Course e-content

# ENS 101/201

# ENVIRONMENTAL STUDIES AND DISASTER MANAGEMENT (2+1)

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2020

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## PREFACE

This e-content is prepared intended to provide the core elements of a curriculum for teaching Environmental studies and Disaster management. This e - content compiled with lecture notes, power points, question banks will be aiding the students for gaining knowledge about environmental studies and disaster management. This content written from the ground up to provide environmental related information and examples. This text, along with global data provides a broader perspective. At the same time, global focus enhance the international context for learning about issues, while in detail examine particular topics in greater depth. Perhaps no other country has moved so rapidly from a position of contentment in creating environmental awareness into infusing these newer pro environmental concepts into formal curricular processes as has happened in India over the last few years. This has undoubtedly been accelerated by the judgement of the Honorable Supreme Court of India that Environmental Education must form a compulsory core issue at every stage in our education processes. For one who has fought to implement a variety of environment education programs for schools and colleges and for the public at large, this is indeed a welcome change. Reports and research works of many scientists /authors have been mentioned in the text to provide valuable information for the student's community. Authors are very much thankful to Deans of all colleges of Tamil Nadu Agricultural University, Coimbatore and Professor and Head, Department of ENS, TNAU, Coimbatore for consent encouragement and motivation for Preparation of this e-content.

**Authors**

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## Syllabus

**ENS 101 Environmental Studies and Disaster Management (2+1)**

**Theory**

**Unit 1:** Multidisciplinary nature of environmental studies Definition, scope and importance

**Unit 2:** Natural Resources: Renewable and non-renewable resources Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

**Unit 3:** Ecosystems. Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem. a. Forest ecosystem. b. Grassland ecosystem. c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**Unit 4:** Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**Unit 5:** Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution. g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies.

**Unit 6:** Social Issues and the Environment: From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.

**Unit 7:** Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies.

**DISASTER MANAGEMENT**

**Unit 8**: Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.

**Unit 9:** Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

**Unit 10:** Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community - based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

**Practical**

Field work: Visit to a local area to document environmental assets river/ forest/ grassland/hill/mountain, visit to a local polluted site -Urban/Rural/ Industrial/ Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.

**Lecture Schedule**

1. Multidisciplinary nature of environmental studies - Definition, scope and importance - Natural Resources: Renewable and non-renewable resources - Natural resources and associated problems
2. Forest resources: Use and over-exploitation, deforestation, case studies - Timber extraction, mining, dams and their effects on forest and tribal people
3. Water resources: Use and over-utilization of surface and ground water - Floods, drought, conflicts over water, dams - benefits and problems
4. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies - Food resources: World food problems, changes caused by agriculture and overgrazing
5. Effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies - Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources. Case studies.
6. Land resources: Land as a resource, land degradation, man induced landslides - Soil erosion and desertification - Role of an individual in conservation of natural resources - Equitable use of resources for sustainable lifestyles
7. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Energy flow in the ecosystem - Ecological succession - Food chains, food webs and ecological pyramids
8. Introduction, types, characteristic features, structure and function of Forest ecosystem, Grassland ecosystem and Desert ecosystem
9. Introduction, types, characteristic features, structure and function of Aquatic ecosystems : ponds, streams, lakes - Rivers, oceans, estuaries
10. Biodiversity and its conservation - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India- Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values
11. Biodiversity at global, National and local levels - India as a mega-diversity nation - Hotspots of biodiversity - Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts

12. Endangered and endemic species of India - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
13. Environmental Pollution - Definition, cause, effects and control measures of Air pollution and Noise pollution
14. Definition, cause, effects and control measures of Water pollution and Soil pollution
15. Definition, cause, effects and control measures of Marine pollution, Thermal pollution and Nuclear hazards
16. Solid Waste Management: Causes, effects and control measures of urban and industrial wastes
17. **Mid Semester Examination**
18. Role of an individual in prevention of pollution - Pollution case studies - Social Issues and the Environment - From Unsustainable to Sustainable development - Urban problems related to energy
19. Water conservation, rain water harvesting, watershed management - Environmental ethics: Issues and possible solutions, climate change, global warming
20. Acid rain, ozone layer depletion, Nuclear accidents and holocaust - Wasteland reclamation- Consumerism and waste products
21. Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act
22. Issues involved in enforcement of environmental legislation - Public awareness - Human Population and the Environment: Population growth, variation among nations, population explosion, Family Welfare Programme
23. Environment and human health: Human Rights, Value Education, HIV/AIDS - Women and Child Welfare - Role of Information Technology in Environment and human health - Case Studies
24. Disaster Management - Natural Disasters - Meaning and nature of natural disasters, their types and effects - Floods, drought
25. Cyclone, earthquakes, Landslides, avalanches
26. Volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion
27. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, Building fire, coal fire, forest fire, oil fire
28. Air pollution, water pollution, deforestation, industrial waste water pollution
29. Road accidents, rail accidents, Air accidents, sea accidents
30. Disaster Management - Effect to migrate natural disaster at national and global levels
31. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements
32. Role of NGOs, community - based organizations and media in disaster management
33. Central, state, district and local administration in disaster management
34. Armed forces in disaster response - Disaster response; Police and other organizations.

**Practical schedule**

1. Visit to a local area to document environmental assets river/forest/grassland/hill/mountain
2. Energy: Biogas production from organic wastes
3. Visit to wind mill / hydro power / solar power generation units
4. Biodiversity assessment in farming system
5. Floral and faunal diversity assessment in polluted and un polluted system
6. Visit to local polluted site-Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds
7. Environmental sampling and preservation
8. Water quality analysis: pH, EC and TDS

9. Estimation of Acidity, Alkalinity
10. Estimation of water hardness
11. Estimation of DO and BOD in water samples
12. Estimation of COD in water samples
13. Enumeration of *E. coli* in water sample
14. Assessment of Suspended Particulate Matter (SPM)
15. Study of simple ecosystem – pond/river/hills
16. Visit to areas affected by natural disaster
17. Practical Examination

**Lecture 1**

# MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES - DEFINITION, SCOPE AND IMPORTANCE - NATURAL RESOURCES: RENEWABLE AND NON-RENEWABLE RESOURCES - NATURAL RESOURCES AND ASSOCIATED PROBLEMS

## Definition and Concept of Environment

The word environment is derived from the French word environ, meaning external conditions or surroundings that favour the growth of flora and fauna, human beings and their properties and protect them from the effects of pollution. According to Douglas and Holland (1947), environment is 'a word which describes, in the aggregate, all of the extrinsic (external) forces influences and conditions, which affect the life, nature, behaviour and the growth, development and maturation of living organisms'. 'Environment covers all the outside factors that have acted on the individual since he began life'. (Woodworth and Marques, 1948) Environment means the aggregate of a complex set of physical, geographical, biological, social, cultural and political conditions that surrounds an individual or organism and eventually determines its appearance as well as nature of its survival.

## Types of Environment

- Environment is practically everything that embraces an organism. Out of all the planets comprising the solar system, the only habitable planet to provide all the necessary conditions for existence of life is the Earth. The physical and chemical environment however varies at places and provides unique conditions for living beings to adapt and survive. On the basis of human interference, environment can be categorized as natural, semi-synthetic or artificial.
- A natural environment is inherent, unaltered and not manipulated by man. Life processes and evolution progresses are unhindered in such an environment.
- A semi-synthetic environment is the natural environment that is modified partially by human intervention, namely development of lakes, aquaculture tanks and so on.
- An artificial or man-made or synthetic environment is when the natural environment is deliberately controlled and converted by mankind. For example, aquariums, cities, community parks, paddy fields or the tissue culture laboratories.

## Multidisciplinary Nature of Environmental Studies

Environmental studies cover every aspect that affects a living organism, as it interacts with the surroundings in its quest to live. Environmental studies are integrative, but the core of the subject comprises biological sciences like zoology, botany, microbiology and physiology. Many environmental concerns can be resolved through application of biotechnology and molecular biology, while bioinformatics can serve as a database at molecular level. Environmental studies is therefore multidisciplinary and aims at unraveling the ways in which human beings and nature correlate and sustain.

Physics, chemistry, biology, anthropology, geology, engineering, archaeology, sociology, economics, statistics, political science, law, anthropology, management, technology and health sciences are all its components. Among these physics, chemistry, geography, geology and atmospheric science help us understand the basic concepts of structural and functional organization, as well as the physical characteristics of our

environment. Data simulation and interpretation needs the application of statistics and computer application, while mathematical science is used in environmental modeling. The technical solutions for pollution management, waste management, green building and green energy can be found with expertise from the fields of engineering and architecture. Achievement of sustainability at all levels is interwoven with and dependent on international cooperation which in turn rests on international relations. Principles of sustainable development determine the negotiation of international accords and security issues. International cooperation is an indispensible factor in dealing with global environmental issues like climate change, trans-boundary pollution, trade in hazardous substances, ozone layer depletion, biodiversity loss, etc. Management studies will enable us to formulate policies, followed by legislation for their implementation.

**Scope of Environmental Studies**

The scope of environmental studies has increased owing to the damage we have done to the environment in terms of global warming, ozone depletion, acids rain and other consequences. The scope of Environmental Studies is not only limited to studying mere concepts, philosophy, ethics, components and the problems associated with resource depletion, pollution and population explosion, but also to find out a practical global solution in the form of raising public awareness – a heart to feel the immediate need for environmental protection leading to increased participation at all levels and a mind to develop scientific and effective management strategies and solution to all the problems we are currently facing. Acceptance of human error and the need for immediate steps to reverse the trends, in this context, is a relatively new concept.

**Expertise in the field of environmental science can be placed as:**

- Environment consultant
- Toxicologist
- Environment manager
- Environmental engineer
- Conservation officer
- Waste management officer
- Scientist in water and air quality
- Public health practitioner
- Architect of landscape design
- Urban planner
- Transport management

*Source :MahuaBasu, Cambridge University Press*
*http://assets.cambridge.org/97811075/36173/excerpt/9781107536173_excerpt.pdf*

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**Lecture 2 and 3**

# NATURAL RESOURCES - SOIL, WATER, MINERAL, FOREST AND ENERGY RESOURCES

## NATURAL RESOURCES

Natural resources are the raw materials and/or forms of energy obtained or derived from nature for the fulfillment of physiological, socio-economic and cultural needs of human beings, both at the individual level and that of the community.

### a. SOIL RESOURCES

India's share of soil resources in world is about 2.3% (329Mha). Of this 29% are inceptisols, 23% entisols, 8% vertisols and 4.5% aridisols. India is gifted with heterogeneous landforms and variety of climatic conditions such as the lofty mountains, the raverine deltas, high altitude forests, peninsular plateaus, variety of geological formations endowed with temperature varying from arctic cold to equatorial hot, and rainfall from extreme aridity with a few cms (<10 cm) to humid with world's maximum rainfall (1120 cm) of several hundred cms. This provides macro relief of high plateau, open valleys, rolling upland, plains, swampy lowlands and barren deserts. These varying environmental situations in the country have resulted in a greater variety of soils.

The major soil types of India are 1. Alluvial soils, 2. Black soils, 3. Red soils, 4. Laterite soils, 5. Forest and mountain soils, 6. Arid and desert soils, 7. Saline and alkaline soils and 8. Peat and marshy soils.

1. **Alluvial soils**: Most important group. Composed of sediments deposited by rivers and waves. Most fertile in the world but deficient in nitrogen and humus. Occupy the plains (from Punjab to Assam) and also occur in the valleys of Narmada and Tapti in M.P. & Gujarat, Mahanadi in the MP and Orissa, Godawari in A.R and Cauvery in T.N. Can be divided into Khadar (new) and Bhangar (older, more clayey and kankary) alluvium.

2. **Black soils :** Also called Regur and ideal for cotton. Formed due to solidification of lava. Mainly found in Deccan plateau. They are black due to compounds of iron and aluminium. Have high moisture retention but poor in nitrogen, phosphorus and organic matter. Suited for cereals, oilseeds, citrus, vegetables, tobacco and sugarcane

3. **Red soils:** Formed due to decomposition of ancient crystalline rocks like granites and gnesses. Rich in Fe and Mg. Covers Whole of TN, Karnataka, AP, Maharashtra, Chaatisgarh, Orissa, Jharkhand and Bundelkhand. Rich in K but deficient in N, P and humus.

4. **Laterite soils :** Found in typical monsoon conditions. Soils rich in Fe and Al compounds. Found in Western and eastern ghats, Rajmahal hills, Maharashtra, Karnataka, Kerala, Orissa, West Bengal, Assam, Tamil Nadu. Poor in N and minerals. Best for tea, coffee, cinchona, coconut, rice and millets.

5. **Forest and mountain soils:** Soils are found in hill slopes covered by forests. In Himalayan region and mountains of peninsular India. Very rich in humus but deficient in K, Lime. Suitable for plantation crops and tropical fruits.

6. **Arid and desert soils:** Prevalent where rainfall is less than 50 cm. Areas of Punjab and Haryana lying between the Indus and aravallis. Covered by mantle and hence inhibits soil growth. High in P, low in N.

7. **Saline and alkaline soils:** Found in drier parts of Bihar, Punjab, Rajasthan, Maharashtra. Salts are transported by rivers, canals which percolates in subsurface. Accumulation of salts make them unfit for agriculture.

8. **Peat and Marshy soils:** Originate in humid regions with more of organic matter (10-40%). Peaty soils are found in kottyam and alappuzha. Marshy soils are found in N.Bihar, coastal Orissa, West Bengal and parts of UP.

### b. WATER RESOURCES

India has a total water surface area of 31440 sq. km and receives an average annual rainfall of 1100 mm. Irrigation accounts for 92% water utilization. India's inland water resources comprising rivers, canals, ponds and lakes and marine resources comprising the east and west coasts of the Indian ocean and other gulfs and bays provide employment to nearly 6 million people in the fisheries sector. In 2008, India had the world's third largest fishing industry.

