Environmental studies

and

Disaster management

(3+1)

Forest Resources
&
Conservation

By

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Forest Resources

A forest can be defined as a biotic community predominant of trees, shrubs or any other woody vegetation usually in a closed canopy. It is derived from latin word 'foris' means 'outside'.

India's Forest Cover **is 6,76,000 sq.km (20.55% of geographic area)**. Scientists estimate that India should ideally have 33% of its land under forests. Today we only have about 12% Thus we need not only to protect our existing forests but also to increase our forest cover.

Forest Functions :

I. Protective and ameliorative functions.

II. Productive functions

III. Recreational and educational functions

IV. Development functions

I. Protective and ameliorative functions

A. Watershed protection

- Reducing the rate of surface run-off of water by increasing infiltration from rate.
- Preventing flash floods and soil erosion
- Producing prolonged gradual run-off and thus safeguarding against drought.

B. Erosion control

- Holding soil (by preventing rain from directly washing soil away)

C. Land bank

- Maintaining soil nutrients and structure.

D. Atmospheric regulation

- Absorption of solar heat during evapotranspiration
- Maintaining carbon dioxide levels for plant growth
- Maintaining the local climatic conditions

II. Productive Functions

- Local use – Consumption of forest produce by local people who collect it for sustenance
- Food: (consumptive use) gathering plants, fishing, hunting from the forest. Fodder for cattle
- Fuel wood and charcoal for cooking and heating

- Poles for building homes in rural and wilderness areas
- Timber for house hold articles and construction
- Fiber for weaving baskets, ropes, nets, strings, etc.,
- Sericulture for silk
- Apiculture for rearing bees for honey (bees as pollinators)
- Medicinal plants for traditional medicines, investigating them as potential source for new modern drugs Market use (productive use) Most of the products used for consumptive purposes and good source of income for supporting their livelihood of forest dwelling people.
- Minor forest products (NTFPs): Fuel wood, fruits, gum, fiber, etc which are collected and solid in local markets as a source of income for forest dwellers
- Major timber extraction for construction, industrial uses, paper pulp etc. Timber extraction is done in India by the forest department, but illegal logging continues in many of the forests of India and the world.

III. Recreational And Educational Functions: Eco tourism

IV. Developmental Functions

- Employment functions
- Revenue

Ecological significance of forests:

1. Balances CO_2 and O_2 levels in atmosphere.
2. Regulates earth temperature and hydrological cycle
3. Encourage seepage and reduces runoff losses, prevents drought
4. Reduces soil erosion (roots binding), prevents siltation of reservoirs and landslides thereby floods
5. Litter helps in maintaining soil fertility
6. Safe habitat for birds, wild animals and organisms against wind, solar radiation and rain

Deforestation:

Deforestation refers to the loss of forest cover; land that is permanently converted from forest to agricultural land, golf courses, cattle pasture, home, lakes or desert. The FAO (Food and Agriculture Organization of the UN) defines tropical deforestation as "change of forest with depletion of tree grown cover more than 90%" depletion of forest tree crown cover less than 90% is considered forest degradation

.Causes for Deforestation:

1. Agriculture: Conversion of forests to agricultural land to feed growing numbers of people
2. Commercial logging: (which supplies the world market with woods such as meranti, teak, mahogany and ebony) destroys trees as well as opening up forest for agriculture. Cutting of trees for fire wood and building material, the heavy lopping of foliage for fodder and heavy grazing of saplings by domestic animals like goats.
3. The cash crop economy: Raising cash crops for increased economy.
4. Mining
5. Increase in population: The needs also increase and utilize forest resources.
6. Urbanization & industrialization
7. Mineral exploration
8. Construction of dam and reservoirs
9. Infrastructure development
10. Forest fires
11. Human encroachment & exploitation
12. Pollution due to acid rain

Environmental effects /Consequences of deforestation

1. Food problems
2. Ecological imbalance
3. Increasing CO2
4. Floods leading to soil erosion
5. Destruction of resources
6. Heavy siltation of dams
7. Changes in the microclimate

8. Loss of biodiversity

9. Desiccation of previously moist forest soil

10. Heavy rainfall and high sunlight quickly damage the topsoil in clearings of the tropical rainforests. In such circumstance, the forest will take much longer to regenerate and the land will not be suitable for agricultural use for quite some time.

11. Where forests are replanted, their replacement can mean a loss of quality

12. Loss of future markets for ecotourism. The value of a forest is often higher when it is left standing than it could be worth when it is harvested.

13. Some indigenous peoples' way of life and survival are threatened by the loss of forests. Fewer trees results an insecure future for forest workers

14. Deforestation can cause the climate to become extreme in nature. The occurrence and strength of floods and droughts affecting the economy.

15. The stress of environmental change may make some species more susceptible to the effect of insects, pollution, disease and fire

16. Most humid regions changes to desert

17. Environmental pollution

18. Global warming

Conservation

Conservation derived from two Latin words, con – together,- servare – to keep or guard measures, i.e. an act of preservation or to keep together .

Concepts in conservation

1. Restraining cutting of trees and submerging the forests

2. Reforestation

3. Afforestation

4. Control forest diseases and forest fire

5. Recycling forest products

6. Replacing forest products

7. Avoids diversion of forest lands for other activities through acts like Forest Conservation Act and Wild life (protection) Act

8. Bringing awareness among people ex: Chipko movement, Appiko , Narmada Bachao Andolan

9. Implementing people's participatory programmes. Ex: Joint Forestry Manangement (JFM)

Loss of Biodiversity With the current rate of development, population growth and migration communities are increasingly unable to meet their sustained needs. However, the present day drastic changes in the environment and habitat due to population explosion and unmanaged developmental activities are so unnatural that the species are not getting full liberty of time and space for their survival and adaptive radiation, therefore, resulting in loss of biodiversity, which is a global crisis. It is high time that our natural wealth be preserved from loss. Threats to Biodiversity the diversity in India i.e. forests, grass lands, wetlands, mountains, deserts and marine ecosystems face many pressures. One of the major causes for the loss of biological diversity in India has been the depletion of vegetative cover in order to expand agriculture. Since most of the biodiversity rich forests also contain the maximum mineral wealth and also the best sites for water impoundment, mining and development projects in such areas have often led to destruction of habitats. Poaching and illegal trade of wildlife products too have adversely affected biological diversity. Causal factors of threat Causal factors of threat may be natural or manmade. They are :

1. Development pressure
    - Construction
    - Forest based industries
    - Hydel/ Irrigation projects
    - Mining
    - Oil drilling
    - Pollution
    - Resource extraction
    - Road & Transport
2. Encroachment
    - Agriculture
    - Expansion of forest villages
    - Fishery
    - Grazing / increased domestic animals
    - Habitat depletion / change
    - New settlements
    - Shifting cultivation

3. Exploitation
    - Collection made by scientific/educational institutions
    - Exploitation by local authorities as revenue resources
    - Firewood collection
    - Food gathering and hunting
    - Poaching

4. Human induced disasters
    - Floods
    - Major oil spills/leakage
    - Epidemics
    - Forest fires

5. Management of Natural resources
    - Genetic uniformity
    - Inadequate water/ food for wildlife
    - Increased competition
    - Introduction of exotic species
    - Predation

6. Management of Human Resource
    - Change in people‘s lifestyle
    - Increasing demands
    - Dilution of traditional values
    - Human harassment
    - Inadequate trained human resources
    - Lack of effective management
    - In appropriate land use

7. Political and policy issues
    - Change in use / legal status
    - Civil unrest
    - Intercommunity conflict
    - Military activities

Categories of threat

The following categories of threat have been recognized by IUCN (International Union for Conservation of Nature and Natural Resources)

1. **Endangered**

   The taxa in danger of extinction and whose survival is unlikely, the causal factors continue operation. The taxa whose number have been reduced to a critical level or whose habitats have been so drastically reduced that they are seemed to be in immediate danger of extinction (eg) *Nepenthes sp., Vanda, Cycas beddomii.*

2. **Vulnerable**

   Taxa likely to move into endangered category in near future, if the causal factors continue operating included taxa of which most or all the population are decreasing because of over exploitation, extensive destruction of habitats or other environmental disturbances. Eg. *Dioscoria deltoidea*

3. **Rare**

   Taxa with small world population that are not at present endangered or vulnerable but are at risk. These taxa are usually localized within restricted geographical areas or habitat or are thinly scattered over more extensive range (eg) *Rauvolfia serpentina*

4. **Threatened**

   The term threatened is used in the conservation for species which fall in one of the above three categories

   Endangered plant and animal species

- 427 – endangered plant species (BSI) in Red Data Book
- Contributes to about 20% of India‘s floristic wealth of higher plants

Endangered plants

- *Acer laevigatum*
- *Phoenix rupicola*
- *Lactuca cooperi*
- *Carum villosum*
- *Amorphophalius bulbifeer*
- *Dioscorea laurifolia*

Endangered animals

Andaman wild pig, Bison, Black buck, Blue whale, Cheetah, crab eating macaque, two horned antelope, giant squirrels, Hyaena, Lion tailed Macaque, musk deer, Nilgiri tahr, Sambar, rhinoceros, Siberian White crane

Conservation of Biodiversity

The very existence of human being is threatened due to continuous loss of biodiversity. Tropical rain forests have been the focal point of the debates on biodiversity conservation. In fact, the rain forest covers only 7% of the earth‘s geographical area but supports more than half of the world‘s identified species. Of these, 15 rain forests have been identified as hot spots. Tropical deforestation will be the single greatest cause of species extinction in the next century.

