultivate cereals, leafy vegetables, pulses and oil crops together in limited area depending on monsoon rain. The practice is such that the seeds of common millet, finger millet, grain and leaf amaranth, pulses and castor are mixed together and broadcasted. Initially the common millet is harvested followed by finger millet. Edible leaves of Amaranth and seeds and pods of pulses are used for daily consumption. Edible grains of amaranth are harvested and stored for future use. Castor seeds are harvested and used both for domestic consumption and for selling in the market.

The MCS not only helps in utilizing the seasonal rainfall but also in keeping the soil unexposed thereby preventing topsoil erosion. The combination of crops with legumes helps in nitrogen fixation, thus maintaining the soil fertility. This not alone helps them derive maximum benefits from their small land holdings but also takes care of their food and economic requirements throughout the year. Hence, this concept of MCS can be adopted and introduced in places where rain fed agriculture is in practice.

Community co-operation and participation prevailing particularly in Malayali tribal community has helped them in conserving the traditional land races. The practice is such that every family in the community will contribute a stipulated amount of their harvest to the community granary maintained and managed by the chieftain of the hamlet. During important occasions like marriages, social events and festivals and also

as and when some one needs for regular consumption, grains can be borrowed on loan and paid back. This system has enabled the tribals to conserve the seed material even if the produce in a particular season is less or if the grains stored for domestic consumption are exhausted.

Traditional methods of storing seeds

Seed material for sowing and the grains for consumption, are preserved in traditional granaries. These granaries are made of bamboo and coated with red soil. The roof is conical which is thatched with local grass. There is a free flow of air in the granaries, which may be one of the reasons that the seeds could remain viable till it is used next time. Another method of storing is that the seeds are stored in earthen pots covered with a cotton cloth. This indigenous practice has saved many varieties of cereals, millets and legumes over many generations in Tamil Nadu. This practice has enabled them to maintain, preserve and conserve the genetic strains from extinction. Leaves of Neem (Azadirachta indica) and Vitex (Vitex negundo) are used in the granaries as insect and pest repellents.

DISCUSSION

Due to the practices described above, these people could conserve the genetic strains for a long period of time. However, at present, because of increasing population in tribal areas and contact with people dwelling in plains, who practice unsustainable life style, there is every threat for the genetic material conserved by the tribes till to-date. In order to prevent this genetic erosion, the traditional cultivars needs to be conserved through protection as they form basic raw material for further crop improvement using the genetic variability present in the traditional cultivars.

Policy decisions, which might affect the ecological balance of biodiversity, should be taken through prior consultation of tribal people inhabiting the areas, who may help us with practical suggestions. Otherwise, ultimately the ethnic people are the worst affected in any environmental crisis, as they exist at the bottom line of social strata. Loss of biodiversity results in the loss of cultural diversity, which is the cradle of knowledge on the values of plants. Ethiopia, a center for the origin of several plants such as coffee, is a standing example, which tells us that the loss of biodiversity would result in the worst form of environmental and social crisis. Ignoring the conservation of cultural diversity and the associated traditional ecological knowledge is detrimental for the cause of conservation of biodiversity on which the entire world depends for its survival.

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Water :

Use and over-exploitation of surface and ground water

Groundwater is the largest source of usable, fresh water in the world. In many parts of the world, especially where surface water supplies are not available, domestic, agricultural, and industrial water needs can only be met by using the water beneath the ground.

The U.S. Geological Survey compares the water stored in the ground to money kept in a bank account. If the money is withdrawn at a faster rate than new money is deposited, there will eventually be account-supply problems. Pumping water out of the ground at a faster rate than it is replenished over the long-term causes similar problems.

Groundwater depletion is primarily caused by sustained groundwater pumping. Some of the negative effects of groundwater depletion:

- **Lowering of the Water Table**

  Excessive pumping can lower the groundwater table, and cause wells to no longer be able to reach groundwater.

- **Increased Costs**

  As the water table lowers, the water must be pumped farther to reach the surface, using more energy. In extreme cases, using such a well can be cost prohibitive.

- **Reduced Surface Water Supplies**

  Groundwater and surface water are connected. When groundwater is overused, the lakes, streams, and rivers connected to groundwater can also have their supply diminished.

- **Land Subsidence**

  Land subsidence occurs when there is a loss of support below ground. This is most often caused by human activities, mainly from the overuse of groundwater, when the soil collapses, compacts, and drops.

- **Water Quality Concerns**

  Excessive pumping in coastal areas can cause saltwater to move inland and upward, resulting in saltwater contamination of the water supply.

Floods

Believe it or not, flooding is the deadliest type of severe weather. There's probably a lot about floods and flooding you don't know.

In this guide, we'll go over everything there is to know about flooding; answering common questions like "What causes flooding?" and "Where does flooding occur?" Use the buttons below to jump to the flood facts you care about the most, or read the entire Flooding 101 guide to become an expert!

What is a Flood? | Types of Floods

When discussing floods, it's important to understand what they are. Let's start with a flooding definition.

A **flood** is an overflow of water that submerges land that is usually dry. Floods are an area of study in the discipline of hydrology. They are the most common and widespread natural severe weather event.

Floods can look very different because flooding covers anything from a few inches of water to several feet. They can also come on quickly or build gradually. To better answer the question of "What is a flood?" we'll answer what each specific type of flooding event is.

According to our friends at the National Severe Storms Laboratory, there are five types of floods. They include:

River Flood

Coastal Flood

Storm Surge

Inland Flooding

Flash Flood

As you can infer from the list above, flooding can happen anywhere, including both coastal and inland locations. Let's take a detailed look at the different types of floods.

What is a River Flood?

The first type of flooding we will explore is river flooding.

What is River Flooding?

A **river flood** occurs when water levels rise over the top of river banks. This flooding can happen in all river and stream channels. This includes everything from small streams to the world's largest rivers.

Causes of River Flooding

River flooding typically happens for four reasons. They are:

- Excessive rain from tropical storm systems making landfall
- Persistent thunderstorms over the same area for extended periods
- Combined rainfall and snowmelt
- Ice jam

More on Riverine Floods

River floods can happen suddenly or slowly. Sudden river flooding events occur more often on smaller rivers, rivers with steep valleys, rivers that flow for much of their length over impermeable terrain, and normally dry channels.

On the other hand, low-rising river floods typically occur in large rivers with large catchment areas. In case you didn't know this already, a **catchment area** is any area of land where precipitation collects and runs off into a common outlet.

What is a Coastal Flood?

The next type of flood you should know about is a coastal flood.

What is Coastal Flooding?

A **coastal flood** is the inundation of normally dry land areas along the coast with seawater.

Causes of Coastal Flooding

Coastal flooding is typically a result of a combination of sea tidal surges, high winds, and barometric pressure.

These conditions typically come from storms at sea like:

- Tropical cyclones
- Tsunami
- Higher-than-average tides

What is Storm Surge?

Another type of flooding that is often associated with coastal flooding is storm surge.

What is Storm Surge?

Storm surge is an abnormal rise in water level in coastal areas over and above the regular astronomical tide.

Causes of Storm Surge

Storm surge is always a result meteorological storms that cause higher than normal tides on the coast. There are three parts of a storm that create this surge. They are:

- Wind
- Waves

Low atmospheric pressure

Learn about storm surge from one of our expert meteorologists, Andrew Rosenthal in the below snippet from our weather safety warmup webinar on hurricanes:

More on Storm Surge

Storm surge is an extremely dangerous form of flooding. It can flood large coastal areas at the same time. It can also cause flooding very quickly.

Extreme flooding occurs when storm surge happens at the same time as high tide. This can cause storm tides to reach over 2o feet!

Our meteorologists always stress that storm surge is the most dangerous aspect of any tropical system. It poses the most threat to both life and property. In the past, we've seen truly devastating storm surge impacts. For example, storm surge took the lives (directly and indirectly) of over 1,500 people during Hurricane Katrina.

What is Inland Flooding?

The next type of flood on our list is an inland flood. Some organizations refer to inland flooding as urban flooding. A flash flood is also a type of inland flood.

What is an Inland Flood?

An **inland flood** is flooding that occurs inland or not in a coastal area. Therefore, coastal flooding and storm surge are not inland floods.

Causes of Inland Flooding

Rainfall is almost always to blame for inland floods. Rain causes inland flooding in two ways. It can happen with steady rainfall over several days or it can happen because of a short and intense period of rainfall.

Snowmelt also causes inland floods, although rainfall is a more common cause. Another way inland flooding happens is when water ways get blocked by debris, ice, or dams.

More on Inland Floods

Inland floods are often worse in urban areas because there isn't anywhere for the water to go. The following urban features can create urban flooding or make inland floods worse:

- Paved roads and streets
- Low-capacity drainage equipment
- Dense buildings
- Low amounts of green space

What is a Flash Flood?

The most well-known and deadly type of flood is a flash flood.

What is a Flash Flood?

A **flash flood** is flooding that begins within 6 hours, and often within 3 hours, of heavy rainfall (or other cause).

What Causes Flash Floods?

Flash floods can happen for several reasons.

Most flash floods happen after extremely intense rainfall from severe thunderstorms over a short period of time (normally 6 hours or less). There are two key elements to determine is flash flooding is likely:

Rainfall rate

Rainfall duration

Flash floods also happen when damns break, when levees fail, or when an ice jam releases a large amount of water.

Dangers of Flash Floods

Flash flooding is the #1 severe weather killer in the United States.

Flash floods are extremely powerful. They have enough force to roll boulders, tear trees from the ground, destroy buildings and bridges, and scour out new channels. This type of flood is characterized by raging torrents that rip through river beds, urban streets, or canyons, wiping out everything in their paths. With heights reaching 30 feet, flash floods can completely cover communities.

Another reason why flash flooding is so dangerous is that it can happen with little to no warning. This is especially true when dams or levees break.

The National Weather Service recommends knowing your area’s flood risk before a flash flooding event happens. They also recommend having a family or business disaster plan ready in the case of a flash flood.

Droughts

While it is relatively easy to define what a hurricane or earthquake is, defining a drought is more subjective. Droughts do not have the immediate effects of floods, but sustained droughts can cause economic stress throughout an area. The word "drought" has various meanings, depending on a person's perspective. To a farmer, a drought is a period of moisture deficiency that affects the crops under cultivation—even two weeks without rainfall can stress many crops during certain periods of the growing cycle. To a meteorologist, a drought is a prolonged period when precipitation is less than normal. To a water manager, a drought is a deficiency in water supply that affects water availability and water quality. To a **hydrologist**, a drought is an extended period of decreased precipitation and streamflow.

What causes droughts?

A drought is a period of drier-than-normal conditions that results in water-related problems. Precipitation (rain or snow) falls in uneven patterns across the country. The amount of precipitation at a particular location varies from year to year, but over a period of years, the average amount is fairly constant. In the deserts of the Southwest, the average precipitation is less than 3 inches per year. In contrast, the average yearly precipitation in Atlanta is about 50 inches.

The amount of rain and snow also varies with the seasons. In Georgia, most of the yearly precipitation falls during winter, early spring, and in July. Even if the total amount of rainfall for a year is about average, rainfall shortages can occur during a period when moisture is critically needed for plant growth, such as in the early summer.

When little or no rain falls, soils can dry out and plants can die. When rainfall is less than normal for several weeks, months, or years, the flow of streams and rivers declines, water levels in lakes and reservoirs fall, and the depth to water in wells increases. If dry weather persists and water-supply problems develop, the dry period can become a drought (Moreland, 1993).

When does a drought begin?

The beginning of a drought is difficult to determine. Several weeks, months, or even years may pass before people know that a drought is occurring. The end of a drought can occur as gradually as it began. Dry periods can last for 10 years or more. During the 1930's, most of the United States was much drier than normal. In California, the drought extended from 1928 to 1937. In Missouri, the drought lasted from 1930 to 1941. That extended dry period produced the "Dust Bowl" of the 1930's when dust storms destroyed crops and farms.

The first evidence of drought usually is seen in records of rainfall. Within a short period of time, the amount of moisture in soils can begin to decrease. The effects of a drought on flow in streams and reservoirs may not be noticed for several weeks or months. Water levels in wells may not reflect a shortage of rainfall for a year or more after a drought begins (Moreland, 1993).

Does a shortage of rain mean that a drought will occur?

A period of below-normal rainfall does not necessarily result in drought conditions. Some rain returns to the air as water vapor when water **evaporates** from water surfaces and from moist soil. Plant roots draw some of the moisture from the soil and return it to the air through a process called transpiration. The total amount of water returned to the air by these processes is called evapotranspiration. Sunlight, humidity, temperature, and wind affect the rate of evapotranspiration. When evapotranspiration rates are large, soils can lose moisture and dry conditions can develop. During cool, cloudy weather, evapotranspiration rates may be small enough to offset periods of below-normal precipitation and a drought may be less severe or may not develop at all (Moreland, 1993).

Why doesn't a drought go away when it rains?

Rainfall in any form will provide some drought relief. A good analogy might be how medicine and illness relate to each other. A single dose of medicine can alleviate symptoms of illness, but it usually takes a sustained program of medication to cure an illness. Likewise, a single rainstorm will not break the drought, but it may provide temporary relief.

A light to moderate shower will probably only provide cosmetic relief. It might make folks feel better for awhile, provide cooling, and make the vegetation perk up. During the growing season, most of the rain that falls will be quickly evaporated or used by plants. Its impact is short term.

A thunderstorm will provide some of the same benefits as the shower, but it also may cause loss of life and property if it is severe. Thunderstorms often produce large amounts of precipitation in a very short time, and most of the rain will run off into drainage channels and streams rather than soak into the ground. If the rain happens to fall upstream of a reservoir, much of the runoff will be captured by the reservoir and add to the available water supply. No matter where the rain falls, stream levels will rise quickly and flooding may result. Also, because the rainfall and runoff can be intense, the resulting runoff can carry significant loads of sediment and pollutants that are washed from the land surface.

Soaking rains are the best medicine to alleviate drought. Water that enters the soil recharges ground water, which in turn sustains vegetation and feeds streams during periods when it is not raining. A single soaking rain will provide lasting relief from drought conditions, but multiple such rains over several months may be required to break a drought and return conditions to within the normal range.

Tropical storm rains are usually of the soaking variety, although they may also be intense such as during a thunderstorm and lead to some of the same problems. Tropical storms often produce more total rainfall than a "regular" soaking rain and can provide longer relief than a single soaking rain. However, tropical rains may also be of such intensity that they exceed the capacity of soil to absorb water and often result in significant runoff and flooding. Tropical rains can help to fill water-supply reservoirs and provide long-term drought insurance. If significant rainfall does not occur upstream of reservoirs, the drought relief aspects of tropical storms may be of only little

consequence. All things considered, a single tropical storm at the right place, at the right time, and with the right amount of rainfall can break a drought.

Considering all of the above, even when a drought has been broken it may not be truly over. The benefits of substantial rainfall such as from a tropical storm may last for months, but a return to normal rainfall patterns and amounts is necessary for conditions in streams, reservoirs, and ground water to also return to normal (Moreland, 1993).

Can drought affect the water level in wells?

Groundwater, which is found in aquifers below the surface of the Earth, is one of the Nation's most important natural resources. Groundwater is used to provide a large portion of the Nation's population with drinking water, it provides business and industries water for their purposes, and is used extensively for irrigation.

The water level in the aquifer that supplies a well does not always stay the same. Droughts, seasonal variations in rainfall, and pumping affect the height of the underground water levels. If a well is pumped at a faster rate than the aquifer around it is recharged by precipitation or other underground flow, then water levels in the well can be lowered. This can happen during drought, due to the extreme deficit of rain. The water level in a well can also be lowered if other wells near it are withdrawing too much water.

Conflicts over water (international & inter-state)

Today, water is considered as the heart of an economy of any country and all economic activities depend on it.

However at the national as well as international level, river water disputes are being created because of continuously increasing demand for water, its decreasing availability, and its deteriorating quality.

Rivers flow in their natural form according to geomorphic conditions. They are not controlled by political units.

Flow of water is distributed according to the relief and size of the watershed area. If a country is situated in an uneven relief where a river is in its primary stage, its distribution will not be in proportion though there may be sufficient quantity of water.Instead it would be distributed to the succeeding drainage area in definite proportion.

Geographical descriptions of important national and international river water disputes and agreements are given below:

National River Water Disputes:

Krishna River Water Dispute:

This dispute is linked with the three states of Karnataka, Andhra Pradesh and Maharashtra. The main basis of the dispute is associated with the Almati Dam constructed on river Krishna in the district Bijapur of Karnataka. Its foundation stone was laid by the then Prime Minister of India, Lai Bahadur Shastri, in 1968.

Thereafter, the Central Water Commission changed it into the form of a multipurpose project having a proposed height of 528 metres. This was objected to by Andhra Pradesh who said that by increasing the height of the dam, the natural water flow of river Krishna would be reduced, resulting in non-availability of water for Jurala, Shri Selam, Nagarjuna Sagar and other projects of Andhra Pradesh.

According to the distribution of water decided by Bachhawat Tribunal, Andhra Pradesh was to get 811 thousand million cubic feet (TMC), Karnataka would use 734 TMC water and Maharashtra could use 656 TMC water, although only 173 TMC feet water had been allotted for the north Krishna project.

Issue of Dispute:
Karnataka wants to raise the height of the dam up to 528 metres. Andhra Pradeshs objection is that with 524.45 metre height, Karnataka would be able to stop 227 TMC feet water, whereas only 173 TMC water has been allotted for north Krishna project. Andhra Pradesh holds that Jurala, Shri Selam, Nagarjuna Sagar and other projects constructed in the Krishna river basin would not be able to get water. This matter is still pending in the Supreme Court.

Cauvery River Water Dispute:
The dispute over Cauvery, famous as the Ganga of South India, is again in the limelight. The problem between Tamil Nadu, Karnataka, the central government and the Supreme Court is at its climax. The origin of river Cauvery is in Brahmgiri hills (1341 m) near Sahyadri (Western ghat) in district Coorg of Karnataka. It flows through Karnataka and Tamil Nadu, finally merging into the Bay of Bengal.

Total length of the river is 802 kms. At present, the problem of distribution of water is pending due to the intervention of central government and Supreme Court. In spite of orders of the Supreme Court dated 5 October 2002, the Karnataka government decided not to give water to Tamil Nadu. Hence J. Jayalalitha, Chief Minister of Tamil Nadu, filed a contempt petition against the decision of Karnataka government in the Supreme Court of India.

The Supreme Court had ordered as per its judgment on 4th November 2002, that Karnataka would release 9000 cusec water daily for Tamil Nadu. Even after the order of the Supreme Court, it was decided in a cabinet meeting under the chairmanship of S. M. Krishna, Chief Minister of Karnataka, not to give water to Tamil Nadu.

This decision was unanimously supported by the all party meeting of Karnataka government. Thereafter J. Jayalalitha, Chief Minister of Tamil Nadu, approached the Supreme Court under Article 355 and 356 of the Constitution for action against Karnataka government. Although Karnataka government has started releasing 1000 cusec water in view of the stern attitude of the supreme Court, but even then a permanent solution of Cauvery river water dispute is still due.

The dispute regarding the distribution of the water of river Cauvery among Kerala, Karnataka and Tamil Nadu is a very complex problem. The real dispute started between Karnataka and Tamil Nadu in 1889 when Karnataka prepared a plan to construct a dam on river Cauvery.

Looking to the seriousness of the dispute between Mysore State and Madras Presidency, Mysore state entrusted the dispute to the central government in 1892. One member of the Mediation Commission (Justice H.D. Griffin, Allahabad) constituted by the central government, gave its decision dated 12th May 1919, but the Madras Presidency refused to follow it.

Thereby the first effort of the central government failed. Another effort for agreement started on 13th April 1920, which was partly successful on 18th February 1924. Both the states got sanction for construction of one dam each (Krishna Sagar in Karnataka and Mysore dam in Tamil Nadu) as per the agreement.

The agreement was valid for 50 years or up to 1974, and neither state could construct any dam/water reservoir without mutual consent. However, the Karnataka Government presented a plan for construction of three water reservoirs in violation of the agreement and in-spite of opposition from Tamil Nadu. In response, the Farmer's Union of Tamil Nadu filed a petition in the High Court opposing the plan, which was withdrawn in 1971 after another agreement.

After the agreement, a committee under the Chairmanship of C.C. Patel presented two reports in September and December 1972, but it did not suit any of the Governments. The Farmer's Union again filed a petition and the dispute continued till 1979.

After termination of the duration of the agreement in 1974, the Chief Ministers of all the three states, in a meeting dated 26th November 1974, temporarily agreed on the "Cauvery Valley Authority", but it has again got into a dispute due to mutual differences. The issue of water dispute has adopted political dimensions by now by the hide and seek method.

As per the insistence by the Tamil Nadu Government in 1986 under International Water Dispute Act, 1956, the Supreme Court constituted a one-man Cauvery Water Dispute Tribunal under the Chairmanship of Justice Chitosh Mukherji on 2 June 1990, with the objective of finding a permanent solution of the dispute among all the four state

The Tribunal announced its judgment on 25 June 1991, according to which:
1. Karnataka will have to release 205 TMC (Thousand Million Cubic feet) water to Tamil Nadu on monthly and weekly basis for Mysore water reservoir.

2. Karnataka will not extend its Cauvery basin (11.2 Lakh).

But the Karnataka government refused to abide by it, saying that it was a unilateral decision.

The central government then called a meeting of all the four states for common consent for it but without any concrete result. The Chief Minister of Tamil Nadu went on a hunger strike in July 1993 and the matter again went to the Supreme court. The then Prime Minster Narsimha Rao announced a three point package on 1st June 1996 for solution of this problem.

1. Release of 600 crore cubic feet water to save crops of Tamil Nadu.

2. Constitution of an expert group.

3. Early meeting of Water Resources Council.

A four-point agreement was arrived at among the Chief Ministers of all the four states on 7 August 1998 after long discussions but without a common consent. Treating the

above agreement as a formality, the central government issued a notification on 11th August 1998 for implementation of the interim order and other related orders of the Tribunal constituted for solving the Cauvery Water dispute.

According to the Government of India Gazette 675(E), a Cauvery River Water Dispute Authority would be constituted under the Chairmanship of the Prime Minister of India with its headquarters at Delhi. Chief ministers of all the four states would be its members. It would prepare its own regulations and a vigilance committee would be constituted for assistance and implementation of decisions of the Authority.

A committee under the chairmanship of the secretary, Central Water Resources, and the Chief Secretaries of all the four states would be its members. In spite of the intervention of the central government and the Supreme Court, the problem of water dispute is still unsolved.

In violation of the orders of the Supreme Court, Karnataka government has decided not to give water to Tamil Nadu from 5 October 2002. As a reaction, Jayalalitha, Chief Minister of Tamil Nadu, has filed a contempt petition in the Supreme Court. Thus, this problem is still continuing and looking to its history and complexity, there is little possibility of its permanent solution in future.

The main reason is that the Cauvery river water dispute has been strongly politicized. Tamil Nadu believes that Karnataka is intentionally doing the malpractice of withholding Cauvery waters to keep Tamil Nadu as an arid region. Karnataka's version is that the water of Karnataka is meant for Karnataka and if it is given to Tamil Nadu, scarcity of water would be faced in Karnataka. In such circumstances, any unanimous solution seems a difficult task unless both the states sympathetically follow the decision of the Supreme Court.

Sutlej-Ravi-Beas Dispute;

The dispute over the waters of Ravi, Beas and Sutlej is mainly between the states of Punjab and Haryana. At the time of partition, an agreement had been signed between India and Pakistan regarding distribution of water of Indus River. According to it, waters of river Indus, Jhelum and Chenab were to go to Pakistan and waters of rivers Sutlej, Ravi and Beas would be for India. India had made a payment of Rs 110 crores to Pakistan in lieu of it.