Inland resources are rivers, canals, reservoirs, tanks, ponds. Total water bodies cover 7Mha. UP occupies first place with more rivers and canals (17%). Among remaining forms of inland waters, tanks and ponds have maximum area (2.9Mha) and reservoirs (2.1Mha). AP, Gujarat, Karnataka, MP, Maharashtra, Orissa and UP account for later area under reservoirs that supplies water for most of cultivation. Orissa, UP and Assam has more than 77% of lakes and total area under brackish water. Hence, there is even distribution of inland water resources. The total annual groundwater resources have been estimated as 433 billion cubic meter (BCM). Keeping 34BCM for natural discharge, the net annual groundwater availability of entire country is 399 BCM. Irrigation potential created from both surface and groundwaters is 93946 and 80 million ha of irrigation potential was utilized till XI plan.

### c. MINERAL RESOURCES

India's major mineral resources include Coal (fourth-largest reserves in the world), Iron ore, Manganese, Mica, Bauxite, Titanium ore, Chromite, Natural gas, Diamonds, Petroleum, Limestone and Thorium (world's largest along Kerala's shores). India's oil reserves, found in Bombay High off the coast of Maharashtra, Gujarat, Rajasthan and in eastern Assam meet 25% of the country's demand. The share of the mining sector in the GDP of these countries in 2010 ranged from 15.1% to 2.3 %. However, in India mining sector accounts for just 2.2% of the GDP (McKinsey Report, 2011). The exploration spending (including for oil and gas) in India is around $ 15 /sq. km. Global spending on exploration in 2010 was $10.68 billion.

### d. ENERGY RESOURCES

India has both exhaustible and renewable energy resources. India ranks 3rd among the coal producing countries in the world. It accounts for 55% of country's energy supplies. Coal production in 400 MT and it comes mainly from open pit mining. The all India gross electricity generation, excluding from coal and petroleum was 565 102 GWh. Energy requirement was 88GW during the period. Per capita electricity consumption rose to 592 kWh.

**Crude oil :** India has 0.4% of the world's proven reserves of crude oil. The production of crude oil is 33.38 MT and production of natural gas is 32 BCM (billion cubic meters). The exports of petroleum products was 14MT and production of petroleum products is 110 MT.

**Natural gas:** Domestic production of natural gas is 132.8 million metric standard cubic meters per day (MMSCMD). The main producers of natural gas are Oil & Natural Gas Corporation Ltd. (ONGC), Oil India Limited (OIL), JVs of Tapti, Panna-Mukta and Ravva and Reliance Industries Limited (RIL) which has discovered gas in the Krishna Godavari basin at its KG D6 block in the east coast of Andhra Pradesh. Natural gas demand has been growing at the rate of about 6.5% during the last 10 years. Industries such as power generation, fertilizer, and petrochemical production are shifting towards natural gas.

**e. FOREST RESOURCES**

The forest area in India is 23.02% (world bank report 2012). Forest are an important renewable natural resource. Forest ecosystem is dominated by trees, their species-content varying in different parts of the world. Forests contribute essentially to the economic development of our country by providing goods and services to the people and industry. India has a rich flora and fauna (rich biological diversity), much of which is present in forest areas.

It is estimated that about 270 million tonnes of fuel wood, 280 million tonnes of fodder, over 12 million cubic meter of timber and countless non-timber forest products are removed from forests annually. Forests meet nearly 40% of the energy needs of the country, of which more than 80% is utilized in rural areas mainly through removal from forests by head load or otherwise. Nearly 27% of the total population of the country, comprising about 300 million rural people, depend on forests for livelihood. Non Timber Forest Products (NTFP) contributes to about 20% to 40% of the annual income of forest dwellers who are mostly disadvantaged and landless communities with a dominant population of tribal.

The other Ecological Services provided by forests are regulation of hydrological cycle, soil & water conservation, flood control, carbon sequestration, fresh air generation, climate stabilization, biodiversity conservation and amelioration of overall environment including urban and semi-urban amenity, eco-tourism etc. Forest plays a vital role in providing carbon sequestration and Carbon stocks in our forests stood at 6662 m MT in the year 2005. Some 2500 plants are used medicinally and 400 million Indians use traditional medicine. The domestic trade of herbal products in 23 billion.

The chief products that forests supply is **wood** which is used as fuel; raw materials for various industries as pulp, paper, news-print, board, plywood; timber for furniture items, toys, sports goods, musical instruments, wooden crates, boxes (for packing articles for fruit, tea, etc.), boats, truck bodies, carts, ploughs, railway sleepers, bridges, buildings; **fodder** for cattle, sheep, goats and camels and **bamboos**. Bamboos, called poor man's timber, are used in rafters, scaffolding, roofing, walling, flooring, basketry, cartwood and cordage. Industrially bamboos are used as a raw material in paper and rayon industry. Indian forests also supply **minor forest products** such as canes (rattans), gums, resins, rubber, dyes, tannins,

fibres, flocs, medicines, katha, insecticides, camphor, essential oils (*e.g.,* rosha grasses, khas and sandal woods), cooking oils and spices. Tendu (kendu) leaves are used as wrappers for *bidis*, soap-substitutes such as *ritha* and*shikakai*, sola pith and ornamental seeds *rudraksha* are important commercial products of the forests. Lac, honey, wax, tusser or moga silk are obtained from forest insects. Feathers, horns, hides and ivory are also other significant forest product (obtained from forest wild life). For tribal people forests also provide food (tuber, roots, leaves, fruits, meat from birds and other animals).

Besides above discussed uses, forests are also a major factor of environmental concern, providing protection to wild life, help in gaseous (*i.e.,* CO2, O2) cycles of atmosphere, tend to enhance local rainfall and water holding capacity of soil, maintain the soil fertility, regulate the earth's temperature regimes and water cycle, check soil erosion, landslides, shifting of sand and silting and reduce the flood havoc. Forests play an important role in reducing atmospheric pollution by collecting the suspended particulate matter and by absorbing carbon dioxide. Lastly, forests have aesthetic and touristic values and serve as gene reserve of important species.

**f. WILDLIFE RESOURCES**

It is a great natural resource comprising of about 75,000 species of animals that include about 800 species of mammals, 2000 of birds, 420 of reptile, 2000 of fish, 50000 of insects, 4000 of mollusks and innumerable species of other invertebrates. During the period of approximately 2000 years, the world had lost by way of extinction about 160 mammals and 88 birds through man's interference with nature.

According to international union for conservation of nature and natural resources (IUCN), 25,000 plant species are threatened with extinction. Based on history of distribution, decline in number of individuals, nature of habitat and the potential value of species, IUCN has classified the plant and animal species into four groups.

***Endangered (E) species*:** represented by fewer individuals because of unfavourable environmental or human factors. If the same factors continue to operate as before these species would become extinct soon. Eg. Indian rhinoceros Asiatic lion and the great Indian bustard. Some of the endangered species of mammals, amphibians, reptiles and birds.

***Vulnerable (V) species*:** these are the species have sufficient number of individuals in their habitats. However, in near future, they may represent the category of endangered species, if unfavourable conditions in the environment continue to operation.

***Rare (R) species*:** the species (or taxa) small world population those are not at present endangered or vulnerable, but are at risk.

***Threatened (T) species*:** These are species that are declining at a faster rate though their population is high.

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**Lecture 4**

# MINERAL RESOURCES: USE AND EXPLOITATION, ENVIRONMENTAL EFFECTS OF EXTRACTING AND USING MINERAL RESOURCES, CASE STUDIES - FOOD RESOURCES: WORLD FOOD PROBLEMS, CHANGES CAUSED BY AGRICULTURE AND OVERGRAZING

## MINERAL RESOURCES

A mineral is a pure inorganic substance that occurs naturally in the earth's crust. All of the Earth's crust, except the rather small proportion of the crust that contains organic material, is made up of minerals. Some minerals consist of a single element such as gold, silver, diamond (carbon), and sulphur.

### Definition :

A 'Mineral Resource' is a concentration or occurrence of material of intrinsic economic interest in or on the earth's crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction.

Minerals provide the material used to make most of the things of industrial - based society; roads, cars, computers, fertilizers, etc. Demand for minerals is increasing worldwide as the population increases and the consumption demands of individual people increase. The mining of earth's natural resources is, therefore accelerating, and it has accompanying environmental consequences.

More than two-thousand minerals have been identified and most of these contain inorganic compounds formed by various combinations of the eight elements (O, Si, Al, Fe, Ca, Na, K, and Mg) that make up 98.5% of the Earth's crust. Industry depends on about 80 of the known minerals. Mineral resources are non-renewable and include metals (e.g. iron, copper, and aluminum), and non-metals (e.g. salt, gypsum, clay, sand, phosphates).

### Types of Mineral Resources

Minerals in general have been categorized into three classes' fuel, metallic and non-metallic. Fuel minerals like coal, oil and natural gas have been given prime importance as they account for nearly 87% of the value of mineral production whereas metallic and non-metallic constitutes 6 to 7%.

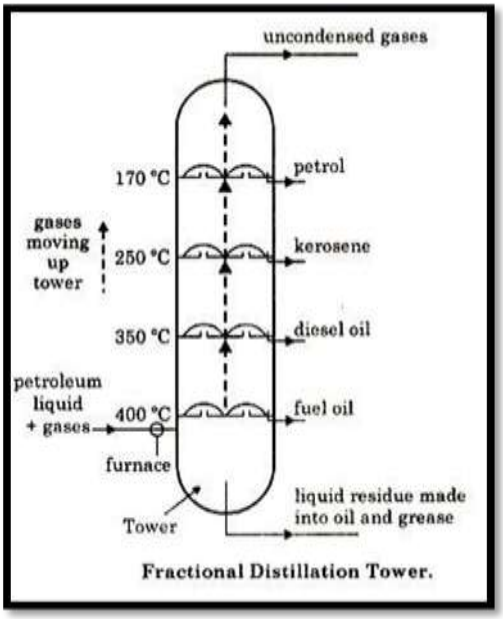
### Use and Exploitation

The use of minerals varies greatly between countries. The greatest use of minerals occurs in developed countries. Like other natural resources, mineral deposits are unevenly distributed around on the earth. Some countries are rich in mineral deposits and other countries have no deposits. The use of the mineral depends on its properties. For example aluminum is light but strong and durable so it is used for aircraft, shipping and car industries.

Recovery of mineral resources has been with us for a long time. Early Paleolithic man found flint for arrowheads and clay for pottery before developing codes for warfare. And this was done without geologists for exploration, mining engineers for recovery or chemists for extraction techniques. Tin and copper mines were necessary for a Bronze Age; gold, silver and gemstones adorned the wealthy of early civilizations; and iron mining introduced a new age of man. Human wealth basically comes from agriculture, manufacturing, and mineral resources. Our complex modern society is built around the exploitation and use of mineral

resources. Since the future of humanity depends on mineral resources, we must understand that these resources have limits; our known supply of minerals will be used up early in the third millennium of our calendar.

Furthermore, modern agriculture and the ability to feed an overpopulated world is dependent on mineral resources to construct the machines that till the soil, enrich it with mineral fertilizers, and to transport the products. We are now reaching limits of reserves for many minerals. Human population growth and increased modern industry are depleting our available resources at increasing rates. The pressure of human growth upon the planet's resources is a very real problem. The consumption of natural resources proceeded at a phenomenal rate during the past hundred years and population and production increases cannot continue without increasing pollution and depletion of mineral resources.



Fractional Distillation Tower.

In a world that has finite mineral resources, exponential growth and expanding consumption is impossible. Fundamental adjustments must be made to the present growth culture to a steady-state system. This will pose problems in that industrialized nations are already feeling a loss in their standard of living and in non-industrialized nations that feel they have a right to achieve higher standards of living created by industrialization. The population growth continues upward and the supply of resources continues to diminish. With the increasing shortages of many minerals, we have been driven to search for new sources.

**Environmental effects of Mineral extraction**

Surface mining removes ore deposits that are close to the surface, and subsurface mining removes minerals that are deep underground. While mineral use is very important to us, there are also many environmental impacts, such as erosion, air and water pollution, land destruction and harm to mine workers.

**FOOD RESOURCES**

Although about 80,000 species of plants are edible only about 30 crops feed the world. The three major sources of food for humans are: - the croplands, the rangelands and fisheries. The croplands provide the bulk amount of food for human. Yet though there are 1000s of

edible plants in the Earth, solely 4 essential crops (potatoes, rice, wheat and corn) account for many of the caloric consumption of human beings. Few animals are raised for milk, meat and eggs (for example. poultry, cattle and pigs) are as well the croplands are fed grain. The rangelands provide a different source of milk and meat from animals grazing (for example: goats, cattle and sheep). The fisheries provide fish which are a major source of animal protein in the Earth, particularly in coastal areas and Asia. As people become more affluent, they incline to consume more cheese, milk, meat and eggs.

**Types of Food Resources**

In the food resources, there are 2 kinds of food production are as follows: 1. The industrialized agriculture. 2. The traditional agriculture. Industrialized agriculture produces large quantities of a single type of crop or livestock for sale within the country where it is grown and to other countries. Traditional/Subsistence agriculture produces enough crops or livestock for the farm family's survival and in good years enough to have some left over to sell or put aside for hard times.

**Industrialized Agriculture**

The industrialized agriculture is called high input agriculture since it uses large amounts commercial fertilizers for field, the pesticides, fossil fuels and water. The large fields of monoculture (single crops) are planted and the plants are selectively covered to produce high productions. Large amounts of grain farmed by this process as well further the production of large numbers in feedlots of livestock animals. Most of the food made by industrialized processes is traded by farmers for profit and this kind of food production is most common in modernized nations because of the involvement of high expenses and technology. Still, the large industrialized plantations specializing in a single cash pasture (for example. crop specifically advanced for profit such as coffee, coca, bananas) are found in some developing nations.

**Traditional Agriculture**

The traditional agriculture is the most widely used form of production of food, happening mostly in developing nations. This can be classified later as either traditional intensive agriculture or traditional subsistence and the differences between the 2 involve the relational amounts of food produced and resources input. The subsistence agriculture practices only animal and human labor and only produces enough food for the families of farmer's. The traditional, intensive agriculture uses more labor of animal and human, irrigated water and fertilizers. This may as well involve growing processes such as intercropping designed to maintain soil fertility rate. The intercropping involves planting 2 crops at the same time (for example, nitrogen-fixing legume crop with a grain pasture). Increased production resulting from the more intensive processes provides sufficient food for the farmer's family and for marketing to other people in the local region.