Strategies of Conservation

Future strategy for Conservation has 4 goals

1. Maintenance of adequate resources
2. Conservation of resources through reduction in demand and achievement of greater end use
3. Maximum use of renewable resources
4. Reduction in dependency of non-renewable resources

In situ strategy

This strategy emphasizes on the conservation work at original site of biodiversity i.e. in wild. Conservation of overall diversity of genes, populations, species, communities and the ecological processes comes under this strategy. There are 37,000 protected area in the world (World Conservation Monitoring Centre , WCMC). India has 17 biosphere reserves, and 19 Ramsar wetlands. Amongst the protected areas, India has 102 national parks and 490 sanctuaries covering an area of 1.53 lakh sq. km.

Ex situ Strategy

This strategy says that conservation work should be done outside the natural habitat in form of botanical and zoological gardens, conservation stand, seed and seedling banks, pollen banks, germ plasm banks, tissue culture banks, gene and DNA banks etc. In India, conservation of genetic diversity of cultivated plants and their wild relatives is done by NBPGR (National Bureau of Plant Genetic Resources).

Reduction of Anthropogenic Pressure

Increasing population and it‘s demands pose remarkable threat to taxa important to human being. About 70% of identified medicinal plants of Indian Himalaya are exposed to destructive harvesting. Cultivation of such plants elsewhere would contribute to their conservation.

Restoration of endangered species

It is tough and difficult strategy. It requires specific knowledge about species and its surrounding. This strategy includes diagnosis of factors responsible for the decline of species, habitat conservation, captive breeding and restriction of harvesting etc. the strategy include:

- Reintroduction programmes in the original site of living
- Augmentation programmes to increase the existing population size and genetic diversity of a species
- Introduction programmes for a new area

Endemic species

Endemic species are the plants, which are limited in their distribution i.e. they are restricted to a small area and are not found elsewhere in the world. Endemism of Indian biodiversity is significant. About 4,900 species of flowering plants and 33% of the recorded floras are endemic to the country. These are distributed over 141 genera belonging to 47 families. These are concentrated in the floristically rich areas of North East India, the western Ghats, North West Himalayas and the Andaman and Nicobar Islands. The Western Ghats and the Himalayas have two of the 18 hot spots identified in the world. It is estimated that 62% of the known amphibian species are endemic to India of which a majority occur in Western Ghats. Endemism may be due to:

- Poor adaptability of a species in a wide range of ecology
- Presence of some geographical barrier
- Failure of dispersal of reproductive organs
- The species might have comparatively been young and not have time to spread.

Biosphere Reserves

Biosphere reserve programme was launched by UNESCO in 1971 under its MAB (Man and Biosphere Programme). Biospheres are sites where protection is granted not only to the flora and fauna of the protected region, but also to the human communities who inhabit these regions, and their ways of life. Biosphere reserves are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Program to promote sustainable development based on local community efforts and sound science. Currently there are 580 sites across 114 countries. The Indian government has established 17 Biosphere Reserves of India. Seven of the seventeen biosphere reserves are a part of the World Network of Biosphere Reserves, based on the UNESCO Man and the Biosphere (MAB) Program list.

Some of the policies, which can be taken into account for biodiversity conservation, are:

- Identifying and monitoring the important components of biological diversity that needs to be conserved and used sustainably.
- Establishing protected areas to conserve biological diversity while promoting environmentally sound development around these areas.
- Respecting, preserving and maintaining traditional knowledge of the sustainable use of biological diversity with the involvement of indigenous peoples and local communities.
- Educating people and raising awareness about the importance of biological diversity and the need to conserve it
- Promoting public participation, particularly when it comes to assessing the environmental impacts of development projects that threaten biological diversity and protecting the biodiversity hot spots from alien species.

Biodiversity conservation is an important step towards a successful disaster management and if policies are implemented to protect it, then we can get one step closer in making a Disaster Free World.

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Water Resources & Ecosystems

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Water Resources

The United Nations has recognized access to water as a basic human right, stating that water is a social and cultural good, not merely an economic commodity. Since ancient times, water has been recognized universally as an invaluable resource. Water has been harvested in India since the dawn of civilization. The Ramayana, Mahabharata and various other Vedic, Buddhist and Jain texts contain several references to water harvesting structures in existence and water being revered as a life giving and sustaining force. Water covers 70% -75% of earth's surface of which 97.2% is locked in sea or oceans (1332 million cu.km, considering total availability as 1400 million cu km), 3% is fresh water 2.15% in polar ice caps (29.20 cu.km), < 1% available as surface and sub surface water (rivers, streams, lakes) with which we have to manage ourselves. Water is renewable resource. It may change it's form but quantity of water on earth has remained same for millions of years. Out of 1400 million cu.km. of water available on earth, only 14 million cu.km. is fresh water. As per the National Commission on Agriculture, considering an average rainfall of 1200mm, the water wealth of India is about 400 million hectare meters.

Main sources of water for our use are:

Rainfall: India can be broadly divided into 15 ecological regions. The vast ecological diversity of this country is reflected in the diversity in available water

resources. With an average annual rainfall of 1170 mm, India is one of the wettest countries in the world. However, there are large variations in the seasonal and geographical distribution of rainfall over the country. At one extreme are areas like Cherrapunji, in the northeast, which is drenched each year with 11,000 mm of rainfall, and at the other extreme are places like Jaisalmer, in the west, which receives barely 200 mm of annual rainfall. Though the average rainfall is adequate, nearly three quarters of the rain pours down in less than 120 days, from June to September.

Groundwater: India's groundwater resources are almost ten times its annual rainfall. According to the Central Groundwater Board of the Government of India, the country has an annual exploitable groundwater potential of 26.5 million hectare-meters. Nearly 85% of currently exploited groundwater is used only for irrigation. Groundwater accounts for as much as 70-80% of the value of farm produce attributable to irrigation. Besides, groundwater is now the source of four- fifths of the domestic water supply in rural areas, and around half that of urban and industrial areas. However, according to the International Irrigation Management Institute (IIMI),

the water table almost everywhere in India is falling at between one to three meters every year. Furthermore, the IIMI estimates that India is using its underground water resources atleast twice as fast they are being replenished. Already, excessive ground water mining has caused land subsidence in several regions of Central Uttar Pradesh.

Surface water: There are 14 major, 44 medium and 55 minor river basins in the country. The major river basins constitute about 83-84% of the total drainage area. This, along with the medium river basins, accounts for 91% of the country's total drainage. India has the largest irrigation infrastructure in the world, but the irrigation efficiencies are low, at around 35%.

Consumption Patterns

Today, due to increasing consumption patterns, water is becoming scarce and this scarcity is an emerging threat to the global population, rendering the adages of the Bible and Koran irrelevant. Global consumption of water is doubling every 20 years, more than twice the rate of human population growth. At present more than one billion people on earth lack access to fresh drinking water. By the year 2025 the demand for freshwater is expected to rise to 56% above what currently available water can deliver, if current trends persist (Maude Barlow, 2003). If per capita water availability is any indication, ‘water stress’ is just beginning to show in India. This index is based on the minimum per capita level of water required to maintain an adequate quality of life in a moderately developed arid zone country. A region where renewable fresh water availability is below 1700 cubic meters/capita/annum is a 'water stress' region, and one where availability falls below 1000 cubic meters/capita/annum experiences chronic 'water scarcity'. The annual per capita availability of renewable freshwater in the country has fallen from around 5,277 cubic meters in 1955 to 2,464 cubic meters in 1990. Given the projected increase in population by the year 2025, the per capita availability is likely to drop to below 1,000 cubic meters i.e., to levels of water scarcity (Sudhirendar Sharma, 2003). If it falls below 500 cu.m. it is the state of “Absolute Scarcity”. India is expected to face critical levels of water stress by 2025. At the global level, 31 countries are already short of water and by 2025 there will be 48 countries facing serious water shortages. The United Nations has estimated that by the year 2050, 4 billion people will be seriously affected by water shortages. This will lead to multiple conflicts between countries over the sharing of water. Around 20 major cities in India face chronic or interrupted water shortages. There are 100 countries that share the waters of 13 large rivers and lakes. The upstream countries could starve the downstream nations leading to political unstable

areas across the world. Examples are Ethiopia, which is upstream on the Nile and Egypt, which is downstream and highly dependent on the Nile. International accords that will look at a fair distribution of water in such areas will become critical to world peace.