The dispute started with the division of Punjab. Haryana demanded a share of the waters of their rivers in 1966 and the dispute started from there. A committee was constituted for it in 1970 and according to its recommendation, Haryana was to get 37.8 lakh acre feet water. Immediately after this, The Planning Commission recommended giving 37.8 lakh acre feet water to Haryana, 32.6 lakh acre feet water to Punjab and 2.00 lakh acre feet water to Delhi, but the dispute has not yet been settled.

Energy Resources :

Renewable and non-renewable energy sources

There are two major categories of energy: renewable and non-renewable.

Non-renewable energy resources are available in limited supplies, usually because they take a long time to replenish. The advantage of these non-renewable resources is that power plants that use them are able to produce more power on demand. The non-renewable energy resources are:

- Coal
- Nuclear
- Oil
- Natural gas

Renewable resources, on the other hand, replenish themselves. The five major renewable energy resources are:

- Solar
- Wind
- Water, also called hydro
- Biomass, or organic material from plants and animals
- Geothermal, which is naturally occurring heat from the earth

While renewable energy resources have the advantage of unlimited supply over the long haul, they are limited in their availability at any given moment.

For example, the sun rises each day, but its ability to generate power is limited when its cloudy**.** Another disadvantage is that power plant operators can't crank up renewable energy production when people are consuming more power, such as on a hot day when many people are running air conditioners at the same time.

States like California are trying to solve this problem by using energy storage, like large batteries, to collect electricity from renewable sources when demand is low in order to use it later when demand goes up.

Sponsored

Non-renewable Energy and Climate Change

When coal, natural gas and oil are burned to produce energy, they emit heat-trapping gases such as carbon dioxide. This process of trapping heat is what drives climate change, and the failure to address this problem is what's catalyzing the current climate crisis.

Fossil fuels are hydrocarbon-containing materials like coal or gas that are found in the Earth's crust and formed in the geological past from the remains of living organisms. These energy sources account for the majority of the world's greenhouse gas emissions**.**

If emissions continue unrestrained, the atmosphere could warm by as much as 2.7 degrees Fahrenheit above preindustrial levels by the year 2040, according to the latest report from the Intergovernmental Panel on Climate Change, a group of international scientists empowered by the United Nations to advise world leaders.

Scientists say this increase in the temperature would threaten life on the planet in a myriad of ways, including severe water shortages; more air pollution; rising sea levels, habitat loss; heat waves; melting ice sheets in West Antarctica and Greenland; and destruction of the world's coral reefs.

Over the last 150 years, humans are responsible for the vast majority of the increase of these gases in the atmosphere, and the burning of fossil fuels through activities like driving a car is the largest source of these emissions.

There is a vocal group of environmentalists and researchers —Stanford's Mark Jacobson, who developed a state-by-state 100% renewable plan for one — who argue that the power grid should be supported only by renewable resources.

Policy makers who invest in renewable energy often do so with the goal of generating power without emitting these planet-warming gases.

The Nuclear Debate

Experts debate whether nuclear energy should be considered a renewable or non-renewable energy resource.

Nuclear energy is considered clean energy, as it doesn't create any air pollution or emit carbon dioxide, but generates energy through nuclear fission, the process of atoms splitting apart.

For this reason, supporters of nuclear energy argue it should be considered renewable.

Those who are in favor of more nuclear energy hold that that even with investment in wind, solar and other renewable resources, nuclear power is necessary, because without it we can't reduce emissions quickly enough to stave off the worst impacts of climate change. Without contributions from nuclear energy "the cost of achieving deep decarbonization targets increases significantly," wrote MIT researchers in a 2018 paper examining the issue.

Detractors of this approach say that both the mining and refining of uranium and the building of nuclear power plants is energy-intensive. Other downsides to nuclear energy are the finite amount of uranium deposits on the planet and the production of harmful waste from nuclear reactors.

For these reasons, the U.S. Energy Information Administration considers it a non-renewable energy resource.

Links to Learn More

Intergovernmental Panel on Climate Change Change
A body of the United Nations, the IPCC regularly assesses the science of climate change and issues annual reports on the impacts and risks of warming, as well as guidance for adaptation and mitigation.

U.S. Energy Administration
This U.S. Department of Energy website includes detailed information, analysis and graphics about energy production and use in the U.S.

The United States of Energy
A series of infographics provides insight on our country's energy production and consumption of both renewable and non-renewable energy sources.

Use of alternate energy sources

Renewable power is booming, as innovation brings down costs and starts to deliver on the promise of a clean energy future. American solar and wind generation are breaking records and being integrated into the national electricity grid without compromising reliability.

This means that renewables are increasingly displacing "dirty" fossil fuels in the power sector, offering the benefit of lower emissions of carbon and other types of pollution. But not all sources of energy marketed as "renewable" are beneficial to the environment. Biomass and large hydroelectric dams create difficult tradeoffs when considering the impact on wildlife, climate change, and other issues. Here's what you

should know about the different types of renewable energy sources—and how you can use these emerging technologies at your own home.

What Is Renewable Energy?

Renewable energy, often referred to as clean energy, comes from natural sources or processes that are constantly replenished. For example, sunlight or wind keep shining and blowing, even if their availability depends on time and weather.

While renewable energy is often thought of as a new technology, harnessing nature's power has long been used for heating, transportation, lighting, and more. Wind has powered boats to sail the seas and windmills to grind grain. The sun has provided warmth during the day and helped kindle fires to last into the evening. But over the past 500 years or so, humans increasingly turned to cheaper, dirtier energy sources such as coal and fracked gas.

Now that we have increasingly innovative and less-expensive ways to capture and retain wind and solar energy, renewables are becoming a more important power source, accounting for more than one-eighth of U.S. generation. The expansion in renewables is also happening at scales large and small, from rooftop solar panels on homes that can sell power back to the grid to giant offshore wind farms. Even some entire rural communities rely on renewable energy for heating and lighting.

As renewable use continues to grow, a key goal will be to modernize America's electricity grid, making it smarter, more secure, and better integrated across regions.

Dirty energy

Nonrenewable, or "dirty," energy includes fossil fuels such as oil, gas, and coal. Nonrenewable sources of energy are only available in limited amounts and take a long time to replenish. When we pump gas at the station, we're using a finite resource refined from crude oil that's been around since prehistoric times.

Nonrenewable energy sources are also typically found in specific parts of the world, making them more plentiful in some nations than others. By contrast, every country has access to sunshine and wind. Prioritizing nonrenewable energy can also improve

national security by reducing a country's reliance on exports from fossil fuel–rich nations.

Many nonrenewable energy sources can endanger the environment or human health. For example, oil drilling might require strip-mining Canada's boreal forest, the technology associated with fracking can cause earthquakes and water pollution, and coal power plants foul the air. To top it off, all these activities contribute to global warming.

Types of Renewable Energy Sources

Solar Energy

Humans have been harnessing solar energy for thousands of years—to grow crops, stay warm, and dry foods. According to the National Renewable Energy Laboratory, "more energy from the sun falls on the earth in one hour than is used by everyone in the world in one year." Today, we use the sun's rays in many ways—to heat homes and businesses, to warm water, or power devices.

Solar, or photovoltaic (PV), cells are made from silicon or other materials that transform sunlight directly into electricity. Distributed solar systems generate electricity locally for homes and businesses, either through rooftop panels or community projects that power entire neighborhoods. Solar farms can generate power for thousands of homes, using mirrors to concentrate sunlight across acres of solar cells. Floating solar farms—or "floatovoltaics"—can be an effective use of wastewater facilities and bodies of water that aren't ecologically sensitive.

Solar supplies a little more than 1 percent of U.S. electricity generation**.** But nearly a third of all new generating capacity came from solar in 2017, second only to natural gas.

Solar energy systems don't produce air pollutants or greenhouse gases, and as long as they are responsibly sited, most solar panels have few environmental impacts beyond the manufacturing process.

Wind Energy

We've come a long way from old-fashioned wind mills. Today, turbines as tall as skyscrapers—with turbines nearly as wide in diameter—stand at attention around the

world. Wind energy turns a turbine's blades, which feeds an electric generator and produces electricity.

Wind, which accounts for a little more than 6 percent of U.S. generation, has become the cheapest energy source in many parts of the country. Top wind power states include California, Texas, Oklahoma, Kansas, and Iowa, though turbines can be placed anywhere with high wind speeds—such as hilltops and open plains—or even offshore in open water.

Other Alternative Energy Sources

Hydroelectric Power

Hydropower is the largest renewable energy source for electricity in the United States, though wind energy is soon expected to take over the lead. Hydropower relies on water—typically fast-moving water in a large river or rapidly descending water from a high point—and converts the force of that water into electricity by spinning a generator's turbine blades.

Nationally and internationally, large hydroelectric plants—or mega-dams—are often considered to be nonrenewable energy. Mega-dams divert and reduce natural flows, restricting access for animal and human populations that rely on rivers. Small hydroelectric plants (an installed capacity below about 40 megawatts), carefully managed, do not tend to cause as much environmental damage, as they divert only a fraction of flow.

Biomass Energy

Biomass is organic material that comes from plants and animals, and includes crops, waste wood, and trees. When biomass is burned, the chemical energy is released as heat and can generate electricity with a steam turbine.

Biomass is often mistakenly described as a clean, renewable fuel and a greener alternative to coal and other fossil fuels for producing electricity. However, recent science shows that many forms of biomass—especially from forests—produce higher carbon emissions than fossil fuels. There are also negative consequences for biodiversity. Still, some forms of biomass energy could serve as a low-carbon option under the right circumstances. For example, sawdust and chips from sawmills that

would otherwise quickly decompose and release carbon can be a low-carbon energy source.

Geothermal Energy

If you've ever relaxed in a hot spring, you've used geothermal energy. The earth's core is about as hot as the sun's surface, due to the slow decay of radioactive particles in rocks at the center of the planet. Drilling deep wells brings very hot underground water to the surface as a hydrothermal resource, which is then pumped through a turbine to create electricity. Geothermal plants typically have low emissions if they pump the steam and water they use back into the reservoir. There are ways to create geothermal plants where there are not underground reservoirs, but there are concerns that they may increase the risk of an earthquake in areas already considered geological hot spots.

Ocean

Tidal and wave energy is still in a developmental phase, but the ocean will always be ruled by the moon's gravity, which makes harnessing its power an attractive option. Some tidal energy approaches may harm wildlife, such as tidal barrages, which work much like dams and are located in an ocean bay or lagoon. Like tidal power, wave power relies on dam-like structures or ocean floor–anchored devices on or just below the water's surface.

Solar Power

At a smaller scale, we can harness the sun's rays to power the whole house—whether through PV cell panels or passive solar home design. Passive solar homes are designed to welcome in the sun through south-facing windows and then retain the warmth through concrete, bricks, tiles, and other materials that store heat.

Some solar-powered homes generate more than enough electricity, allowing the homeowner to sell excess power back to the grid. Batteries are also an economically attractive way to store excess solar energy so that it can be used at night. Scientists are hard at work on new advances that blend form and function, such as solar skylights and roof shingles.

Geothermal Heat Pumps

Geothermal technology is a new take on a recognizable process—the coils at the back of your fridge are a mini heat pump, removing heat from the interior to keep foods fresh and cool. In a home, geothermal or geoexchange pumps use the constant temperature of the earth (a few feet below the surface) to cool homes in summer and warm houses in winter—and even to heat water.

Geothermal systems can be initially expensive to install but typically pay off within 10 years. They are also quieter, have fewer maintenance issues, and last longer than traditional air conditioners.

Small Wind Systems

A backyard wind farm? Boats, ranchers, and even cell phone companies use small wind turbines regularly. Dealers now help site, install, and maintain wind turbines for homeowners, too—although some DIY enthusiasts are installing turbines themselves. Depending on your electricity needs, wind speeds, and zoning rules in your area, a wind turbine may reduce your reliance on the electrical grid.

Selling the Energy You Collect

Wind- and solar energy–powered homes can either stand alone or get connected to the larger electrical grid, as supplied by their power provider. Electric utilities in most states allow homeowners to only pay the difference between the grid-supplied electricity consumed and what they have produced—a process called net metering. If you make more electricity than you use, your provider may pay you retail price for that power.

Growing energy needs

India, the second largest populated nation in the world with more than a billion people has an economy which is growing at nearly 8% over the last decade and about 6% on the average since her independence in 1947.
It is expected that India’s economy will go at more or less the same rate even till 2050, which will naturally demand enormous amounts of energy. This is also highlighted by the fact that globally, the nations with improved quality of life, as reflected by the larger value of the human development index, consume more amount of energy per capita.

Though India is presently the fourth largest electricity producing country in the world, her per capita energy consumption (500 kWh) is rather small, which is only about 1/2 of

China , 1/4 of World average and about 1/13th of developed nations. This is also reflected by the low life expectancy in India and other similar nations.

However, India aspires to reach at least the global average by 2050, which would require her to produce about 1300 GW of electricity, ten times more than the present value of about 130 GW. Of the present electricity generation, about 80% of the resources is fossil fuels. Hydro about 15%, renewable about 2% and nuclear about 3%. Relying on fossil fuels alone to increase the energy production is both impractical and impossible, first because of lack of access to required resources and second, even if resources are available, it would produce irreparable damage to the environment through global warming.

The conventional nuclear power production based on fission reactions is slated to grow to about 20% of the total by 2050. To meet the energy demand in coming decades, it is essential to find alternate resources. Thus fusion, which can be viewed as an advance nuclear technology, provides a great opportunity to countries like India and China to meet their energy needs.

Growing Energy Needs in India

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Region	**Oil**	**Gas**	**Coal**	**Nuclear Energy**	**Hydro-electricity**	**Total**
North America	1122.4	705.9	603.8	210.4	141.9	2784.4
South and Central	221.7	106.2	18.7	4.4	132.1	483.1
America						
Europe and	957.3	997.7	537.2	287.2	184.7	2964.0

Eurasia						
So called Middle east	250.9	218.0	9.1	–	4.0	481.9
Africa	124.3	61.8	102.8	3.4	19.8	312.1
Asia Pacific	1090.5	330.9	1506.6	118.9	152.0	3198.8
World	3767.1	242.4	2778.2	624.3	634.4	10224.4

Case Studies

Everything is connected and everything is complicated. That is especially true when it comes to today's major environmental issues. From a changing climate to watersheds to supply chains to urban ecosystems, it's impossible to get a grasp on a system without knowing where the science is firm and where it's nuanced. At the same time, we can only effectively define problems and make informed decisions if we can look at these questions holistically. That means combining hydrology with policy, sustainability pledges with remote sensing, and sociology with ecology.

And that's something we do every day here at F&ES. The school offers students unique exposure to top experts across the environmental sciences while also preparing them to apply that knowledge to practice outside of academia.
Through coursework, internships, capstones, independent research projects, field trips, and seminars, students and faculty regularly dive into these questions. Yet illustrating concepts with concrete examples and giving students the opportunity to think through how they would make decisions in the face of complexity and uncertainty is no easy feat.

In the spring of 2015, with the support of the Dean's Office and Associate Dean of Professional Practice, Brad Gentry, F&ES launched its Case Study Integration Initiative

to provide dynamic resources that help the F&ES community look at coupled human-natural resource management questions from a variety of lenses.

"I think the case study approach that you are using – multiple courses all looking at an important case from different perspectives – is a great way to help students (and faculty) make connections among different courses and see the real-world applications of what they are learning. It is a valuable addition to our curriculum." – Shimon Anisfeld

Initiative Overview: Building a diverse case study library

F&ES Case studies

In-depth online interdisciplinary case studies form the bedrock of case study work at F&ES. These resources are built collaboratively with faculty, students, SIGS, and alumni and are designed to be used by many professors within their existing courses. Case studies are grounded in peer-reviewed literature, but also include a broad spectrum of interactive videos, images, and maps, as well as links to NGO reports and news stories. Subjects are selected with faculty and student interests in mind, and tackle forward-looking dilemmas without clear solutions. Guiding questions and assignments help to orient class sessions, though faculty members are encouraged to pick and choose content relevant to their courses. Workshops, webinars, team-taught class sessions, and panel discussions are a few of the forums we use to bring disciplinary perspectives together. These platforms also allow us to integrate new feedback and ideas into our case studies. Students and faculty are strongly encouraged to suggest case study topics of interest.

Student case studies
Through summer internships, clinical partnerships, and Masters' projects, students at F&ES often get unprecedented views into complicated situations. Knowing that writing a case study can be as powerful as using one in a classroom, we work with students to process their experiences into case studies of their own by providing templates, workshops, and technical support. These reports can then be used by faculty, compiled for publication, or give students a head start on future projects.

Case study library
When YSE and student case studies are not available on a subject, we also curate a collection of case studies from across academia and partner organizations.

Some great resources include:

- SESYNC case study collection (classroom-tested case studies with an emphasis on interdisciplinarity)
- National Center for Case Study Teaching in Science collection

- Yale SOM sustainability cases
- Harvard Business School Environment cases
- University of Michigan Sustainability Cases
- McGraw Hill case collection

Unit-4

Environmental Pollution :-

Types

There are various types of pollution chiefly arising as a result of anthropogenic causes. Also contributing to pollution is globalisation, where humanity's constant need for natural resources has slowly started to change the face of the earth.

Though the quality of living has drastically improved, other new issues have risen that gradually impact human health and the environment. In this article, we shall explore the meaning, causes and types of pollution. Also, we shall analyse the repercussions of pollution on human health and the environment.

What is Pollution?

"Pollution is the introduction of substances (or energy) that cause adverse changes in the environment and living entities ."

Pollution need not always be caused by chemical substances such as particulates (like smoke and dust). Forms of energy such as sound, heat or light can also cause pollution. These substances that cause pollution are called pollutants.

Pollution, even in minuscule amounts, impacts the ecological balance. Pollutants can make their way up the food chain and eventually find their way inside the human body. Read on to explore the types of pollution and their implications.

Types of Pollution

As stated before, there are different types of pollution, which are either caused by natural events (like forest fires) or by man-made activities (like cars, factories, nuclear wastes, etc.) These are further classified into the following types of pollution:

- Air Pollution
- Water Pollution
- Soil Pollution
- Noise Pollution

Besides these 4 types of pollution, other types exist such as light pollution, thermal pollution and radioactive pollution. The latter is much rarer than other types, but it is the deadliest.

Air Pollution

Air pollution refers to the release of harmful contaminants (chemicals, toxic gases, particulates, biological molecules, etc.) into the earth's atmosphere. These contaminants are quite detrimental and in some cases, pose serious health issues. Some causes that contribute to air pollution are:

- Burning fossil fuels
- Mining operations
- Exhaust gases from industries and factories

The effects of air pollution vary based on the kind of pollutant. But generally, the impact of air pollution ranges from:

- Increased risk of respiratory illness and cardiovascular problems
- Increased risk of skin diseases
- May increase the risk of cancer
- Global warming
- Acid rain
- Ozone depletion
- Hazards to wildlife

Among the other types of pollution, air pollution is theorized to have a planet-wide implication. Scientists have even speculated an apocalypse-like scenario where air pollution if left unchecked, can bring about an extreme form of global warming called the runaway greenhouse effect. Though this is purely speculative, it is a phenomenon that has already occurred on Venus.

More to Read: Steps to Control Air Pollution

Water Pollution

Water pollution is said to occur when toxic pollutants and particulate matter are introduced into water bodies such as lakes, rivers and seas. These contaminants are generally introduced by human activities like improper **sewage treatment** and oil spills. However, even natural processes such as eutrophication can cause water pollution.

Other significant causes of water pollution include:

- Dumping solid wastes in water bodies
- Disposing untreated industrial sewage into water bodies
- Human and animal wastes
- Agricultural runoff containing pesticides and fertilisers

The effects of water pollution are very pronounced in our environment. Furthermore, toxic chemicals can bioaccumulate in living beings, and these chemicals can travel their way up the food chain, ultimately reaching humans.

Among the other types of pollution, water pollution has a more disastrous consequences on humans. For instance, in 1932, a grave case of water pollution incapacitated the inhabitants of an entire city in Japan with neurological diseases and mental illness for many decades. However, the immediate cause was not apparent but was eventually attributed to acute mercury poisoning. Methylmercury was dumped into the surrounding bay and had ultimately bioaccumulated inside the fish. The local population then consumed these fish, and this resulted in the manifestation of ill-effects and neurological diseases.

Read More: A grave case of water pollution

Other consequences of water pollution include:

- Disruption of the ecosystem
- Threats to marine life
- Increased risk of water-borne diseases
- Increases toxic chemicals (such as mercury) in water bodies
- Eutrophication

Soil Pollution

Soil pollution, also called **soil contamination**, refers to the degradation of land due to the presence of chemicals or other man-made substances in the soil. The xenobiotic substances alter the natural composition of soil and affect it negatively. These can drastically impact life directly or indirectly. For instance, any toxic chemicals present in the soil will get absorbed by the plants. Since plants are producers in an environment, it gets passed up through the food chain. Compared to the other types of pollution, the effects of soil pollution are a little more obscured, but their implications are very noticeable.

Some of the common causes of soil pollution are:

- Improper industrial waste disposal
- Oil Spills

- Acid rain which is caused by air pollution
- Mining activities
- Intensive farming and agrochemicals (like fertilisers and pesticides)
- Industrial accidents

The effects of soil pollution are numerous. Specific wastes, such as radioactive waste become particularly hazardous when they are not well-contained. A well-documented example is a nuclear accident in Chernobyl, which has left an area of 2,600 km^2 uninhabitable for several thousand years.

Other effects of soil pollution include:

- Loss of soil nutrients, which renders the soil unfit for agriculture
- Impacts the natural flora and fauna residing in the soil
- Degrades vegetation due to the increase of salinity of the soil
- Toxic dust (such as silica dust) can cause respiratory problems or even lung cancer

Read More: Soil Profile

Noise Pollution

Noise pollution refers to the excessive amount of noise in the surrounding that disrupts the natural balance. Usually, it is man-made, though certain natural calamities like volcanoes can contribute to noise pollution.

In general, any sound which is over 85 decibels is considered to be detrimental. Also, the duration an individual is exposed plays an impact on their health. For perspective, a normal conversation is around 60 decibels, and a jet taking off is around 15o decibels. Consequently, noise pollution is more obvious than the other types of pollution.

Noise pollution has several contributors, which include:

- Industry-oriented noises such as heavy machines, mills, factories, etc.
- Transportation noises from vehicles, aeroplanes, etc.
- Construction noises
- Noise from social events (loudspeakers, firecrackers, etc.)
- Household noises (such as mixers, TV, washing machines, etc.)

Noise pollution has now become very common due to dense urbanisation and industrialisation. Noise pollution can bring about adverse effects such as :

- Hearing loss

- Tinnitus
- Sleeping disorders
- Hypertension (high BP)
- Communication problems

Learn more about pollution, the types of pollution, its causes and effects by registering at BYJU'S Biology

Frequently Asked Questions

What are the different types of pollution?

The different types of pollution include:

- Air pollution
- Water pollution
- Soil pollution
- Radioactive pollution
- Noise pollution

Name the harmful pollutants responsible for polluting the environment.

The harmful pollutants responsible for polluting the environment are:

- Nitrogen oxide
- Sulphur oxide
- Mercury
- Particulate matter
- Chlorofluorocarbon
- Volatile organic compounds

What are the different types of pollutants?

The different types of pollutants are:

- Primary Pollutants: These are the pollutants that are emitted directly from the sources such as volcanic eruptions, combustion of fossil fuel, etc. These include nitrogen oxide, sulphur oxide, etc.
- Secondary Pollutants: These are the pollutants that are not directly emitted from the sources but are formed when primary pollutants react in the atmosphere. For eg., ozone.

What is radioactive pollution?

Radioactive pollution is the pollution caused by the release of radioactive substances in the atmosphere during activities such as nuclear explosions, mining of radioactive ores, etc.

What are the consequences of mercury pollution?