**Major world food problems**

The major food problems are food quantity, food quality, food storage and distribution, poverty, economic incentives for growing food and the harmful environmental effects of agriculture. World food production more than double between 1950 and 1984 and the average per capita production rose by 40%. Most of the increase in food production since 1950 came from increases in the yields per acre by means of improved labour subsistence agriculture and energy intensive industrialized agriculture.

Poor people who cannot grow or buy enough food for good health and survival suffer from under nutrition. Survival and good health also require that people consume food containing the proper amounts of protein, carbohydrates, fats, vitamins and minerals. Most poor people are forced to live on a low protein, high starch diet of grains such as wheat, rice or corn. As a result, they often suffer from malnutrition or deficiencies of protein and other key nutrients. Each year 20 million to 40 million people – half of them children under age 5 – die prematurely from under nutrition, malnutrition or more non-fatal infections and diseases such as diarrhea, measles, and flu, worsened by these nutritional deficiencies. Adults suffering from chronic under nutrition and malnutrition are vulnerable to diseases and are too weak to work productively or think clearly. (Eg.) Too little iron causes Anemia. Anemic cause fatigue, increases a women's chance of dying in childbirth and increases an infant's chances of dying from infecting during its first year of life. The two most widespread nutrition – deficient diseases are marasmus and kwashiorkor.

**Marasmus** (Greek, to waste away) occurs when a diet is low in both total energy and protein most of the victims are infants in poor families which food quantity and quality are insufficient. A child suffering from marasmus typically has a bloated be a thin body, shriveled skin, wide eyes and an old looking face.

**Kwashiorkor** (meaning displaced child) occurs in infants and children 1 to 2 years old who suffer from severe protein deficiency. Children suffer from kwashiorkor have skin swollen with fluids, a bloated abdomen, hair loss, liver damage, diarrhea, stunted growth, mental retardation. Too little iodine in the diet can cause Goiter, an abnormal enlargement of the thyroid gland in the neck, a condition that leads to deafness if untreated.

The United Nations Children's Fund (UNICEF) estimates that between half and two-thirds of the worldwide annual childhood deaths from under nutrition, malnutrition and other diseases. About 15% of the people also suffer from over nutrition. This is an excessive intake of food that can cause excess body fat, high blood pressure, stroke and heart disease. Fish and shellfish are important sources of animal protein. Governments can increase food production by distributing land to the rural poor, making credit available to small farmers, providing farmer price supports and subsidies and controlling import and export food prices. Many analysts believe the key to reducing world hunger and decreasing the pollution and environmental degradation caused by agriculture is to shift sustainable – earth agricultural systems. This does not require large inputs of fossil fuel, promotes polyculture instead of monoculture, conserves top soil and builds new top soil with organics, conserve irrigation water and control pests with naturally available organic pesticides.

**Effects of modern agriculture - Fertilizer Pesticide problems, Water logging, Salinity**

Agriculture is an art, science and industry of managing the growth of plants and animals for human use. Agriculture includes preparation of soil for cultivation of crops, harvesting crops, breeding and raising livestock, dairying and forestry.

The two major types of agriculture are: Traditional agriculture and Modern or Industrialized agriculture.

Modern agriculture makes use of hybrid seeds of single crop variety, technologically advanced equipment, fertilizers, pesticides and water to produce large amounts of single crop.

**Problems using fertilizers**

1. Micronutrient imbalance: Chemical fertilizers used in modern agriculture contain Nitrogen, Phosphorus and Potassium (N,P,K) which are macronutrients. Excess use of fertilizers in fields causes micronutrient imbalance. Ex: Excessive use of fertilizers in Punjab and Haryana caused deficiency of micronutrient Zinc thereby affecting productivity of soil.
2. Nitrate pollution: Excess Nitrogenous fertilizers applied in fields leach deep into the soil contaminating the groundwater. If the concentration of nitrate in drinking water exceeds 25 mg/L it leads to a fatal condition in new-born babies. This condition is termed "Blue Baby Syndrome"
3. Eutrophication: The application of excess fertilizers in fields leads to wash off of the nutrient loaded water into nearby lakes causing over-nourishment. This is called "Eutrophication". Eutrophication causes the lakes to be attacked by "algal blooms". Algal blooms use nutrients rapidly and grow fast. Their life is short, they die and pollute water thereby affecting aquatic life in the lake.

**Problems in using Pesticides**

In order to improve crop yield, pesticides are used indiscriminately in agriculture. Pesticides are of two types:

1. First generation pesticides that use Sulphur, Arsenic, Lead or Mercury to kill pests.
2. Second generation pesticides such as Dichloro Diphenyl Trichloroethane (DDT) used to kill pests. These pesticides are organic in nature. Although these pesticides protect our crops from severe losses due to pests, they have several side-effects as listed below:

    - Death of non-target organisms: Several insecticides kill not only the target species but also several beneficial not target organisms
    - Pesticide resistance: Some pests that survive the pesticide generate highly resistant generations that are immune to all kinds of pesticides. These pests are called "super pests"
    - Bio-magnification: Most pesticides are non-biodegradable and accomplish ate in the food chain. This is called bio-accumulation or bio-magnification. These pesticides in a bio-magnified form are harmful to human beings.
    - Risk of cancer: Pesticide enhances the risk of cancer in two ways (i) It acts as a carcinogen and (ii) It indirectly suppresses the immune system.

**Water logging**

If water stands on land for most of the year, it is called water logging. In water logged conditions, pore-voids in the soil get filled with water and soil-air gets depleted. In such a condition the roots of plants do not get enough air for respiration. Water logging also leads to low mechanical strength of soil and low crop yield.

**Causes of water logging**

1. Excessive water supply to the croplands
2. Heavy rain
3. Poor drainage

**Measures to prevent water logging**

1. Avoid and prevent excessive irrigation
2. Sub-surface drainage technology
3. Bio-drainage by trees like Eucalyptus

**Salinity**

Water not absorbed by soil, is evaporated leaving behind a thin layer of dissolved salts in the top soil. This is called salinity of the soil. Saline soils are characterized by accumulation of soluble salts like sodium chloride, calcium chloride, magnesium chloride, sodium sulphate, sodium carbonate and sodium bicarbonates. Saline conditions are exhibited when pH is greater than 8.0.

**Problems in salinity**

1. Saline soils yield less crop

In order to remedy the condition of saline soils the following two techniques may be used:

1. Salt deposit is removed by flushing with good quality water
2. By using a sub-surface drainage system, the salt water is flushed out slowly

**Case Studies**

Canal irrigation in Haryana resulted in rising water table followed by water logging and salinity causing low crop productivity thereby huge economic losses. Similarly the "Indira Gandhi Canal Project" in Rajasthan converted a big area into a "water soaked waste land".

In Delhi, accumulation of pesticides and DDT in the body of mothers caused premature deliveries or low birth weight infants.

Food centre at Center for Science and Environment (CSE) India reported Pepsi and Coca-Cola companies sold soft drinks with pesticide content 30-40 times higher than EU guidelines permit. At the reported concentrations the pesticides damage the nervous system.

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**Lecture 5**

# EFFECTS OF MODERN AGRICULTURE, FERTILIZER-PESTICIDE PROBLEMS, WATER LOGGING, SALINITY, ENERGY RESOURCES: GROWING ENERGY NEEDS RENEWABLE AND NON-RENEWABLE ENERGY SOURCES USE OF ALTERNATE ENERGY SOURCES

## Agriculture

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**Death of non-target organisms:** Several insecticides kill not only the target species but also several beneficial not target organisms

**Pesticide resistance**: Some pests that survive the pesticide generate highly resistant generations that are immune to all kinds of pesticides. These pests are called "superpests"

**Bio-magnification:** Most pesticides are non-biodegradable and accumulis ate in the food chain. This is called bio-accumulation or bio-magnification. These pesticides in a bio-magnified form are harmful to human beings.

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**Causes ff Water Logging**

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2.Salt deposit is removed by flushing with good quality water

3.By using a sub-surface drainage system, the salt water is flushed out slowly.

## ENERGY RESOURCES

Energy may be defined as "**any property which can be converted into work**" Energy is defined as "**the capacity to do work**"

Energy is available on earth in a number of forms and some forms may be used immediately while others might require some transformation. It is difficult to imagine Life without energy. All the developmental activities in the world are directly or indirectly dependent on energy. Both energy production and energy utilization indicate a country's progress.

### Growing energy needs

Energy is essential to the existence of mankind. All industrial processes like mining, transport, lighting, heating and cooling in buildings need energy. With the growing population, the world is facing an energy deficit. Lifestyle change from simple to a complex and luxurious lifestyle adds to this energy deficit. Almost 95% of commercial energy is available from fossil fuels like coal and natural gas. These fossil fuels will not last for more than a few years. Hence, we must explore alternative fuel/energy options.

### Renewable and non-renewable energy sources

Based on continual utility, natural resources can be classified into two types:

**Renewable energy sources:** These resources can be generated continuously and are inexhaustible.
Ex: Wood, Solar energy, Wind energy, Hydro power, tidal energy, Geo-thermal energy, etc.

***Merits of Geo-thermal energy*:**

1. Unlimited supply
2. Provides energy security
3. Fits in the concept of sustainable development
4. Reliable and devices are modular in size
5. Decentralized energy production

**Non-renewable energy sources:** Non-renewable energy sources are natural resources that cannot be regenerated once they are exhausted. They cannot be used again. Ex: Coal, Petroleum, Natural gas and Nuclear fuels.

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**Lecture 6**

# LAND RESOURCES: LAND AS A RESOURCE LAND DEGRADATION, MAN INDUCED LANDSLIDES – SOIL EROSION AND DESERTIFICATION – ROLE OF AN INDIVIDUAL IN CONSERVATION OF NATURAL RESOURCES EQUITABLE USE OF RESOURCES FOR SUSTAINABLE LIFESTYLES.

## Land degradation

Land degradation is the process of deterioration of soil or loss of fertility of soil.

## Effects of land degradation

1. Soil texture and structure are deteriorated
2. Loss of soil fertility due to loss of valuable nutrients
3. Increase in water logging, salinity, alkalinity and acidity problems
4. Loss at a social, economic and biodiversity level

## Causes of land degradation

**Population**: With the increase in population, more land is needed for producing food, fibre, and fuel wood leading to increasing pressure on the limited land resources. Therefore the land gets degraded due to over exploitation

**Urbanization**: Increased urbanization due to population growth reduces the agricultural land. To compensate for loss of agricultural land, new lands comprising of natural ecosystems such as forests are cleared. Therefore, urbanization leads to deforestation which in-turn affects millions of plant and animal species.

**Fertilizers and Pesticides:** Increased application of fertilizers and pesticides are needed to increase farm output in new lands thereby leading to pollution of land, water and soil degradation.

**Damage to top soil:** Increase in food production generally leads to damage of top soil through nutrient depletion.

Water-logging, soil erosion, salination and contamination of the soil with industrial waste cause land degradation.

## LANDSLIDES

Landslides are the downward movement of a slope composed of earth materials such as rock, soil or artificial fills. Landslides are also called rock-slide, debris-slide, slump, earth-flow or soil-creep.

During construction of roads and mining activities huge portions of mountainous fragile areas are cut down and thrown into adjacent areas and streams. These land masses weaken the already fragile mountain slopes leading to man-induced landslides.

**EFFECTS OF LANDSLIDES:**

1. Landslides increase the turbidity of nearby streams, thereby reducing their productivity.
2. Destruction of communicative links
3. Loss of habitat and biodiversity
4. Loss of infrastructure and economic loss

**CAUSES OF LANDSLIDES**

1. Removal of vegetation - Deforestation in slopes creates soil erosion leading to landslides.
2. Underground mining activities cause subsidence of the ground
3. Movement of heavy vehicles in areas with unstable slopes causes landslides.
4. Addition of weight by construction on slopes causes landslides.
5. Over exploitation of groundwater also leads to landslides.

**SOIL EROSION**

Soil erosion is the process of removal of superficial layer of soil. Soil erosion removes soil components and litter.

**HARMFUL EFFECTS OF SOIL EROSION**

1. Soil fertility is lost
2. Loss of soil ability to hold water and sediment
3. Sediment runoff can pollute water courses and kill aquatic life

**TYPES OF SOIL EROSION**

- **Normal erosion:** This is caused by the gradual removal of topsoil by natural processes. The rate of erosion is slow.
- **Accelerated erosion:** This is caused by man made activities. In this case, the rate of erosion is much faster than the rate of formation of soil.

**CAUSES OF SOIL EROSION**

- **Water**: Water affects soil erosion in the form of rain, run-off, rapid flow or wave action
- **Wind**: Wind is an important climate agent that carries away the fine particles of soil thereby contributing to soil erosion.
- **Biotic agents**: Overgrazing, mining and deforestation are the major biotic agents causing soil erosion. These processes disturb the top soil thereby exposing the soil to various physical forces inducing erosion
- Landslides cause soil erosion
- Construction of dams, buildings and roads removes the protective vegetal cover leading to soil erosion

**SOIL CONSERVATION PRACTICES**

- **Conservational till farming or no-till farming**: Traditionally, land is ploughed to make a planting surface. This disturbs the soil and makes it susceptible to erosion. The no-till farming method makes minimum disturbance to the top soil by making slits in the unploughed soil. Seeds, fertilizers and water are injected in these slits.
- **Contour farming**: In this method, crops are planted in rows along contours of gently sloped land. Each row acts as a small dam to hold soil thereby slowing water runoff.
- **Terracing**: In this method, steep slopes are converted into a series of broad terraces that run across the contour. This retains water for crops and reduces soil erosion by controlling runoff.
- **Alley cropping or Agro forestry**: This method involves planting crops in strips or alleys between rows of trees or shrubs that provide fruits and fuel wood. Hence, when the crop is harvested, the soil will not be eroded as the trees and shrubs remain on ground holding the soil particles.
- **Wind breaks or shelter belts**: In this technique, trees are planted in long rows along the boundary of cultivated land which block the wind and reduce soil erosion. Wind breaks help in retaining soil moisture, supply wood for fuel and provide habitat for birds.

**<u>Role of an individual in conservation of natural resources</u>**

**Conservation of energy:**

1. Switch off light, fan and other appliances when not in use.
2. Use solar heater for cooking.
3. Dry the cloth in the sun light instead of driers.
4. Use always pressure cookers
5. Grow trees near the house to get cool breeze instead of using AC and ai cooler.
6. Ride bicycle or just walk instead of using scooter for a short distance.