USES: Water is essential for all forms of life. Many uses of water include agricultural, industrial, household, recreational and environmental activities. Virtually, all of these human uses, require fresh water. No plant or animal species can survive without water. If water in our body drops by 1% we feel thirst, if it drops by 10% we face death.

REASONS FOR DECLINE OF GROUND WATER

Population continues to rise at an unprecedented and unsustainable rate; many more areas are expected to experience this imbalance in the near future.

i) **Population explosion**: World population is > 6 billion and will continue to increase significantly during the next few decades - Enormous demands on the world's limited freshwater supply. The total annual freshwater withdrawals today are estimated at 3800 cubic kilometers, twice as much as just 50 years ago (World Commission on Dams, 2000).

ii) **Over utilization of Surface and Groundwater:** occurs at various levels. Use of more water than really needed by human beings. Many agriculturists use more water than necessary to grow crops. Industries in order to maximize short-term economic gains does not bother its liquid waste and releases it into streams, rivers and the sea.

iii) Deforestation: Once hill slopes are denuded of forest cover, the rainwater rushes down the rivers and is lost. Forest cover permits water to be held in the area permitting it to seep into the ground. This charges the underground stores of water in natural aquifers. This can be used in drought years if the stores have been filled during a good monsoon. This soil and water management and afforestation are long-term measures that reduce the impact of droughts. The destruction of forests influence the regulation of natural water cycle. The removal of dense and uniform cover over the hilly zones leads to occurrence of floods in drainage basins. Nations situated in tropical climates including India experience disastrous floods caused by the indiscriminate deforestation of the slopes above the valleys.

iv) Hydropower generation: Large amount of water is used for generating power which other wise used for human needs.

v) **Dams -** for Agriculture and Power Generation

vi).**Rain fall**: The erratic and inadequate rainfall results in reduction in storage in subsurface reservoirs. The building construction activities are sealing the permeable zone, reducing the area for pereolation of rainwater into subsurface and increase in surface runoff. India's increasing demand for water for intensive irrigated agriculture, for generating electricity, and for consumption in urban and industrial centers, has been met by creating large dams. Dams support 30 to 40% of this area.

DAMS: It can be unequivocally stated that dams have made significant contributions to human development and the benefits derived from them have been considerable. Large dams are designed to control floods and to help the drought prone areas, with supply of water. But large dams have proved to cause catastrophic environmental damage. Hence an attempt has been made to construct small dams. Multiple small dams have less impact on the environment.

Benefits: Dams ensure a year round supply of water for domestic use and provide extra water for agriculture, industries and hydropower generation.

Problems: They alter river flows, change nature's flood control mechanisms such as wetlands and flood plains, and destroy the lives of local people and the habitats of wild plant and animal species, particularly is the case with mega dams. Some of the problems are mentioned below.

¬ Dam construction and submersion leads to significant loss of areable farmland
and forest and land submergence

¬ Siltation of reservoirs, water logging and salination in surrounding lands reduces agricultural productivity

¬ Serious impacts on ecosystems - significant and irreversible loss of species and ecosystems, deforestation and loss of biodiversity, affects aquaculture

¬ Socio economic problems for example, displacement, rehabilitation and
resettlement of tribal people

¬ Fragmentation and physical transformation of rivers

¬ Displacement of people - People living in the catchment area, lose property and livelihood

¬ Impacts on lives, livelihoods, cultures and spiritual existence of indigenous and tribal people

¬ Dislodging animal populations

¬ Disruption of fish movement and navigational activities

¬ Emission of green house gases due to rotting of vegetation

¬ Large landholders on the canals get the lion's share of water, while poor and small farmers get less and are seriously affected leading to conflicts. Irrigation to support cash crops like sugarcane produces an unequal distribution of water.

¬ Natural disasters – reservoirs induced seismicity, flash floods etc and biological hazards due to large-scale impounding of water – increase exposure to vector bone diseases, such as malaria, schistosomiasis, filariasis

Ecosystems: Definition, concept, structure and functions

Ecology is the science that deals with the relationships between living organisms with their physical environment and with each other. Ecology can be approached from the viewpoints of

(1) the environment and the demands it places on the organisms in it or

(2) (2) organisms and how they adapt to their environmental conditions. An ecosystem consists of an assembly of mutually interacting organisms and their environment in which materials are interchanged in a largely cyclical manner.

An ecosystem has physical, chemical, and biological components along with energy sources and pathways of energy and materials interchange. The environment in which a particular organism lives is called its habitat. The role of an organism in a habitat is called its niche. For the study of ecology it is often convenient to divide the environment into four broad categories.

Terrestrial environment –

The terrestrial environment is based on land and consists of biomes

,• such as grasslands, one of several kinds of forests, savannas, or deserts. Freshwater environment - The freshwater environment can be further subdivided

• between standing-water habitats (lakes, reservoirs) and running-water habitats (streams, rivers). Oceanic marine environment - The oceanic marine environment is characterized by saltwater• and may be divided broadly into the shallow waters of the continental shelf composing the neritic zone Oceanic region - The deeper waters of the ocean that constitute the oceanic region.

• Two major subdivisions of modern ecology are

Ecosystem ecology - which views ecosystems as large units, and

- Population ecology - which attempts to explain ecosystem behavior from the properties of individual units.

In practice, the two approaches are usually merged. Descriptive ecology describes the types and nature of organisms and their environment, emphasizing structures of ecosystems and communities and dispersions and structures of populations. Functional ecology explains how things work in an ecosystem, including how populations respond to environmental alteration and how matter and energy move through ecosystems. Ecosystems are broadly divided into natural and artificial. Natural ecosystems are those that are existing in nature; they are further classified into terrestrial and aquatic. Terrestrial includes hot desert, grassland, tropical and temperate rainforest and aquatic includes ponds, river, streams, lakes, estuaries, oceans, mangroves, swamps and bays etc. However these two ecosystems are self regulating, opensystem with a free exchange of inputs and outputs with other systems. Artificial ecosystems are simple,human-made, unstable and subjected to human intervention and manipulation. Usually it is formedby clearing a part of the forest or grassland e.g. crop field, agricultural land.

Structure and Function of an ecosystem

An ecosystem has two components the biotic components consisting of living things, and the abiotic portion, consisting of elements that are not alive. The non living constituents are said to include the following category, habitat, gases, solar radiation, temperature, moisture and inorganic and organic nutrients. The living organisms may be sub divided into producers, consumers and decomposers. Abiotic Components include basic inorganic and organic components of the environment or habitat of the organism. The inorganic components of an ecosystem are carbon dioxide, water nitrogen, calcium phosphate all of which are involved in matter cycle (biogeochemical cycles). The organic components of an ecosystem are proteins, carbohydrates, lipids and amino acids, all of which are synthesized by the biota (flora and fauna) of an ecosystem and are reached to ecosystem as their wastes, dead remains etc. the climate 'microclimate' temperature, light soil etc. are abiotic components of the ecosystems.

Functions of an Ecosytem

Ecosystem function is the capacity of natural processes and components to provide goods and services that satisfy human needs, either directly or indirectly. Ecosystem functions are subset of ecological processes and ecosystem structures. Each function is the result of the natural processes of the total ecological sub-system of which it is a part. Natural processes, in turn, are the result of complex interactions between biotic (living organisms) and abiotic (chemical and physical) components of ecosystems through the universal driving forces of matter and energy. There are four primary groups of ecosystem functions

(1) regulatory functions,

(2) habitat functions,

(3) production functions and

(4) information functions.

This grouping concerns all ecosystems, not only for forests.

General characterization of ecosystem functions are:

(1) Regulatory functions: this group of functions relates to the capacity of natural and semi-natural ecosystems to regulate essential ecological processes and life support systems through bio-geochemical cycles and other biospheric processes. In addition to maintaining the ecosystem (and biosphere health), these regulatory functions provide many services that have direct and indirect benefits to humans (i.e., clean air, water and soil, and biological control services).

(2) Habitat functions: natural ecosystems provide refuge and a reproduction habitat to wild plants and animals and thereby contribute to the (in situ) conservation of biological and genetic diversity and the evolutionary process.