Mercury pollution is the pollution caused by the release of mercury from the mercury products or emissions from coal-burning power plants in air, water or land. Mercury pollution results in neurological and behavioural disorders in humans. Insomnia, memory loss, headaches, tremors are some of the symptoms of mercury pollution.

Causes

The causes of environmental pollution are many, including oil, air pollution, and soil erosion.Oil spillage causes environmental pollution when oil is spilled in water. Oil kills the aquatic animals, thus causing decomposition that will lead to further pollution. Smoke and fumes from industries also cause environmental pollution since it produces smoke that may limit oxygen supply. The agro-chemicals are also something that pollutes the environment. These chemicals affect the respiratory activities of aquatic organism since they contain heavy metals. These chemicals also accumulate along food chains, becoming lethal at a higher trophic level.

Soil erosion is another factor that can cause environmental pollution. Through soil erosion, silt is transported to water bodies, making water unclean for human consumption. Silt clogs in respiratory systems of aquatic organisms, such as gills of fish and stomata in plants.

We should try to work together to end pollution and build a comfortable environment. We should remember that if you educate one individual, they will hold hands with you and reach up for the others, thus doing the best for our environment. Our environment is life, health and love.

effects and controls :
Air

Air pollutants are broadly classified into particulate and gaseous. The particulate substances include solid and liquid particles. The gaseous include substances that are in the gaseous state at normal temperature and pressure. The air pollutants have adverse effect on human beings, animals, vegetation, buildings. Air pollutants also change earth’s climate. Aesthetic sense is also influenced by air pollutants. The different air pollutants and their effects are as follows:

1. Particulate Matter:

It is of two types—settleable and suspended. The settleable dusts have a particle longer than 10 (am. The smaller particles are able to remain suspended for long periods in the air. The important effects of particulate matter are.

(i) Dust and smoke particles cause irritation of the respiratory tract and produces bronchitis, asthma and lung diseases.

(ii) Smog is a dark or opaque fog which is formed by the dust and smoke particles causing condensation of water vapours around them as well as attracting chemicals like SO2, H2S, NO2, etc. Smog harms plant life through glazing and necrosis besides reduced availability of light. In human beings and animals it produces respiratory troubles.

(iii) Particulate matter suspended in air, scatters and partly absorbs light. In industrial and urban areas, sunlight is reduced to 1/3 in summer and 2/3 in winter.

(iv) At a concentration above 150 g/100m3, cotton dust in ginning process produces pneumoconiosis or lung fibrosis called byssinosis. Lung fibrosis produced in other industries includes asbestosis (in asbestos industry), silicosis (stone grinders), siderosis (iron mill), coal miners' pneumoconiosis, flour mill pneumoconiosis, etc.

2. Carbon monoxide:

It accounts for 50% of the total atmospheric pollutants. It is formed by incomplete combustion of carbon fuels in various industries, motor vehicles, hearths, kitchens, etc. Carbon monoxide combines with haemoglobin of blood and impairs its oxygen carrying capacity. At higher concentration, carbon monoxide proves lethal.

3. Sulphur Oxides:

They occur mainly in the form of sulphur dioxide. It is produced in large quantity during smelting of metallic ores and burning of petroleum and coal in industries, thermal plants, home and motor vehicles. In the air, SO2 combines with water to form sulphurous acid (H2SO3) which is the cause of acid rain. It causes chlorosis and necrosis of vegetation. Sulphur dioxide, above 1 ppm, affects human beings. It causes irritation to eyes and injury to respiratory tract. It results in discolouration and deterioration of buildings, sculptures, painted surfaces, fabrics, paper, leather, etc.

4. Nitrogen Oxides:

They are produced naturally through biological and non-biological activities from nitrates, nitrites, electric storms, high energy radiations and solar flares. Human activity forms nitrogen oxides in combustion process of industries, automobiles, incinerators

and nitrogen fertilizers. Nitrogen oxides act on unsaturated hydrocarbons to form peroxy-acyl nitrates or PAN. It gives rise to photochemical smog. They cause eye irritation, respiratory troubles, blood congestion and dilation of arteries.

5. Carbon dioxide:

Due to excessive combustion activity, the content of C02 has been steadily rising. As carbon dioxide accumulates in the atmosphere it absorbs more and more of the reflected infrared radiation. This could cause an increase in temperature referred to as the green house effect. Melting polar ice caps and glaciers could cause sea levels to rise, flooding most of the major population centres and fertile lands.

6. Phosgene and Methyl Isocyanate:

Phosgene (COCl2) is a poisonous and suffocating volatile liquid which is employed in dye industry and synthesis of organic compounds. Release of phosgene and MIC in industrial accident of Bhopal (Dec. 2, 1984) killed over 2500 and maimed several thousand persons.

7. Aerosols:

They are widely used as disinfectants. Other sources are jet plane emissions which contain chlorofluorocarbons. Chlorofluorocarbons are also used in refrigeration and formation of certain types of solid plastic foams. Burning of plastics produces polychlorinated biphenyls (PCBs). The latter are persistent and pass into the food chain. Chlorofluorocarbons and carbon tetrachloride react with ozone layers of stratosphere and hence deplete the same.

8. Photochemical oxidants:

Hydrocarbons have carcinogen properties. Some of these are also harmful to plants because they cause senescence and abscission. In the presence of sunlight, hydrocarbons react with nitrogen oxides to produce ozone, peroxy-acyl nitrates, aldehydes and other compounds. Peroxy-acyl nitrates are a major constituent of air pollution. They cause eye irritation and respiratory diseases.

9. Automobile Exhausts:

They are one of the major sources of air pollution. The important pollutants are Carbon monoxide, Benzpyrene, Lead, Nitrogen oxides, Sulphur compounds and Ammonia.

10. Pollen and Microbes:

Excess of microbes in the atmosphere directly damage the vegetation, food articles and causes diseases in plants, animals and human beings. Excess of pollen causes allergic

reactions in several human beings. The common reactions are also collectively called hay-fever. The important allergic pollen belong to Amaranthus spinosus, Chenopodium album, Cynodon dactylon, Ricinus communis, Sorghum vulgare, Prosopis chilensis etc.

Control of Air Pollution:

1. Industrial estates should be established at a distance from residential areas.

2. Use of tall chimneys shall reduce the air pollution in the surroundings and compulsory use of filters and electrostatic precipitators in the chimneys.

3. Removal of poisonous gases by passing the fumes through water tower scrubber or spray collector.

4. Use of high temperature incinerators for reduction in particulate ash production.

5. Development and employment of non-combustive sources of energy, e.g., nuclear power, geothermal power, solar power, tidal power, wind power, etc.

6. Use of non-lead antiknock agents in gasoline.

7. Attempt should be made to develop pollution free fuels for automobiles, e.g., alcohol, hydrogen, battery power. Automobiles should be fitted with exhaust emission controls.

8. Industrial plants and refineries should be fitted with equipment for removal and recycling of wastes.

9. Growing plants capable of fixing carbon monoxide, e.g. Phaseolus vulgaris, Coleus blumei, Daucus carota, Ficus variegata (Bidwell and Bebee, 1974).

10. Growing plants capable of metabolising nitrogen oxides and other gaseous pollutants, e.g., Vitis, Pimis, Jttniperus, Quercus, Pyrus, Robinia pseudo-acacia, Viburnum, Crataegus, Ribes, Rhamnus.

11. Afforestation of the mining area on priority basis.

Water

Water is one of the most vital natural resources on earth and has been around for a long time. In fact, the same water which we drink has been around in one form or the other since the time of the dinosaurs.

The earth has more than two-thirds of its surface covered with water. This translates to just over 1 octillion litres (1,260,000,000,000,000,000,000 litres) of water distributed in the oceans, rivers, lakes and streams.

That is a lot of water, however, less than 0.3% is accessible for human consumption. As commercialization and industrialization have progressed, that number continues to dwindle down. Furthermore, inefficient and outdated practices, lack of awareness and a plethora of other circumstances have led to water pollution.

Table of Contents

What is Water Pollution?

Water pollution can be defined as the contamination of water bodies. Water pollution is caused when water bodies such as rivers, lakes, oceans, groundwater, and aquifers get contaminated with industrial and agricultural effluents.

When water gets polluted, it adversely affects all lifeforms that directly or indirectly depend on this source. The effects of water contamination can be felt for years to come.

Also Refer: Types of Pollution

Sources Of Water Pollution

The key causatives of water pollution in India are:

- Urbanization.
- Deforestation.
- Industrial effluents.
- Social and Religious Practices.
- Use of Detergents and Fertilizers.
- Agricultural run-offs- Use of insecticides and pesticides.

Water Pollution – A Modern Epidemic

One of the primary **causes of water pollution** is the contamination of water bodies by toxic chemicals. As seen in the example mentioned above, the dumped plastic bottles, tins, water cans and other wastes pollute the water bodies. These result in water pollution, which harms not just humans, but the whole ecosystem. Toxins drained from these pollutants, travel up to the food chain and eventually affect humans. In most cases, the outcome is destructive to only local population and species, but it can have an impact on a global scale too.

Nearly 6 billion kilograms of garbage is dumped every year in the oceans. Apart from industrial effluents and untreated sewage, other forms of unwanted materials are dumped into various water bodies. These can range from nuclear waste to oil spills – the latter of which can render vast areas uninhabitable.

Effects Of Water Pollution

The effect of water pollution depends upon the type of pollutants and its concentration. Also, the location of water bodies is an important factor to determine the levels of pollution.

- Water bodies in the vicinity of urban areas are extremely polluted. This is the result of dumping garbage and toxic chemicals by industrial and commercial establishments.

- Water pollution drastically affects aquatic life. It affects their metabolism, behaviour, causes illness and eventual death. Dioxin is a chemical that causes a lot of problems from reproduction to uncontrolled cell growth or cancer. This chemical is bioaccumulated in fish, chicken and meat. Chemicals such as this travel up the food chain before entering the human body.

- The effect of water pollution can have a huge impact on the food chain. It disrupts the food-chain. Cadmium and lead are some toxic substances, these pollutants upon entering the food chain through animals (fish when consumed by animals, humans) can continue to disrupt at higher levels.

- Humans are affected by pollution and can contract diseases such as hepatitis through faecal matter in water sources. Poor drinking water treatment and unfit water can always cause an outbreak of **infectious diseases** such as cholera etc.

- The ecosystem can be critically affected, modified and destructured because of water pollution.

Minamata Incident

In 1932, a factory in Minamata City, Japan began dumping its industrial effluent – Methylmercury, into the surrounding bay and the sea. Methylmercury is incredibly toxic to humans and animals alike, causing a wide range of neurological disorders.

Its ill-effects were not immediately noticeable. However, this all changed as methylmercury had started to bioaccumulate inside shellfishes and fish in the Minamata Bay. These affected organisms were then caught and consumed by the local population. Soon, the ill-effects of methylmercury was becoming apparent.

Initially, animals such as cats and dogs were affected by this. The city’s cats would often convulse and make strange noises before dying – hence, the term “dancing cat

disease” was coined. Soon, the same symptoms were observed in people, though the cause was not apparent at the time.

Other affected people showed symptoms of acute mercury poisoning such as ataxia, muscle weakness, loss of motor coordination, damage to speech and hearing etc. In severe cases, paralysis occurred, which was followed by coma and death. These diseases and deaths continued for almost 36 years before it could be officially acknowledged by the government and the organisation.

Since then, various control measures of water pollution have been adopted by the government of Japan to curb such environmental disasters in the future.

Pollution of the Ganges

Some rivers, lakes, and groundwater are rendered unfit for usage. In India, the River Ganges is the sixth most polluted river in the world. This is unsurprising as hundreds of industries nearby release their effluents into the river. Furthermore, religious activities such as burials and cremations near the shore contribute towards pollution. Apart from the ecological implications, this river poses serious health risk as it can cause diseases like typhoid and cholera.

Pollution of the Ganges is also driving some of the distinct fauna to extinction. The Ganges River shark is a critically endangered species that belong to the order Carcharhiniformes. The Ganges River dolphin is another **endangered species** of dolphin that is found in the tributaries of the Ganges and Brahmaputra rivers.

As per a survey, by the end of 2026, around 4 billion people will face a shortage of water. Presently, around 1.2 billion people worldwide do not have access to clean, potable water and proper sanitation. It is also projected that nearly 1000 children die every year in India due to water-related issues. Groundwater is an important source of water, but unfortunately, even that is susceptible to pollution. Hence, water pollution is quite an important social issue that needs to be addressed promptly.

Control Measures of Water Pollution

Water pollution, to a larger extent, can be controlled by a variety of methods. Rather than releasing sewage waste into water bodies, it is better to treat them before discharge. Practising this can reduce the initial toxicity and the remaining substances can be degraded and rendered harmless by the water body itself. If the secondary treatment of water has been carried out, then this can be reused in sanitary systems and agricultural fields.

A very special plant, the Water Hyacinth can absorb dissolved toxic chemicals such as cadmium and other such elements. Establishing these in regions prone to such kinds of pollutants will reduce the adverse effects to a large extent.

Some chemical methods that help in the control of water pollution are precipitation, the ion exchange process, **reverse osmosis**, and coagulation. As an individual, reusing, reducing, and recycling wherever possible will advance a long way in overcoming the effects of water pollution.

Soil

In some extremely rare processes, some pollutants are naturally accumulated in soils. This can occur due to the differential deposition of soil by the atmosphere. Another manner in which this type of soil pollution can occur is via the transportation of soil pollutants with precipitation water.

An example of natural soil pollution is the accumulation of compounds containing the perchlorate anion (ClO_4^-) in some dry, arid ecosystems. It is important to note that some contaminants can be naturally produced in the soil under the effect of certain environmental conditions. For example, perchlorates can be formed in soils containing chlorine and certain metals during a thunderstorm.

Anthropogenic Soil Pollution

Almost all cases of soil pollution are anthropogenic in nature. A variety of human activities can lead to the contamination of soil. Some such processes are listed below.

- The demolition of old buildings can involve the contamination of nearby soil with asbestos.
- Usage of lead-based paint during construction activities can also pollute the soil with hazardous concentrations of lead.
- Spillage of petrol and diesel during transportation can contaminate soils with the hydrocarbons found in petroleum.
- Activities associated with metal casting factories (foundries) often cause the dispersion of metallic contaminants into the nearby soils.
- Underground mining activities can cause the contamination of land with heavy metals.
- Improper disposal of highly toxic industrial/chemical waste can severely pollute the soil. For example, the storage of toxic wastes in landfills can result in the seepage of the waste into the soil. This waste can go on to pollute groundwater as well.
- Chemical pesticides contain several hazardous substances. Excessive and inefficient use of chemical pesticides can result in severe soil pollution.
- Sewage produced in urbanized areas can also contaminate soil (if not disposed of correctly). These wastes may also contain several carcinogenic substances.

Other forms of waste that can pollute soil include nuclear waste, e-waste, and coal ash.

What are the Negative Consequences of Soil Pollution?

Soil pollution harbours a broad spectrum of negative consequences that affect plants, animals, humans, and the ecosystem as a whole. Since children are more susceptible to diseases, polluted soil poses a greater threat to them. Some important effects of soil pollution are detailed in this subsection.

Effects on Human Beings

Soil contaminants can exist in all three phases (solid, liquid, and gaseous). Therefore, these contaminants can find their way into the human body via several channels such as direct contact with the skin or through the inhalation of contaminated soil dust.

The short term effects of human exposure to polluted soil include:

- Headaches, nausea, and vomiting.
- Coughing, pain in the chest, and wheezing.
- Irritation of the skin and the eyes.
- Fatigue and weakness.

A variety of long-term ailments have been linked to soil pollution. Some such diseases are listed below.

- Exposure to high levels of lead can result in permanent damage to the nervous system. Children are particularly vulnerable to lead.
- Depression of the CNS (Central Nervous System).
- Damage to vital organs such as the kidney and the liver.
- Higher risk of developing cancer.

It can be noted that many soil pollutants such as petroleum hydrocarbons and industrial solvents have been linked to congenital disorders in humans. Thus, soil pollution can have several negative effects on human health.

Effects on Plants and Animals

Since soil pollution is often accompanied by a decrease in the availability of nutrients, plant life ceases to thrive in such soils. Soils contaminated with inorganic aluminium can prove toxic to plants. Also, this type of pollution often increases the salinity of the soil, making it inhospitable for the growth of plant life.

Plants that are grown in polluted soil may accumulate high concentrations of soil pollutants through a process known as bioaccumulation. When these plants are consumed by herbivores, all the accumulated pollutants are passed up the food chain. This can result in the loss/extinction of many desirable animal species. Also, these pollutants can eventually make their way to the top of the food chain and manifest as diseases in human beings.

Effects on the Ecosystem

- Since the volatile contaminants in the soil can be carried away into the atmosphere by winds or can seep into underground water reserves, soil pollution can be a direct contributor to air and water pollution.
- It can also contribute towards acid rain (by releasing huge quantities of ammonia into the atmosphere).

- Acidic soils are inhospitable to several microorganisms that improve soil texture and help in the decomposition of organic matter. Thus, the negative effects of soil pollution also impact soil quality and texture.
- Crop yield is greatly affected by this form of pollution. In China, over 12 million tons of grain (worth approximately 2.6 billion USD) is found to be unfit for human consumption due to contamination with heavy metals (as per studies conducted by the China Dialogue).

How can Soil Pollution be Controlled?

Several technologies have been developed to tackle soil remediation. Some important strategies followed for the decontamination of polluted soil are listed below.

- Excavation and subsequent transportation of polluted soils to remote, uninhabited locations.
- Extraction of pollutants via thermal remediation – the temperature is raised in order to force the contaminants into the vapour phase, after which they can be collected through vapour extraction.
- Bioremediation or phytoremediation involves the use of microorganisms and plants for the decontamination of soil.
- Mycoremediation involves the use of fungi for the accumulation of heavy metal contaminants.

Chemical and noise Pollution

Chemical manufacturing businesses may create **noise** in many ways, for example by:

- operating large processing plant and machinery, eg compressors and vacuum pumps
- moving raw materials and goods to and from site
- using vehicles on site, especially if they have reversing alarms

Chemical manufacturing activities can also create **vibration**.

If noise or vibration from your activities causes a nuisance to the surrounding community, your district council can limit your operations or even stop you from working. They can restrict:

- the machinery you use
- your working hours
- noise levels from your premises

If you have a permit, licence or exemption and you breach noise conditions, the Northern Ireland Environment Agency (NIEA) or your district council can take

enforcement action against you. If you do not address a noise problem you could face legal action and a fine.

You must comply with any noise conditions set out in the planning approval for your site.

Register your burglar alarms

If your business is located in an **alarm notification area** you must:

- register your burglar alarm with your district council
- provide the details of a person who holds the keys
- ensure the key holder knows how to use the alarm system

You could be fined if you do not register. Contact your district council to find out if your business is in an alarm notification area.

Protect your employees from loud noise

Loud noise can cause irreversible hearing damage. You must protect your employees' hearing.

Check your permit conditions

If you have a pollution prevention and control permit, a waste management licence or a waste exemption, it may contain conditions that control emissions, such as noise. You must comply with all of the conditions in your permit, licence or exemption. If you don't comply, the NIEA or your district council can take enforcement action against you, such as issuing you with an enforcement notice or a suspension notice for breach of a condition.

Good practice to avoid noise pollution

- Carry out **noisy activities** away from areas where noise may cause a nuisance. Position noisy equipment away from your site boundary. You can use existing buildings to shield the noise source.
- Make sure your buildings have adequate **soundproofing**. Shutting your doors and windows will also reduce noise. Use solid panelled fencing around your site instead of wire fences. This can help to screen the source and reduce the level of noise from your site.
- Reduce noise from your equipment and vehicles by servicing them regularly. Consider fitting noise-reducing devices, and when you replace equipment consider buying quieter alternatives.
- You should regularly **monitor noise** from your site, when it is fully working and also when it is shut down. This will give you an idea of the impact of your work on noise levels in the surrounding community. Monitoring will also help you identify any change in noise levels. If you are in any doubt about noise levels, you should get advice from a noise expert.

- Limit noisy activities to **daylight hours** as noise is more likely to be a nuisance at night.
- If you operate a night shift, move materials into the work area during the day or early evening. This will reduce the risk of complaints from the local community.
- If you receive a **complaint** make sure you deal with it properly.

Nuclear hazards and human health risks

Radionuclides are elements (uranium 235, uranium 283, thorium 232, potassium 40, radium 226, carbon 14 etc.) with unstable atomic nuclei and on decomposition release ionizing radiations in the form of alpha, beta and gamma rays.

Out of the known 450 radioisotopes only some are of environmental concern like strontium 90, tritium, plutonium 239, argon 41, cobalt 60, cesium 137, iodine 131, krypton 85 etc. These can be both beneficial and harmful, depending on the way in which they are used.

We routinely use X-rays to examine bones for fractures, treat cancer with radiation and diagnose diseases with the help of radioactive isotopes. About 17% of the electrical energy generated in the world comes from nuclear power plants.

Radioactive substances when released into the environment are either dispersed or become concentrated in living organisms through the food chain. Other than naturally occurring radioisotopes, significant amounts are generated by human activity, including the operation of nuclear power plants, the manufacture of nuclear weapons, and atomic bomb testing.

For example, strontium 90 behaves like calcium and is easily deposited and replaces calcium in the bone tissues. It could be passed to human beings through ingestion of strontium-contaminated milk. Again another example is tritium, which is radioactive hydrogen.

The amount of tritium released from nuclear power plants to the atmosphere have reached as high as tens of thousands of curies in one year, and releases to bodies of water have measured as high as tens of millions of picocuries per litre. The U.S. Environmental Protection Agency standard for permissible levels of tritium in drinking water is 20,000 picocuries per litre.

Nuclear power plants routinely and accidentally release tritium into the air and water. Tritium has a half-life of 12.3 years and emits radioactive beta particles. Once tritium is

inhaled or swallowed, its beta particles can bombard cells causing a mutation.

Few occupations that involve radioactive exposures are uranium mineworkers, radium watch dial painters, technical staff at nuclear power plants, etc. Exposure to radioactive and nuclear hazards has been clinically proven to cause cancer, mutations and teratogenesis (Teratogenesis is a prenatal toxicity characterized by structural or functional defects in the developing embryo or fetus).

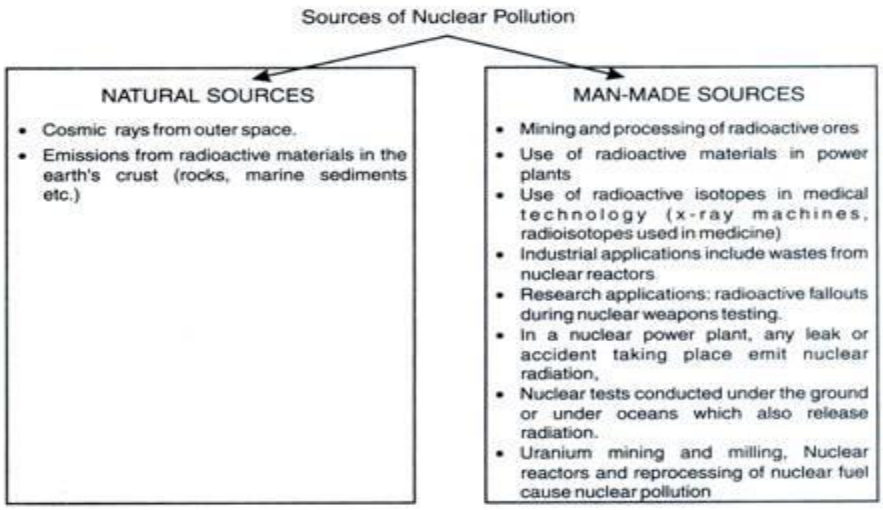
Nuclear hazard effects can be either initial or residual. Initial effects occur in the immediate area of explosion and are hazardous immediately after the explosion where as the residual effects can last for days or years and cause death. The principal initial effects are blast and radiation.