**Conservation of water:**

1. Use minimum water for all domestic purposes.
2. check the water leaks in pipes and repair them properly.
3. Reuse the soapy water, after washing clothes for washing courtyard, carpets etc.
4. Use drip irrigation.
5. Rain water harvesting system should be installed in all the houses.
6. Sewage treatment plant may be installed in all industries and institution.
7. Continuous running of water taps should be avoided.
8. Watering of plants should be done in the evening.

**Conservation of soil:**

1. Grow different type plants i.e trees, herbs and shrubs.
2. In the irrigation process, using strong flow of water should be avoided.
3. Soil erosion can be prevented by sprinkling irrigation.

**Conservation of food resources:**

1.Cook required amount of food.
2.Don’t waste the food, give it to some one before spoiling.
3.Don’t store large amount of food grains and protect them from damaging insects.

**Conservation of forest:**

1.Use non timber product.
2.Plant more trees.
3.Grassing must be controlled
4.Minimise the use of paper and fuel.
5.Avoid the construction of dam, road in the forest areas.

**Equitable use of resources for sustainable life style**:

**Sustainable development:** Development of healthy environment without damaging natural resources.

**Unsustainable development:** Degradation of the environment due to over utilization of natural resources.

**Life style in more developed countries**: 22% of world population, 88% of it's natural resources and 85% of total global income. Consumption is more and pollution is more.

**Life style in less developed countries:** 78% of world population, 12% of it's natural resources and 15% of total global income. Consumption is less and pollution is less.

**Causes of unsustainability:** Main cause – difference between MDCs and LDCs.

**Sustainable life style:**
MDCs should have to reduce the utilisation of natural resources, that should have to be diverted to LDCs. This will reduce the gap between MDCs and LDCs, leads to sustainable development of the entire world.

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**Lecture 7**

# ECOSYSTEMS - CONCEPT OF AN ECOSYSTEM - STRUCTURE AND FUNCTION OF AN ECOSYSTEM - PRODUCERS, CONSUMERS AND DECOMPOSERS - ENERGY FLOW IN THE ECOSYSTEM - ECOLOGICAL SUCCESSION - FOOD CHAINS, FOOD WEBS AND ECOLOGICAL PYRAMIDS

## ECOSYSTEM

The word *ecosystem* was coined by *A.G. Tansley* in 1935. This term is derived from two words, namely eco and *system*. Eco refers to environment and system refers to a complex coordinated unit. A ecosystem is a basic *functional ecological unit*. It consists of *living* organisms (biotic factors) and *non-living* substances (abiotic factors). It is an *interacting system* where the biotic and abiotic factors interact to produce an exchange of materials between the living and non-living factors.

An ecosystem is *a sum total of living organisms, the environment and the process of interaction between and within all parts of the system (Mathavan, 1974).*

According to ODUM and ecosystem is the *basic fundamental of ecology which includes both the organisms and the non-living environment each influencing the properties of the other and each is necessary for the maintenance of life.*

Pond is a suitable example for ecosystem. Lake is another ecosystem. Other examples of ecosystem are river, estuary, ocean, forest, grassland, town etc.,

### 1. Structure

The structure of any ecosystem is formed of two components, namely 1. abiotic factors and 2. biotic factors.

**1. Abiotic Factors.**

The abiotic factors of an ecosystem include the non-living substances of the environment. Eg. Water, soil, air, light, temperature, minerals, climat, pressure etc. The biotic factors of the ecosystem depend on the abiotic factors for their survival.

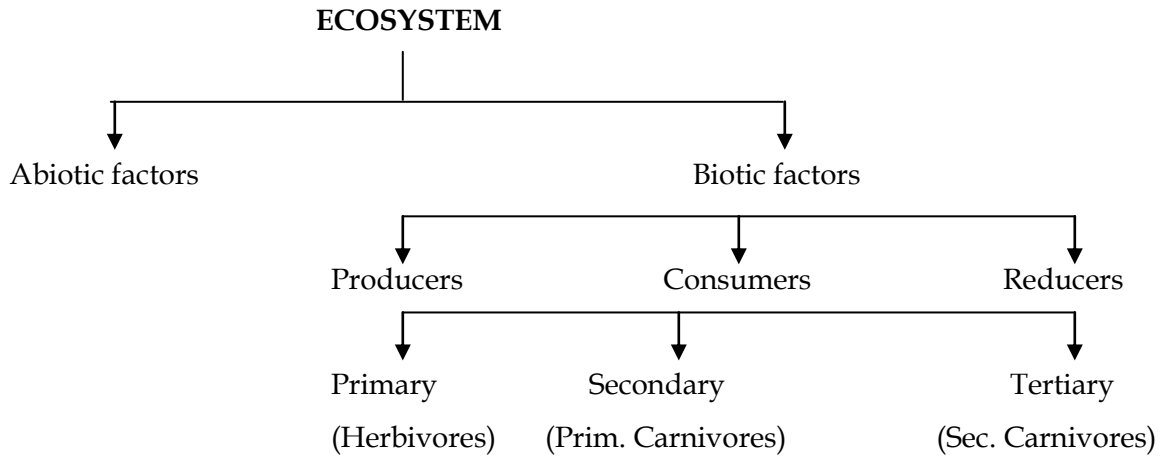
**2. Biotic Factors**

The biotic factors include the living organisms of the environment. Eg. Plants, animals, bacteria, viruses etc., The biotic factors of an ecosystem are classified into three main groups, namely 1. Producers 2. Consumers and 3. Reducers or decomposers.

**1. Producers :** The organisms which carry out photosynthesis constitute the producers of an ecosystem. Eg. Plants algae and bacteria. The producers depend on the abiotic factors of the ecosystem for producing energy. They are provided with chlorophyll. Chlorophyll is used in the synthesis of energy rich compounds with the utilization of abiotic factors like light, $CO_2$, water and minerals. A portion of the energy synthesized, is used by the producers for their growth and survival and the remaining energy is stored for future use.

**2. Consumers:** Consumers are organisms, which eat or devour other organisms. The consumers are further divided into three or more types. They are *Primary consumers, Secondary Consumers* and *tertiary consumers.*

**1. Primary Consumers:** They eat the producers like plants, algae and bacteria. The primary consumers are also called *herbivores*. *Elton* referred the herbivores as *key industry animals*. Rabbit, deer, etc., are primary consumers in a terrestrial ecosystem.




**2. Secondary Consumers:** They kill and eat the herbivores. They are also called *carnivores*. As these carnivores directly depend on herbivores, they are specifically called *primary carnivores.* Fox, Wolf, etc., are the *secondary consumers* in a terrestrial ecosystem.

**3. Tertiary Consumers:** They kill and eat the secondary consumers. They are also *called secondary* carnivores. Eg. Lion, Tiger, etc.,

**3. Reducers or Decomposers:** The decomposers are organisms that break up the dead bodies of plants and their waste products. They include *fungi* and certain *bacteria*. They secrete enzymes. The enzymes digest the dead organisms and the debris into smaller bits or molecules. These molecules are absorbed by the reducers. After taking energy, the reducers release molecules to the environment as chemicals to be used again by the producers.

**3. Typical Ecosystem – Pond Ecosystem**

A pond is a suitable example for ecosystem. It is a lentic fresh-water ecosystem. It contains shallow standing water. The pond ecosystem is formed of abiotic factors and biotic factors.

**1. Abiotic Factors :**

The abiotic factors of the pond ecosystem are water, $CO_2$, $O_2$ , inorganic compounds, organic compounds, light , temperature, pressure, pH etc.

**2. Biotic Factors :**

The biotic factors of the pond ecosystem are producers, consumers and reducers.

1. **Producers :** The producers synthesize the energy from abiotic substances. The producers of a pond include phytoplankton like diatoms, blue green algae. (*Oscillatoria),* green algae, green flagellates ( *Volvox, Euglena, Chlamydomonas),* rooted plants, submerged plants and floating plants.

**2. Consumers :** Consumers eat other organisms. The organisms which depend on producers are called *Primary* Consumers or herbivores. Eg. Zooplankton *(Cyclops, Daphnia*, larvae of. *Chironomus* etc), *Dysticus* (insect) , *Lymnaea* (snail) etc.

The primary consumers are eaten by the secondary consumers or carnivores. These carnivores are called primary carnivores because they are the first carnivores in the food chain. Eg small fishes, frogs etc. The secondary consumers are eaten by the *tertiary consumers or secondary carnivores.* Eg. Large fishes, snakes etc.

3. **Reducers or Decomposers**

The *Decomposers are organisms that break up* the dead bodies of organisms and their waste products. They include microbes like bacteria. They secrete enzymes. The enzymes digest the dead organisms and the debris into smaller bits or molecules. These molecules are absorbed by the reducers. After taking energy, the reducers release molecules to the environments as chemicals to be used again by the producers.

4. **TYPES OF ECOSYSTEM**

The ecosystem may be large, as large as the world or small, as small as a cowdung ecosystem . The *biosphere* (the total life content of the world) is the major ecosystem. It comprises all other ecosystems.

**1. Mega Ecosystem :**

The biosphere is formed of four *mega ecosystems.* They are as follows:

1. **Marine Ecosystem :** It includes saline-water ecosystems like oceans, seas, estuaries, brackish waters, etc.
2. **Limnic Ecosystem :** It includes all fresh water ecosystems like ponds, pools, lakes, rivers, streams etc.
3. **Terrestrial Ecosystem :** It includes the ecosystems of air, forests, grasslands, deserts, etc.
4. **Industrial Ecosystems :** These are manmade ecosystems. Eg. Crop land, city, town, etc.

**2. Macro Ecosystems :**

The megaesystem is further divided into sub units called *macroecosystems.* Eg. Forests. The terrestrial macroecosystem is formed of many forest ecosystems.

**3. Meso Ecosystems :**

The macro ecosystem is further divided into *mesoecosystems.* For example, the forest ecosystem is formed of many mesoecosystems like deciduous forest, coniferous forests, etc.

**4. Micro Ecosystems**

The mesoecosystem is further divided into microecosystems. Eg. A low land in a forest, a mountain in a forest, etc.

All ecosystems in the world are further divided into *natural* and *artificial* ecosystems.

**5. Natural Ecosystems**

These are self-regulating systems without much direct human interference and manipulations. Eg. Ponds, lakers, rivers, seas, oceans, grasslands, deserts, etc.

**6. Artificial Ecosystems**

These are man made ecosystems. Eg. Crop lands, cities, towns, villages etc.

5. **DYNAMICS OF ECOSYSTEM**

The various components of the ecosystem constitute an interacting system. They are connected by energy, nutrients and minerals. The nutrients and minerals circulate and recirculate between the abiotic and biotic factors of the ecosystem several times. The flow of energy, on the other land, is one way, once used by the ecosystem, it is lost.

The continuous survival of the ecosystem depends on the flow of energy and the circulation of nutrients and minerals in the ecosystem. Thus the dynamics (functions) of the ecosystem includes the following

.

1. Energy
2. Primary production
3. Secondary production
4. Food chain
5. Food web
6. Trophic levels
7. Energy flow
8. Ecological pyramids
9. Biogeochemical cycles

**1. Energy**

Energy is the ability to do work. The main source of energy for an ecosystem is the radiant energy or light energy derived from the sun. The amount of solar radiation reaching the surface of the earth is 2 Cals/sq.cm/min. It is more or less constant and is called *solar constant or solar flux.* About 95 to 99% of the energy is lost by reflection. Plants utilize only 0.02% of the energy reaching earth. The light energy is converted into chemical energy in the form of sugar by photosynthesis.

$$6H_2O + 6\,CO_2 + \text{Light} \longrightarrow C_6H_{12}O_6 + 6O_2$$

The sugar synthesized is utilized for many purposes;

1. It can be converted into starch and stored.
2. It combines with other sugars to form cellulose.
3. It combines with inorganic substances ($N_2$, P, S, etc) to form amino acids, protein, nucleic acids, pigments, hormones, etc.
4. Some amount of sugar is oxidized during respiration and the energy is released to do various functions.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{Energy}$$

**2. Primary Production**

Plants convert light energy into chemical energy in the form of sugar by photosynthesis. The total amount of sugar and other organic materials produced in plants per unit area per unit time is called gross *Primary production.*

During photosynthesis respiration is also going on side by side. During respiration some amount of sugar is oxidised. Hence it is not easy to measure gross primary production. The total organic material actually present (biomass) in plants is called *net primary production.*

Net primary production = Gross primary production – Respiration ie.,

$P_n = P_g - R$ where $P_g$ = Grosspri. Production

$P_g = P_n + R$ $P_n$ = Netpri. Production

R = Respiration

Thus the amount of organic material produced during a given period of time per unit area is called *Primary Production.* The productivity is generally expressed in terms of grams or kilocalories per square meter per day or per year. If $P_g$ equals R no storage of energy occurs. When $P_g$ is less than R, productivity decreases. When $P_g$ is greater than R, productivity increases.

**Measurement of Primary Production**

Primary production refers to the amount and the rate of energy produced by autotrophs. There are many methods to measure the primary production. They are following :

1. Harvest method
2. Carbondioxide assimilation method
3. Oxygen production method and
4. Radio isotope method

**1. Harvest method :**

In this method the plants grown on a particular area are harvested at ground level and their weight is taken. They are dried and again weighed. This is done at regular intervals. The primary production is expressed in terms of biomass or mass per unit area per unit time.

**2. Carbondioxide Assimilation Method :**

Plants utilize carbondioxide for photosynthesis. So the rate of photosynthesis can be calculated by calculating the amount of carbondioxide utilized by plants per unit time. The incorporation of carbondioxide in photoshnthesis can be determined using infrared gas analyzer. With the help of this analyzer, it is possible to measure the amount of carbondioxide entering or leaving air tight chamber of known volume.

**3. Oxygen Production Method :**

This method is used to measure primary production in aquatic ecosystem. In this method the amount of oxygen produced per unit time is taken as an index to measure the rate of photosynthesis. For this, *light and darkbottle* technique is used. Samples of water containing the autographs are collected in a *light bottle* (transparent bottle) and in a dark bottle. The light bottle allows light to enter in and the dark bottle does not allow light. The two bottles are suspended at the same depth from which the sample is collected. After a certain period of time the amount of oxygen present in the two bottles is calculated by titration using sodium thiosulphate. (*Winkler's method).* In dark bottle photosynthesis does not occur but respiration occurs.