(3) Production functions: Photosynthesis and nutrient uptake by autotrophs converts energy, carbon dioxide, water and nutrients into a wide variety of carbohydrate structures which are then used by secondary producers to create an even larger variety of living biomass. This broad diversity in carbohydrate structures provides many ecosystem goods for human consumption, ranging from food and raw materials to energy resources and genetic material

(4) Information functions: Since most of human evolution took place within the context of an undomesticated habitat, natural ecosystems contribute to the maintenance of human health by providing opportunities for reflection, spiritual enrichment, cognitive development, recreation and aesthetic experience**.**

Components of an ecosystem:

Complete ecosystem consists of four basic components such as producers, consumers, decomposers and abiotic components e.g. Pond. If anyone of these four components are lacking, then it is grouped under incomplete ecosystem e.g. Ocean depth or a cave.

Productivity in the Environment: The productivity of an ecosystem is the rate at which solar energy is fixed by the vegetation of the ecosystem; it is further classified into primary productivity, secondary productivity and net productivity. Primary productivity refers to the rate at which radiant energy is stored by photosynthetic and chemosynthetic activity of producers; it is further distinguished as gross primary productivity (GPP) and net primary productivity (NPP). It is expressed in terms of weight (g/m2/yr) or energy (kcal/m2). Secondary productivity refers to the rates of energy storage at consumer levels. An understanding of ecology is essential in the management of modern industrialized societies in ways that are compatible with environmental preservation and enhancement. The branch of ecology that deals with predicting the impacts of technology and development and making recommendations such that these activities will have minimum adverse impacts, or even positive impacts, on ecosystems may be termed as Applied Ecology. It is a multidisciplinary approach . Interactions among living organisms are grouped into two major groups viz.,

- **Positive interactions**
- **Negative interactions**

I. Positive interactions

Here the populations help one another, the interaction being either one way or reciprocal. These include

(i) Commensalism,

(ii) Proto co-operation and

(iii) mutualism.

1. Commensalism In this one species derives the benefits while the other is unaffected. Eg. (i) Cellulolytic fungi produce a number of organic acids from cellulose which serve as carbon sources for non-cellulolytic bacteria and fungi.

(ii) Growth factors are synthesised by certain microorganisms and their excretion permits the proliferation of nutritionally complex soil inhabitants.

2. Proto-cooperation It is also called as non-obligatory mutualism. It is an association of mutual benefit to the two species but without the co-operation being obligatory for their existence or for their performance of reactions. Eg. N_2 can be fixed by Azotobacter with cellulose as energy source provided that a cellulose decomposer is present to convert the cellulose to simple sugars or organic acids.

3. Mutualism Mutually beneficial interspecific interactions are more common among organisms. Here both the species derive benefit. In such association there occurs a close and often permanent and obligatory contact more or less essential for survival of each. Eg. (i) Pollination by animals. Bees, moths, butterflies etc. derive food from hectar, or other plant product and in turn bring about pollination. (ii) Symbiotic nitrogen fixation: Legume - Rhizobium symbiosis. Bacteria obtain food from legume and in turn fix gaseous nitrogen, making it available to plant.

II. Negative interactions

Member of one population may eat members of the other population, compete for foods, excrete harmful wastes or otherwise interfere with the other population. It includes (i) Competition, (ii) Predation, (iii) Parasitism and (iv) antibiosis.

(i) Competition

It is a condition in which there is a suppression of one organism as the two species struggle for limiting quantities of nutrients O2 space or other requirements. Eg. Competition between Fusarium oxysporum and Agrobacterium radiobacter.

(ii) Predation

A predator is free living which catches and kills another species for food. Most of the predatory organisms are animals but there are some plants (carnivorous) also, especially fungi, which feed upon other animals.

Eg. (i) Grazing and browsing by animals on plants. (

ii) Carnivorous plants such as Nepenthes, Darligtoria, Drosera etc. consume insects and other small animals for food.

(iii) Protozoans feeding on bacteria.

(iii.) Parasitism

A parasite is the organism living on or in the body of another organisms and deriving its food more or less permanently from its tissues. A typical parasite lives in its host without killing it, whereas the predator kills its upon which it feeds. Eg. Species of Cuscuta (total stem parasite) grow on other plants on which they depend for nourishment. Parasitism may occur even with in the species. Hyperparasites which are chiefly fungi growing parasitically on other parasites, (ie) Parasite on a parasite. Eg. *Cicinnobolus cesatii* is found as hyperparasite on a number of powdery mildew fungi.

(iv) Antibiosis

The phenomenon of the production of antibiotic is called as antibiosis. Antibiotic is an organic substance produced by one organism which in low concentration inhibits the growth of other organism. Eg. *Streptomycin - S.griseus , Penicillin - P. notatum , Trichoderma harzianum inhibits the growth of Rhizoctonia* sp.

Matter and cycles of matter

Biogeochemical cycles describe the circulation of matter, particularly plant and animal nutrients, through ecosystems. These cycles are ultimately powered by solar energy, fine-tuned and directed by energy expended by organisms. In a sense, the solar-energy-powered hydrologic cycle acts as an endless conveyer belt to move materials essential for life through ecosystems.

Most biogeochemical cycles can be described as elemental cycles involving nutrient elements such as carbon, oxygen, nitrogen, sulfur and phosphorus. Many are gaseous cycles in which the element in question spends part of the cycle in the atmosphere – O2 for oxygen, N2 for nitrogen, CO2 for carbon. Others, notably the phosphorus cycle, do not have a gaseous component and are called sedimentary cycles. All sedimentary cycles involve salt solutions or soil solutions that contain dissolved substances leached from weathered minerals that may be deposited as mineral formations or they may be taken up by organisms as nutrients. The sulfur cycle, which may have H2S or SO2 in the gaseous phase or minerals ($CaSO_4$ $2H_2O$) in the solid phase, is a combination of gaseous and sedimentary cycles.

Carbon Cycle Carbon, the basic building block of life molecules, is circulated through the carbon cycle. This cycle shows that carbon may be present as gaseous atmospheric CO2, dissolved in groundwater as HCO3 or molecular CO2 (aq), in underlying rock strata as limestone (CaCO3), and as organic matter, represented in a simplified manner as (CH2O). Photosynthesis fixes inorganic carbon as biological carbon, which is a constituent of all life molecules. An important aspect of the carbon cycle is that it is the cycle by which energy is transferred to biological systems. Organic or biological carbon, (CH2O), is an energy-rich molecule that can react biochemically with molecular oxygen, O2, to regenerate carbon dioxide and produce energy. This can occur in an organism as shown by the ―decay‖ reaction or it may take place as combustion, such as when wood is burned. Oxygen Cycle The oxygen cycle involves the interchange of oxygen between the elemental form of gaseous O2 in the atmosphere and chemically bound O in CO2, H2O, and organic matter. Elemental oxygen becomes chemically bound by various energy-yielding processes, particularly combustion and metabolic processes in organisms. It is released during photosynthesis. Nitrogen Cycle Nitrogen, though constituting much less of biomass than carbon or oxygen, is an essential constituent of proteins. The atmosphere is 78% by volume elemental nitrogen, N2 and constitutes an inexhaustible

Environmental studies

and

Disaster management

(3+1)

Food Resources

&

Energy Resources

By

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Food Resources

Our food comes almost entirely from agriculture, animal husbandry and fishing i.e., - 76% from crop lands, 17% from range lands i.e., meat from grazing livestock and 7% - marine and fresh water i.e., fisheries. The FAO (Food & Agricultural Organization of UN) defines sustainable agriculture as the one which conserves land, water and plant and animal genetic resources, does not degrade the environment and is economically viable and socially acceptable. The report, "The Food Gap –the Impacts of Climate Change on Food Production: A 2020 Perspective", produced after a year-long assessment by America's Universal Ecological Fund (FEU-US), revealed that :

- Global food production would not meet the food requirements of the world's estimated 7.8 billion people by 2020.
- Food prices are expected to jump by 20% in the next ten years as prolonged droughts and floods take their toll on food production.
- The report, which looked at the impact of climate change on four cereals - wheat,`rice, maize and soybean - pointed out that
- global wheat production will experience a 14 percent deficit between production and demand
- Rice production will experience 11 percent deficit, and percent deficit in maize production.
- Soybean is the only crop showing an increase in global production, with an estimated five percent surplus.
- Current wheat production is estimated to decline to 663 million tons by 2020 yet772.3 million tons is the estimated need at that time, creating a gap of 109 million tons.
- Rice is estimated to grow to 692.1 million tons by 2020 yet demand at that time is estimated at 775.1 million –creating a shortage of 82.9 million tons.
- Maize production stands at 826.2 million tons and is estimated to grow to 849.1 million tons by 2020 yet demand at that time is estimated at 933.7 million ton, creating a shortage of 85 million tons.