Blast causes damage to lungs, ruptures eardrums, collapses structures and causes immediate death or injury. Thermal Radiation is the heat and light radiation, which a nuclear explosion's fireball emits producing extensive fires, skin burns, and flash blindness. Nuclear radiation consists of intense gamma rays and neutrons produced during the first minute after the explosion.

This radiation causes extensive damage to cells throughout the body. Radiation damage may cause headaches, nausea, vomiting, diarrhea, and even death, depending on the radiation dose received.

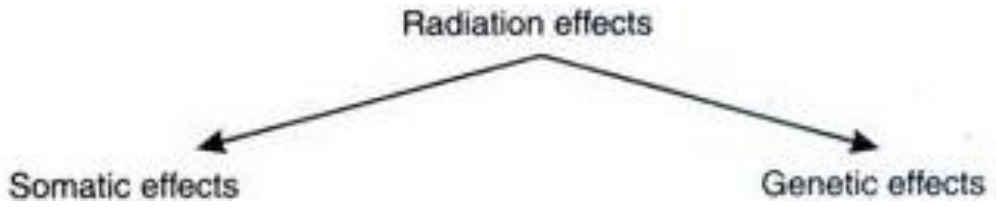
Sources of Nuclear Pollution:

The sources of radioactivity include both natural and manmade.



Effects of Nuclear Pollution:

Studies have shown that the health effects due to radiation are dependent on the level of dose, kind of radiation, duration of exposure and types of cells irradiated. Radiation effects can be somatic or genetic.



1. Somatic effects:

Somatic effects the function of cells and organs. It causes damages to cell membranes, mitochondria and cell nuclei resulting in abnormal cell functions, cell division, growth and death.

2. Genetic effects:

Genetic effects the future generations. Radiations can cause mutations, which are changes in genetic makeup of cells. These effects are mainly due to the damages to DNA molecules. People suffer from blood cancer and bone cancer if exposed to doses around 100 to 1000 roentgens. Instantaneous deaths on exposure in the event if disasters are many.

Management of Radioactive Waste:

a. The radioactive waste which comes out from industry, nuclear reactors should be stored and allowed to decay either naturally in closed drums or in very large underground air tight cemented tanks (Delay and Decay).

b. The intermediate radioactive waste should be disposed off into the environment after diluting it with some inert materials (Dilute and Disperse)

c. Now-a-days small quantities of high activity wastes are converted into solids such as concrete and then it is buried underground or sea. (Concentrate and contain)

Control Measures:

a. Laboratory generated nuclear wastes should be disposed off safely and scientifically.

b. Nuclear power plants should be located in areas after careful study of the geology of the area, tectonic activity and meeting other established conditions.

c. Appropriate protection against occupational exposure.

d. Leakage of radioactive elements from nuclear reactors, careless use of radioactive elements as fuel and careless handling of radioactive isotopes must be prevented.

e. Safety measure against accidental release of radioactive elements must be ensured in nuclear plants.

f. Unless absolutely necessary, one should not frequently go for diagnosis by x-rays.

g. Regular monitoring of the presence of radioactive substance in high risk area should be ensured.

Among the many options for waste disposal, the scientists prefer to bury the waste in hundreds of meters deep in the earth's crust is considered to be the best safety long term option.

Solid waste management :
Control measures of urban and industrial waste

Solid wastes are the material that arises from various human and economic activities. It is being produced since the beginning of civilization. Ever increasing population growth, urbanization and industrialization are contributing to the generation of solid waste in huge quantities.

Waste is enviable; waste is by product of human activity which has lack of use. The term waste refers to the useless material generated from different sources such as household, public places, hospital, commercial centre construction sites and production of waste from industries.

Waste can be classified through various methods on the basis of physical state (solid, liquid and gaseous) and then within solid waste (according to its original use packaging waste, food waste etc.) material (glass, paper etc.) physical properties, domestic,

commercial, biodegradable, non-biodegradable etc. Solid wastes have prevailing characteristics which sets them apart from the liquid and gaseous wastes.

The characteristics are that the waste remains highly visible in the environment. Liquid wastes are quickly relegated to sewer and are out of sight and gaseous wastes disperse in to the atmosphere. Accumulation of large quantities of solid wastes is having an adverse impact on the environment.

Different sources of wastes are mentioned as follows:

(i) Industrial Waste

(ii) Municipal Solid Wastes

(iii) Agricultural Waste

(iv) Mining Waste

(v) Energy Production Waste

(vi) Dredging Waste

Pollution case studies

Accurate data is essential for monitoring and managing the environment and enabling the design and implementation of effective environmental regulation. Recognising the hazards posed by pollution, the EU has developed an extensive body of legislation which establishes health-based standards and objectives for pollutants in air, water and soil. Key to the successful implementation of these policies is an underpinning measurement infrastructure that ensures that environmental data is robust and consistent across monitoring networks, across national borders and over time.

As allowable pollutant levels decrease, and new types of pollutant are identified, measurement capabilities must be constantly improved to support robust and fit-for-purpose pollutant monitoring and mitigation. This requires both improved measurement accuracy across the measurement infrastructure – at National Measurement Institutes, in accredited laboratories and in environmental monitoring networks – and the development of innovative, practical and cost-effective measurement technologies.

NEW MEASUREMENT CAPABILITIES TO PROTECT THE MARINE ENVIRONMENT

Underwater noise from man-made activity, such as shipping or construction work, can have a profound effect on marine organisms such as whales, damaging their hearing or driving them from their native habitats. European directives are in place to protect the most vulnerable species, but no validated calibration methods were available for

underwater measurement instruments in the sound range of greatest environmental concern.

IMPROVING INNER CITY AIR QUALITY

Small particles from petrol and diesel engine exhausts create major hazards in city air, especially for those with asthma or other breathing problems. The EU's Air Quality Directive requires monitoring of airborne pollution which is important for assessing the effectiveness of strategies such as London's ultralow emission zone. Ensuring the accuracy of instruments used for measuring vehicle particle emissions in city air relies on introducing standardized aerosols and testing regimes.

Climate change

Climate Change is the defining issue of our time and we are at a defining moment. From shifting weather patterns that threaten food production, to rising sea levels that increase the risk of catastrophic flooding, the impacts of climate change are global in scope and unprecedented in scale. Without drastic action today, adapting to these impacts in the future will be more difficult and costly.

The Human Fingerprint on Greenhouse Gases

Greenhouse gases occur naturally and are essential to the survival of humans and millions of other living things, by keeping some of the sun's warmth from reflecting back into space and making Earth livable. But after more than a century and a half of industrialization, deforestation, and large scale agriculture, quantities of greenhouse gases in the atmosphere have risen to record levels not seen in three million years. As populations, economies and standards of living grow, so does the cumulative level of greenhouse gas (GHGs) emissions.

There are some basic well-established scientific links:

- The concentration of GHGs in the earth's atmosphere is directly linked to the average global temperature on Earth;
- The concentration has been rising steadily, and mean global temperatures along with it, since the time of the Industrial Revolution;

- The most abundant GHG, accounting for about two-thirds of GHGs, carbon dioxide (CO_2), is largely the product of burning fossil fuels.

The UN Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) was set up by the World Meteorological Organization (WMO) and United Nations Environment to provide an objective source of scientific information. In 2013 the IPCC provided more clarity about the role of human activities in climate change when it released its Fifth Assessment Report. It is categorical in its conclusion: climate change is real and human activities are the main cause.

Fifth Assessment Report

The report provides a comprehensive assessment of sea level rise, and its causes, over the past few decades. It also estimates cumulative CO_2 emissions since pre-industrial times and provides a CO_2 budget for future emissions to limit warming to less than 2°C. About half of this maximum amount was already emitted by 2011. The report found that:

- From 1880 to 2012, the average global temperature increased by 0.85°C.
- Oceans have warmed, the amounts of snow and ice have diminished and the sea level has risen. From 1901 to 2010, the global average sea level rose by 19 cm as oceans expanded due to warming and ice melted. The sea ice extent in the Arctic has shrunk in every successive decade since 1979, with 1.07 × 106 km² of ice loss per decade.
- Given current concentrations and ongoing emissions of greenhouse gases, it is likely that by the end of this century global mean temperature will continue to rise above the pre-industrial level. The world's oceans will warm and ice melt will continue. Average sea level rise is predicted to be 24–30 cm by 2065 and 40–63 cm by 2100 relative to the reference period of 1986–2005. Most aspects of climate change will persist for many centuries, even if emissions are stopped.

There is alarming evidence that important tipping points, leading to irreversible changes in major ecosystems and the planetary climate system, may already have been reached or passed. Ecosystems as diverse as the Amazon rainforest and the Arctic tundra, may be approaching thresholds of dramatic change through warming and drying. Mountain glaciers are in alarming retreat and the downstream effects of reduced water supply in the driest months will have repercussions that transcend generations.

Global Warming of 1.5°C

In October 2018 the IPCC issued a special report on the impacts of global warming of 1.5°C, finding that limiting global warming to 1.5°C would require rapid, far-reaching and unprecedented changes in all aspects of society. With clear benefits to people and natural ecosystems, the report found that limiting global warming to 1.5°C compared to 2°C could go hand in hand with ensuring a more sustainable and equitable society. While previous estimates focused on estimating the damage if average temperatures were to rise by 2°C, this report shows that many of the adverse impacts of climate change will come at the 1.5°C mark.

The report also highlights a number of climate change impacts that could be avoided by limiting global warming to 1.5ºC compared to 2ºC, or more. For instance, by 2100, global sea level rise would be 10 cm lower with global warming of 1.5°C compared with 2°C. The likelihood of an Arctic Ocean free of sea ice in summer would be once per century with global warming of 1.5°C, compared with at least once per decade with 2°C. Coral reefs would decline by 70-90 percent with global warming of 1.5°C, whereas virtually all (> 99 percent) would be lost with 2ºC.

The report finds that limiting global warming to 1.5°C would require “rapid and far-reaching” transitions in land, energy, industry, buildings, transport, and cities. Global net human-caused emissions of carbon dioxide (CO2) would need to fall by about 45 percent from 2010 levels by 2030, reaching ‘net zero’ around 2050. This means that any remaining emissions would need to be balanced by removing CO2 from the air.

United Nations legal instruments

United Nations Framework Convention on Climate Change

The UN family is at the forefront of the effort to save our planet. In 1992, its “Earth Summit” produced the United Nations Framework Convention on Climate Change (UNFCCC) as a first step in addressing the climate change problem. Today, it has near-universal membership. The 197 countries that have ratified the Convention are Parties to the Convention. The ultimate aim of the Convention is to prevent “dangerous” human interference with the climate system.

Kyoto Protocol

By 1995, countries launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol. The Kyoto Protocol legally binds developed country Parties to emission reduction targets. The Protocol’s first commitment period started in 2008 and ended in 2012. The second commitment period

began on 1 January 2013 and will end in 2020. There are now 197 Parties to the Convention and 192 Parties to the Kyoto Protocol.

Paris Agreement

At the 21st Conference of the Parties in Paris in 2015, Parties to the UNFCCC reached a landmark agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. The Paris Agreement builds upon the Convention and – for the first time – brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping the global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.

On Earth Day, 22 April 2016, 175 world leaders signed the Paris Agreement at United Nations Headquarters in New York. This was by far the largest number of countries ever to sign an international agreement on a single day. There are now 186 countries that have ratified the Paris Agreement.

2019 Climate Action Summit

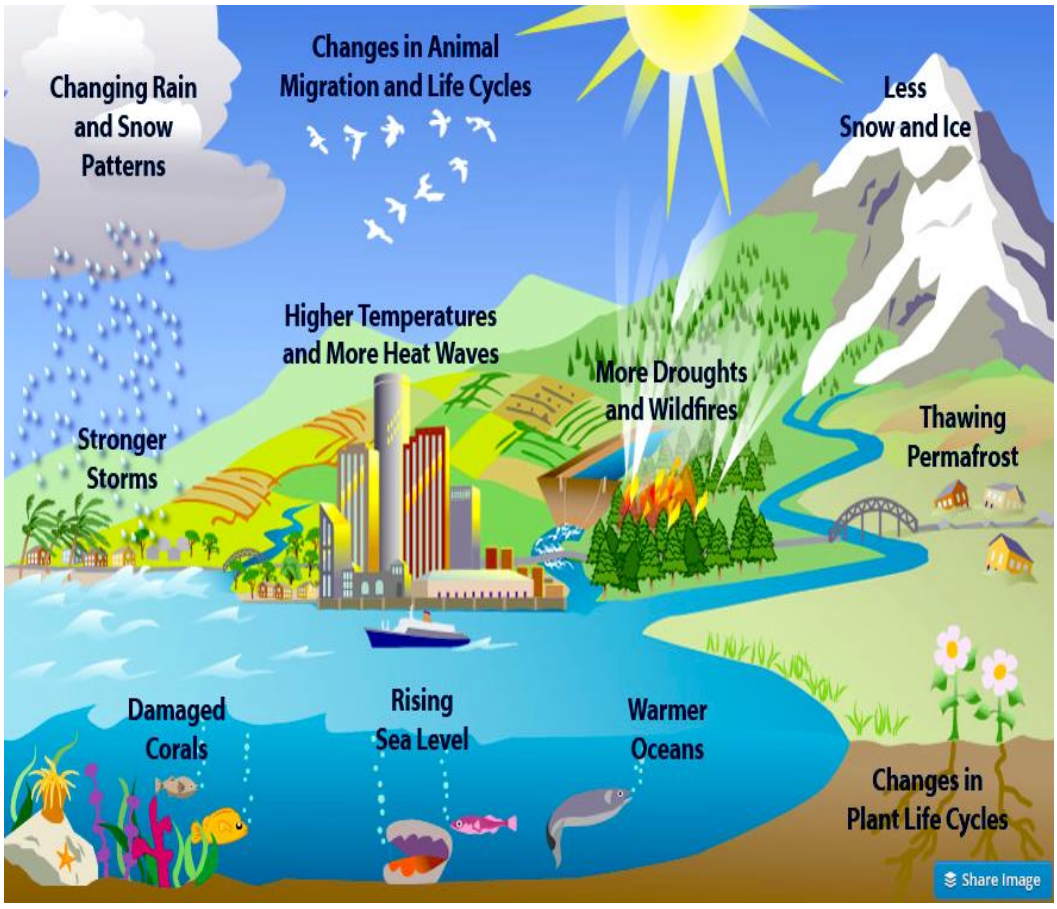
On 23 September 2019, Secretary-General António Guterres convened a Climate Summit to bring world leaders of governments, the private sector and civil society together to support the multilateral process and to increase and accelerate climate action and ambition. He named Luis Alfonso de Alba, a former Mexican diplomat, as his Special Envoy to lead preparations. The Summit focused on key sectors where action can make the most difference—heavy industry, nature-based solutions, cities, energy, resilience, and climate finance. World leaders reported on what they are doing, and what more they intend to do when they convene in 2020 for the UN climate conference, where commitments will be renewed and may be increased. In closing the Climate Action Summit, the Secretary-General said "You have delivered a boost in momentum, cooperation and ambition. But we have a long way to go."

global warming

Global warming is a term used for the observed century-scale rise in the average temperature of the Earth's climate system and its related effects. Scientists are more

than 95% certain that nearly all of global warming is caused by increasing concentrations of greenhouse gases (GHGs) and other human-caused emissions.

Within the earth's atmosphere, accumulating greenhouse gases like water vapor, carbon dioxide, methane, nitrous oxide, and ozone are the gases within the atmosphere that absorb and emit heat radiation. Increasing or decreasing amounts of greenhouse gases within the atmosphere act to either hold in or release more of the heat from the sun.



Our atmosphere is getting hotter, more turbulent, and more unpredictable because of the “boiling and churning” effect caused by the heat-trapping greenhouse gases within the upper layers of our atmosphere. With each increase of carbon, methane, or other greenhouse gas levels in the atmosphere, our local weather and global climate is further agitated, heated, and “boiled.”

Global warming is gauged by the increase in the average global temperature of the Earth. Along with our currently increasing average global temperature, some parts of the Earth may actually get colder while other parts get warmer—hence the idea of

average global temperature. Greenhouse gas-caused atmospheric heating and agitation also increase the unpredictability of the weather and climate, and dramatically increase the severity, scale, and frequency of storms, droughts, wildfires, and extreme temperatures.

Global warming can reach levels of irreversibility, and increasing levels of global warming can eventually reach an extinction level where humanity and all life on earth will end. In this book, irreversible global warming is defined as a continuum of increasing temperature that causes the global climate to rapidly change until those higher temperatures becomes irreversible on practical human time scales. The eventual temperature range associated with triggering and marking the beginning of the irreversible global warming processes is an increase in average global temperature of 2.2°-4° Celsius (4°-7.2° Fahrenheit) above preindustrial levels.

Extinction level global warming is defined in this book as temperatures exceeding preindustrial levels by 5-6° Celsius (9-10.8° Fahrenheit) or the extinction of all planetary life, or the eventual loss of our atmosphere. If our atmosphere is also lost, this is referred to as runaway global warming. The result would be similar to what is thought to have happened to Venus 4 billion years ago, resulting in a carbon-rich atmosphere and minimum surface temperatures of 462 °C.

The temperature levels described above for irreversible and extinction level global warming are not hard and rigid boundaries, but boundary ranges that describe the related consequences and their intensities within a certain level of global warming. These temperature boundary levels may be modified by future research. More about irreversible global warming and extinction-level global warming can come about because of complex interactions that will be explained fully in Chapter 4. Chapter 4 and Chapter 5 will set the foundation necessary to understand how we are already creating the conditions that will precipitate irreversible and extinction-level global warming if we keep going as we are now.

How long carbon dioxide remains in our atmosphere

Carbon dioxide is currently the most important greenhouse gas related to global warming. For the longest time, our scientists believed that once in the atmosphere, carbon dioxide remains there for about 100 years. New research shows that is not true. 75% of that carbon will not disappear for thousands of years. The other 25% stays forever. We are creating a serious global warming crisis that will last far longer than we ever thought possible.

"The lifetime of fossil fuel CO2 in the atmosphere is a few centuries, plus 25 percent that lasts essentially forever. The next time you fill your tank, reflect upon this...[the climatic impacts of releasing fossil fuel CO2 to the atmosphere will last longer than Stonehenge… Longer than time capsules, longer than nuclear waste, far longer than the age of human civilization so far." —“Carbon is forever,” Mason Inman

How carbon dioxide in our atmosphere is tracked

Atmospheric carbon from fossil fuel burning is the main human-caused factor in the escalating global warming we are experiencing now. The current level of carbon in our atmosphere is tracked using what is called the Keeling curve. The Keeling curve measures atmospheric carbon in parts per million (ppm).

Each year, many measurements are taken at Mauna Loa, Hawaii to determine the parts per million (ppm) of carbon in the atmosphere at that time. At the beginning of the Industrial Revolution around 1880, before we began fossil fuel burning, our atmospheric carbon ppm level was at about 270. Here is the current Keeling curve graph for where we are today:

As you can see, we are not doing very well. In later chapters, you will learn what this exponentially rising carbon means to your future. You also will see other graphs that will show you how today’s atmospheric carbon levels compare to those of our near and far distant past (hundreds, thousands, hundreds of thousands, and millions of years ago).

No matter what you hear in the media, if the total carbon ppm level is not going down or carbon’s average ppm level per year is not falling or at least slowing its steep increase, we are not making any significant progress on resolving the escalating global warming emergency. Total atmospheric carbon and carbon’s average ppm level per year are the mostdependable measurements of our progress and a predictor of what will be happening with global warming and its many consequences.

ozone layer depletion

The ozone layer is found in the lower portion of the earth’s atmosphere. It has the potential to absorb around 97-99% of the harmful ultraviolet radiations coming from the sun that can damage life on earth. If the ozone layer was absent, millions of people would develop skin diseases and may have weakened immune systems.

However, scientists have discovered a hole in the ozone layer over the Antarctic. This has focussed their concern on various environmental issues and steps to control them. The main reasons for the ozone hole are chlorofluorocarbons, carbon tetrachloride, methyl bromide and hydrochlorofluorocarbons.

Let us have a detailed look at the various causes and effects of ozone layer depletion.

Ozone Layer Depletion

“Ozone layer depletion is the gradual thinning of the earth’s ozone layer in the upper atmosphere caused due to the release of chemical compounds containing gaseous bromine or chlorine from industries or other human activities.”

What is Ozone Layer Depletion?

Ozone layer depletion is the thinning of the ozone layer present in the upper atmosphere. This happens when the chlorine and bromine atoms in the atmosphere come in contact with ozone and destroy the ozone molecules. One chlorine can destroy 100,000 molecules of ozone. It is destroyed more quickly than it is created.

Some compounds release chlorine and bromine on exposure to high ultraviolet light, which then contributes to the ozone layer depletion. Such compounds are known as Ozone Depleting Substances (ODS).

The ozone-depleting substances that contain chlorine include chlorofluorocarbon, carbon tetrachloride, hydrochlorofluorocarbons, and methyl chloroform. Whereas, the ozone-depleting substances that contain bromine are halons, methyl bromide, and hydro bromofluorocarbons.

Chlorofluorocarbons are the most abundant ozone-depleting substance. It is only when the chlorine atom reacts with some other molecule, it does not react with ozone.

Montreal Protocol was proposed in 1987 to stop the use, production and import of ozone-depleting substances and minimize their concentration in the atmosphere to protect the ozone layer of the earth.

auses of Ozone Layer Depletion

The ozone layer depletion is a major concern and is associated with a number of factors. The main causes responsible for the depletion of the ozone layer are listed below:

Chlorofluorocarbons

Chlorofluorocarbons or CFCs are the main cause of ozone layer depletion. These are released by solvents, spray aerosols, refrigerators, air-conditioners, etc.

The molecules of chlorofluorocarbons in the stratosphere are broken down by the ultraviolet radiations and release chlorine atoms. These atoms react with ozone and destroy it.

Unregulated Rocket Launches

Researches say that the unregulated launching of rockets result in much more depletion of ozone layer than the CFCs do. If not controlled, this might result in a huge loss of the ozone layer by the year 2050.

Nitrogenous Compounds

The nitrogenous compounds such as NO2, NO, N2O are highly responsible for the depletion of the ozone layer.

Natural Causes

The ozone layer has been found to be depleted by certain natural processes such as Sun-spots and stratospheric winds. But it does not cause more than 1-2% of the ozone layer depletion.

Acid rain and impacts on human communities and agriculture

An ecosystem is a community of plants, animals and other organisms along with their environment including the air, water and soil. Everything in an ecosystem is connected. If something harms one part of an ecosystem – one species of plant or animal, the soil or the water – it can have an impact on everything else.

Effects of Acid Rain on Fish and Wildlife

The ecological effects of acid rain are most clearly seen in aquatic environments, such as streams, lakes, and marshes where it can be harmful to fish and other wildlife. As it flows through the soil, acidic rain water can leach aluminum from soil clay particles and then flow into streams and lakes. The more acid that is introduced to the ecosystem, the more aluminum is released.

Some types of plants and animals are able to tolerate acidic waters and moderate amounts of aluminum. Others, however, are acid-sensitive and will be lost as the pH declines. Generally, the young of most species are more sensitive to environmental conditions than adults. At pH 5, most fish eggs cannot hatch. At lower pH levels, some adult fish die. Some acidic lakes have no fish. Even if a species of fish or animal can tolerate moderately acidic water, the animals or plants it eats might not. For example, frogs have a critical pH around 4, but the mayflies they eat are more sensitive and may not survive pH below 5.5.

Effects of Acid Rain on Plants and Trees

Dead or dying trees are a common sight in areas effected by acid rain. Acid rain leaches aluminum from the soil. That aluminum may be harmful to plants as well as animals. Acid rain also removes minerals and nutrients from the soil that trees need to grow.

At high elevations, acidic fog and clouds might strip nutrients from trees' foliage, leaving them with brown or dead leaves and needles. The trees are then less able to absorb sunlight, which makes them weak and less able to withstand freezing temperatures.