In light bottle both respiration and photosynthesis occur. The rate of photosynthesis is calculated by calculating the amount of oxygen present in the two bottles.

**4. Radio Isotope Method :**

This method is similar to the oxygen production method. In this method a known quantity of $C^{14}$ is introduced into the light and dark bottles along with the sample and the bottles are suspended for six hours. During this period the $C^{14}$ is incorporated into the protoplasm of the autotrophs. The autotrophs are filtered and dried. After drying the radioactivity is measured. The amount of radio activity is proportionate to the amount of carbohydrate produced.

**3. Secondary Production**

The energy trapped by the products (primary production) is utilized by the consumers. The producers are directly consumed by the herbivores that are eaten by the primary carnivores that in turn are consumed by the secondary carnivores. The consumers store some amount of energy in their tissues. This energy, stored by the consumers, is called secondary production. Only about 10 to 20% of the primary production is converted into secondary production. The remaining 80 to 90% is lost by the consumers in the form of faces.

**4. Food chain :**

The biotic factors of the ecosystem are linked together by food. For example, the producers from the food for the herbivores. The herbivoresform the food for the carnivores. The *sequence of the eaters being eaten is called food chain.*

Producers $\longrightarrow$ Herbivores $\longrightarrow$ Carnivores

The various steps in a food chain are called *trophic levels* . Owing to repeated eating being eaten, the energy is transferred from one trophic level.

Phytoplankton → Zooplankton → Fishes → Snakes
Tr.$L_1$ Tr. $L_2$ Tr.$L_3$ Tr.$L_4$

Plants → Mouse → Snake → Hawk = GRASSLAND
Plants → Goat → Man → Lion = FOREST

to another trophic level. This transfer of energy from one trophic level to another is called *energy flow.* A typical food chain can be seen in a pond ecosystem. The algae and phytoplankton are eaten by the zooplankton. The zooplanktons are eaten by fishes which are eaten by snakes.

**1. TYPES OF FOOD CHAINS :**

The food chains are of two types, namely 1. *grazing food chain and 2. detritus food chain.*

**1. Grazing Food Chain :**

This food chain start from plants, goes through herbivores and ends in carnivores.
Plants → Herbivores → Primary Carnivores → Sec. Carnivores

This type of food chain depends on the autotrophs which capture the energy from solar radiation. A few chains are given below:
Grass → Grasshopper → Lizard → Hawk
Grass → Mouse → Snake → Hawk
Phytoplankton → Zooplankton → Fish → Snake

**2. Predator Chain :**

In predator food chain one animal captures and devours another animal. The animal which is eaten is called *prey* and the animal which eats other animals is called *Predator.* The predator food chain is formed of plants, herbivores, primary carnivores, secondary carnivores and so on.

**3. Parasitic food chain :**

The plants and animals of the grazing food chain are infected by *parasites.* The parasites derive their energy from their hosts. Thus the *Parasitic chain* within the grazing food chain is formed.

**2. Detritus food chain :**

It starts from dead organic matter and ends in inorganic compounds. There are certain groups of organisms, which feed exclusively on the dead bodies of animals and plants. These organisms are called *detritivores.* The detritivores include algae, bacteria, fungi, protozoans, insects, millipdes, centipeds, crustaceans, mussels, clams, annelid worms, nematodes, ducks, etc. These organism ingest and idgest the dead organic materials. Some amount of energy if trapped and the remainder is excreted in the form of simple organic compounds. These are again used by another set of detritivores until the organic compounds are converted into $CO_2$ and water.

Dead organic materials → Detritivores → $CO_2+H_2O$

**Linking of Grazing and Detritus Food Chains :**

The two main food chains cannot operate independently. They are interconnected at various levels. According to *Wilson an Bossert (1971) the stability of the ecosystem directly proportional to the number of such links.* The detritus feeders obtain energy from the dead bodies of animals and plants which are components of the grazing food chain. Again some of the detritus feeders are eaten by the consumers of the grazing food chain. For example, in a pond ecosystem earthworms belonging to the detritus food chain are eaten by fishes belonging to the grazing food chain.

**5. Food web :**

In an ecosystem the various food chains are interconnected with each other to form a net work called food web. The interlocking of *many food chains is called food web*. Simple food chains are vary rare in nature. This is because each organism may obtain food from more than one tropiclevel. In other words, one organism forms food for more than one organisms of the higher trophic level.

**Examples :**

In a grassland ecosystem, grass is eaten by *grasshopper, rabbit* and *mouse.* Grasshopper is eaten by lizard which is eaten by hawk. Rabbit is eaten by hawk. Mouse is eaten by snake which is eaten by hawk. In addition hawk also directly eats grasshopper and mouse. Thus there are five linear food chains which are inter connected to form a food web.

This is very simple food web. But in any ecosystem the food web is more complex. For example, in the grassland itself, in addition to hawk, there are many other carnivores such as vulture, crow, wolf, fox, man, etc.

**Significance of Food web :**

Food webs are very important in maintaining the stability of an ecosystem. For example, the deleterious growth of grasses is controlled by the herbivores. When one type of herbivore becomes extinct, the other types of herbivores increase in number and control the vegetation. Similarly, when one type of herbivorous animal becomes extinct, the carnivore predating on this type may eat another type of herbivore.

**5. Trophic levels :**

Each food chain contains many steps like producers, herbivores, primary carnivores and so on. Each step of the food chain is called *trophic level.* The number of trophic levels in a food chain is always restricted to 4 or 5. But very often the chains are very much complicated with many trophic levels.

| Phytoplankton | → | Zooplankton | → | Fishes | → | Snakes |
|---|---|---|---|---|---|---|
| Tr. $L_1$ | | Tr.$L_2$ | | Tr.$L_3$ | | Tr.$L_4$ |

**6. Energy Flow**

The transfer of energy from one trophic level to another trophic level is called *energy flow.* The flow of energy in an ecosystem is *unidirectional.* That is, it flows from the producer level to the consumer level and never in the reverse firection. Hence energy can be used only once in the ecosystem. But the minerals circulate and recirculate many times in the ecosystem.

A large amount of energy is lost at each trophic level. It is estimated that 80% to 90% of the energy is lost when it is transferred from one trophic level to another . Hence the amount of energy available decreases from step to step. When the food chain is short, the final consumers may get a large amount of energy. But when the food chain is long, the final consumer may get a lesser amount of energy.

As shown in the figure, about 3000K cal of light falls on the green plants. Of this approximately 50% (1500 K cal) is absorbed. Of the 50% only 1%(15 K cal) is converted at the first trophic level. Thus the net primary production is merely 15 K cals. Secondary productivity ($P_2$ and $P_3$) is 10% (1.5 K cal & o.3 K cal) at the herbivores and carnivores levels.

**7. Ecological Pyramids :**

The number, biomass and energy of organisms gradually decrease from the producer level to the consumer levels. This can be represented in the form of a pyramid called *ecological pyramid.* Ecological pyramid is the *graphic representation of the number, biomass, and energy of the successive trophic levels of an ecosystem.* The use of ecological pyramid was first described by *Charles Elton* in 1927. In the ecological pyramid, the producer forms the base and the final consumer occupies the apex. There are three types of ecological pyramids, namely

1. the pyramid of numbers
2. the pyramid of biomass and
3. the pyramid of energy

**1. The Pyramid of Number :**

The number of individuals at the trophic level decrease from the producer level to the consumer level. That is , in an ecosystem the number of producers is far high. The number of herbivores is lesser than producers. Similarly, the number of carnivores is lesser than the herbivores.

**In a Cropland Ecosystem**: In croplands the crops are more in numbers. The grasshoppers feeding on crop plants are lesser in number. The frogs feeding on grasshopper are still lesser in number. The snakes feeding on frogs are fewer in number.

Crop → Grosshopper → Frogs → Snakes → Hawks

**In a grassland Ecosystem:** In grassland the grasses are there in large numbers.

The consumers decrease in the following order:

Grass → Grasshopper → Lizard → Hawk
Grass → Rabbit → Fox → Lion

**In a Pond Ecosystem***:* The number in a pond ecosystem decreases in the following order:

**In a grassland:** In a grassland and the biomass of grasses in the maximum and is gradually decreases towards the consumer level in the following order.

Phytoplankton → Zooplankton → Fishes → Snakes

**2. The Pyramid of Biomass:**

Biomass refers to the total weight of living matter per unit area. In an ecosystem the biomass decreases from the producer level to the consumer level.

**In a grass land :** In a grass land and the biomass of the grasses is the maximum and is gradually decreased towards the consumer levelling the following order.

Grass → Mouse → Snake → Hawk
Grass → Grasshopper → Lizard → Hawk

**In a forest :** In a forest the biomass or trees is the maximum and the biomass of the top consumer is the minimum. The decrease in weight occurs in the following order:

Plants → Deer → Fox → Tiger
Plants → Rabbit → → Fox → Lion

**3. Pyramid of Energy:**

The energy flows in an ecosystem from the producer level to the consumer level. At each trophic level 80 to 90% of energy is lost. Hence the amount of energy decreases from the producer level to the consumer level. This can be represented in a pyramid of energy.

**In a Grassland:** In grassland green plants trap the maximum light energy. The energy gradually decreases towards the top consumer level.

Grass → Grasshopper → Lizard → Hawk
Grass → Rabbit → Fox → Lion
Grass → Mouse → nake → Hawk

**In a Pond:** In a pond maximum energy is trapped by the phytoplankton. Then the amount of energy decreases towards the top-consumer level.

Phytoplankton → Zooplankton → Fish → Snake
Phytoplankton → Zooplankton → Small Fish → Large fish

**Inverted Pyramids :**

In most of the ecosystems the number and biomass of producers are more and those of consumers are less. This type of ecosystem has a pyramid where the apex is pointed upwards. This type of pyramid is called *upright pyramid.* In some ecosystems the number and the biomass of the producers are less and those of consumers are more. This type of ecosystem produces a pyramid where the apex is directed downwards. This type of pyramid is called *inverted pyramid.* Inverted pyramid occurs in numbers and biomass. The pyramid of energy is always upright.

**Inverted Pyramid of numbers:** when the ecosystem contains lesser number of producers and more number of consumers, the pyramid will be inverted in shape. Inverted pyramid occurs in a tree ecosystem. A single tree (producer) contains many fruit eating birds (primary consumers). The birds contain numerous parasites (Secondary consumers).

**Inverted Pyramid of Biomass:** When the biomass of producers is less and that of consumers is more the pyramid will have inverted shape. It occurs in a pond or lake ecosystem. Here the biomass of diatoms and phytoplankton are negligible as compared to that of crustaceans and small fishes.

## ECOLOGY AND ECOSYSTEM

### WHAT IS ECOLOGY?

Ecology comes from the GREEK Words OIKOS (HOUSE OR PLACE WHERE ONE LIVES) and LOGOS (STUDY OF). Ecology then means the Study of the "House" in which We Live.

Ecology can be defined more specifically as the **Study of the Interactions between Organisms and the Nonliving Components of their Environment**.

The Earth includes a tremendous variety of living things. Each organism Depends in some way on other living and nonliving things in its Environment. Ecology involves collecting information about organisms and their environment, looking for patterns, and seeking to explain these patterns.

### LEVELS OF ORGANIZATION

The surface of the Earth as a whole is an Ecosystem. We call the Surface of the Earth the **BIOSPHERE**. The Biosphere is the surface of the Earth (AIR, WATER, and LAND) Where Living Things Exist.

The Biosphere is composed of smaller units called **ECOSYSTEMS**. **An Ecosystem includes all the Organisms and the Nonliving Environment found in a particular place.**

Ecosystems can be as large or as small as we decide. Any area you decide to Study can be considered an Ecosystem. For example you may choose to study your back yard, campus, agricultural fields, gardens or forests. Any of these would be considered an Ecosystem.

The simplest Level of Organization in Ecology is that of the **ORGANISM**.

A **Population** includes all the members of the Same Species that Live in one place at one time.

Populations are individual species, all the interacting Organisms (All the Different Populations) that live in a particular area make up a **COMMUNITY**.

The Physical Location of a Community is called the **HABITAT**.

The **DIVERSITY** of an Ecosystem is a measure of the number of different species there, and how common each species is.

Ecosystems are very Complex. They can contain hundreds or even thousands of interacting species.

There are three different types of ecology

- Physiological Ecology
- Population Ecology
- Community Ecology &
- Ecosystem Ecology

**Physiological ecology-** focused on responses of the individual organism to the physical environment (temperature, light, water, nutrients). Examples include: responses of plants to water stress or changes in light intensity; responses of fish to heavy metal contamination; adaptations to living in a saline environment. The focus is on physiological responses of individual organisms.

**Population ecology-** focused on populations, and the factors affecting the distribution and abundance of a population. Units of study are # individuals/area.

**Community ecology-** focused on groups of more than one species, and the interactions among different species. Ex.) competition between different plant species for water and nutrients; impact of bison or cattle grazing on plant diversity; colonization and changes in plant communities following flooding.

**Ecosystems ecology-** interest is in movement of energy, mass, nutrients, and/or water in and through ecosystems. Ex) cycling of nitrogen through soils, grass and bison at prairie; production and energy flow in an agricultural field; factors controlling accumulation and storage of organic matter in soils.

**THE NICHE**

Each Organism or Species in the Community has a **ROLE** or PROFESSION in that Community and in Ecology this is the Organisms **NICHE**.

A species' Niche is its way of life, or the role the species plays in its Environment.

The Niche includes the range of conditions that the species can tolerate, the methods by which it obtains needed resources, the number of offspring it has, its time of reproduction and all its other interaction with its environment. (Figure 19-13)

- The **FUNDAMENTAL NICHE** is the Range of Conditions that a species can Potentially Tolerate and the Range of Resources it can Potentially Use.
- The **REALIZED NICHE** of a species is the Range of Resources It Actually Uses.

**GENERALIST** are species with Broad Niches; they can tolerate a range of conditions and use a variety of resources. Species that have narrow Niches, such as the Koala, are called SPECIALIST.