WORLD FOOD PROBLEMS AND ENVIRONMENTAL CONCERNS:

1) Population growth: Food production in 64 of the 105 developing countries is lagging behind their population growth levels.

2) Poor agricultural practices: Poor environmental agricultural practices such as slash and burn, shifting cultivation, or 'rab' (wood ash) cultivation degrade forests.

3) Degradation of agricultural lands: Globally 5 to 7 million hectares of farmland is degraded each year. Loss of nutrients and overuse of agricultural chemicals are major factors in land degradation. Water scarcity is an important aspect of poor agricultural outputs. Salinization and water logging has affected a large amount of agricultural land worldwide.

4) Our fertile soils are being exploited faster than they can recuperate.

5) Forests, grasslands and wetlands have been converted to agricultural use, which has led to serious ecological questions.

6) Use of genetically modified seed variety, without minding the conducive environment for such experimentation, will seriously affect the land ecosystem.

7) Our fish resources, both marine and inland, show evidence of exhaustion.

8) There are great disparities in the availability of nutritious food. Some communities such as tribal people still face serious food problems leading to malnutrition especially among women and children.

9) Loss of Genetic Diversity: Modern agricultural practices have resulted in a serious loss of genetic variability of crops. India's distinctive traditional varieties of rice alone are said to have numbered between 30 and 50 thousand. Most of these have been lost to the farmer during the last few decades as multinational seed companies push a few commercial types. This creates a risk to our food security, as farmers can loose all their produce due to a rapidly spreading disease. A cereal that has multiple varieties growing in different locations does not permit the rapid spread of a disease.

Food security: It is the ability of all people at all times to access enough food for an active and healthy life. It is estimated that 18 million people worldwide, most of whom are children, die each year due to starvation or malnutrition, and many others suffer a variety of dietary deficiencies. The earth can only supply a limited amount of food. If the world's carrying capacity to produce food cannot meet the needs of a growing population, anarchy and conflict will follow.

The following 3 conditions must be fulfilled to ensure food security

- Food must be available
- Each person must have access to it.
- The food utilized must fulfill nutritional requirements

Options To Achieve Food Security

Food security is closely linked with population control through the family welfare program. It is also linked to the availability of water for farming. Food security is only possible if food is equitably distributed to all. Many of us waste a large amount of food carelessly. This eventually places great stress on our environmental resources.

1) Institutional support for small farmers: A major concern is the support needed for small farmers so that they remain farmers rather than shifting to urban centers as unskilled industrial workers.

2) Trade related issues: International trade policies in regard to an improved flow of food across national borders from those who have surplus to those who have a deficit in the developing world is another issue that is a concern for planners who deal with International trade concerns. 'Dumping' of under priced foodstuffs produced in the developed world, onto markets in undeveloped countries undermines prices and forces farmers there to adopt unsustainable practices to compete.

3) Protecting genetic diversity: The most economical way to prevent loss of genetic diversity is by expanding the network and coverage of our Protected Areas. Collections in germplasm, seed banks and tissue culture facilities, are other possible ways to prevent extinction but are extremely expensive. The most effective method to introduce desirable traits into crops is by using characteristics found in the wild relatives of crop plants. As the wilderness shrinks, these varieties are rapidly disappearing. Once they are lost, their desirable characteristics cannot be introduced when found necessary in future.

4) Ensuring long-term food security may depend on conserving wild relatives of crop plants in National Parks and Wildlife Sanctuaries. If plant genetic losses worldwide are not slowed down, some estimates show that as many as 60,000 plant species, which accounts for 25% of the world's total, will be lost by the year 2025. Scientists now believe that the world will soon need a second green revolution to meet our future demands of food based on a new ethic of land and water management that must be based on values which include environmental sensitivity, equity, biodiversity conservation of cultivars and in-situ preservation of wild relatives of crop plants.

5) Environmental friendly farming methods: Shift from chemical agriculture to organic farming, practicing integrated nutrient management (INM), integrated pest management (IPM).

6) Several crops can be grown in urban settings, including vegetables and fruit which can be grown on waste household water and fertilizers from vermi-composting pits.

7) Prevention of water and land degradation: Pollution of water sources, land degradation and desertification must be rapidly reversed. Adopting soil conservation measures, using appropriate farming techniques, especially on hill slopes, enhancing the soil with organic matter, crop rotation and managing watersheds at the micro level are a key to agricultural production to meet future needs.

8) Population control: Most importantly food supply is closely linked to the effectiveness of population control programs worldwide.

9) Education: Educating women about nutrition, who are more closely involved with feeding the family, is an important aspect of supporting the food needs/security of many developing countries.

10) Changing food habits : Today the world is seeing a changing trend in dietary habits. As living standards are improving, people are eating more non-vegetarian food. As people change from eating grain to meat, the world's demand for feed for livestock based on agriculture increases as well. This uses more land and water per unit of food produced and the result is that the world's poor do not get enough to eat.

11) Women play an extremely vital role in food production as well as cooking the meal and feeding children. In most rural communities they have the least exposure to technical training and to health workers trained in teaching/learning on issues related to nutritional aspects. Women and girls frequently receive less food than the men. These disparities need to be corrected.

12) Alternate Food Source: Food can be innovatively produced if we break out of the current agricultural patterns.

This includes

- Working on new avenues to produce food, such as using forests for their multiple non-wood forest products such as fruit, mushrooms, sap, etc. which can be used for food if harvested sustainably. Of course, this takes time, as people must develop a taste for these new foods.
- Using unfamiliar crops such as Nagli, which are grown on poor soil on hill slopes is another option. This crop grown in the Western Ghats now has no market and is thus rarely grown. Only local people use this nutritious crop themselves. It is thus not as extensively

cultivated as in the past. Popularising this crop could add to food availability from marginal lands. (snake gourd in Italy)

- Several foods can be popularized from yet unused seafood products such as seaweed

as long as this is done at sustainable levels. We must not only provide food for all, but also work out more equitable distribution of both food and water, reduce agricultural dependence on the use of fertilizers and pesticides (which have long term ill effects on human wellbeing) and provide an increasing support for preserving wild relatives of crop plants in Protected Areas.

World Food Day – October 16th

Case study - The Aral Sea Tragedy

The Aral sea, covering an area the size of Lithuania, started receding in the 1960s after Soviet state planners diverted its water sources, the Amu Dar ya and the Syr Dar' ya rivers, to irrigate cotton on other crop. From 1960 to 1990, the area of irrigated land in central Asia increased from 3.5 million hectares to 7.5 millino ha. Cotton production soared, making the region the world's fourth largest producer. But by 1980s the annual flow of fresh water into the Aral was barely one-tenth of the 1950 supply. The salinity level increased, destroying the sea's flora and fauna. The change in water chemistry wiped out huge populations of fish. The decline of the fish populations in turn, wiped out the commercial fishing industry on the lake. Today, fishing boats sit in the desert many kilometers from the water's edge. The lakebed sediments that are now exposed on the desert floor become airborne quite easily, contributing to large dust storms in the region. In 1989, Aral sea was divided into a smaller northern sea and a large southern one. Drinking water in the region contains four times more salt per liter than recommended by the world health organization. This has caused increases in kidney disease, diarrhea and other serious ailments. Tuberculosis has reached epidemic proportions. Cancers, lung diseases and infant mortality are 30 times higher than they used to be because the drinking water is heavily polluted with salt, cotton fertilizers and pesticides.

When the former sovient Union diverted the Ama Dariya and the Syr Dariya (the rivers which fed the Aral Sea) to grow cotton in the desert, they created an ecological and human disaster. What was the fourth biggest inland sea is now mostly desert. All of this was done in the name of cotton (grow where it would not grow naturally).

The worsening health and environmental problems of people living the Aral Sea basin, which consists of part of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, are the

direct consequences of man-made environmental disaster in the region. The children of Muynak have made a playground out of the wrecks of ships, which might have provided food and a future for them.

Experts say the disaster has left behind a 36 000 km2 area of seabed covered with accumulated salts, which the wind carries away and deposits over thousand of squares kilometers of cultivated land. Pesticides and fertilizers have also found their way into water and irrigation channels, poisoning food and drinking water affecting the lives of about five million people.

After the collapse of the Soviet Union in 1991, international donor agencies rushed to the central Asian region to asses the environmental impact of the shrinking of the Aral Sea and to find ways of restoring it to its original level. Now, almost a decade later, after countless studies and reports have been written, experts say that restoration is impossible and efforts should now focus on avoiding a humanitarian catastrophe.