Buffering Capacity

Many forests, streams, and lakes that experience acid rain don't suffer effects because the soil in those areas can **buffer** the acid rain by neutralizing the acidity in the rainwater flowing through it. This capacity depends on the thickness and composition of the soil and the type of bedrock underneath it. In areas such as mountainous parts of the Northeast United States, the soil is thin and lacks the ability to adequately neutralize the acid in the rain water. As a result, these areas are particularly vulnerable and the acid and aluminum can accumulate in the soil, streams, or lakes.

Episodic Acidification

Melting snow and heavy rain downpours can result in what is known as episodic acidification. Lakes that do not normally have a high level of acidity may temporarily experience effects of acid rain when the melting snow or downpour brings greater amounts of acidic deposition and the soil can't buffer it. This short duration of higher acidity (i.e., lower pH) can result in a short-term stress on the ecosystem where a variety of organisms or species may be injured or killed.

Nitrogen Pollution

It's not just the acidity of acid rain that can cause problems. Acid rain also contains nitrogen, and this can have an impact on some ecosystems. For example, nitrogen pollution in our coastal waters is partially responsible for declining fish and shellfish populations in some areas. In addition to agriculture and wastewater, much of the nitrogen produced by human activity that reaches coastal waters comes from the atmosphere.

Effects of Acid Rain on Materials

Not all acidic deposition is **wet**. Sometimes dust particles can become acidic as well, and this is called **dry deposition**. When acid rain and dry acidic particles fall to earth, the nitric and sulfuric acid that make the particles acidic can land on statues, buildings, and other manmade structures, and damage their surfaces. The acidic particles corrode metal and cause paint and stone to deteriorate more quickly. They also dirty the surfaces of buildings and other structures such as monuments.

The consequences of this damage can be costly:

- damaged materials that need to be repaired or replaced,
- increased maintenance costs, and
- loss of detail on stone and metal statues, monuments and tombstones.

Other Effects of SO_2 and NO_X

Visibility

In the atmosphere, SO_2 and NO_X gases can be transformed into sulfate and nitrate particles, while some NO_X can also react with other pollutants to form ozone. These particles and ozone make the air hazy and difficult to see through. This affects our enjoyment of national parks that we visit for the scenic view such as Shenandoah and the Great Smoky Mountains.

Human Health

Walking in acid rain, or even swimming in a lake affected by acid rain, is no more dangerous to humans than walking in normal rain or swimming in non-acidic lakes. However, when the pollutants that cause acid rain —SO_2 and NO_X, as well as sulfate and nitrate particles— are in the air, they can be harmful to humans.

SO_2 and NO_X react in the atmosphere to form fine sulfate and nitrate particles that people can inhale into their lungs. Many scientific studies have shown a relationship between these particles and effects on heart function, such as heart attacks resulting in death for people with increased heart disease risk, and effects on lung function, such as breathing difficulties for people with asthma.

Unit 5

Environmental Policies, Human communities, Practices and the Environment

Environment Laws

The need for protection and conservation of environment and sustainable use of natural resources is reflected in the constitutional framework of India and also in the international commitments of India. The Constitution under Part IVA (Art 51A-Fundamental Duties) casts a duty on every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures. Further, the Constitution of India under Part IV (Art 48A-Directive Principles of State Policies) stipulates that the State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country.

Several environment protection legislations existed even before Independence of India. However, the true thrust for putting in force a well-developed framework came only after the UN Conference on the Human Environment (Stockholm, 1972). After the Stockholm Conference, the National Council for Environmental Policy and Planning was set up in 1972 within the Department of Science and Technology to establish a regulatory body to look after the environment-related issues. This Council later evolved into a full-fledged Ministry of Environment and Forests (MoEF).

MoEF was established in 1985, which today is the apex administrative body in the country for regulating and ensuring environmental protection and lays down the legal and regulatory framework for the same. Since the 1970s, a number of environment legislations have been put in place. The MoEF and the pollution control boards ("CPCB", ie, Central Pollution Control Board and "SPCBs", ie, State Pollution Control Boards) together form the regulatory and administrative core of the sector.

Some of the important legislations for environment protection are as follows:

- The National Green Tribunal Act, 2010
- The Air (Prevention and Control of Pollution) Act, 1981
- The Water (Prevention and Control of Pollution) Act, 1974
- The Environment Protection Act, 1986
- The Hazardous Waste Management Regulations, etc.

These important environment legislations have been briefly explained in the succeeding paragraphs.

The National Green Tribunal Act, 2010

The National Green Tribunal Act, 2010 (No. 19 of 2010) (NGT Act) has been enacted with the objectives to provide for establishment of a National Green Tribunal (NGT) for the effective and expeditious disposal of cases relating to environment protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto.

The Act received the assent of the President of India on June 2, 2010, and was enforced by the Central Government *vide* Notification no. S.O. 2569(E) dated October 18, 2010, with effect from October 18, 2010. The Act envisages establishment of NGT in order to deal with all environmental laws relating to air and water pollution, the Environment Protection Act, the Forest Conservation Act and the Biodiversity Act as have been set out in Schedule I of the NGT Act.

Consequent to enforcement of the National Green Tribunal Act, 2010, the National Environment Tribunal Act, 1995 and the National Environment Appellate Authority Act, 1997 stand repealed. The National Environment Appellate Authority established under s 3(1) of the National Environment Appellate Authority Act, 1997stands dissolved, in view of the establishment of the National Green Tribunal under the National Green Tribunal Act, 2010 *vide* Notification no. S.O. 2570(E) dated October 18, 2010.

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

The Air (Prevention and Control of Pollution) Act, 1981 (the "Air Act") is an act to provide for the prevention, control and abatement of air pollution and for the establishment of Boards at the Central and State levels with a view to carrying out the aforesaid purposes.

To counter the problems associated with air pollution, ambient air quality standards were established under the Air Act. The Air Act seeks to combat air pollution by prohibiting the use of polluting fuels and substances, as well as by regulating appliances that give rise to air pollution. The Air Act empowers the State Government, after consultation with the SPCBs, to declare any area or areas within the Sate as air pollution control area or areas. Under the Act, establishing or operating any industrial plant in the pollution control area requires consent from SPCBs. SPCBs are also expected to test the air in air pollution control areas, inspect pollution control equipment, and manufacturing processes.

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

The Water Prevention and Control of Pollution Act, 1974 (the "Water Act") has been enacted to provide for the prevention and control of water pollution and to maintain or restore wholesomeness of water in the country. It further provides for the establishment of Boards for the prevention and control of water pollution with a view to carry out the aforesaid purposes. The Water Act prohibits the discharge of pollutants into water bodies beyond a given standard, and lays down penalties for non-compliance. At the

Centre, the Water Act has set up the CPCB which lays down standards for the prevention and control of water pollution. At the State level, SPCBs function under the direction of the CPCB and the State Government.

Further, the Water (Prevention and Control of Pollution) Cess Act was enacted in 1977 to provide for the levy and collection of a cess on water consumed by persons operating and carrying on certain types of industrial activities. This cess is collected with a view to augment the resources of the Central Board and the State Boards for the prevention and control of water pollution constituted under the Water (Prevention and Control of Pollution) Act, 1974. The Act was last amended in 2003.

The Environment Protection Act, 1986

The Environment Protection Act, 1986 (the "Environment Act") provides for the protection and improvement of environment. The Environment Protection Act establishes the framework for studying, planning and implementing long-term requirements of environmental safety and laying down a system of speedy and adequate response to situations threatening the environment. It is an umbrella legislation designed to provide a framework for the coordination of central and state authorities established under the Water Act, 1974 and the Air Act. The term "environment" is understood in a very wide term under s 2(a) of the Environment Act. It includes water, air and land as well as the interrelationship which exists between water, air and land, and human beings, other living creatures, plants, micro-organisms and property.

Under the Environment Act, the Central Government is empowered to take measures necessary to protect and improve the quality of environment by setting standards for emissions and discharges of pollution in the atmosphere by any person carrying on an industry or activity; regulating the location of industries; management of hazardous wastes, and protection of public health and welfare. From time to time, the Central Government issues notifications under the Environment Act for the protection of ecologically-sensitive areas or issues guidelines for matters under the Environment Act.

In case of any non-compliance or contravention of the Environment Act, or of the rules or directions under the said Act, the violator will be punishable with imprisonment up to five years or with fine up to Rs 1,00,000, or with both. In case of continuation of such violation, an additional fine of up to Rs 5,000 for every day during which such failure or contravention continues after the conviction for the first such failure or contravention, will be levied. Further, if the violation continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term which may extend to seven years.

Hazardous Wastes Management Regulations

Hazardous waste means any waste which, by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics, causes danger or is

likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances.

There are several legislations that directly or indirectly deal with hazardous waste management. The relevant legislations are the Factories Act, 1948, the Public Liability Insurance Act, 1991, the National Environment Tribunal Act, 1995 and rules and notifications under the Environmental Act. Some of the rules dealing with hazardous waste management are discussed below:

- **Hazardous Wastes (Management, Handling and Transboundary) Rules, 2008**, brought out a guide for manufacture, storage and import of hazardous chemicals and for management of hazardous wastes.

- **Biomedical Waste (Management and Handling) Rules, 1998**, were formulated along parallel lines, for proper disposal, segregation, transport, etc, of infectious wastes.

- **Municipal Solid Wastes (Management and Handling) Rules, 2000**, aim at enabling municipalities to dispose municipal solid waste in a scientific manner.

In view of the short-comings and overlapping of some categories causing inconvenience in implementation of the Biomedical Waste (Management and Handling) Rules, 1998 as well as the Municipal Solid Wastes (Management and Handling) Rules, 2000, the Ministry of Environment, Forest and Climate Change has formulated the draft Bio-Medical Waste (Management & Handling) Rules, 2015 (Draft BMW Rules) and the draft Solid Waste Management Rules, 2015 (Draft SWM Rules) and sought comments on the draft Rules.

The Draft BMW Rules are to replace the Biomedical Waste (Management and Handling) Rules, 1998, and the Draft SWM Rules are to replace the Municipal Solid Waste (Management and Handling) Rules, 2000. The objective of the Draft BMW Rules is to enable the prescribed authorities to implement the rules more effectively, thereby, reducing the bio- medical waste generation and also for its proper treatment and disposal and to ensure environmentally sound management of these wastes, and the Draft SWM Rules aim at dealing with the management of solid waste including it segregation at source, transportation of waste, treatment and final disposal.

- **E - Waste (Management and Handling) Rules, 2011** have been notified on May 1, 2011 and came into effect from May 1, 2012, with primary objective to reduce the use of hazardous substances in electrical and electronic equipment by specifying threshold for use of hazardous material and to channelize the e-waste generated in the country for environmentally sound recycling. The Rules apply to every producer, consumer or bulk consumer, collection centre, dismantler and recycler of e-waste involved in the manufacture, sale, purchase and processing of electrical and electronic equipment or components as detailed in the Rules.

- **Batteries (Management & Handling) Rules, 2001** deal with the proper and effective management and handling of lead acid batteries waste. The Act requires all manufacturers, assemblers, re-conditioners, importers, dealers, auctioneers, bulk consumers, consumers, involved in manufacture, processing, sale, purchase and use of batteries or components thereof, to comply with the provisions of Batteries (Management & Handling) Rules, 2001.

Other Laws Relating to Environment

In addition, there are many other laws relating to environment, namely –

The Wildlife Protection Act, 1972

The Wild Life (Protection) Act, 1972 was enacted with the objective of effectively protecting the wild life of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. The Act was amended in January 2003 and punishment and penalty for offences under the Act have been made more stringent. The Ministry has proposed further amendments in the law by introducing more rigid measures to strengthen the Act. The objective is to provide protection to the listed endangered flora and fauna and ecologically important protected areas.

The Forest Conservation Act, 1980

The Forest Conservation Act, 1980 was enacted to help conserve the country's forests. It strictly restricts and regulates the de-reservation of forests or use of forest land for non-forest purposes without the prior approval of Central Government. To this end the Act lays down the pre-requisites for the diversion of forest land for non-forest purposes.

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, recognises the rights of forest-dwelling Scheduled Tribes and other traditional forest dwellers over the forest areas inhabited by them and provides a framework for according the same.

The Indian Forest Act, 1927 consolidates the law relating to forests, the transit of forest-produce and the duty leviable on timber and other forest-produce.

Public Liability Insurance Act, 1991

The Public Liability Insurance Act, 1991 was enacted with the objectives to provide for damages to victims of an accident which occurs as a result of handling any hazardous substance. The Act applies to all owners associated with the production or handling of any hazardous chemicals.)

The Biological Diversity Act, 2002

The Biological Diversity Act 2002 was born out of India's attempt to realise the objectives enshrined in the United Nations Convention on Biological Diversity (CBD), 1992 which recognises the sovereign rights of states to use their own Biological Resources. The Act aims at the conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner. The National Biodiversity Authority in Chennai has been established for the purposes of implementing the objects of the Act.

Coastal Regulation Zone Notification

The Ministry of Environment and Forests had issued the Coastal Regulation Zone Notification *vide* Notification no. S O. 19(E), dated January 06, 2011 with an objective to ensure livelihood security to the fishing communities and other local communities living in the coastal areas, to conserve and protect coastal stretches and to promote development in a sustainable manner based on scientific principles, taking into account the dangers of natural hazards in the coastal areas and sea level rise due to global warming.

Environment Protection Act

An Act to provide for the protection and improvement of environment and for matters connected there with.

WHEREAS the decisions where taken at the United Nations Conference on the Human Environment held at Stockholm in June, 1972, in which India participated, to take appropriate steps for the protection and improvement of human environment.

AND WHEREAS it is considered necessary further to implement the decisions aforesaid in so far as they relate to the protection and improvement of environment and prevention of hazards to human beings, other living creatures, plants and property.

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION under Section 3(2) (v) of Environment (Protection) Act, 1986 and Rules 5 (3) (d) of Environment (Protection)Rules, 1986 Prohibiting Industries in Murud-janjira Area in the Raligarh District of Maharastra.

S.O.No.20 (E) – Whereas a notification under sub-rule (3) of the rule 5 of the Environment (Protection) Rules, 1986 inviting objecting against the imposition of prohibition on the location of all industries in Murud-Janjira area in Raigarh district of Maharastra was published vide No.S.O. 85 (E), dated the 7th September, 1988.And Whereas all objections received have been duly considered by the Central Government.

Now, therefore, in exercise of the powers conferred by clause (d) of sub-rule (3) of Rule 5 of the said rules, the Central Government hereby prohibits location of all industries, carrying on of operations or processes in a belt of one kilometre from the high tide mark from the Revdanda Creek at 190 35″) upto Devgarh Point (near Shrivardhan) at 180 O') as well as in one kilometre belt along the banks of the Rajpuri Creek upto Mhasia, except those industries, operations of precesses which are in connection with the promotion and development of Tourism and those thich are permitted by the Central Government after examining the environment impact.

How Are The Terms "Environment", "Environmental Pollutant", "Environmental Pollution" And "Hazardous Substance" Defined Under The E.P.A. 1986?

According to Section 2 of E.P.A.

"Environment" includes water, air and land and the inter-relationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro-organism and property.

"Environmental pollutant" means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be, injurious to environment.

"Environmental pollution" means the presence in the environment of any environmental pollutant.

"Hazardous substance" means any substance or preparation which, by reason of its chemical or physico-chemical properties or handling, is liable to cause harm to human beings, other living creatures; plants, micro-organisms, property or the environment.

What Are The General Powers Of The Central Government Under E.P.A. For The Protection And Improvement Of Environment?

Section 3. Power of Central Government to take measure to protect and improve the environment

Subject to the provisions of this Act, the Central Government shall have the power to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment pollution.

In particular, and without prejudice to the generality of the provisions of sub-section (1), such measures may include measures with respect to all or any of the following matters, namely.

Co-ordination of actions by the State Governments, officers and other authorities

Under this Act, or the rules made thereunder or

Under any other law for the time being in force which is relatable to the objects of this Act.

Planning and execution of a nation-wide programme for the prevention, control and abatement of environmental pollution.

Laying down standards for the quantity of environment in its various aspects.

Laying down standards for emission or discharge of environmental pollutants from various sources whatsoever. Provided that different standards for emission or discharge may be laid down under this clause from different sources having regard to the quality or composition of the emission lr discharge of environmental pollutants from such sources.

Restriction of areas in which any industries, operations or processes or class of industries, operations or processes shall not be carried out or shall be carried out subject to certain safeguards.

Laying down procedures and safeguards for the prevention of accidents which may cause environmental pollution and remedial measures for such accidents.

Laying down procedures and safeguards for the handling of hazardous substances.

Examination of such manufacturing processes, materials and substances as are likely to cause environmental pollution.

Carrying out and sponsoring investigations and research relating to problems of environmental pollution.

Inspection of any premises, plant, equipment, machinery, manufacturing or other processes, materials or substances and giving, by order, of such directions to such authorities, officers or persons as it may consider necessary to take steps for the prevention, control and abatement of environmental pollution.

Establishment or recognition of environmental laboratories and institutes to carry out the functions entrusted to such environmental laboratories and institutes under this Act.

Collection and dissemination of information in respect of matters relating to environmental pollution.

Preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution.

Such other matters as the Central Government deems necessary or expedient for the purpose of securing the effective implementation of the provisions of this Act.

The Central Government may, if it consider it necessary or expedient so to do for the purposes of this Act, by order published in the Official Gazettee, constitute an authority or authorities by such name or names as may be specified in the order for the purpose of exercising and performing such of the powers and functions (including the power to issue directions under Section

of the Central Government under this Act and for taking measures with respect to such of the matters referred to in sub-section(2) as may be mentioned in the order and subject to the supervision and control of the Central Government and the provisions of such order, such authority or authorities may exercise the powers or perform the functions or take the measures so mentioned in the order as if such authority had been empowered by this Act to exercise those powers or perform those functions or take such measures.

Air (Prevention & Control of pollution) Ac

Industrialization and urbanization have resulted in a profound deterioration of India's air quality. of the 3 million premature deaths in the world that occur each year due to outdoor and indoor air pollution, the highest numbers are assessed to occur in India. According to the World Health Organization, the capital city of New Delhi is one of the top ten most polluted cities in the world. Surveys indicate that in New Delhi the incidence of respiratory diseases due to air pollution is about 12 times the national average.

The Act provides for the prevention, control and abatement of air pollution. It also provides for the establishment of Boards with a view to carrying out the aforesaid purposes.

Decisions were taken at the United Nations Conference on the Human Environment held in Stockholm in June, 1972, in which India participated, to take appropriate steps for the preservation of the natural resources of the earth which, among other things, include the preservation of the quality of air and control of air pollution;

The Air (Prevention and Control of Pollution) Act, 1981 extends to the whole of India.

"**Air pollutant**" means any solid, liquid or gaseous substance 2[(including noise)] present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment;

"**Air pollution,"** means the presence in the atmosphere of any air

Effects of air pollution on human beings

Hydrocarbons emitted by automobiles are toxic and react with hemoglobin in the blood. The effect of nitrogen is adverse and permanent. It increases children's susceptibility to diseases like influenza. Sulphur dioxide in the air spreads air acidity and corrodes buildings. It causes irritation to various parts of the respiratory systems.

The heart may be damaged by air pollution, secondary to lung diseases. Nitrogen dioxide results in pulmonary edema and aggravation of coronary disease. Toxic effects of lead pollution include impaired IQ development defects in children. These are few of the many effects of air pollution on human beings.

Water (Prevention and control of Pollution) Ac

Water (Prevention & Control of Pollution) Act, 1974 is a comprehensive legislation that regulates agencies responsible for checking on water pollution and ambit of pollution control boards both at the centre and states. The Water (Prevention & Control of Pollution) Act, 1974 was adopted by the Indian parliament with the aim of prevention and control of Water Pollution in India. Some of the important sections regulating the prevention of water pollution as per the act are as discussed below.

Functions of the State Board

Section 17 of the Water (Prevention & Control of Pollution) Act, 1974 clearly lists all functions of the respective state boards for countering water pollution. The state board of respective states is empowered to plan a comprehensive program for the prevention, control or abatement of pollution of streams and wells, collect and disseminate information relating to water pollution and encourage, conduct and participate in investigations and research relating to problems of water pollution and prevention. The state water boards also have the right to inspect sewage or trade effluents, works and plants for the treatment of sewage and trade effluents and to review all water purification plants. The Board may establish or recognize a laboratory or laboratories to enable the Board to perform its functions under this section efficiently, including the analysis of samples of water from any stream or well or of samples of any sewage or trade effluents.

Consent of the State Board is necessary to discharge sewage

Section 25 of the Water (Prevention & Control of Pollution) Act, 1974 states that Prior Consent of the State Board under section 25 is necessary to set up any industry, plant or process which is likely to discharge sewage or trade effluent into a stream or well or sewer or on land or bring into use any new or altered outlets for the discharge of sewage or begin to make any new discharge of sewage. The section further states that every State Board is liable to maintain a register containing particulars or conditions imposed under the section related to any outlet, or to any effluent, from any land or premises which must be open to inspection by the state board.

Power to take emergency measures

Section 32 of the Water (Prevention & Control of Pollution) Act, 1974 describes the power to take emergency measures in case of pollution of stream or well. Under the act, State Board may issue orders to re move the matter, which is, or may cause pollution; or remedy or mitigate the pollution, or issue prohibition orders to the concerned persons from discharging any poisonous or noxious or polluting matter.

Section 24 and 43 of the Water (Prevention & Control of Pollution) Act, 1974 relate to prohibition on use of stream or well for disposal of polluting matter and penalty for contravention thereof Under the scope of the provision, no person shall knowingly cause or permit any poisonous, noxious or polluting mater as determined by the State Board to enter into any stream or sewer or on land. Anyone failing to abide by the laws of under is liable for imprisonment under Section 24 & Section 43 ranging from not less than one year and six months to six years along with monetary fines. The section further states that No person shall knowingly cause or permit to enter any other matter which may impede the flow of water of the stream causing pollution of any kind.

Penalties and fines

Section 42 of the of the Water (Prevention & Control of Pollution) Act, 1974 states penalties and fines for certain acts including pulling down pillars, Obstructs any person acting under the orders or direction of the Board, Damages any works or property belonging to the Board and Failure to furnish any officer other employee of the Board any information required. The fine and penalty includes Imprisonment for a term which may extend up to three months or with fine to Rs. 10,000/- or both.

Understanding Water Class

Depending on the pollution of the water, water is demarked under various water classes in accordance with the Water (Prevention & Control of Pollution) Act, 1974. Drinking water at source found without conventional treatment but after disinfection is designated as Class A while water designated for outdoor bathing comes under Class B. Any drinking water source which has been conventionally treated comes under Class C while water used for propagation of wildlife and fisheries is demarked as Class D. Water under Class E is used for irrigation and industrial cooling along with waste disposal.

Some Key Points of Water Act 1974

- Water Act 1974 aims to prevent and control water pollution.
- Under Water Act, 1974, pollution control boards were created, who are responsible for implementation of its provisions.
- One of the important provision of the Water Act, 1974 is to maintain and restore the ‘wholesomeness’ of our aquatic resources.
- Under Water Act 1974, Sewage or pollutants cannot be discharged into water bodies including lakes and it is the duty of the state pollution control board to intervene and stop such activity.

- Anyone failing to abide by the laws of under is liable for imprisonment under Section 24 & Section 43 ranging from not less than one year and six months to six years along with monetary fines.

Wildlife protection Act

Wild Life, which is a part and parcel of the environment, constitutes wealth of the nation. it included wild animals, birds, plants etc. However, man, in the process of progress and development and also for his selfish ends, is causing much damage to the forests and wild life. Wild life is nature's gift and its decline has an adverse effect of ecology and hence there is an urgent need to protect the wild life. Therefore, in order to protect the wild life from destruction, the Indian Parliament passed the Wild Life (Protection) Act in the year 1972.