**BIOTIC AND ABIOTIC FACTORS**

An Ecosystem possesses both LIVING COMPONENTS OR BIOTIC FACTORS and NONLIVING OR ABIOTIC FACTORS.

The Living Components of the environment are called Biotic Factors. They include all the Living Things that affect an organism. Biotic Components are often categorized as Producers, Consumers, and Decomposer.

The Nonliving Factors, called Abiotic Factors, are Physical and Chemical Characteristics of the environment. They include Solar Energy (Amount of Sun Light), Oxygen, CO2, Water, Temperature, Humidity, pH, and availability of Nitrogen.

**FLOW OF ENERGY IN ECOSYSTEMS**

The MOST Important Factor Determining HOW MANY and WHAT KIND of Organisms that can live in an Ecosystem is the amount of ENERGY Available.

The amount of energy an Ecosystem receives and the amount that is transferred from organism to organism has an important effect on the Ecosystem's structure. All Organisms need Energy to carry out essential functions, such as growth, movement, maintenance and repair, and reproduction.

Energy in an Ecosystem FLOWS from the SUN to Autotrophs (Producers) then to Organisms that Eat the Autotrophs, then to Organisms that feed on other Organisms (Consumers).

The Primary Source of Energy for an Ecosystem is the SUN.

**PRODUCERS** are Autotrophic Organisms (Autotrophs) with the capability of carrying out Photosynthesis, and making food for themselves and storing some for other Organisms to consume. Examples are plants, some bacteria, and algae.

All Other Organisms in Ecosystem are **CONSUMERS** or Heterotrophs that eat the Producers or other Organisms. Consumers can be broken into different groups depending on what they EAT:

A. **Decomposers –** Consumers who feed on Remains of Dead Plants and Animals.

B. **Herbivores –** Eat Producers or Plant Eaters.

C. **Carnivores –** Eat other Consumers. Meat Eaters.

D. **Omnivores –** Eat Both Producers and Consumers. Plant and Meat Eaters (US).

E. **Detritivores –** Feed on the "Garbage" of an Ecosystem.

In an Ecosystem these Producers and Consumers are placed in **Trophic Levels** (Feeding Levels).

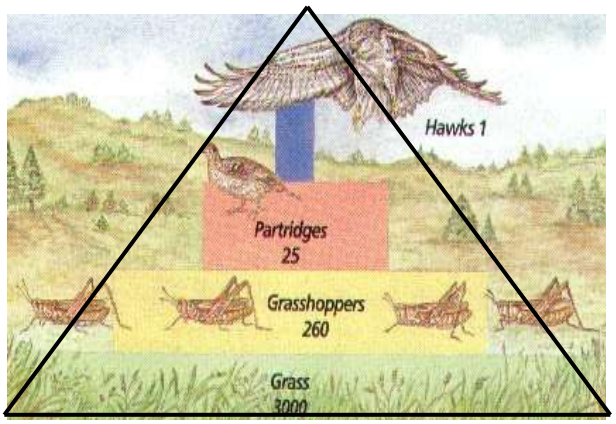
**A Trophic Level is a group of organisms whose feeding source is the same number of steps from the Sun.**

A. Producers (Autotrophs) are the First Trophic Level.

B. Herbivores are the Second Trophic Level.

C. Carnivores are the Third, Forth and Fifth Trophic Levels.

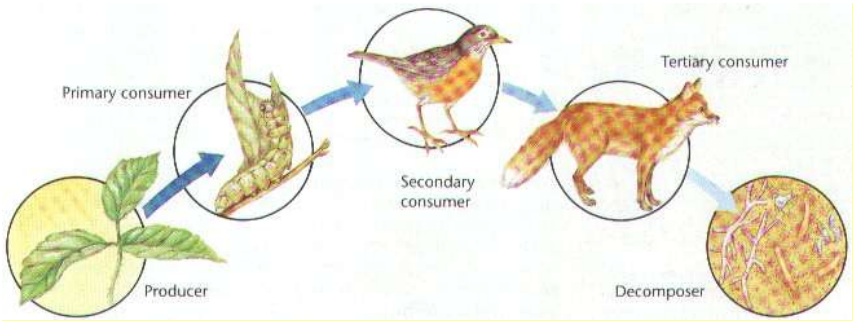
Most Animals (Carnivores) feed at more than one Trophic Level.



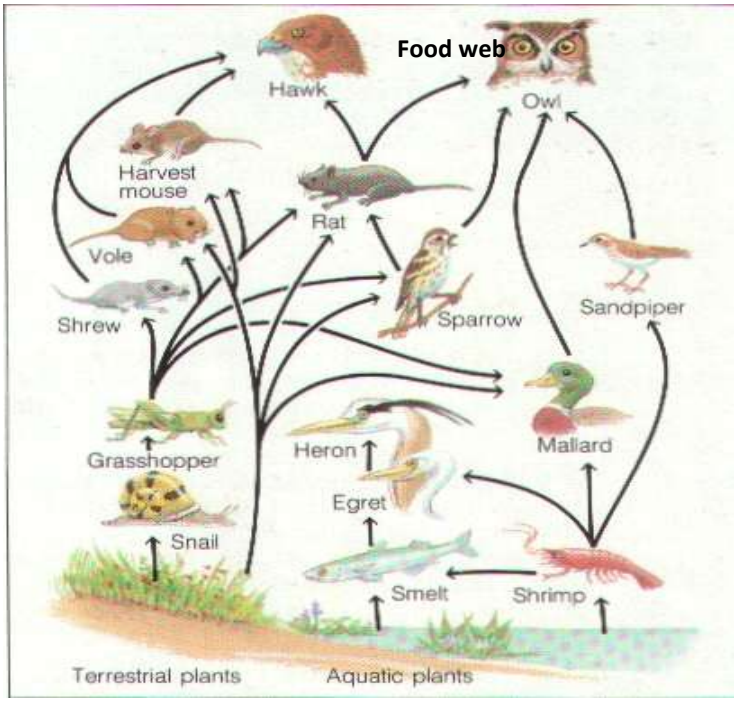

**ECOLOGICAL PYRAMID**

A **FOOD CHAIN indicates who eats whom in an Ecosystem**.

**Food Chain**



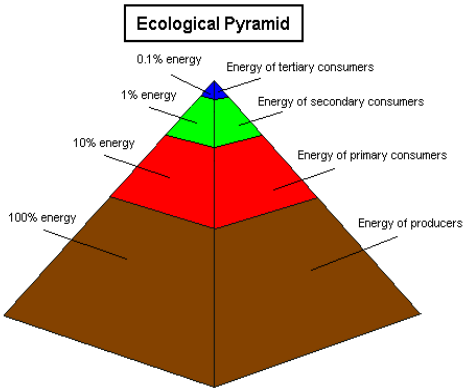

**A Food Web may contain several Food Chains.** Energy Flows through an Ecosystem in a Complex Network of Feeding relationships called a FOOD WEB.




Energy is Lost or Used as it flows through the Trophic Levels of an Ecosystem.

Producers (Plants) absorb Energy from the Sun, but only about ½ of the Energy capture from the Sun becomes part of the Plants Body. The other ½ is used for Living and Growing or Lost as HEAT. At each Trophic Level, the Energy stored in an organism is about 1/10 that of the Level Below it. (10%). Because Energy diminishes at each successive Trophic Level, Few Ecosystems can contain more than 4 or 5 Trophic Levels.

Organisms at Higher Trophic Levels, Large Carnivores, tend to be Fewer in number than those at Lower Trophic Levels, Producers

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**Lecture 8**

# INTRODUCTION, TYPES, CHARACTERISTIC FEATURES, STRUCTURE AND FUNCTION OF FOREST ECOSYSTEM, GRASSLAND ECOSYSTEM AND DESERT ECOSYSTEM

The biosphere forms a thin crust of living beings over the surface of our planet and consists an immense variety of organisms out of which only about 1.5 million species have been identified and described. The existence and well being of living organisms depend on a system of complex interactions within and in between the components of environment – the lithosphere, hydrosphere, atmosphere and the biosphere and the biosphere itself. These interactions, which satisfy all needs of all living organism such as shelter, oxygen to respire, mates to reproduce etc. – essential for sustained life and continuation of species.

## TERRESTRIAL HABITAT – BIOMES

Terrestrial habitat refers to the land where the organisms live. Land constitutes only 30% of the earth's surface. However, it is characterized by a variety of climates diversity of abiotic factors and heterogeneity of biotic communities.

### 1. Characteristics of Terrestrial Habitat:

1. Water is very much limited, and there is the scarcity of water. Dryness prevails.
2. Dehydration predominates
3. Temperature fluctuations are great
4. The intensity of light is high
5. Atmospheric air is the source of $O_2$
6. $O_2$ and $CO_2$ are provided at a constant rate
7. The land is not continuous, but is provided with a number of geographical barriers in the form of mountains, valleys, lakes, rivers, seas, etc.
8. Soil contains all the necessary nutrients for the production of energy.
9. On land the buoyancy is lesser when compared to water.

### 2. Geographical Classification of Land:

Based on the distribution of animals and plants, the earth's surface is divided into six *realms*, namely,

1. Palaeractic realm
2. Nearctic realm
3. Neotropical realm
4. Ethiopian realm
5. Oriental realm
6. Australian realm

Each realm includes wide land masses and is separated from adjacent realms by oceans, mountains or deserts.

### 3. Ecological Classification of Land :

Ecologically, the terrestrial habitat is subdivided into a number of subunits called *biomes.* A biome is defined as a *major terrestrial community characterised by distinctive plants and animals.*

**Examples :** 1. Forest biome, 2. Grassland biome, 3. Tundra biome, 4. Coniferous biome, 5. Cave biome and 6. Desert biome.

**4. Characteristics of Biomes**

1. A biome is a major terrestrial community.
2. It is formed of distinctive animals and plants
3. Many biomes are present in a geographical realm.
4. Each biome has a climax community which is dominant. The climax community forms the matrix of the biome. The biome is named after the climax community. For example, in a grassland biome, grasses form the climax community ; in a forest biome trees form the climax community.
5. In addition to climax community, each biome has many intermediate communities. Thus a biome consists of a special combination of a complex of communities.
6. The communities of a biome are maintained under the climatic conditions the region.
7. There is no clear-cut demarcation between adjacent communities.
8. The adjacent communities blend in the meeting place to form an ecotone.
9. A biome is different from an ecosystem in that the ecosystem consists of both *biotic factors* and abiotic factors. But a biome includes only *plants* and *animals*.

**5. Tundra Biomes**

Tundra refers tot eh *treeless* plain of the arctic region which remains marshy during summer and frozen hard in winter. About 5 million acres of Tundra stretch across North America, Northern Europe and Siberia. Tundra is characterised by the following salient features :

1. It lies between the Arctic ocean and the polar ice caps on the north and the coniferous forest in the south.
2. Rainfall is low.
3. Climate is cold
4. Winter is characterised by the continuous darkness and summer is characterised by continuous light. Even in summer the intensity of light is low.
5. The ground except the surface remains frozen. (10 or 20 cm), the frozen deeper soil is called *permafrost.*
6. The frozen soil starts thawing during summer.
7. The vegetation grows only for a brief period of 60 days in summer.
8. **Flora** : Trees are absent. All plants are low and ground –hugging forms. Eg. Lichen (reindeer moss), mosses, grasses, sedges and shrubs.
9. **Fauna** : Arctic fox, hare, reindeer, lemmings, oxen, polar bear, caribou, walruses, seals, penguins, migratory birds and insects appear during summer.

**6. Grassland Biomes**

This biome is a plain land occupied by grasses. Grasses form the climax community in this biome. Grassland biome is also called *prairies, steppes, pampas,* etc. It is found in north America, Asia, Siberia, Russia and Africa. Grassland has the following characteristics.

1. Grasses form the climax community.
2. Trees are also present. They grow along the streams.
3. Grasses are of three types, namely tall grasses (above 1 meter), mid grasses (between 0.5 and 1 meter) and short grasses (less than 0.5 meter).
4. Grassland biome is intermediate between desert and forest in the amount of precipitations (rainfall). It ranges from 20 to 40 inches.
5. It is distributed in the interiors of continents.
6. Grassland soil is rich in humus.
7. It is an ideal home for grazing animals.

**Fauna :** Bison, Wildhorses, ass, antelopes, zebra, rabbits, ground squirrels, prairie dogs, kangaroos, wallabies, prairie chicken, lark, sparrow, rattle snake Bufo (amphibian) etc.

**7. Forest Biomes**

A forest biome is a land of thick growth of trees. Trees constitute the climax community. Precipitation is high. The moisture of the soil is high and constant. It exhibits a clear vertical stratification. It consists of an upper layer formed of leaves and braches of trees, a middle layer formed of herbs and shrubs and the forest floor. Based on the types of plants and the geographical location, forest biomes are classified into three types, namely,

1. Coniferous forests
2. Tropical rain forests and
3. Deciduous forests

**1. Coniferous Forests (Taiga)**

1. This biome is thickly populated with pine trees characterized by needle-like leaves. These trees belong to the class of *Gymnosperms.*
2. The leaves of the trees are evergreen.
3. It is confined to the northern hemisphere at high altitudes.
4. It stretches as a belt south of Tundra in North America and Eurasia
5. It is also called *taiga* because it gives thick shade and prevents the growth of herbs and shrubs.
6. The annual rate of production is great because of the ever-green leaves and continuous photo-synthesis throughout the year.
7. It forms the major supplier of timber.
8. The seeds of pine trees form the major source of food for certain animals.
9. **Fauna** : Hyla, Rana, Woodpeckers, Cross-bills, squirrels, hares, beavers, deers, Canadian porcupine, wolves, bears, foxes, caribou, lynx, wolf, bears, red fox, elk, insects like bark beetles, saw flies, geometrid moths etc.

**2. Tropical Rain Forests :**

1. This forest is characterized by thick growth of tall trees. The leaves of these trees are broad and evergreen.
2. Rain forests are found in tropical countries like India, Western ghats, Malaya, East Indias, Africa, Northern Australia, etc.
3. In these forests precipitation is high. It is more than 200 cm per year.
4. In these forests humidity is high.
5. In these forests illumination is reduced because of thick vegetation.
6. From these forests air-currents are absent.
7. Here vertical stratification is distinct. It is formed of three layers, namely an upper of leaves and branches, a middle layer of shrubs and small trees and a a lower of forest floor.
8. **Fauna** : Worms, snails, millipeds, centipeds, scorpions, isopods, spiders, insects, planarians, leeches, tree frogs, chamaeleon, geckoes, snakes, parakeets, birds of paradise, insectivores, leopards, jungle cats, ant eaters, flying squirrels, monkeys , sloths, arboreal kangaroos, tiger, elephant, samphar deer, spotted deer, gaur, etc.