The Aral Sea is not an example of a success in water resource management. In fact, it is a classic example of what can happen if we don't start to take action before a crisis begins. Still, the Aral Sea is very instructive sustainability case study, as it demonstrates how few environmental problems are not international in scope. The world is getting increasingly smaller and the problems require multinational solutions.(Benny Joseph, 2006)

Pesticides

The term pesticide is used to cover a range of chemicals that kill organisms that humans consider undesirable and includes the more specific categories of insecticides, herbicides, rodenticides, and fungicides. There are three main groups of synthetic organic insecticides: organochlorines (also known as chlorinated hydrocarbons), organophosphates, and carbamates. In addition, a number of herbicides, including the chlorophenoxy compounds 2,4,5-T (which contains the impurity dioxin, which is one of the most potent toxins known) and 2,4-D are common water pollutants. The most well-known organ chlorine pesticide is DDT (dichlorodiphenyltrichloroethane) which has been widely used to control insects that carry diseases such as malaria, typhus, and plague. By contributing to the control of these diseases, DDT is credited with saving literally millions of lives worldwide. In spite of its more recent reputation as a dangerous pesticide, in terms of human toxicity DDT is considered to be relatively safe. It was its impact on food chains, rather than human toxicity that led to its ban. Organo chlorine pesticides, such as DDT, have two properties that cause them to be particularly

disruptive to food chains. They are very persistent,which means they last a long time in the environment before being broken down into other substances, and they are quite soluble in lipids, which means they easily accumulate in fatty tissue. This phenomenon in which the concentration of a chemical increases at higher levels in the food chain is known as biomagnification orbioconcentration. Other widely used organochlorines included methoxychlor, chlordane, heptachlor, aldrin, dieldrin, endrin, endosulfan, and kepone. Animal studies have shown dieldrin, heptachlor, and chlordane produce liver cancers, and aldrin, dieldrin, and endrin have been shown to cause birth defects in mice and hamsters. Given the ecosystem disruption, the toxicity, and the biological resistance to these.

Salinity

The distinguishing characteristic of saline soils from the agricultural standpoint is that they contain sufficient neutral soluble salts to adversely affect the growth of most crop plants. For purposes of definition, saline soils are those which have an electrical conductivity of the saturation soil extract of more than 4 dS/m at 25°C (Richards 1954). This value is generally used the world over although the terminology committee of the Soil Science Society of America has lowered the boundary between saline and non-saline soils to 2 dS/m in the saturation extract. Soluble salts most commonly present are the chlorides and sulphates of sodium, calcium and magnesium.

Excess salts keep the clay in saline soils in a flocculated state so that these soils generally have good physical properties. Structure is generally good and tillage characteristics and permeability to water are even better than those of non-saline soils. However, when leached with a low salt water, some saline soils tend to disperse resulting in low permeability to water and air, particularly when the soils are heavy clays. Leaching may also result in a slight increase in soil pH due to lowering of salt concentration but saline soils, as will be shown later, rarely become strongly sodic upon leaching if there is an adequate drainage system.

Salinity and plant growth

Excess soil salinity causes poor and spotty stands of crops, uneven and stunted growth and poor yields, the extent depending on the degree of salinity. The primary effect of excess salinity is that it renders less water available to plants although some is still present in the root zone. This is because the osmotic pressure of the soil solution increases as the salt concentration increases.

Apart from the osmotic effect of salts in the soil solution, excessive concentration and absorption of individual ions may prove toxic to the plants and/or may retard the absorption of other essential plant nutrients

Reclamation and management

Salt leaching

The amount of crop yield reduction depends on such factors as crop growth, the salt content of the soil, climatic conditions, etc. In extreme cases where the concentration of salts in the root zone is very high, crop growth may be entirely prevented. To improve crop growth in such soils the excess salts must be removed from the root zone. The term reclamation of saline soils refers to the methods used to remove soluble salts from the root zone. Methods commonly adopted or proposed to accomplish this include the following:

Scraping: Removing the salts that have accumulated on the soil surface by mechanical means has had only a limited success although many farmers have resorted to this procedure. Although this method might temporarily improve crop growth, the ultimate disposal of salts still poses a major problem.

Flushing: Washing away the surface accumulated salts by flushing water over the surface is sometimes used to desalinize soils having surface salt crusts. Because the amount of salts that can be flushed from a soil is rather small, this method does not have much practical significance.

Leaching: This is by far the most effective procedure for removing salts from the root zone of soils. Leaching is most often accomplished by ponding fresh water on the soil surface and allowing it to infiltrate. Leaching is effective when the salty drainage water is discharged through subsurface drains that carry the leached salts out of the area under reclamation. Leaching may reduce salinity levels in the absence of artificial drains when there is sufficient natural drainage, i.e. the ponded water drains without raising the water table. Leaching should preferably be done when the soil moisture content is low and the groundwater table is deep. Leaching during the summer months is, as a rule, less effective because large quantities of water are lost by evaporation. The actual choice will however depend on the availability of water and other considerations. In some parts of India for example, leaching is best accomplished during the summer months because this is the time when the water table is deepest and the soil is dry. This is also the only time when large quantities of fresh water can be diverted for reclamation purposes.

Water Logging

Water logging is the natural flooding and over- irrigation that brings water at underground levels to the surface. As a consequence, displacement of the air occurs in the soil with corresponding changes in soil processes and an accumulation of toxic substances that impede plant growth. In more simple terms when the conditions are so created that the crop root-zone gets deprived of proper aeration due to the presence of excessive moisture or water content, the tract is said to be waterlogged. To create such conditions it is not always necessary that underground table should enter the crop root-zone. Sometimes even if water table is below the root-zone depth the capillary water zone may extend in the root-zone depth and makes the air circulation impossible by filling the pores in the soil.

Causes of Water logging:

After studying the phenomenon of water logging in the light of hydrologic equation main factors which help in raising the water-table may be recognized correctly.

They are:

i. Inadequate drainage of over-land run-off increases the rate of percolation and in turn helps in raising the water table.

ii. The water from rivers may infiltrate into the soil.

iii. Seepage of water from earthen canals also adds significant quantity of water to the underground reservoir continuously.

iv. Sometimes subsoil does not permit free flow of subsoil water which may accentuate the process of raising the water table.

v. Irrigation water is used to flood the fields. If it is used in excess it may help appreciably in raising the water table. Good drainage facility is very essential.

Effects on plant growth

Low levels of oxygen in the root zone trigger the adverse effects of waterlogging on plant growth. Waterlogging of the seedbed mostly affects germinating seeds and young seedlings. Established plants are most affected when they are growing rapidly. Therefore, if a soil becomes waterlogged in July, final yields may not be greatly reduced; soils are cold, the demand for oxygen is low and plant growth is slow at this time of year. Prolonged waterlogging during the warmer spring period could be more detrimental, however the probability for this to occur is much lower than water logging in July. When plants are growing actively, root tips begin to die

within a few days of waterlogging. The shallow root systems that then develop limit the uptake of nutrients (particularly nitrogen) and water, particularly when the soil profile starts to dry in spring. As a result plants may ripen early and grains may not fill properly. Nitrogen is lost from waterlogged soils by leaching and denitrification (degassing). Denitrification leads to the gaseous loss of nitrous oxide (N_2O) into the atmosphere, which is a major greenhouse gas. These losses, together with the lowered ability of plants to absorb nutrients from waterlogged soil, cause the older leaves to yellow. Waterlogging also directly reduces nitrogen fixation by the nodules of legume crops and pastures.

Effects of Water logging:

The water logging affects the land in various ways. The various after effects are the following:

1. Creation of Anaerobic Condition in the Crop Root-Zone:

When the aeration of the soil is satisfactory bacteriological activities produce the required nitrates from the nitrogenous compounds present in the soil. It helps the crop growth. Excessive moisture content creates anaerobic condition in the soil. The plant roots do not get the required nourishing food or nutrients. As a result crop growth is badly affected.

2. Growth **of Water Loving Wild Plants:**

When the soil is waterlogged water loving wild plant life grows abundantly. The growth of wild plants totally prevent the growth of useful crops.

3. Impossibility of Tillage Operations:

Waterlogged fields cannot be tilled properly. The reason is that the soil contains excessive moisture content and it does not give proper tilth.

4. Accumulation of Harmful Salts:

The upward water movement brings the toxic salts in the crop root-zone. Excess accumulation of these salts may turn the soil alkaline. It may hamper the crop growth.

5. Lowering of Soil Temperature:

The presence of excessive moisture content lowers the temperature of the soil. In low temperature the bacteriological activities are retarded which affects the crop growth badly.

6. Reduction in Time of Maturity:

Untimely maturity of the crops is the characteristic of waterlogged lands. Due to this shortening of crop period the crop yield is reduced considerably.

Energy Resources

Energy is defined as 'the capacity to do work'. Sun is the primary source of energy.

Joule is the standard unit of energy in SI units. Energy utilization is an index of economic development, which does not take into account of ill effects/damage on to environment.