Object

The main object of the Act is to provide protection to the wild animals birds and plants. The Act empowers the Central Govt. to declare certain areas as Sanctuaries or National Parks. The Act prohibits hunting of wild animals; birds etc. and impose punishment for violating the same.

Salient Features

The Act contains 66 Sections divided into seven chapters and six schedules. Chapter- I (Secs. 1 and 2) contains short title and definitions. Chapter - II deals with Authorities under the Act. Chapter - III deals with the protection of Specified Plants. Chapter - IV provides for declaration of sanctuaries, National Parks and Closed Areas. Chapter - IV - A deals with Central Zoo Authority and Recognition of Zoos. Chapter- V deals with Trade or Commerce in Wild Animals, Animal Articles and Trophies. Chapter - V- A deals with prohibition of Trade or Commerce in Trophies, Animal Articles etc. Chapter- VI relates to Prevention and Detection of offences and finally Chapter- VII contains Miscellaneous Provisions.

Authorities

Sec. 3 of the Act empowers the Central Govt. to appoint the Director and Asst. Director Wild Life Preservation and other officials and employees. Further, Sec. 4 empowers, the State Govt. to appoint Chief Wild Life Warden, Wild Life Wardens and on Honorary Wild Life Warden in each District and other officers and employees as may be necessary.

Wild Life Advisory Board

It is constituted in each State or Union Territory to advise the State govt. in selection and declaration of Sanctuaries, National Parks, Closed Areas etc. for protection and conservation of wild life.

Hunting of Wild Animals

The Act prohibits hunting of wild animals. No person shall hunt any wild animals as specified in the Schedules. However, there are certain exceptions. The State Govt. may order to kill or wound in good faith any wild animal for self-defense or to protect or save another. Any animal so killed or wounded is not and offence and shall be govt. property. The Govt. may permit killing of certain wild animals for academic purpose.

Sanctuaries

The State govt. by notification, may declare any area within the reserved forest or territorial waters as a sanctuary if it considers fit the area for protection and conservation of wild life.

National Parks

The State govt. by notification, may declare an area whether within a sanctuary or not, is by reason of its ecological or other technical grounds needed to be constituted as a national, park for the purpose of protection, propagating or developing wild life.

Recognition of Zoos

No Zoo shall be operated without being recognized by the authority. The person intends to operate a Zoo shall apply to the Authority in such form and pay such fee prescribed. The applicant should fulfill all the conditions. Then only the Authority shall grant permission. No recognition to a Zoo shall be granted unless the Authority having due regard to interest of protection and conservation of wild life and such standards, norms and other matters as may be prescribed, is satisfied that recognition may be granted. Such Zoo shall acquire or transfer any wild animal specified in this Act with the previous permission of the Authority. No person shall tease, molest, injure or feed any animal or cause disturbance to the animals by noise, or otherwise or litter the grounds in a zoo.

Trade or Commerce in wild animals, animal articles and trophies

All the wild animals, animal articles and trophies shall be the property to the State Government. No person is entitled to hunt any wild animals. No person, without the previous permission in the writing of the Chief Wild Life Warden or the Authorized Officer, acquire or keep in his possession, custody, or control, or transfer to any person whether by a way of gift, sale or otherwise or destroy or damage. At the commencement of this Act, If any person possesses any animal specified in this Act or any uncured

trophy derived from such animal or salted or dried skins of such animal or the musk or a musk deer or horn of a rhinoceros shall declare and obtain the permission from the Chief Wild Life Warden or the authorized person. After the commencement of this Act no person shall acquire, receive, keep in his control, custody or possession sell, offer for sale or otherwise transfer or transport any animal specified in the Act or any uncured trophy or meat derived from such animal or the skins or musk or horn without the previous permission in writing of the Chief Wild Life Warden or the Authorized person. Dealings in trophies and animal articles without license is prohibited.

Purchase of animal:

The person who obtains wild animals with the previous permission of the Authorities shall not sell it. He shall keep it in a habitat and healthy conditions.

Power of entry, search, arrest, and detention:

Any authorized person under this Act is entitled and has power of entry, search, arrest and detention of any premises. He can stop vehicle or vessel. He can enter any premises. He can seize any captive animal - wild animal, animal article, meat, trophy or uncured trophy or any specified plant or part of derivative thereof forms the possessor.

Penalties: (Section 51 of Wild Life Protection Act)

Any person who contravenes any provision of the act [except chapter V-A (prohibition of trade or commerce in trophies or Animal articles) and section 38 J (prohibition of teasing of animals)] or any rule made there under, or who commits a breach of any conditions of any licence or permit granted under this act shall be punishable with imprisonment for a term which may extend to Three years or with fine may extend to Twenty Five Thousand rupees or both .

If any offence committed in relation to any animal specified in Schedule-I or Part-II of Schedule-II on where offence relates to hunting in a Sanctuary or National Park or altering the boundaries of Sanctuary or National Park such offence shall be punishable with imprisonment for a term which shall not be less than Three years but may extend to seven years and also with fine which shall not be less than Ten Thousand rupees.

For second & subsequent offence, the term of imprisonment shall not be less than Three years & may extend to Seven years and also fine which shall not be less than Five Thousand rupees.

Any person who contravenes any provisions of chapter V-A i.e. Prohibition of trade or commerce in trophies or animal articles, shall be punishable with imprisonment for a term which shall not be less than Three years and also fine should not less than Ten Thousand rupees.

Any person who contravenes any provisions of section 38 J [prohibition of teasing of animals] shall be punishable for a term which may extend to Six Months or with fine may extend to Two Thousand rupees or both.

Forest Conservation Act

An Act to provide for the conservation of forests and for matters connected therewith or ancillary or incidental thereto.

BE it enacted by Parliament in the Thirty-first year of the Republic of India as follows:-

1. **Short title, extent and commencement**. -

(1) This Act may be called the Forest (Conservation) Act, 1980.

(2) It extends to the whole of India except the State of Jammu and Kashmir.

(3) It shall be deemed to have come into force on the 25th day of October, 1980.

2. **Restriction on the de-reservation of forests or use of forest land for non-forest purpose.** - Notwithstanding anything contained in any other law for the time being in force in a State, no State Government or other authority shall make, except with the prior approval of the Central Government, any order directing -

- that any reserved forest (within the meaning of the expression "reserved forest" in any law for the time being in force in that State) or any portion thereof, shall cease to be reserved;

(ii) that any forest land or any portion thereof may be used for any non-forest purpose;

(iii) [1][that any forest land or any portion thereof may be assigned by way of lease or otherwise to any private person or to any authority, corporation, agency or any other organisation not owned, managed or controlled by Government;

(iv) that any forest land or any portion thereof may be cleared of trees which have grown naturally in that land or portion, for the purpose of using it for reafforestation].[2]

[Explanation_ For the purposes of this section "non-forest purpose" means the breaking up or clearing of any forest land or portion thereof for-

- the cultivation of tea, coffee, spices, rubber, palms, oil-bearing plants, horticulture crops or medicinal plants;

b) any purpose other than reforestation,

but does not include any work relating or ancillary to conservation, development and management of forests and wild-life, namely, the establishment of check-posts, fire lines, wireless communications and construction of fencing, bridges and culverts, dams, waterholes, trench marks, boundary marks, pipelines or other like purposes].

3. **Constitution of Advisory Committee**. -

The Central Government may constitute a Committee consisting of such number of persons as it may deem fit to advise that Government with regard to -

(i) the grant of approval under section 2; and

- any other matter connected with the conservation of forests which may be referred to it by the Central Government.

(3)[3A. Penalty for contravention of the provisions of the Act. - Whoever contravenes or abets the contravention of any of the provisions of section 2, shall be punishable with simple imprisonment for a period which may extend to fifteen days.

3B. **Offences by authorities and Government departments.** - (1) Where any offence under this Act has been committed -

a) by any department of Government, the head of the department; or

- by any authority, every person who, at the time the offence was committed, was directly in charge of, and was responsible to, the authority for the conduct of the business of the authority as well as the authority,

shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly:

Provided that nothing contained in this sub-section shall render the head of the department or any person referred to in clause (b), liable to any punishment if he proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence.

- Notwithstanding anything contained in sub-section(1), where an offence punishable under the Act has been committed by a department of Government or any authority referred to in clause (b) of sub-section (1) and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of, any officer, other than the head of the department, or in the case of an authority, any person other than the persons referred to in clause (b) of sub-section (1), such officer or persons shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly].

4. **Power to make rules**. -

(1) The Central Government may, by notification in the Official Gazette, make rules for carrying out the provisions of this Act.

- Every rule made under this Act shall be laid, as soon as may be after it is made, before each House of Parliament, while it is in session, for a total period of thirty days which may be comprised in one session or in two or more successive sessions, and if, before the expiry of the session immediately following the session or the successive sessions aforesaid, both Houses agree in making any modification in the rule or both Houses agree that the rule should not be made, the rule thereafter have effect only in such modified form or be of no effect, as the case may be; so, however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule.

5. **Repeal and saving**. -

(1) The Forest (Conservation) Ordinance, 1980 is hereby repealed.

- Notwithstanding such repeal, anything done or any action taken under the provisions of the said Ordinance shall be deemed to have done or taken under the corresponding provisions of this Act.

1. Ins. by Act 69 of 1988, sec.2(w.e.f. 15.3.1989)

2. Subs. by Act 69 of 1988, sec.2(w.e.f. 15.3.1989)

3. Section 3B ins. by Act 1988, sec.(w.e.f. 15.3.1989)

International agreements

International agreement, instrument by which states and other subjects of international law, such as certain international organizations, regulate matters of concern to them. The agreements assume a variety of form and style, but they are all governed by the law of treaties, which is part of customary international law.

A treaty, the typical instrument of international relations, is defined by the 1969 Vienna Convention on the Law of Treaties as an “agreement concluded between States in written form and governed by international law, whether embodied in a single instrument or in two or more related instruments and whatever its particular designation. Contractual treaties are treaties by which the parties agree to exchange pieces of

territory or settle a dispute or claims—that is, by which they deal with a particular kind of business. Lawmaking treaties, which have grown tremendously in number and significance since World War II, are instruments in which the parties formulate principles or detailed rules for their future conduct.”

Some multilateral agreements set up an international organization for a specific purpose or a variety of purposes. They may therefore be referred to as constituent agreements. The United Nations Charter (1945) is both a multilateral treaty and the constituent instrument of the United Nations. An example of a regional agreement that operates as a constituent agreement is the charter of the Organization of American States (Charter of Bogotá), which established the organization in 1948. The constitution of an international organization may be part of a wider multilateral treaty. The Treaty of Versailles (1919), for example, contained in Part I the Covenant of the League of Nations and in Part XIII the constitution of the International Labour Organisation.

The term *supranational* is of recent origin and is used to describe the type of treaty structure developed originally by six western European states: France, Germany, Italy, the Netherlands, Belgium, and Luxembourg. The first treaty was that of Paris, signed in 1951, establishing the European Coal and Steel Community (ECSC); the second, the Rome treaty, signed in 1957, establishing the European Economic Community (EEC); the third, the Rome treaty of the same date establishing the European Atomic Energy Community (Euratom). A clause in the ECSC treaty provides for the complete independence of the members of the executive organ from the governments that appoint them.

Treaties, however, are not the only instruments by which international agreements are concluded. There are single instruments that lack the formality of a treaty called agreed minute, memorandum of agreement, or modus vivendi; there are formal single instruments called convention, agreement, protocol, declaration, charter, covenant, pact, statute, final act, general act, and concordat (the usual designation for accords with the Holy See); finally there are less formal agreements consisting of two or more instruments, such as “exchange of notes” or “exchange of letters.”

In the absence of an international legislature, the multilateral treaty is the chosen instrument for adapting international law to changing circumstances brought about by rapid technological developments and the ever-growing interdependence of nations.

Despite the extreme diversity of international agreements, it is possible to classify them according to the functions that they serve in international society. Three such broad functions may be discerned; namely, the development and codification of international law, the establishment of new levels of cooperation

and integration between states, and the resolution of actual and potential international conflict.

The Vienna Convention on the Law of Treaties contains a compromissory clause (whereby participants agree to submit disputes to arbitration or the International Court of Justice) for certain types of disputes and a procedure of conciliation for others. The resistance of states to compulsory arbitration or adjudication is indicative of their limited commitment to universal integration through the rule of law. In this respect the European Economic Community is an exception, providing as it does for the compulsory settlement of disputes arising under the three constituent treaties by the Court of Justice, which is open even to individuals. It may be noted that western Europe was the cradle of nationalism and the doctrine of the sovereignty of states. Now it may have become the cradle of supranational integration.

Montreal and Kyoto protocols and conservation on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD), known informally as the Biodiversity Convention, is a multilateral treaty. The convention has three main goals: the conservation of biological diversity (or biodiversity); the sustainable use of its components; and the fair and equitable sharing of benefits arising from genetic resources. Its objective is to develop national strategies for the conservation and sustainable use of biological diversity, and it is often seen as the key document regarding sustainable development.

The convention was opened for signature at the Earth Summit in Rio de Janeiro on 5 June 1992 and entered into force on 29 December 1993. It has two supplementary agreements, the Cartagena Protocol and Nagoya Protocol.

The Cartagena Protocol on Biosafety to the Convention on Biological Diversity is an international treaty governing the movements of living modified organisms (LMOs) resulting from modern biotechnology from one country to another. It was adopted on 29 January 2000 as a supplementary agreement to the CBD and entered into force on 11 September 2003.

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity is another supplementary agreement to the CBD. It provides a transparent legal framework for the effective implementation of one of the three objectives of the CBD: the fair and equitable sharing of benefits arising out of the utilization of genetic resources. The Nagoya Protocol was adopted on 29 October 2010 in Nagoya, Japan and entered into force on 12 October 2014.

2010 was also the International Year of Biodiversity, and the Secretariat of the CBD was its focal point. Following a recommendation of CBD signatories at Nagoya, the UN declared 2011 to 2020 as the United Nations Decade on Biodiversity in December 2010. The convention's Strategic Plan for Biodiversity 2011-2020, created in 2010, include the Aichi Biodiversity Targets.

The meetings of the parties to the convention are known as Conferences of the Parties (COP), with the first one (COP 1) held in Nassau, Bahamas in 1994 and the most recent one (COP 14) held in Sharm El-Sheikh, Egypt.

Origin and scope

The notion of an international convention on bio-diversity was conceived at a United Nations Environment Programme (UNEP) Ad Hoc Working Group of Experts on Biological Diversity in November 1988. The subsequent year, the Ad Hoc Working Group of Technical and Legal Experts was established for the drafting of a legal text which addressed the conservation and sustainable use of biological diversity, as well as the sharing of benefits arising from their utilization with sovereign states and local communities. In 1991, an intergovernmental negotiating committee was established, tasked with finalizing the convention's text.[1]

A Conference for the Adoption of the Agreed Text of the Convention on Biological Diversity was held in Nairobi, Kenya, in 1992, and its conclusions were distilled in the Nairobi Final Act.[2] The convention's text was opened for signature on 5 June 1992 at the United Nations Conference on Environment and Development (the Rio "Earth Summit"). By its closing date, 4 June 1993, the convention had received 168 signatures. It entered into force on 29 December 1993.[1]

The convention recognized for the first time in international law that the conservation of biodiversity is "a common concern of humankind" and is an integral part of the development process. The agreement covers all ecosystems, species, and genetic resources. It links traditional conservation efforts to the economic goal of using biological resources sustainably. It sets principles for the fair and equitable sharing of the benefits arising from the use of genetic resources, notably those destined for commercial use.[3] It also covers the rapidly expanding field of biotechnology through its Cartagena Protocol on Biosafety, addressing technology development and transfer, benefit-sharing and biosafety issues. Importantly, the convention is legally binding; countries that join it ('Parties') are obliged to implement its provisions.

The convention reminds decision-makers that natural resources are not infinite and sets out a philosophy of sustainable use. While past conservation efforts were aimed at

protecting particular species and habitats, the Convention recognizes that ecosystems, species and genes must be used for the benefit of humans. However, this should be done in a way and at a rate that does not lead to the long-term decline of biological diversity.

The convention also offers decision-makers guidance based on the precautionary principle which demands that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat. The Convention acknowledges that substantial investments are required to conserve biological diversity. It argues, however, that conservation will bring us significant environmental, economic and social benefits in return.

The Convention on Biological Diversity of 2010 banned some forms of geoengineering.

Human population and growth Impacts on environment, human health and welfares

Everyone understands that many of the Earth's resources are finite. We are currently completely reliant on fossil fuels, iron and other metals, minerals and even such basic commodities as sand to keep the modern world ticking over. Adding more consumers makes those resources run out faster.

The Earth also provides for our needs with renewable resources, such as timber, clean water and air, healthy soils and wild fish consumed for food. However, our demands are so great that according to the Global Footprin Network, we are now using those resources at almost twice the rate that the Earth can renew them. That rate has increased continually since the 1970s and, unless thing change, we will require three Earths to supply our needs by 2050.

Some people believe that greater efficiencies in the use of resources mean we will use less of them. There is no evidence to support that, however. A study by the Massachussets Institute of Technology in 2017 evaluated the use of raw materials such as crude oil and silicon, and found that greater efficiencies led to price reductions, making commodities more affordable and, increasing their demand and usage. They investigated more than 60 materials, and found that only in six was consumption decreasing.

FOOD AND WATER

More than 800 million people currently do not get enough food to meet their nutritional needs every day. Meanwhile, 650 million are obese. People go hungry not because there is insufficient food but because our global economic system distributes it unfairly. The number of people suffering from hunger has actually increased in recent years due to development progress not keeping up with rapid population growth.

Every extra mouth to feed puts more pressure on our food supply. That is already under threat from multiple factors, including shortage of fresh water, soil depletion, decimated populations of insect pollinators and climate change. The UN currently projects that we will need 70% more food by 2050. Increasing agricultural production comes at a cost to nature, however. Habitat loss and exploitation are the two most significant threats to biodiversity - currently 80% of extinction threats to mammals and birds are due to agriculture.

A landmark report on diet and sustainability by the EAT-Lancet Commission in 2019 concluded that it is possible to feed a population of 10bn sustainably if radical action is taken to revolutionise dietary habits and food production. It went on to say, however:

“ Global population is expected to exceed 11 billion people by 2100 unless actions are taken to stabilise population growth. Healthy diets from sustainable food systems are possible for up to 10 billion people but become increasingly unlikely past this population threshold.”
Action to address population is essential if we are to meet the most basic human right of all - ensuring people have enough to eat.

Water is an absolute basic human necessity, and each person adds to demand Threats to fresh water are even more critical. An MIT study concluded that nearly five billion people will live in water-stressed regions by 2050. The United Nations has calculated that water shortages as a result of climate change could displace hundreds of millions of people by 2030. Regional variations in water availability are extreme but many of the world's poorest regions, and those which have high population growth, are among those with the shortest supply. Developed countries also suffer from the effects of population pressure on water supply. The densely-populated south-east of England is ranked in the bottom 10% of global regions for ability to supply water to its inhabitants.

POLLUTION

As with every environmental problem, while there are many solutions to pollution, adding more people to the population adds more polluters and makes those solutions less effective. While rich countries produce more plastic waste per person, for instance, poor regions where population growth outstrips the infrastructure to dispose of waste may contribute more plastic overall.

GREED, NEED AND INJUSTICE

Vast disparities exist in consumption and impact between the rich world and the Global South, and within countries themselves. A more just global system, in which resources are distributed more equitably, is essential. Whatever form that takes, in order to ensure that there is enough to meet everyone's right to a decent standard of living, the richest must consume more sustainably - in other words, consume less. When nations leave poverty, their fertility rates rates reduce - but hand-in-hand with that increasing prosperity comes increased consumption. People should not have to compete for the Earth's resoures.

That's why population and family size is an issue in both developed and developing countries. Where affluence and consumption is high, reducing the number of new

consumers is an effective, permanent way of reducing the drain they place on resources, as well as their environmental impact. It does not mean that people should not do other things to reduce their consumption, or that wider isues of global injustice do not need to be urgently addressed. Nevertheless, reducing, through effective, ethical means, the number of affluent people consuming is an essential, effective method to relieve the pressure.

In the developing world, fewer people means less competition for natural resources, especially local resources such as land and fresh water. In the longer term, fewer people being born means that as countries move out of poverty, their level of consumption will be lower.

Carbon foot-print

Carbon footprint, amount of carbon dioxide (CO_2) emissions associated with all the activities of a person or other entity (e.g., building, corporation, country, etc.). It includes direct emissions, such as those that result from fossil-fuel combustion in manufacturing, heating, and transportation, as well as emissions required to produce the electricity associated with goods and services consumed. In addition, the carbon footprint concept also often includes the emissions of other greenhouse gases, such as methane, nitrous oxide, or chlorofluorocarbons (CFCs).
The carbon footprint concept is related to and grew out of the older idea of ecological footprint, a concept invented in the early 1990s by Canadian ecologist William Rees and Swiss-born regional planner Mathis Wackernagel at the University of British Columbia. An ecological footprint is the total area of land required to sustain an activity or population. It includes environmental impacts, such as water use and the amount of land used for food production. In contrast, a carbon footprint is usually expressed as a measure of weight, as in tons of CO_2 or CO_2 equivalent per year.

Carbon Footprint Calculation

Carbon footprints are different from a country's reported per capita emissions (for example, those reported under the United Nations Framework Convention on Climate Change). Rather than the greenhouse gas emissions associated with production, carbon footprints focus on the greenhouse gas emissions associated with consumption. They include the emissions associated with goods that are imported into a country but are produced elsewhere and generally take into account emissions associated with international transport and shipping, which is not accounted for in standard national inventories. As a result, a country's carbon footprint can increase even as carbon emissions within its borders decrease.

The per capita carbon footprint is highest in the United States. According to the Carbon Dioxide Information Analysis Center and the United Nations Development Programme, in 2004 the average resident of the United States had a per capita carbon footprint of

20.6 metric tons (22.7 short tons) of CO_2 equivalent, some five to seven times the global average. Averages vary greatly around the world, with higher footprints generally found in residents of developed countries. For example, that same year France had a per capita carbon footprint of 6.0 metric tons (6.6 short tons), whereas Brazil and Tanzania had carbon footprints of 1.8 metric tons (about 2 short tons) and 0.1 metric ton (0.1 short ton) of CO_2 equivalent, respectively.

In developed countries, transportation and household energy use make up the largest component of an individual's carbon footprint. For example, approximately 40 percent of total emissions in the United States during the first decade of the 21st century were from those sources. Such emissions are included as part of an individual's "primary" carbon footprint, representing the emissions over which an individual has direct control. The remainder of an individual's carbon footprint is called the "secondary" carbon footprint, representing carbon emissions associated with the consumption of goods and services. The secondary footprint includes carbon emissions emitted by food production. It can be used to account for diets that contain higher proportions of meat, which requires a greater amount of energy and nutrients to produce than vegetables and grains, and foods that have been transported long distances. The manufacturing and transportation of consumer goods are additional contributors to the secondary carbon footprint. For example, the carbon footprint of a bottle of water includes the CO_2 or CO_2 equivalent emitted during the manufacture of the bottle itself plus the amount emitted during the transportation of the bottle to the consumer.

A variety of different tools exist for calculating the carbon footprints for individuals, businesses, and other organizations. Commonly used methodologies for calculating organizational carbon footprints include the Greenhouse Gas Protocol, from the World Resources Institute and the World Business Council for Sustainable Development, and ISO 14064, a standard developed by the International Organization for Standardization dealing specifically with greenhouse gas emissions. Several organizations, such as the U.S. Environmental Protection Agency, the Nature Conservancy, and British Petroleum, created carbon calculators on the Internet for individuals. Such calculators allow people to compare their own estimated carbon footprints with the national and world averages.