**3. Deciduous Forests**

1. This forest is characterized by tall trees with broad and thin leaves, which fall during water.
2. Deciduous forests are found in Australia, Europe, Japan and Eastern United States.
3. The climate is warm during summer and cold during winter.

4. Precipitation is moderate and it ranges from 60 cm to 150 cm per year.
5. The winter is characterized by short days and summer by long days.
6. During autumn the trees shed their leaves and in winter the trees are without leaves and in a dormant condition.
7. Fauna : Deer, fox, bear, beaver, squirrel, flying squirrel, raccoon, wild boar, *rattle* snake, song birds, birds of prey, horned *owl, hawks,* crested fly catcher, thrushes, woodpecker, *amphibians* insects, etc.

**4. Forest Adaptations :**

1. Most of the forest animals are arboreal inhabit and they have adaptations for arboreal life (life on trees). The arboreal adaptations are as follows :
    a. Small and slender body
    b. Opposable toes Eg. *Chamaeleon*.
    c. Digits are fused in groups – *Syndactyly*
    d. Presence of claws.
    e. Presence of adhesive discs on the digits. Eg. tree frogs
    f. The tail is prehensile and it acts as the fifth limb.
    g. Development of parachuting mechanism
    h. The pectoral girdles are strong.
    i. Limb are elongated.
    j. Protective colouration
    k. Reproduction is specially adapted for tree life. For example, the amphibian *Phyllomedusa* lays its eggs on rolled up leaves hanging above water, the tadpoles directly fall into the water on hatching.
2. The sense of hearing is well developed. The vision is poor.
3. Forest animals living on land are heavily built.
4. The antlers and horns are short or reduced.

**8. Desert Biomes :**

A desert is a waterless, treeless, large waste-land often covered with sand. It is characterized by low or no rainfall, scarcity of water, extremes of temperature and dust – storms. The important deserts in the world are *Rajasthan* (India), *Gobi* (China), *Sahara* and *Kalahari (*Africa). Deserts are broadly classified into two groups, namely *hot-deserts* and *cold deserts.* In hot deserts the temperature is very high. Eg. Sahara, gobi, Rajasthan etc. In cold deserts the temperature is very low. They are situated at high altitudes. Eg. Tadakh, Tibet, Alps, Scandinavian mountains etc.

**1. Desert Fauna**

*Uromastix, Moloch horridus, Heloderma, Mabuia,* rattle snakes, *Phrynosoma, Phrynocephalus,* birds like quails, Indian bustard, grey partidge, and mammals like bats, hedgehog, hare, ant eater, porcupine, mouse, wild boar, samphar deer, spotted deer, wolf, red foxes, jungle cats, *Panther* etc. are some of the desert animals.

**2. Desert Adaptations**

Desert animals develop adaptations for four purposes. They are :

1. Water conservation
2. Water getting
3. Tolerance of heat and
4. Protection.

**1. Water conservation**

Desert is characterised by dry atmosphere. Hence desert animals tend to lose water from their body through evaporation. So the desert animals have plenty of adaptations for conserving water.

1. **Imprevious Skin :** In desert animals evaporation through body-surface is prevented by the development of impervious skin. The skin may be covered by scales, spines, scutes, shields etc. eg. *Moloch horridus.*
2. **Nocturnal Habit :** To prevent evaporation, certain desert animals are active during night only.
3. **Shady Places :** Diurnal animals rest in shady places to prevent the loss of water.
4. **Burrowing Habit :** Evaporation is prevented by living inside burrows during hot days.
5. **Aestivation :** Certain desert animals like pocket mice, Kangaroo rat, etc. aestivate to prevent desiccation.
6. **Excretion :** Desert insects, reptiles and birds produce *uric acid* as their nitrogenous waste product, since the disposal of *uric acid* does not require water. Again water from faeces and urine is reabsorbed in these animals. Hence the faeces and urine are in the form of paste.
7. **Absence of Sweat Glands :** The desert rodents and ruminants have no sweat glands.
8. **Reduced Metabolic Rate :** The African antelope *Oryx* reduces its metabolic rate and conserves water.

**4. Water Getting :**

Water scarcity is prevalent in deserts. Hence desert animals face problems of getting water. Water problem in deserts is solved in the following ways:

1. **Water Holes :** Desert animals get water from water holes.

2. **Migration :** Desert animals migrate short or long distances to get water.

3. **Water From Food :** Certain desert animals depend on the small amount of water present in the food taken in. The water present in succulent plants forms the source of water for rabbits and turtles.

4. **Water From Seed :** The rodent Jerboas can live without water except that obtained from dry seeds.

5. **Water From Blood :** Carnivorous animals get water from the blood of their prey.

6. **Metabolic Water :** Animals like ants and kangaroo rats depend on the small amount of water arising as a by product in metabolism.

$$C_6H_{12}O_6 + O_2 \longrightarrow H_2O + CO_2 + \text{Energy}$$

7. **Hygroscopic Skin :** The skin of spiny lizard *Moloch horridus* is hygroscopic. It absorbs water from the atmosphere like a blotting paper.

8. **Intestinal storage :** The *lizard Uromastix* stores water in the intestine.

9. **Water Cells :** Camel can take in large quantities of water when available. For example, it drinks 40 litres of water in 10 minutes. The water is stored in the *water cells* present in the rumen of stomach.

10. **No Drinks :** Desert birds like black – throated sparrow, zebra finch, grey-backed finch, lark etc., can survive indefinitely without drinking water. Similarly kangaroo rat can seal its burrow by day and thus keeps its chamber moist and can live throughout the year without drinking water.

**3. Tolerance of Heat :**

Heat is very high in deserts. To escape from heat, desert animals possess the following adaptations.

1. **Heat Resistance:** Camel is resistant to heat. The body- temperature of camel is labile. During day it can allow its body-temperature to rise to 40.6°C without sweating. Similarly, at night it allows its body-temperature to drop to 33.8°C. Hence camel is resistant to heat.

Similarly, the African antelope *Oryx can* store heat in its body during day. It causes a substantial rise in body-temperature (hyperthermia).

2. **Aestivation:** Certain desert animals like pocket mice, Kangaroo rat etc., aestivate to tide over extreme heat.

3. **Tolerance of Dehydration:** Most mammals die, when they lose as much as 20% of the water from their bodies. But camel can lose over 40% without serious danger.

4. **Absence of Fatty Insulation:** Camel accumulates its fat in the hump rather than over the body. This speeds up the flow of heat away from the body.

**4. Protection**

Desert Animals protect themselves in the following ways :

1. Nocturnal habit protects them form the scorching sun.
2. They live in burrows.
3. They have adaptations for swift running.
4. They are provided with long legs to keep their body above the burning sand.
   In *Mabuya* the lower eyelid is much enlarged and transparent ; it can be used to close the eye without affecting vision.
5. Their nostrils, eyes and ears are protected from dust-storms. In camel the nostril can be closed like eyes.
6. They are provided with spines for protection.
7. The presence of poison is another desert adaptation Eg. *Rattle snake, Helodermapunctatum* (lizard) , etc.

**9. Cave Biome**

Caves are *natural hollows on the earth* . They may be present on the surface of the earth or in the sides of hills, mountains, and rocks or underground or under bodies of water.

**1. Origin of Caves**

**Caves are formed in the following ways :**

1. **Flowing Rivers :** Most of the caves are abandoned channels through which underground rivers must have flowed in the past.
2. **Dissolution of Limestone :** Limestone is readily soluble in water. When limestone is present somewhere on the earth, it gradually dissolves and the surface water gradually sinks to form crevices. These crevices deepen to form caves.
3. **Wind Erosion :** Caves in sand is formed by the erosion caused by winds.
4. **Sea Erosion :** Caves in the sea are formed by the dashing of waves.

**2. Zonation of Caves**

Based on the penetration of light, a cave is divided into three zones, namely the *dysphotic (twilight)* region, the middle region and the *inner* region.

1. **Dysphotic or Twilight Region :** This is the mouth region of the cave. It extends upto the region where light can penetrate.
2. **Middle Region : In** this region, the penetration of light is lesser.
3. **Inner Region :** This region has no light at all. Total darkness prevails here.

**3. Characteristics of Cave**

1. **Darkness :** Light is absent from caves; hence total darkness prevails in caves.
2. **Uniform Temperature :** The temperature in caves remains uniform throughout the year.
3. **High Humidity :** The humidity in caves is high.
4. **Absence of Air Currents :** The air in caves remains stagnant.

**4. Cave Flora**

**The cave flora includes only the non-green plants like fungus, mold, mushrooms, etc.**

**5. Cave Fauna**

Caves are inhabited by the following animals :

| | | |
|---|---|---|
| Platyhelminthes | : | Turbellarian worms |
| Annelida | : | Chaetopod worms, leeches, etc. |
| Annelida | : | Decapods,Isopods, Amphipods, Springtails, Mites, spiders, silverfish, cockroaches, cricket, etc. |
| Mollusca | : | Snails |
| Fishes | : | *Amblyopsis, Typhlichthyes, Gronias nigrilabris, etc* |
| Amphibia | : | *Proteus anguinus, Typhlotriton Spelerpes, Typhlomolge* |
| Birds | : | *Owls* |
| Mammals | : | White-footed mouse, *Peromyscus teucopus,* bats, etc. |

**5. Cave Adaptations**

The animals living in caves are called *cavernicolous* animals and their adaptations are called *Cavernicolous* adaptations.

- **Loss of Pigmentations:** Development of pigments on the skin requires light. As there is no light in the cave, pigments are absent from cave animals. Hence they are pale or light in colour. When cave animals are brought to light, they develop pigments and become dark in colour. Hence the ability to develop pigments is not permanently lost in cave animals.
- **Absence of Eyes :** Eyes are photoreceptors. They require light for their function. As there is no light in the cave, the eyes in cave animals are either nonfunctional or rudimentary or completely lost.
- **Weak Exoskeleton:** The exoskeleton of cave arthropods is weak and fragile. The shell of cave snails i thin; scales are completely lost from cave fishes.
- **Slender Body:** Cave animals are provided with a slender long body.
- **Tactile organs:** As photoreceptors are inefficient, cave animals are provided with powerful tactile organs in the form of long antennae, taste buds on head, snout, lips, etc.
- **Scarcity of Food:** Caves are characterised by scarcity of food. This scarcity of food is due to lack of green vegetation. Hence cave animals have adaptations to live without food for many days.
- **Neoteny :** Cave urodeles exhibit neoteny. By neoteny the larval urodeles can produce young ones.
- **Carnivorous Habit:** As there is no vegetation, most of the cave animals are carnivorous in habit.
- **Degeneration:** There is no struggle for existence and no competition in caves. Hence there is no specialization in cave animals; instead, they have undergone degeneration in many respects.
- **Primitiveness:** Caves provide a constant unchanging environment. Hence cave animals possess primitive characters and many archaic forms persist in caves.

## MANGROVES

Mangroves refer to *groups of small land trees that inhabit inertida flats and estuarine deltas along the tropical and subtropical sea-coasts.* Several plant species dominate in mangroves. Hence mangroves are commonly called mangrove forests. The common representatives of mangroves are *Rhizophora, Avicennia and Bruguiera.* Mangroves can tolerate salinities from full strength sea water to fresh water. Hence the mangroves are *polyhaline.*

**Salient Features of Mangroves**

Mangroves are characterized by the following salient features :

1. Mangrove is an intertidal ecosystem found along the sea coasts of tropical and subtropical countries.
2. It is commonly found in estuarine deltas.
3. The mangrove ecosystem is dominated by trees and hence the mangroves are called *mangrove forests.*

4. The mangroves have the ability to tolerate wide ranges of salinity from sea water to fresh water. Hence they are called *polyhaline.*
5. They can tolerate dissolved oxygen levels low as zero.
6. The mangroves develop between the level of sea and the level of high tide.
7. Mangrove plants are recognized by the presence of *pneumatophores, prop roots and viviparous* seeds.
8. Mangroves grow in sheltered shores, penetrating into the estuaries of rivers, tidal creeks, backwaters, salt marshes, and coastal mudflats where salt water penetrates.
9. Mangroves are protected from continuous wave action.
10. Mangroves receive terrestrial freshwater runoff.
11. Mangrove is a good habitat for a variety of organisms. It is an excellent rearing area for juvenile fish, shellfish and reptiles. Crabs are abundant in the mangrove ecosystem.
12. Mangrove is a human resource potential. It helps in building up an maintaining the coastline from erosion damage. It is a source of building material, as a source of tanning material in the leather industry and for productive fisheries.
13. Mangroves are *open systems* since they are constantly subject to tidal flow and seasonal flooding.
14. The mangrove soil is mainly formed of silt. The silt brought by the high tides from the sea contains shells of foraminifera and molluses.

**The Mangroves of India**

**About 80% of mangroves in India are located in West Bengal. The common mangroves are as follows:**

1. Pitchavaram mangrove at Cauvery delta.
2. Muthupet Chatram mangrove.
3. Orda mangrove in Goa.
4. Ribandar mangrove in Goa.
5. Andaman and Nicobar mangroves.
6. Sunderbans in West Bengal.

**The Ecological Conditions of Mangrove**

The development of mangrove vegetation requires the following ecological conditions:

1. Shallow water.
2. Thick mud
3. High rainfall
4. High humidity and cloudy weather
5. Water-logged saline soil or loose soil with a large amount of organic matter.