Energy Resources

All energy sources ultimately come from the sun, the moon or the earth.

Sources of Energy

Solar energy drives the following:

- The global climate system which give as wind power.
- Wave power
- Hydroelectric power
- Solar heating and Solar lighting
- The global ecosystems which give as biomass power such as wood or muscle.
- The ancient ecosystem whose energy is now stored as fossil fuels.

The moon's gravitational energy is responsible for the ideal effect, which give rise to tidal power.

The earth itself is the key source of energy such as the following:

- Gravitational energy for hydroelectric power
- Chemical energy for nuclear power, electro- chemical reaction and hydrogen fuel cells.
- Geothermal power from the heat of lower crust.

Other exciting energy sources are currently untapped, such as energy in the earth's magnetic field, the energy potential caused by temperature differences in different layers of the ocean and the energy contained in combustible deposits of methyl hydrates in the sediments of the continental shelves. There are undoubtedly energy types we have not yet discovered. The relatively recent discovery of radiation remains us that novel discoveries will continue to happen. There are also energy types that are not new but are simply untapped. The average human beings give of f 60 watts of heat by simply standing in a room. With effective insulation and ventilation it is possible to heat many building types by the heat energy of their occupants alone.

Types of Energy resources can be described as renewable, non renewable and sustainable. **Renewable energy** sources include

- Wind power
- Wave power
- Ocean Thermal Exchange Capacity (OTEC) - based on temperature differences in ocean layers.
- Solar Power
- Hydro power
- Fuel cells
- Bio- fuels- also known as biomass fuels-such as alcohol form, sugar, methane from organic waste or charcoal from trees and biodiesel. The key characteristics of renewable energies is that the energy sources are continually available, still some cases such as with hydro power and biomass, continuing availability requires good management – for example tree planting or river management. Other renewable like solar and wind power are available for the foreseeable future without any human intervention.

Non- renewable types of energy include all the fossil fuels – coal, oil, gas and their derivatives such as petrol and diesel. The non- renewable are finite in supply because their rate of formation is so low that they are, in reality, finite sources.

Sustainable energy is a term sometimes applied to nuclear power. The supplies are not exactly renewable but they will lost for a very long time because a great of electricity is produced from a small amount of radioactive material.

In general, the three types of energy have very different characteristics. This means there is no 'ideal' energy source. The future will most likely to be a mix of sources with increase in emphasis on the renewable.

Advantages and Disadvantages of various Energy Types

Energy type Advantages Disadvantages

Renewable

Non renewable

Sustanible (Nuclear Power)

- Wide availability
- Lower running cost

- Decentralized power production
- Low Pollution
- Available for the foreseeable future
- Available in highly concentrated form
- Easy to store
- Reliable supply
- Lower cost per unit of energy produced as the technology is matured.
- Highly reliable
- Produces large amounts of energy with very little CO2emissions
- Uses small amount of raw material per unit energy production.
- Unreasonable supply
- Usually produced in small quantities
- Often very difficult to store
- Currently per unit cost of energy is more compared to other types.
- Highly polluting
- Available only in few places
- High running cost
- Limited supply and will one day get exhausted
- Risk of radioactivity
- High waste disposal costs
- High capital investment and maintenance cost

Non Renewable Energy Sources:

Environmental Impacts of fossil fuels in general

Fossil fuels- (coal, oil, gas, peat, lignite, etc.)

Extraction of fuel by mining, drilling, quarrying and/ or excavation leads to significant impacts on the surrounding environment and landscape (habitat modification and destruction, pollution etc.)

- Spoil and solid wastes from mining and extraction have both visual and environmental impacts.
- Wastewater and leachates from mining, drilling and excavation, and gas leaks from pipelines can pollute surrounding waters, air and land.

- Purification or modification of raw products for use as fuels requires energy, and may lead to secondary sources of pollution.
- Transportation of fuels to energy production sites uses fuel (causes air pollution) and possibly a pollution risk, eg.oil tankers are at risk from accidents and may lead to oil spills at sea.
- Combustion of fuels to produce energy leads to air pollution (carbon, nitrogen and sulphur oxides) and in some cases, the production of solid wastes (in the form of ash).

Oil and Its Environmental Impacts:

India's oil reserves which are being used at present lie off the coast of Mumbai and in Assam. This wastes nearly 40% of available gas. The processes of oil and natural gas drilling, processing, transport and utilisation have serious environmental consequences, such as leaks in which air and water are polluted and, during refining oil, solid waste such as salts and grease are produced which also damage the environment. Accidental fires that may go on burning for days or weeks before the fire can be controlled. Oil slicks are caused at sea from offshore oil wells, cleaning of oil tankers and due to shipwrecks. Oil powered vehicles emit carbon dioxide, sulphur dioxide, nitrous oxide, carbon monoxide and particulate matter which is a major cause of air pollution especially in cities with heavy traffic density. Running petrol vehicles with unleaded fuel has been achieved by adding catalytic converters on all the new cars, but unleaded fuel contains benzene and butadiene which are known to be carcinogenic compounds. Delhi, which used to have serious smog problems due to traffic, has been able to reduce this health hazard by changing a large number of its vehicles to CNG, which contains methane. Dependence on dwindling fossil fuel resources, especially oil, results in political tension, instability and war. At present 65 percent of the world's oil reserves are located in the Middle East.

Coal and Its Environmental Impacts:

Coal is the world's single largest contributor of green house gases and is one of the most important causes of global warming. At the current rates of use the world's coal reserves lasts for another 200 years. Many coal-based power generation plants are not fitted with devices such as electrostatic precipitators to reduce emissions of suspended particulate matter (SPM) which is a major contributor to air pollution. Burning coal also produces oxides of sulphur and nitrogen which, combined with water vapour, lead to 'acid rain'. This kills forest vegetation, and damages architectural heritage sites, pollutes water and affects human health. Thermal power stations that

use coal produce waste in the form of 'fly ash'. Large dumps are required to dispose off this waste material, while efforts have been made to use it for making bricks/cement ingredient. Among the fossil fuels coal is most harmful to the environment.

Natural gas:

Is a mixture of methane, butane, ethane and propane found above oil reserves. Propane and butane are liquified and removed as LPG and Methane is cleaned and pumped in to pipelines. Natural gas is in abundance, low production cost and low pollution. It is an ideal fuel transition from fossil fuels to renewable sources. Most of our natural gas is linked to oil and, because there is no distribution system, it is just burnt off.

Sustainable energy

Nuclear Power and it's Environmental Impacts:

Energy that is trapped inside each atom is nuclear energy. In 1938 two Ger***man scientists Otto Hahn and Fritz Strassman demonstrated nuclear fission***. They found that they could split the nucleus of a uranium atom by bombarding it with neutrons. As the nucleus split, some mass was converted to energy. The nuclear power industry however was born in the late 1950s. The first large-scale nuclear power plant in the world became operational in 1957 in Pennsylvania, USA. **Dr. Homi Bhabha was the father of Nuclear Power development in India**. India has uranium mines in Bihar. There are deposits of thorium in Kerala and Tamilnadu. The nuclear reactors use Uranium 235 to produce electricity. Energy released from 1kg of Uranium 235 is equivalent to that produced by burning 3,000 tons of coal. Uranium 235 (U235) is made into rods which are fitted into a nuclear reactor. The control rods absorb neutrons and thus adjust the fission which releases energy due to the chain reaction in a reactor unit. The heat energy produced in the reaction is used to heat water and produce steam, which drives turbines that produce electricity.

Impacts on the environment

The rods need to be changed periodically. This has impacts on the environment due to disposal of nuclear waste. The reaction releases very hot waste water that damages aquatic ecosystems, even though it is cooled by a water system before it is released. The disposal of nuclear waste is becoming an increasingly serious issue.

Uranium (fuel used in nuclear power stations) mining can cause high levels of pollution in the surrounding environment, as well as posing health risks for mine workers. Transport of uranium and nuclear fuels carries potential pollution and environmental contamination risks. The

radioactive waste produced in nuclear power plants remains highly toxic for centuries. There are currently no safe ways to either store this waste or dispose of it permanently. Waste (such as cooling water) from nuclear power and fuel reprocessing plants can cause radioactive pollution in the surrounding environment. The cost of Nuclear Power generation must include the high cost of disposal of its waste and the decommissioning of old plants. These have high economic as well as ecological costs that are not taken into account when developing new nuclear installations.