Carbon Footprint Reduction

Individuals and corporations can take a number of steps to reduce their carbon footprints and thus contribute to global climate mitigation. They can purchase carbon offsets (broadly stated, an investment in a carbon-reducing activity or technology) to compensate for part or all of their carbon footprint. If they purchase enough to offset their carbon footprint, they become effectively carbon neutral.

Carbon footprints can be reduced through improving energy efficiency and changing lifestyles and purchasing habits. Switching one's energy and transportation use can have an impact on primary carbon footprints. For example, using public transportation, such as buses and trains, reduces an individual's carbon footprint when compared with driving. Individuals and corporations can reduce their respective carbon footprints by installing energy-efficient lighting, adding insulation in buildings, or using renewable energy sources to generate the electricity they require. For example, electricity generation from wind power produces no direct carbon emissions. Additional lifestyle choices that can lower an individual's secondary carbon footprint include reducing one's consumption of meat and switching one's purchasing habits to products that require fewer carbon emissions to produce and transport.

Carbon Credit

A carbon credit is a permit that allows the company that holds it to emit a certain amount of carbon dioxide or other greenhouse gases. One credit permits the emission of a mass equal to one ton of carbon dioxide.

The carbon credit is one half of a so-called "cap-and-trade" program. Companies that pollute are awarded credits that allow them to continue to pollute up to a certain limit. That limit is reduced periodically. Meanwhile, the company may sell any unneeded credits to another company that needs them.

Private companies are thus doubly incentivized to reduce greenhouse emissions. First, they will be fined if they exceed the cap. Second, they can make money by saving and reselling some of their emissions allowances.

Understanding a Carbon Credit

The ultimate goal of carbon credits is to reduce the emission of greenhouse gases into the atmosphere.

As noted, a carbon credit is equal to one ton of carbon dioxide. According to the Environmental Defense Fund, that is the equivalent of a 2,400-mile drive in terms of carbon dioxide emissions.

Companies or nations are allotted a certain number of credits and may trade them to help balance total worldwide emissions. "Since carbon dioxide is the principal greenhouse gas," the United Nations notes, "people speak simply of trading in carbon."

The intention is to reduce the number of credits over time, thus incentivizing companies to find innovative ways to reduce greenhouse gas emissions.

Cap-And-Trade Programs Today

Cap-and-trade programs remain controversial in the U.S. However, 12 states have adopted such market-based approaches to the reduction of greenhouse gases, according to the Center for Climate and Energy Solutions. Of these, 10 are Northeast states that banded together to jointly attack the problem through a program known as the Regional Greenhouse Gas Initiative (RGGI).

California's Cap-and-Trade Program

The state of California initiated its own cap-and-trade program in 2013. The rules apply to the state's large electric power plants, industrial plants, and fuel distributors.

The state claims its program is the fourth largest in the world after those of the European Union, South Korea, and the Chinese province of Guangdong.

The U.S. Clean Air Act

The U.S. has been regulating energy emissions since the passage of the U.S. Clean Air Act of 1990, which is credited as the world's first cap-and-trade program (although it called the caps "allowances").

The program is credited by the Environmental Defense Fund for substantially reducing emissions of sulfur dioxide from coal-fired power plants, the cause of the notorious "acid rain" of the 1980s.

The United Nations' Kyoto Protocol

The United Nations' Intergovernmental Panel on Climate Change (IPCC) developed a carbon credit proposal to reduce worldwide carbon emissions in a 1997 agreement known as the Kyoto Protocol. The agreement set binding emission reduction targets for the countries that signed it. Another agreement, known as the Marrakesh Accords, spelled out the rules for how the system would work.

The Kyoto Protocol divided countries into industrialized and developing economies. Industrialized countries, collectively called Annex 1, operated in their own emissions trading market. If a country emitted less than its target amount of hydrocarbons, it could sell its surplus credits to countries that did not achieve its Kyoto level goals, through an Emission Reduction Purchase Agreement (ERPA).

The separate Clean Development Mechanism for developing countries issued carbon credits called a Certified Emission Reduction (CER). A developing nation could receive these credits for supporting sustainable development initiatives. The trading of CERs took place in a separate market.

Resettlement and rehabilitation of project affected persons; case studies

In 1998, Development Alternatives formulated a social assessment and management plan for Baranj Coal Mining Project in Bhadrawati near Chandrapur, Maharashtra. The project was to be implemented in partnership by Central India Coal Company (CICCO), a joint venture company of the Ispat Group of Industries and Rio Tinto (India) and Central India Power Company (CIPCO). It was agreed that CICCO would produce coal for captive consumption by the 1084 MW thermal power station of Central India Power Company (CIPCO). It was estimated that 5 million tonnes of coal would be required by CIPCO for the next 20 years. In order to extract the coal, CICCO planed to acquire approximately 1523 hectares of land, on which a population of 1269 belonging to 226 families was spread over hamlets of 3 villages namely Baranj Mokasa, Chak Baranj and Chichordi. The distribution of population followed a distinct pattern with those belonging to Manora, Chichordi and Baranj Mokasa (Old and New) being primarily agriculturists who owned agricultural land. Those belonging to Old Pipalbodi, New Pipalbodi and Balaji Nagar were migrants from states like Tamil Nadu, Kerala, Andhra Pradesh, Uttar Pradesh and Bihar and were employed at the ordinance factory.

Methodology Adopted

Since the primary requirement of the project was complete evacuation of all families residing inside the lease boundary; the most effected in terms of there livelihoods would be the residents of gaothans (hamlets), directly or indirectly dependent on the agricultural land. Apart from the direct economic factors, there were innumerable socio-cultural issues that were associated with the displacement. Thus owing to the seriousness of the issue and the complexity involved, a detailed Social Assessment and Management Plan (SAMP) was prepared, which would address all relevant socio-economic issues and also guide Project Implementation Agency (PIA) to implement the project. The plan consisted of a socio-economic database, cultural and political situation of the PAPs (Project Affected Peoples), priorities for Rehabilitation and Resettlement, identification of income generation options and the support service providers to ensure long term sustainability of the programme. A multidisciplinary team carried out the study and collected both qualitative and quantitative information from 234 households. Inspite of the resistance from the villagers, the team conducted several group meetings in the villages and tried to understand the reason for their resistance to the Rehabilitation & Resettlement process. One of the causes of resistance among the villagers was that a few families had already experienced rehabilitation and the proposed resettlement was perceived in the context of the cultural history of repeated relocation and resettlement. The team also held discussions with key persons and local Non Government Organisations (NGO's) to assess their possible role in the implementation of SAMP.

Relevance of Social Assessment and Management Plan (SAMP)

Involuntary Resettlement for any development project adversely affects the way of life of

the people. The loss of occupation, loss of shelter, loss of access to natural resources and loss of social bonds are synonymous with large scale developmental projects which demand displacement of a section of population. The population getting affected by such projects need to be given special attention to protect their rights, minimise their losses and to help them to restore a secure means of livelihood. The need of SAMP comes from a realisation that the PAPs cannot cope with the fast changing socio-economic scenario caused due to the displacement. There are a host of factors that play a crucial role in making the problems associated with rehabilitation and resettlement extremely complex. The loss of land of a service class is entirely different from that of marginal farmers whose only means of livelihood is agriculture. Land for land is the best way to handle such issues but the problem remains the same if this arrangement does not materialise due to improper "barter" (the quality/size of land). The only way then to mitigate the issue is by monetary compensation, which too does not help much since cash runs out quickly leaving the PAPs in a situation full of insecurity and hardships. The loss of agriculture creates different levels of impact among the family members. For the head of the household who is the owner of land, loss of land means the loss of social-economic security while among the children it is the loss of ancestral property. Women, who play an active role and contribute in a major way to agricultural produce, will be left with no work except routine household jobs. Moreover, loss of the social environment that is knitted into the complete fabric of society, remains an irreparable hole.

Impact of Mining on PAPs Livelihoods

The degree of impact due to the mining would definitely be different from one group of PAPs to another. The PAPs under fragile groups were ones who are most affected by the acquisition and therefore needed maximum attention by the Project Implementing Agency (PIA). They would be unable to support themselves financially after the acquisition. The restoration of the economic status of this group by providing a suitable means of livelihood should have been the first priority of the PIA. Vulnerable groups of PAPs are those who could sustain themselves for a limited time period without support services from the PIA but in the long run would slip into the fragile category in absence of sustained assistance from PIA. The PAPs having a secure means of livelihood, like a job in the Ordinance Factory, will not be affected financially due to the acquisition and were thus categorised as Stable.

Proposed Approach to Rehabilitation & Resettlement Process

The approach suggested by the research team implementing SAMP was to help establish Income Generation packages to PAPs with a full support system. A source of steady income would enable them to maintain, if not improve, the standards of living currently enjoyed by them. Restoration of income source for the PAPs could be done either absorbing them in activities directly or indirectly related to the mine or involving them in various production or service based income generation options. There were sources of finance and training available to develop sustainable income generation programmes but the underlying factors needed careful considerations. The majority of

the PAPs are agriculturists. Shifting of occupations from their traditional mode to business oriented occupation would have been a major hurdle for them. Trainings could be provided but not everyone would be able to make full use of it. Literacy levels were high but the levels of education were not high enough to enable them to manage a production / service unit by themselves. Chandrapur region has a limited demand of goods and services and thus the marketing of the products produced by the PAPs would be a major bottleneck. The financial condition of the PAPs did not allow them to take high financial risks associated with such options. The approach suggested towards the restoration of sources of income by the PIA was to try and absorb maximum number of PAPs in the mining operations, directly or indirectly. For contractual jobs, the PIA could prevail on the contractor to employ PAPs at every step starting from the provision of training in requisite skills, helping them financially and establishing marketing linkages etc.

The perception of PAPs and Status of the Project

The PAPs were not in favour of the project. The main points of contention were provision of jobs in the mine - which for them implied a secure means of livelihood, valuation of land and homesteads. The prevailing atmosphere in the villages was charged with mistrust resulting mainly because of a lack of transparency and poor flow of communication between the PAPs and the PIA. Proper attention and action on the above mentioned issues was the best way to resolve the crisis. The DA team suggested that there was a need for the PIA to gain the confidence of the PAPs through a comprehensive community development programme. But ultimately the project was called off from the area due to objection of Ministry of Defence (MoD). The Ministry did not approve of coal mining activity in the vicinity of the ordinance factory because there were chances of damage to the high tech and sensitive equipment in the factory due to proposed underground mining.

Disaster management: floods, earthquakes, cyclones and landslides

They are however disastrous in their impact when they affect human settlements. Human societies have witnessed a large number of such natural hazards in different parts of the world and have tried to learn to control these processes to some extent.

Table. Frequently Occurring Natural Disaster in India

Sr.No.	Type	Location/area	Affected pollution
1.	Floods	8 major river valleys	260

		spread over 40 million hectares of area in the entire country	
2.	Droughts	Spread in 14 states	86
3.	Earthquakes	Nearly 55% of the total area of the country falling in the seismic zone IV and V	400
4.	Cyclones	Entire 5700 km long coastline of Southern Peninsular India covering 9 states	10
5.	Landslides	Entire Sub-Himalayan Regions and Western Ghats	10

Major such disasters include a devastating earthquake which hit Bhuj Town in Gujarat caused massive damage. Earth-quake generated water waves called Tsunamis caused tremendous damage in Tamil Nadu and Kerala.

Types of Disasters:

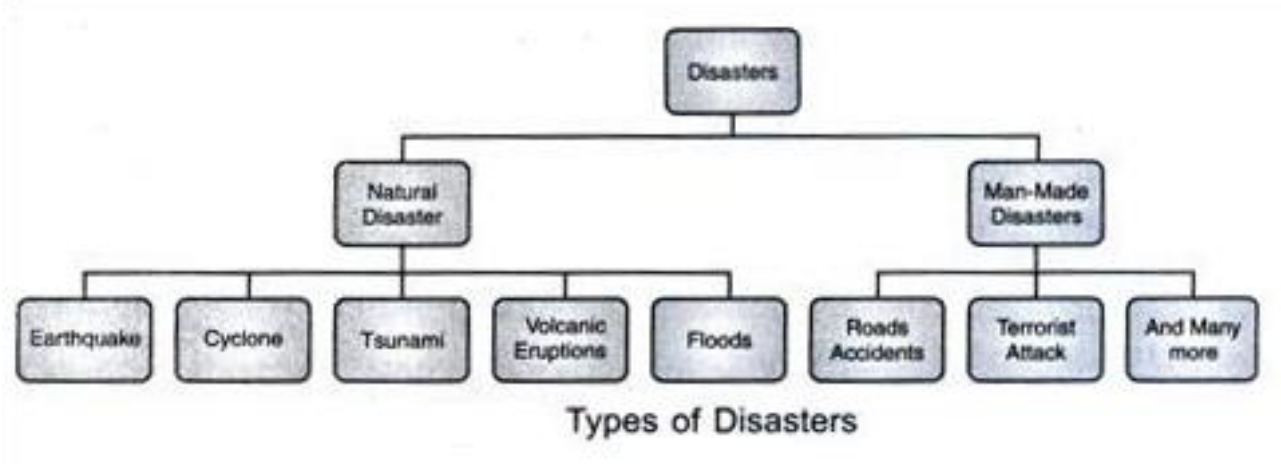
There are two types of disasters:

(i) Natural Disasters:

The disasters that are caused by nature are termed as natural disasters e.g., earthquake, cyclone etc.

(ii) Man-made Disaster:

The disasters which are caused as a result of human activities are termed as Man-Made Disasters e.g., Road accident, terrorist attack.



Types of Disasters

Natural Disasters:

1. **Earthquake**:

Earthquake is a sudden and violent shaking of ground causing great destruction as a result of movement of earth's crust. An earthquake has the potential to tsunami or volcanic eruption.

Earthquake of magnitude 9.2 on the Richter's scale in 2004 in Indonesia is the second largest earthquake ever recorded. The deadliest earthquake happened in Central China, killing over 800,000 in 1556. People during that time and region lived in caves and died from the caves collapsing.

Earthquake mitigation strategies:

a. Existing critical facilities built on reclaimed land should be inspected and retrofitted if necessary to ensure earthquake resistance.

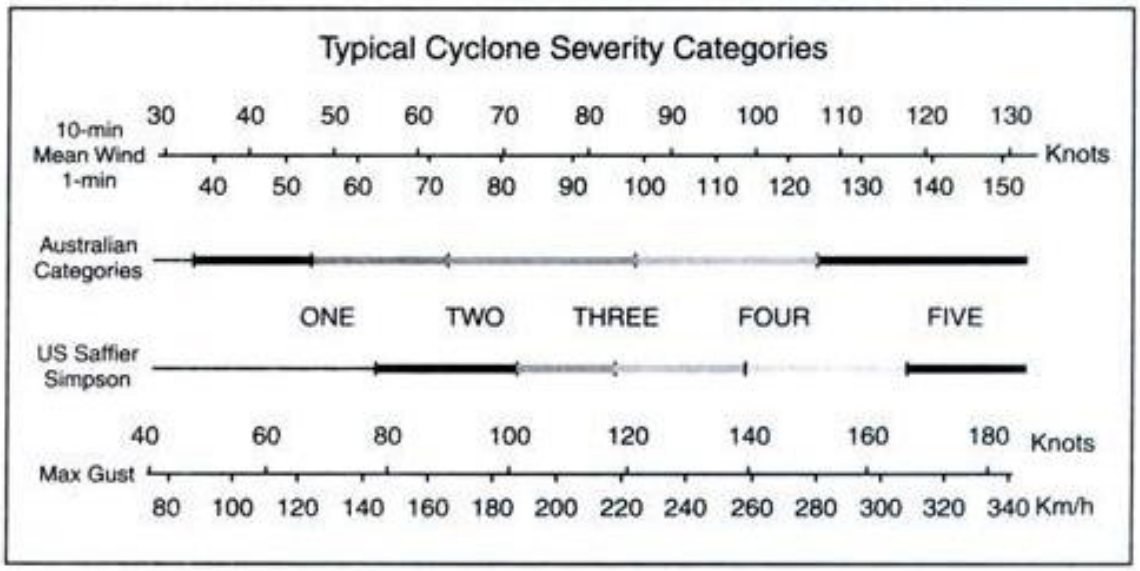
b. Future critical facilities should not be located on reclaimed land because of the high potential for liquefaction.

c. Older unreinforced masonry buildings should be inspected and retrofitted if necessary to increase earthquake resistance.

d. Older unreinforced masonry buildings should not be used for critical functions.

2. **Cyclone**:

Cyclones (or more properly called Tropical Cyclones) are a type of severe spinning storm that occurs over the ocean near the tropics.



Saffir-Simpson scale

The most famous Australian historic cyclone was Cyclone Tracy, December 1974, where around 11 people died in Darwin, Northern Territory. The direction they spin depends on which hemisphere they are in. In the Southern hemisphere they spin in a clockwise direction and Northern hemisphere they spin in an anti-clockwise direction.

Cyclone mitigation strategies:

a. Future critical facilities should not be located in areas of accelerated winds.

b. The most significant aspect of structural damage to buildings by high velocity wind results from roof damage. The roofs of existing buildings should be inspected and if necessary retrofitted to adequate standards.

c. The roofs of existing critical facilities should be retrofitted to a higher standard to ensure wind resistance.

d. Building openings such as windows and doors also suffer damage from high velocity winds. These openings if not constructed of wood or metal should be protected with shutters or temporary covers of adequate design.

Table. Classification of cyclone based on speed

Category	Strongest Guse (Km/h)	Typical Effects (Indication Only)

1 (Tropical Cyclone)	Less than 125 (Gales)	Negligible house damage. Damage to some crops, trees and caravans. Craft may drag moorings.
2 (Tropical Cyclone)	125-169 (Destructive winds)	Minor house damage, Significant damage to signs, trees and caravans, Heavy damage to some crops. Risk of power failure. Small craft may break moorings.
3 ADVERTISEMENTS: (Srvere Tropical Cyclone e.g., Roma)	170-224 (Very destructive winds)	Some roof and structural damage. Some caravans destroyed. Power failure likely.
4 (Srvere Tropical Cyclone e.g., Tracy)	225-279 (Very destructive winds)	Significant roofing loss and structural damage. Many caravans destroyed and blown away. Dangerous airborne debris. Widespread power failures
5 (Srvere Tropical Cyclone e.g., Vance)	More than ‘280 (Very destructive winds)	Extremely dangerous with widespread destruction.

3. **Tsunami**:

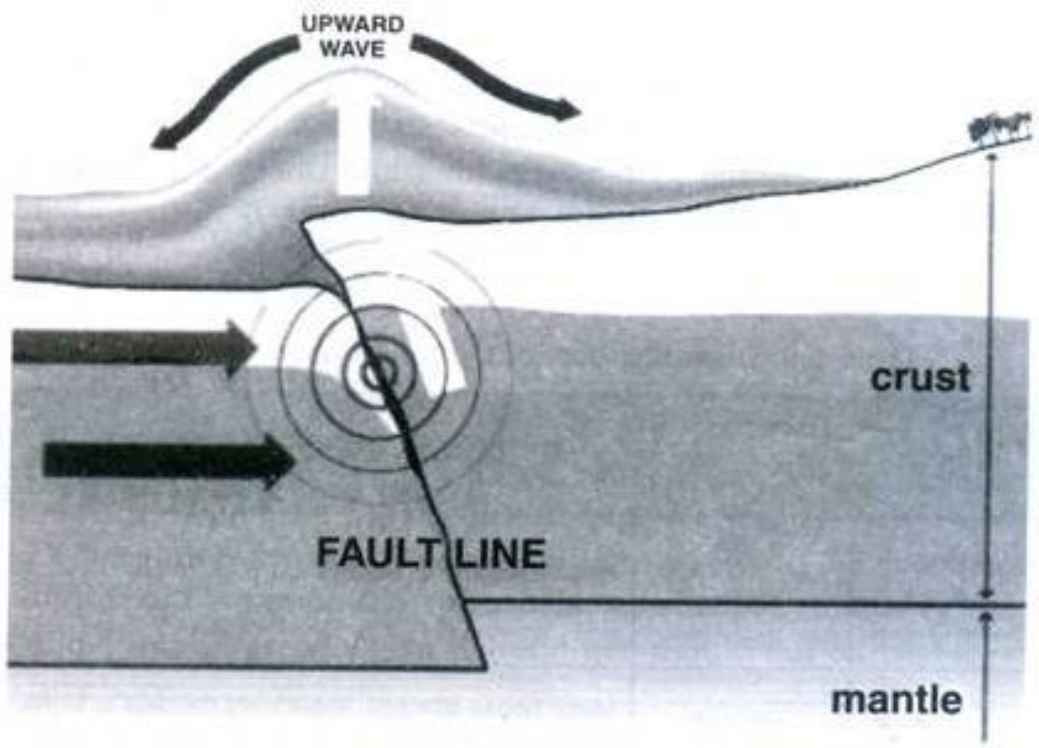
Tsunamis are giant waves, initiated by a sudden change, usually in relative position of underwater tectonic plates. The sudden jerk is enough to propagate the wave; however, its power can be enhanced and fed by lunar positioning and boundaries that focus its energy.

Tsunami mitigation strategies:

a. In some tsunami-prone countries earthquake engineering measures have been taken to reduce the damage caused onshore.

b. Japan, where tsunami science and response measures first began following a disaster in 1896, has produced ever-more elaborate countermeasures and response plans. That country has built many tsunami walls of up to 4.5 metres (15 ft) to protect populated coastal areas.

c. Other localities have built floodgates and channels to redirect the water from incoming tsunami.



Formation of Tsunami

4. Volcanic eruptions:

Volcanic disasters are caused by lava flows, volcanic mudflows and pyroclastic flows triggered by volcanic activities such as eruptions. It covers extensive areas; volcanic disasters can cause a large-scale damages and serious personal injury. Secondary disasters such as debris flows are often triggered by rainfall after a volcanic eruption.

In the 1815, the Indonesian eruption threw rocks more than 100 cubic km of ash killing 92,000 people. The greatest volcanic explosion occurred in Indonesia in 1883, which

resulting in rocks hurling 55 km up into the air. The explosion was heard in Australia and generated a 40 m high tsunami, killing 36,000 people.

Volcanic disasters mitigation strategies:

a. Learn about community warning systems and of disasters that can come from volcanoes (earthquakes, flooding, landslides, mudflows, thunderstorms, tsunamis)

b. Make evacuation plans to higher ground with a backup route.

c. Have disaster supplies on hand (flashlight, extra batteries, portable battery-operated radio, first aid kit, emergency food and water, nonelectric can opener, cash and credit cards, and sturdy shoes)

5. Floods:

Flooding is the unusual presence of water on land to a depth which affects normal activities. Flooding can arise from: overflowing rivers (river flooding), heavy rainfall over a short duration (flash floods), or an unusual inflow of sea water onto land (ocean flooding). Ocean flooding can be caused by storms such as hurricanes (storm surge), high tides (tidal flooding), seismic events (tsunami) or large landslides.

Flood mitigation strategies:

a. Watercourses which pass through significant settlement areas should be properly configured and lined with concrete.

b. Existing bridges should be inspected to determine which ones are too low or which have support pillars within the watercourse channel. Where possible these should be replaced as these features restrict water flow and cause the channels to be easily blocked with debris.

c. Future bridges should not be built with these undesirable features.

d. Buildings constructed adjacent to watercourses should be elevated by at least one meter to prevent potential flood inundation.

e. Critical facilities should not be located adjacent to watercourses.

Man-made Disasters:

1. Road Accidents:

Road accidents are common in India due to reckless driving, untrained drivers and poor maintenance of roads and vehicles. According to Lifeline Foundation, the Ahmedabad

based organization working for road safety, India accounts for 13 per cent of road accident fatalities worldwide.

With 130,000 deaths in 2007, India tops in the number of people killed in road accidents, surpassing China's 90,000. Most of these deaths occurred due to bad road designs and lack of proper traffic management systems to separate different streams of traffic.