Although, the conventional environmental impacts from nuclear power are negligible, what overshadows all the other types of energy sources is that an accident can be devastating and the effects last for long periods of time. While it does not pollute air or water routinely like oil or biomass, a single accident can kill thousands of people, make many others seriously ill, and destroy an area for decades by its radioactivity which leads to death, cancer and genetic deformities for generations. Land, water, vegetation are destroyed for long periods of time. There have been nuclear accidents at Chernobyl in USSR and at the Three Mile Island in USA. Management, storage and disposal of radioactive wastes resulting from nuclear power generation are the biggest expenses of the nuclear power industry. Low level waste can be stored safely for 100 – 500 years while the high level wastes remains radioactive for 240,000 years! Decommissioning an old plant costs more than the original construction cost!

Renewable Energy:

Renewable energy systems use resources that are constantly replaced and are usually less polluting. Ex: hydropower, solar, wind, and geothermal (energy from the heat inside the earth). We also get renewable energy from burning trees and even garbage as fuel and processing other plants into biofuels. Renewable energy technologies will improve the efficiency and cost of energy systems. We may reach the point when we may no longer rely mostly on fossil fuel energy.

Hydroelectric Power:

This uses water flowing down a natural gradient to turn turbines to generate electricity known as ‘hydroelectric power’ by constructing dams across rivers. Between 1950 and 1970, Hydropower generation worldwide increased seven times.

Advantages:

- The long life of hydropower plants,

- the renewable nature of the energy source
- very low operating and maintenance costs, and
- absence of inflationary pressures as in fossil fuels

Environmental impact / Drawbacks: Although hydroelectric power has led to economic progress around the world, it has created serious ecological problems.

- To produce hydroelectric power, large areas of forest and agricultural lands are submerged. These lands traditionally provided a livelihood for local tribal people and farmers. Conflicts over land use are inevitable.
- Silting of the reservoirs (especially as a result of deforestation) reduces the life of the hydroelectric power installations.
- The reservoir drown large areas of farm land, wild life habitats and places of historical & cultural importance
- Water is required for many other purposes besides power generation. These include domestic requirements, growing agricultural crops and for industry. This gives rise to conflicts.
- The use of rivers for navigation and fisheries becomes difficult once the water is dammed for generation of electricity.
- Resettlement of displaced persons is a problem for which there is no ready solution. The opposition too many large hydroelectric schemes is growing as most dam projects have been unable to resettle people that were affected and displaced.
- In certain regions large dams can induce seismic activity which will result in earthquakes. There is a great possibility of this occurring around the Tehri dam in the Himalayan foothills. With large dams causing social problems, there has been a trend to develop small hydroelectric generation units. Multiple small dams have less impact on the environment. The development of small hydroelectric power units could become a very important resource in India, which has steeply falling rivers and the economic capability and technical resources to exploit them.

Solar Energy:

Sun is the primary source of energy. Sun's energy each day is 600 times greater than produced from all other sources (1/5 of known reserves of fossil fuels). If it was possible to harness this colossal quantum of energy, humanity would need no other source of energy. Several methods were developed for collecting this energy for heating water and generating electricity. Solar energy is Readily available source of energy and is free; Non conventional source of energy and non polluting. The major problem with solar energy is its intermittent nature, during day less in cloudy weather. Hence, supplementary source of energy is essential. It needs people's initiatives and high initial expenses. After dramatic rise in oil prices during 1970's several countries started research and developmental programmes to exploit the solar energy.

Is PV cells are environment friendly? PV cells are environmentally benign, i.e. they do not release pollutants or toxic material to the air or water, there is no radioactive substance, and no catastrophic accidents. Some PV cells, however, do contain small quantities of toxic substances such as cadmium and these can be released to the environment in the event of a fire. Solar cells are made of silicon which, although the second most abundant element in the earth's crust, has to be mined. Mining creates environmental problems. PV systems also of course only work when the sun is shining, and thus need batteries to store the electricity.

Biomass Energy:

Biomass is organic material which has stored sun light in the form of chemical energy. Because plants and trees depend on sunlight to grow, biomass energy is a form of stored solar energy. Although wood is the largest source of biomass energy, we also use agricultural waste, sugarcane wastes, and other farm by products to make energy. Half a kilo of dry plant tissue – produce as much as 1890 Kcal of heat – equivalent to quarter kilo of coal A typical biogas sample contains 68% methane, 31% CO2, 1% Nitrogen and calorific value is 5871 Kcal/m3 (i.e. 80% natural gas).

Biogas is produced from plant material and animal waste, garbage, waste from households and some types of industrial wastes, such as fish processing, dairies, and sewage treatment plants. It is a mixture of gases which includes methane, carbon dioxide, hydrogen sulphide and water vapour. In this mixture, methane burns easily. With a ton of food waste, one can produce 85 Cu. M of biogas. Once used, the residue is used as an agricultural fertilizer. Denmark produces a

large quantity of biogas from waste and produces 15,000 megawatts of electricity from 15 farmers' cooperatives. London has a plant which makes 30 megawatts of electricity a year from 420,000 tons of municipal waste which gives power to 50,000 families. In Germany, 25% of landfills for garbage produce power from biogas. Japan uses 85% of its waste and France about 50%.

Biogas plants have become increasingly popular in India in the rural sector. These biogas plants use cow dung (Gobar gas), which is converted into a gas which is used as a fuel – for lighting/cooking. It is also used for running dual fuel engines.

Wind Power:

Wind was the earliest energy source used for transportation by sailing ships.Wind energy produces electricity at low cost; capital costs are moderate and there are no emission. Some 2000 years ago, windmills were developed in China, Afghanistan and Persia to draw water for irrigation and grinding grain. Most of the early work on generating electricity from wind was carried out in Denmark, at the end of the last century. Five nations (Germany, USA, Denmark, Spain and India) produce 80% of world's wind energy capacity. Today, Denmark and California have large wind turbine cooperatives which sell electricity to the government grid. Wind Farms – cluster of wind turbines (aero generators) to charge large batteries. The power in wind is a function of the wind speed and therefore the average wind speed of an area is an important determinant of economically feasible power. Wind speed increases with height.

Environmental Impacts:

Wind power has few environmental impacts, as there are virtually no air or water emissions, or radiation, or solid waste production. The principal problems are bird kills, noise, effect on TV reception etc. Although large areas of land are required for setting up wind farms, the amount used by the turbine bases, the foundations and the access roads is less than 1% of the total area covered by the wind farm. The rest of the area can also be used for agricultural purposes or for grazing. Setting windmills offshore reduces their demand for land and visual impact. Wind is an intermittent source and the intermittency of wind depends on the geographic distribution of wind. Wind therefore cannot be used as the sole resource for electricity, and requires some other backup or stand-by source (as in solar system).

Tidal and Wave Power:

The energy of waves in the sea that crash on the land of all the continents is estimated at 2 to 3 million megawatts of energy. From the 1970s, several countries have been experimenting with technology to harness the kinetic energy of the ocean to generate electricity. Water flows from a higher level to lower level, greater the difference between high and low tides more energy can be extracted. Tidal power is tapped by placing a barrage across an estuary and forcing the tidal flow to pass through turbines. In a one-way system the incoming tide is allowed to fill the basin through a sluice, and the water so collected is used to produce electricity during the low tide. In a two way system power is generated from both the incoming as well as the outgoing tide.

Environmental impact:

Tidal power stations bring about major ecological changes in the sensitive ecosystem of coastal regions and can destroy the habitats and nesting places of water birds and interfere with fisheries. A tidal power station at the mouth of a river blocks the flow of polluted water into the sea, thereby creating health and pollution hazards in the estuary. Other drawbacks include offshore energy devices posing navigational hazards. Residual drift current could affect spawning of some fish, whose larvae would be carried away from spawning grounds. They may also affect the migration patterns of surface swimming fish.

Thermal Energy:

Ocean collects and store huge quantities of solar radiations in the form of heat. This is another developing concept to harnesses energy due to the differences in temperature between the warm upper layers of the ocean and the cold deep sea water.

Geothermal Energy:

It is the energy stored within the earth ("geo" for earth and "thermal" for heat). Core of the earth is very hot – as high as 60000C, temperature rises with depth @ 300C per Km. Geothermal energy starts with hot, molten rock (called magma) deep inside the earth which surfaces at some parts of the earth's crust (volcanoes). With modern technology, wells are drilled deep below the surface of the earth to tap into geothermal reservoirs. This is called direct use of geothermal energy, and it provides a steady stream of hot water that is pumped to the earth's

surface. Geothermal energy is nearly as cheap as hydropower and will thus be increasingly utilised in future.

Environmental impact:

Water from geothermal reservoirs often contains minerals that are corrosive and polluting and they may be toxic to fishes. Steam contains H2S gas which gives rotten egg smell and cause air pollution. Geothermal fluids are a problem which must be treated before disposal.

Methods to solve energy crisis

- Avoid fossil fuels
- Smokeless stoves
- Use solar energy extensively
- Biogas – (500kg litter gives 50m3/day)
- Trees should be planted.