2. Building and Bridge Collapse:

Building collapses are frequent in India where construction is often hastily done, with little regard for safety regulations, particularly in the western part of the country.

3. Terrorist Attack:

Devastating acts such as the terrorist attacks on the World Trade Centre and the Pentagon have left many concerned about the possibility of future incidents in the United States and their potential impact. Terrorism may involve devastating acts using weapons of mass destruction ranging from chemical agents, biological hazards, a radiological or nuclear device, and other explosives.

Mitigation strategies for man-made disasters:

a. For road accidents, traffic rules and regulations need to be followed strictly.

b. For building and bridge collapse, standard building materials should be used.

c. Moreover, more and more public awareness should be made to minimize the effects of man-made disasters.

If a Terrorism-Related Event Happens:

a. Stay calm and be patient.

b. Listen to a local radio or television station for news and follow the instructions of emergency service personnel.

c. Be vigilant. If the incident occurs near you, look out for secondary hazards such as falling debris or additional attacks.

d. Check for injuries and summon help for seriously injured people.

Awareness through Mass Media:

a. Media plays a significant role in educating the population about] disaster and its management.

b. Without media we could not aware people about disaster in remote areas of the country.

Central Sector Scheme for Disaster Management:

a. Human resource Development

b. Setting up of National Centre for Disaster Management (NCDM)

c. Setting up of Disaster Management Faculties in States

d. UNDP is a united nation's global development programs working in 166 countries.

e. Programs for Community Participation and Public Awareness

f. Observing National Disaster Reduction Day

Environmental movements: Chipko, Silent valley, Bishnios of Rajasthan

However, for many centuries, human beings have been exploiting the Earth's many natural resources. With the depleting resources and natural energy, and the ill-effects of carbon emissions, we are now facing the detrimental effects of our actions. In India, in the past and the present, social activists have fought to preserve and restore Mother Nature. Through environmental and social movements, citizens have time and again reminded the world of the importance of preserving our Pale Blue Dot, and raised their voices to highlight environmental concerns. Here are some of the environmental movements that have left a mark on our rich Indian history: The Bishnoi Movement In the 1700s, in Khejarli, in the Marwar region of Rajasthan, trees were ordered to be cleared for a new palace to be built.

One of the villagers, Amrita Devi, could not bear to witness such an exploitation of the floral habitation. To stop the deforestation, she hugged the trees, while also encouraging others to do the same. More than 360 Bishnoi villagers were martyred in this movement. The Bishnoi faith, that was established in 1485 AD by Guru Maharaj Jambaji, prohibited them from harming trees and animals. The Maharaja, upon learning about these events, rushed to the village and apologised to the community, and ordered the soldiers to cease their operations. He then declared the Bishnoi state a protected area. The Chipko and Appiko Movements

Led by Sundarlal Bahuguna, Gaura Devi, Sudesha Devi, Bachni Devi, Chandi Prasad Bhatt, Govind Singh Rawat, Dhoom Singh Negi, Shamsher Singh Bisht and

Ghanasyam Raturi in 1973, the main objective of the Chipko movement was to protect the trees from the axes of forest contractors. Bahuguna enlightened the villagers about the importance of trees, telling them how they prevent soil erosion and benefit the environment with rain and purified water. The main demand of the protests was that the trees should not be cut as they benefit the locals. The Chipko movement garnered publicity in 1978 when a few women had to face police brutalities.

The then Uttar Pradesh Chief Minister Hemwati Nandan Bahuguna set up a committee to look into the matter, which eventually ruled in the favour of the villagers. The event went on to become an example for all future environmental movements across the world. Similarly, Uttara Kannada and Shimoga districts of Karnataka saw a southern version of the Chipko movement, known as the Appiko movement or Appiko Chaluvali. The movement used various methods to raise awareness such as foot marches in the interior forest, slide shows, folk dances, street plays etc. The main aim of the movement was to rally against the felling and commercialisation of the natural forest and disturbing the tribal livelihood. Save Silent Valley Movement Silent Valley is a tropical area in Kerala which is rich in biodiversity. In 1978, however, the lush evergreen cover was to be deforested for the construction of a hydroelectric dam across the Kunthipuzha river by the Kerala State Electricity Board (KSEB).

The locals feared that the project would submerge at least 8.3 square kilometres of the green cover around the dam area. Several NGOs opposed the project, and urged the government to abandon it. Kerala Sastra Sahitya Parishad (KSSP), an NGO, and the poet-activist Sughathakumari played an important role in the Silent Valley protests In January 1981, the government relentlessly gave in to the demands of the population and called off the project. They declared the Silent Valley as a protected area. Jungle Bachao Andolan In 1982, in the Singhbhum district of Bihar, the state government had decided to replace the natural Sal forests with the highly-priced teakwood trees. The tribals of Singhbhum protested this decision. The movement was called by many environmentalists as ‘Greed Game Political Populism’. It later spread into the states of Jharkhand and Odisha. Narmada Bachao Andolan (NBA) Led by Medha Patkar with the support of Arundhati Roy, Baba Amte, and Aamir Khan, along with the adivasis, farmers, environmentalists, and human rights activists, the Narmada Bachao Andolan took place in the year 1985.

The main aim of the movement was to protest the building of several large dams across the Narmada river. It was kicked off when the people displaced by the construction of the Sardar Sarovar Dam were not provided proper rehabilitation and resettlement. Although unsuccessful in their endeavour, they turned the focus into the preservation of the environment and the ecosystems of the valley. The NBA questioned the model of unchecked development across the world.

Environmental ethics: Role of Indian and other religions and cultures in environmental conservation

Nature has always been very vibrant, giving and resilient to a very large extent. We, as Indians, take pride in our strong cultural heritage. Religion protects and nurtures nature. If we take a look at Hinduism, we worship the sun, wind, land, trees, plants, and water which is the very base of human survival. Likewise, respect and conservation of wildlife—garuda, lion, peacock, and snake—are part of our cultural ethos from time immemorial. Almost the entire living of God Ram and Goddess Sita was very close to nature. Further, ancient texts written in Sanskrit, Pali or other languages can provide significant details. For instance, the scripture Vishnu Samhitâ in Sanskrit language contains some direct instructions dealing with biodiversity conservation.

In fact, whole civilisations have come into existence near sources of water like Indus Valley Civilisation. In this sense, nature and culture become intertwined. Culture reflects our history, tradition and our beliefs. Revolutions in the technological and communication fields and the advent of globalisation have made an impact on our culture which have also evolved with time. However, it becomes imperative that we adapt new things without losing the basic character of our long cherished traditions and values which include environmental conservation. India is a culturally rich and diverse country where people speak many different languages, with many communities which live in their respective social structures completely depending on their environment to ensure their livelihood.

The process of economic growth and development, though vital for any nation's progress, done at the cost of environmental degradation through industrialisation and urbanisation—transportation, burning of fossil fuels and deforestation—has led to the emission of green house gases into the atmosphere. These gases absorb the heat of solar rays, which results in the warming of the atmosphere, seas and oceans leading to floods, droughts, severe storms, melting of ice at the poles, receding of glaciers and rise in sea water levels. These issues have brought the concerns for environmental conservation and sustainable development to the forefront.

At the international level, the Convention on Biological Diversity, signed at the 1992 Rio Earth Summit, is dedicated to promoting sustainable development. It recognises that biological diversity is about more than plants, animals and microorganisms and their ecosystems—it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live. At the national level, Article 48(A) of the Indian Constitution imposes a constitutional obligation on the state to protect and improve the environment and safeguard the forests and wildlife of the country. Article 51(A)(g) imposes a constitutional obligation on the citizens of India to protect and improve the natural environment, including forests, lakes, rivers and

wildlife and to have compassion for all living creatures. We also have laws to deal with air pollution, emission of greenhouse gases and use of ozone-depleting substances like the Water Act, the Air Act and the Environment Protection Act but the need is for their strict implementation.

The Convention for the Safeguarding of the Intangible Cultural Heritage, adopted by the 32nd session of the General Conference of UNESCO in September 2003, calls for safeguarding knowledge and skills that are recognised by communities, groups, and in some cases individuals, as forming part of their cultural heritage; are transmitted from generation to generation and constantly recreated; are crucial for the sense of identity and continuity of communities and groups; are in conformity with human rights, and, mutual respect and sustainable development. This is commonly known as traditional or indigenous knowledge. The UN Declaration on the Rights of Indigenous Peoples, endorsed by the UN Human Rights Council in June 2006, recognises “that respect for indigenous knowledge, cultures and traditional practices contributes to sustainable and equitable development and proper management of the environment”. In India, the Biological Diversity Act contains a framework provision for the protection of this rare knowledge of indigenous communities but it is always in the implementation part that we lag behind.

TRADITIONAL knowledge had always contributed to modern medicine and health care. Further for centuries, indigenous communities were used to surviving and adjusting their agriculture, fishing and hunting in the event of changes in climate. It is ironical that now when the threat of climate change is so imminent we are looking for solutions outside. However, there is another threat looming large, that is, of losing these communities to outright annihilation or due to their amalgamation in the mainstream. Moreover, with the commercialisation of even natural resources, traditional knowledge that managed to maintain sustainable levels of harvest has been sidelined. Issues of privatisation, alienation and ‘bio-piracy’ are major areas of concern. With globalisation these pressures are stronger than ever. The existing policy and legal mechanisms to protect traditional knowledge usually does not involve these communities themselves. Hence they do little to safeguard local community needs, values and customary laws relating to traditional knowledge and genetic resources of indigenous and local communities. We have to preserve this aspect of culture and amalgamate it with modern methods to work towards environmental conservation.

By analysing the ethnic communities we can understand this aspect of inherited knowledge. I shall substantiate this point further by highlighting some instances very briefly.

In the first instance, we have two success stories in two different eco-cultural landscapes, that is, Demazong (the Buddhist eco-cultural landscape in Sikkim

Himalayas) and the Apatani eco-cultural landscape in Arunachal Pradesh, which illustrate the utility value of traditional ecological knowledge in sustainable natural resource management.1

Another example is that of natural resource conservation at the village of Mendha in Gadhchiroli district of Maharashtra. In 1987, the villagers renewed their efforts at biodiversity conservation. It was decided that no commercial exploitation of the forests, except for Non-Timber Forest Produce, would be allowed. Further, villagers would themselves regulate the amount of resources they could extract from the forests and undertake measures to tackle soil erosion. Forests would not be set on fire. Encroachment would not be allowed. The important aspect of this community is that the villagers decide for themselves, yet they are open to information from the outside world.

A third case study is that of the North-Eastern region of India which is home to diverse tribal and other ethnic groups. These communities meet a substantial proportion of their resource requirements from a relatively small catchment area in which they have been living for a long time. They live in complete harmony with nature. For example, the Meetei communities in the States of Manipur and Assam. Sacred groves, or Umang Lais, as they are called in the Meetei language, form an integral part of the Manipuri tradition of nature worship. Several species of plants are protected in these groves, which also offer protection to birds and animals. These include teak, several fruit trees like lemon, plants of medicinal value such as ginger, eucalyptus and bamboo. Fishes, waterfowl and other aquatic animals like snails and insects are very common items in the diet of the Meetei. However, many of these animals are not eaten during certain periods, probably with the motive of sustainable harvesting and conservation.2 Thus, in this case certain religious beliefs and practices help in the conservation of nature and its biodiversity.

Similarly, the indigenous inherited knowledge provided by the fishermen of Greater Mumbai and Sindhudurg districts of Maharashtra was found to be rich, varied with potential technical know-how associated with the management of bag net, shore-seine, gill net, long line and traditional trawl fishery.3

In another case study, ethno-botanical surveys were conducted during 1998 and 1999 in villages of Bhadra Wild Life Sanctuary area, situated in the Western Ghats region of Karnataka. The utilisation of leaves of Centella Asiatica, and roots of Ichnocarpus Frutescens in the treatment of jaundice, diabetes were found to be noteworthy.4 It is ironical that at a time when the West is seeking solace in our traditional practices be it medicine, meditation or Yoga, we, despite having a rich herbal wealth, have a share in the world herbal market that is not even 1.5 per cent.

Another example is that of medicinal expertise of Yanadi tribals in Chittoor, Andhra Pradesh. The alienation of the Yanadi from forest resources and the resultant loss of Yanadi traditional knowledge is a serious issue.

Policy Implications

FIRST, the government should take further steps to preserve, protect, and promote the traditional cultures and knowledge of the indigenous people. Second, side by side they should also be encouraged to develop, and opportunity be provided for education and scientific study. Third, related departments should coordinate to avoid overlapping as well as for smooth implementation of a particular policy. Fourth, there is further need to involve related non-government organisations as at times it is easy for NGOs to interact and get across to tribal people. Fifth, another important aspect is to sensitise and educate concerned officials at the state and especially at the local levels to understand and respect the culture differences. Sixth, ways have to be worked out so that benefits can be shared from accessing traditional knowledge. There is need for synergy between locals and scientists. Oral presentations complemented by video can bridge the gap between the two. Both are complementary to each other. Modern science can give a broader perspective to local sustainability whereas traditional knowledge can provide in depth experience in the local context. Seventh, though it may be crucial that in the designated areas, customary landowners are prohibited from excessive harvesting of biological resources to protect biological diversity, however their rights to land and resources should be formally approved. Eighth, to promote alternative means of livelihood products and services, including forest and agricultural products, herbal medicines, cultural heritage or traditional health-based tourism, ecotourism, scientific tourism and handicrafts based on traditional knowledge and skills be encouraged. Ninth, indigenous people should be fully involved in every stage of policies and plans related to sustainable development. Finally, young people should be encouraged to learn more about their cultural heritage as well as tolerance and respect for other cultures and traditions.

Hence, we are faced today with the challenge of not only industrialisation, liberalisation and urbanisation but also to make sure that fresh air and clean water are available to our people. This is possible only by active participation both by the government and the people in resource conservation and management. This requires political will, education, and a change in the mindset of the people at large. Conservation of natural resources and culture can be achieved only through the empowerment of indigenous communities and their development. Finally, it is good to know that our efforts at preservation of natural resources have been recognised the world over with the latest survey by National Geographic magazine calling Indians as the most environment-friendly people. But this puts an additional responsibility on Indians, that is, not only to protect, preserve and promote Indian cultural heritage and traditional knowledge, but

also to lead the world in environment conservation through sustainable development through the ages.

NOTES

1. Rai, S. C. (2007), “Traditional ecological knowledge and community-based natural resource management in northeast India”, Journal of Mountain Science, Volume 4, Number 3, pp. 248-258.

2. Singh, L. Jeetendro et al.(1998), “Environmental Ethics in the Culture of Meeteis from North East India” in Song Sang-yong et al.(eds), Bioethics in Asia in the 21st Century, Christchurch: Eubios Ethics Institution.

3. Nirmale, Vivek H et al. (2004), “Assessment of indigenous knowledge of coastal fisherfolk of Greater Mumbai and Sindhudurg districts of Maharashtra”, Indian Journal of Traditional Knowledge, Vol. 3(1), pp. 37-50.

4. Parinitha, M. et al.(2004), “Ethno-botanical wealth of Bhadra wild life sanctuary in Karnataka”, Indian Journal of Traditional Knowledge, Vol. 3(1), pp. 51-58.

Environmental communication and public awareness, case studies (e'g', CNG vehicles in Delhi

CNG as an Alternative Fuel

The usage of natural gas as a vehicle fuel was discovered back in the early 1920s in Italy. However, after the Second World War, there has been a growing interest on the usage of natural gas as vehicle fuel. In the 20th century, the usage of natural gas expanded to most part of Western Europe and USA and it became a commercial item in the form of liquefied natural gas (Tiratsoo, 1979 and Bassi, 1990) for exports and imports.

The conscious endeavor towards searching for alternatives to the polluting conventional fuels started a long time ago. In 1991, Italy became the leading country in the research of natural gas vehicles. Italy had about 235,000 gasoline vehicles and 20 diesel vehicles that were converted to natural gas. The country with the second highest natural gas vehicles is Argentina, which has about 100,000 gasoline vehicles and 10 converted diesel vehicles (Shamsudin & Yusaf, 1995). For automotive use, Natural gas is compressed in a high pressure seamless tank of 18-20 MPa to form compressed

natural gas (CNG). Table .1 gives the comparative properties of Diesel and CNG, which shows that the auto-ignition temperature, octane number and net energy content of CNG is considerably higher as compared to the diesel fuel.

The Worldwide Scenario of CNG use

A study released by the American Clean Skies Foundation (ACSF) and conducted by Navigant Consulting, Inc. (NCI) concludes that the United States has 2,247 trillion cubic feet (tcf) of natural gas proved reserves and unproved technically recoverable resources. Canada is a large producer of natural gas, so it follows that CNG is used in Canada as an economical motor fuel. The New Zealand CNG program commenced in 1979 and now it is leading the world. The cost for CNG fuel is between 1/3rd to half of other fossil fuels in Europe. In Asian countries India and Pakistan are using CNG vehicles. China is also using CNG as an alternative fuel but not as much as India and Pakistan. Delhi is using world's largest CNG bus fleet. In Asian Economies such as India, CNG costs are at Rupees 18.90 per kg compared with Rs.40.56 per liter of petrol. In Singapore CNG is being increasingly used by public transport vehicles like buses and taxis, as well as goods vehicles.

Status of Adaption of CNG as a Fuel in Delhi

The Supreme Court's involvement in policies to curb air pollution in Delhi began with public interest litigation brought to the court by M.C. Mehta in the form of a petition no. 13029 filed on December 17, 1985. Concerned about rising levels of air pollution and the government's apparent lack of interest in dealing with this growing problem, Mehta asked the court to direct various government ministries and departments to implement the Air Act of 1981 in Delhi. Bottlenecks in the Adaption of CNG

The switchover to CNG from traditional fuels for transportation took considerable initiative from the Supreme Court of India, apart from Public Interest Litigations (PIL) and hard work of various agencies to implement CNG as a viable alternative automobile fuel in Delhi. Detailed study on use of CNG began when a CNG pilot project was commissioned by Gas Authority of India Limited (GAIL) in the year 1992-93 in Delhi, Mumbai and Baroda with the objective of identifying and resolving technical, institutional, regulatory and economic issues that would have an impact on using CNG as an alternative fuel.

In 1999, the Indraprastha Gas limited (IGL) acquired the ongoing city gas distribution project from GAIL, including nine CNG Stations and the City Gas distribution network in many areas in Delhi. IGL started implementing the Supreme Court of India's directives for increasing the number of CNG stations. Presently, IGL has total 154 CNG Stations in Delhi and has a CNG compression capacity of 21 Lakh Kgs/day. (Urvashi Nraian and Alan Krupnick, February 2007) CNG adaption in Delhi was fraught with numerous

challenges and hurdles. Various issues such as multiplicity of agencies involved, reluctance of public transport operators, misconceptions about CNG and inadequacy of Natural Gas supply, were hurdles in the path of CNG adaption. The following hurdles were faced in adopting the CNG transportation system.

* Limited CNG allocation leading to delay in management decisions on infrastructure

* Uncertainty about conversion of vehicles & therefore the demand for CNG

* Lack of indigenous technology

* Capital intensive project-a mother station cost would be 5-6 times the cost of a petrol pump.

* Pipelines need to be placed

* Infrastructural constraints (electricity, land etc.)

After CNG adaption, Pollution levels in general have decreased in Delhi. Statistics have shown that not only has the rising trend in pollution level been checked, but the levels of various pollutants in the ambient air are also coming down. The results of data analysis of pollution levels in Delhi, before and after adaption of CNG as an automotive fuel, point to the success of a number of policies implemented in Delhi but also to a number of areas of growing concern. The policies that led to the switchover to CNG from conventional fuels has helped to reduce S[O.sub.2], CO and [PM.sub.10] concentrations but, contrary to popular belief, have not contributed much to increase the NOx levels in Delhi. There is a significant improvement in the air quality. The best place to witness this change is the busy ITO traffic intersection, where toxic fumes no longer irritate the eyes as was the case earlier. [PM.sub.10] and S[O.sub.2] levels have shown a significant declining trend, as it is evident from the figure 1 and 2 (Source: www.cpcb.nic.in). Whereas PM has shown a slight decrease, in the Nitrogen Dioxide levels earlier there was slight increase which now shows a declining trend. This may be due to the differences in the emissions of Nitrogen Dioxide levels from retrofitted and dedicated CNG vehicles.

Adverse Effects of CNG usage

Two-stroke two-wheelers, followed by cars, were responsible for C[H.sub.4] emission but after conversion of diesel buses into CNG it is the buses-which contribute the most to methane emission. It has been observed that CNG vehicles might be emitting high NOx on account of poor maintenance. Some studies also suggested that while bringing the PM level down, CNG is producing a higher number of below 10 micron, 5 micron and 2.5 micron pollutants which may prove harmful to human health in long term and

takes more time to settle in the atmosphere. Under the current Pollution Under Control (PUC) tests, only CO is monitored(Karimi, 2004). In future it is being suggested to enforce the HC and NOx limits on PUC Certification. There were number of problems faced by the commuters during the process of conversion of public transport vehicles to CNG, including the lack of availability of the buses on the road and long queues for refilling and unavailability of CNG on filling stations, which led to complete chaos on city roads.

Result and Conclusions

The CNG adaption process in Delhi has been a success. Delhi today has one of the world's largest public transport fleet of buses running on CNG. Although CNG adaption has helped a lot to reduce pollutant concentrations in Delhi, but the gains have been negated by- poor technology, increase in number of diesel cars and an overall increase in the number of all types of vehicles. Therefore, while implementing any such necessary changeovers; proper plan must be prepared, for the minimization of the chaos on roads and availability of alternative means of transport to the commuters of Delhi.

* The Governments and the regulating agencies need to aggressively advocate and promote the public transportation system.

* The emission norms for diesel cars need to be made more stringent and separate emission standards for the CNG vehicles must be enforced.

* Any city or authority thinking of adopting CNG as an automotive fuel, must learn from the experiences of the agencies involved in CNG adaption in Delhi

References

[1] Bassi, A. 'Natural gas vehicles for a clean environment--an overview and the trends for the future', in Carvallo, Maria da Graca, Fiveland, Woodrow A., Lockwood, F.C. & Papadopoulos, Christos (eds), Clean combustion technologies, vol 2, Part B, 1990, pp. 739-762.

[2] Karimi, M.N. and Nath, B.K., 'Adaption of Compressed Natural Gas Technology In Delhi Transport System' , Proceeding of GLOGIFT, March 13-15, 2004, Jamia Millia Islamia, New Delhi, pp 374-387.

[3] M.C. MEHTA V. UNION OF INDIA & ORS [1998] RD-SC 8 (7 January 1998)(Supreme court of India judgement)

[4] Narain, Urvashi and Alan Krupnick, 'The Impact of Delhi's CNG Program on Air Quality', RFF DP 07-06, February 2007

[5] Tiratsoo, E.N. 'Natural gas--fuel for the future?' "A world survey", 3rd edn, 1979, Gulf

Publishing Company Houston, Texas,.

[6] Yusaf, T.F., Shamsudin, A.H., Ali, Y. & Ahamd, F.I., 'Design modification of high speed diesel engine to accommodate compressed natural gas', RERIC International Energy Journal, vol. 18, no. l, 1996, pp. 19-26.

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Table 1: Comparison of Properties of CNG and Diesel.

PROPERTIES	NATURAL GAS	DIESEL
Flash Point (K)	124	325
Boiling Point (K @1 Atm)	147	433-655
Density (kg/cum)	128	785-881
Auto Ignition Temperature (K)	900	477-533
Octane / Cetane Number	130	46-51
Flammability Limits Range	5.0-15	0.7-5
Net Energy Content (MJ/Kg)	49.5	43.9
Combustion Energy (KJ/cum)	24.6	36
Vaporization Energy (MJ/cum)	215-276	192