**Mangrove plants**

Mangrove vegetation is formed of the following plant types :

| | |
|---|---|
| *Rhizophora* | *Sonneratia* |
| *Avicennia* | *Excoecaria* |
| *Acanthus* | *Ceriops* |
| *Casula* | *Xylocarpus* |
| *Oryza* | *Bruguiera,etc.* |

**Adaptations of Mangrove Plants**

The mangrove vegetation possesses the following adaptations:

1. **Pneumatophores :** These are respiratory roots produced by mangroves for efficient aeration of root system in the water-logged conditions.
2. **Prop Roots and Stilt Roots :** These are produced from the main trunk of the tree for the efficient anchorage of the plants.
3. **Habit :** Most of the mangrove plants are shrubs. Herbs are rare.
4. **Succulent Stem :** Mangrove plants are provided with succulent stem.
5. **Germination :** Mangrove plants exhibit vivparous germination.
6. **Salt-Coping Strategy** : Though mangroves exist in saline environment, they depend to a great extent on freshwater to maintain an optimum salinity balance and to get nutrient salts. *Rhizophore* has a salt excluding device in the root system allowing passage of water and essential nutrients into the tree and not the slat. Avicennia freely allows salt to enter and pass through the leaf stomata in the transpiration stream of water, the salt –ex-cluding mechanism being between the xylem and phloem.

**Fauna of Mangroves**

The roots, the stems and the branches of the mangroves provide a good habitat for tropical animals. The pockets of organic mud held between the roots and stems of mangrove vegetation form a good dwelling place for or-ganisms. Mangrove is a unique ecosystem where animals of the terrestrial, fresh water and marine animals inhabit. The following are the organisms of the mangroves:

**1. Phytoplankton :** The following are the common phytoplankton of mangroves : *Asterionella, Thalassiothrix, Hemidiscus, Bellerochea, Melosira, Chaetoceros, Stephanopyxis, Eucampia, Biddulphioa, Navivula, Pleurosigma.*

**2. Zooplankton :** Zooplanktonic components of mangroves are the following : *Ceratium, peridinium, oithona, Acrocalanus, Lucifer, Sagitta, Pleurobrachia, Oikopleura (Urochordate),etc.*

**3. Annelids :** Burrowing polychaetes are abundant in the sediments of mangroves. The following annelids are represented in the mangroves : *Arenicola, Dendronereis, Cossura delta, Laonome indica, Ldopatra neapolitina, Harmathoe, Nerine cirratulus, Ammotrypane aulogaster, Clymene annandalei, Sternaspis, Stylaroides, Ochetostomia septemyotum,* (echiuroid worm),etc.

**4. Crustacea :** Crustaceans are abundant in the mangroves. Crabs are dominant among crustaceans. The following are the crustaceans of the mangroves : *Uca* (fiddler crab), *Metaplex crenulatus* (mud crab), crabs such as *Birgus tro, Sesarma, Coenobtia, Scylla serrata, Macrophthalmus, etc., Thalassina anomala* (mud lobster), etc. Large number of barnacles are found attached to the roots and stems of mangroves. The hermit crab *Clibanarius longitarsus* is abundant in mangroves. It can climb to trees reaching heights well above those reached by high tides.

**5. Molluses :** Molluscs are also abundant in the mangroves, large number of oysters are found attached to the roots and stems of mangroves. Eg. *Cras-sostrea calcullate. Littorinids in habit the twigs and trunks of mangroves. Eg : Littorinids melanostoma, L., scabra, I undulata,etc.* Other molluscs are *Martesis striata, Bankia edmondsoni, Teredo juttingae, Onchidium, verruculatum, Telescopium telescopium, Cerithidea fluviatilis, Trebralia palustris,etc.*

**6. Fishes :** Mudskippers are abundant in the mangroves. Eg. *Periophtalmus and Boleophthalmus.* They are small fish having large heads with protruding stalked eyes. When the tide goes out, the mudskippers breathe in air and use their fins like legs to crawl and hop over the mud. They have special sucker-like fins to climb up mangrove roots and stems. If danger threatens the fish quickly jumps or skips away.

**7. Reptiles :** *Boiga dendrophila* is a mangrove snake. It lives on birds *Laticauda colubrina is a sea* snake of mangroves. The monitor *lizard Varanus slavator a*nd the sea crocodile *Crocodylus porosus* are other reptiles.

**8. Birds :** The birds of mangroves are the graceful fish eagles, *Haliaeetus leucogaster,* and the tall adjutant storks *Leptoptilos Javanicus.*

**9. Mammals :** Mammals of mangroves include *Macacacrus (*long-tailed monkey) and *Nasalis larvatus* (proboscis monkey) .

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**Lecture 9**

# INTRODUCTION, TYPES, CHARACTERISTIC FEATURES, STRUCTURE AND FUNCTION OF AQUATIC ECOSYSTEMS: PONDS, STREAMS, LAKES - RIVERS, OCEANS, ESTUARIES

## AQUATIC BIOMES

Water covers nearly 70% of the earth's surface, providing abode to numerous species of organisms. In contrast to terrestrial biomes, which are identified and classified on the dominant vegetation, aquatic biomes are distinguished on the basis of physical attributes such as salinity, strength of current, availability of light and oxygen content. Global aquatic ecosystems fall into two broad categories– the freshwater biomes and marine biomes.

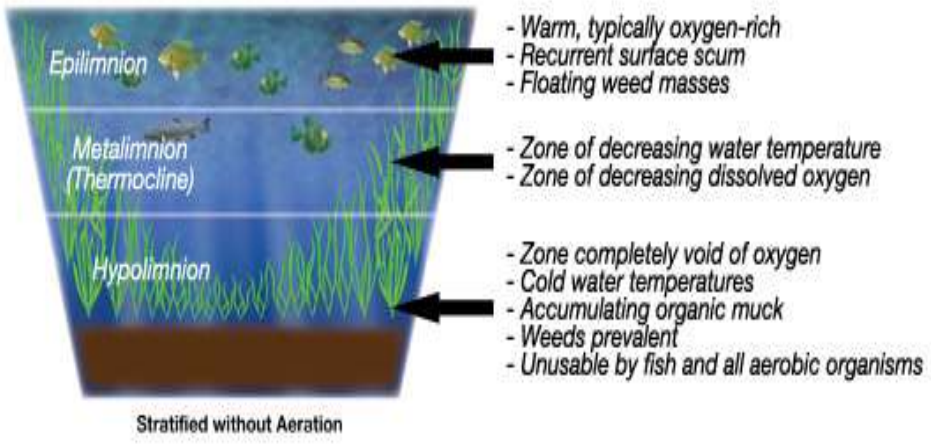
## FRESHWATER BIOMES

Freshwater regions occupy a relatively small portion of the Earth's surface (less than 5%) as compared to marine and terrestrial habitats but their importance to humans is greater than their relative area because they are the most convenient and cheapest source of water for domestic and industrial use and provide a convenient and economical waste disposal system. Freshwater habitats are divided into two groups – ***lentic*** or standing-water ecosystems such as lakes and ponds and ***lotic*** or running-water ecosystems such as springs, streams and rivers. Associated with lentic and lotic ecosystems are the ***wetlands***, where water is at or near the surface or the land is covered by shallow water such as swamps, marshes and bogs.

***Lentic ecosystems*** **(Lakes and ponds).**

Lakes and ponds are inland depressions containing standing water. They are geographically isolated from one another and scattered throughout the earth's surface. They vary in size from just a few square meters to thousands of square kilometers and range in depth from one meter to over 1000 meters. The life span of ponds ranges from a few weeks or months for small seasonal or temporary ponds to several hundred years for larger ponds. Although a few lakes, such as lake Baikal, are ancient, most large lakes dates back to Pleistocene glaciation.

In summer, the high atmospheric temperature warm the upper layer of water and the wind mixes this water well. This upper, warm, circulating layer of water is called **epilimnion.** Below this lies denser, cold, non-circulating water layer called the **hypolimnion**. Between these two layers is a zone of steep temperature gradient called **thermocline**, that acts as a barrier to the exchange of materials.



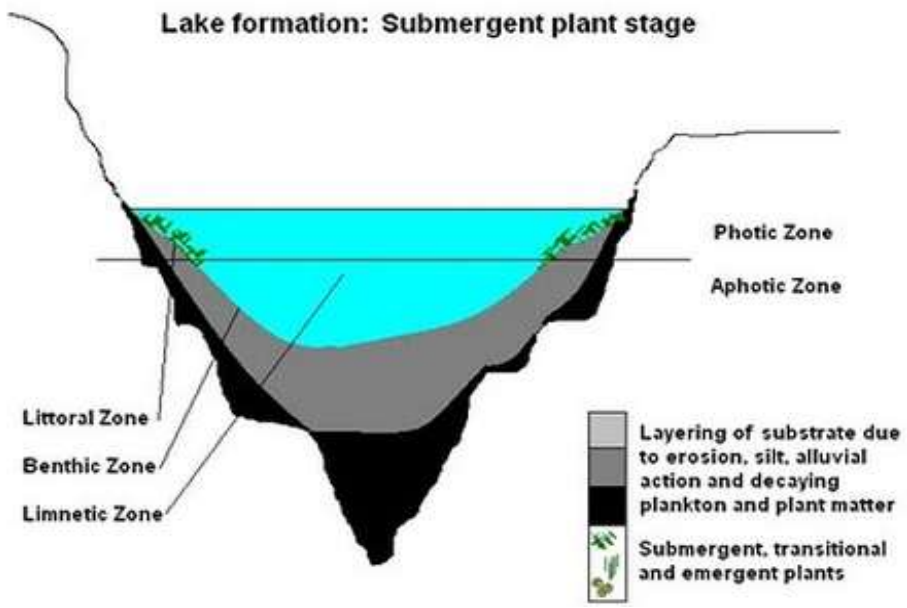
**Typically lakes and ponds can be subdivided into following zones based on the depth and distance from the shoreline**

(a) **Littoral zone –** It is the shallow water zone near the shore of a lake or pond in which light penetrates to the bottom. It is typically occupied by rooted and floating aquatic plants.

(b) **Limnetic zone –** It is the near-surface open water zone that is surrounded by littoral zone and extends upto the depth of effective light penetration. This zone is dominated by plankton, both phytoplankton and zooplankton. Both littoral and limnetic zones constitute the euphotic zone where production is greater than respiration (P/R >1).

(c) **Profundal zone –** The deep water zone which is beyond the depth of effective light penetration is the profundal zone where respiration is greater than production (P/R< 1). Between the limnetic and profundal zone is a level at which P/R=1 and is known as **compensation level**. In ponds the littoral zone is relatively large and the limnetic and profundal zones are small or even absent.

(d) **Benthic zone –** The bottom region of both littoral and profundal zones is the benthic zone which is the zone of decomposition.




**Based on primary productivity lakes may be classified into two broad categories**

**Oligotrophic lakes**

These are deep lakes having low surface to volume ratio with the hypolimnion larger than the epilimnion. Water is clear and appear blue to blue-green in sunlight. Bottom sediments are largely inorganic. The nutrient content of the water is low. Low nutrient availability results from a low input of nutrients from external sources and this causes low primary productivity. Littoral plants are scarce and plankton density is low.

**Eutrophic lakes**

These are shallow lakes with high surface to volume ratio. They are rich in nutrients, especially nitrogen and phosphorus, that stimulate a heavy growth of algae and other aquatic plants and result in high primary productivity. Littoral vegetation is more abundant and plankton density is high and such lakes exhibit characteristic plankton blooms.

Phytoplankton become concentrated in the upper layer of the water, giving it a green colour. The turbidity reduces the light penetration and restricts biological productivity to a narrow zone of surface water. Dead organic matter accumulates on the lake bottom where bacteria convert the dead matter into inorganic substances. The activities of decomposers deplete the oxygen level to a point where the aerobic life cannot exist. The number of species declines in such lakes although the number and biomass of organisms may remain high. The high rate of decomposition speeds up cycling of nutrients that further increases plant production. This natural filling in of lake basin with organic matter and nutrient enrichment is termed as **eutrophication.**

**Lotic ecosystems (Rivers)**

Streams and rivers are the bodies of continuously flowing water moving in one direction. They get their start at headwaters, which may be springs, snowmelt or even lakes, and then travel all the way to their mouths, usually another water channel or the ocean. The direction of flow is dictated by the lay of land, the underlying rock condition and the slope. Fast flowing water moving downstream cause extensive erosion that cuts the channel wider and deeper, and carries lot of debris that sooner or later are deposited within or along the stream where flow of water is less. Lotic system is an open ecosystem in which land-water interchange is relatively more extensive than other aquatic ecosystems. The major source of energy and nutrients is in the form of detritus carried into the streams from the surrounding land. Sometimes they also receive plankton and detritus from the connected lakes and ponds.

The lotic ecosystem is essentially a continuum of physical and biological conditions from the headwaters to the river's mouth. These changing conditions in the gradient from small to large streams have been termed the **river continuum concept.**

**Wetlands**

Wetlands are the lands transitional between terrestrial and aquatic systems and thus exhibit some of the characteristics of each. There are many kinds of wetlands which can be grouped into three major categories: swamps, marshes and peatlands.

**Swamps** are the wetlands with wooded vegetation (trees and shrubs). They may be deepwater swamps dominated by swamp oaks and cypress trees; or they may be shrub swamps dominated by alder and willows; or they may be forested woodlands along large river systems that are occasionally flooded by river waters.

**Marshes** are the wetlands dominated by emergent vegetation, plants with roots in soil (which is covered part or all of the time by water) and leaves held above the water. There are no trees in marshes and dominant vegetation are reeds, sedges, grasses and cattails.

**Peatlands** are the waterlogged areas saturated by groundwater or rainwater in which there is an accumulation of partially decayed organic matter. Peatlands fed by water moving through mineral soil dominated by sedges and slightly acidic are called ***fens***. Peatlands dominated by *Sphagnum* mosses, receiving their water supply largely from precipitatin and highly acidic are called ***Bogs***.

**MARINE/OCEAN ECOSYSTEMS**

Marine regions cover about 71% of the earth's surface and include oceans and associated ecosystems like estuaries, tidal marshes and swamps, sea shores and coral reefs. Oceans are the largest of all ecosystems and play a key role in controlling the world's climates, the atmosphere, and the functioning of major mineral cycles.

**The important physical factors that influence life in marine environments are listed as follows:-**

**Salinity –** The average salinity of sea water is 35‰ of which about 80% is contributed by sodium chloride and the rest by calcium, magnesium and potassium salts. The major anions in sea water are chloride, sulfate, bicarbonate, carbonate and bromide.

**Light –** Light is an important factor in the life of marine organisms due to its influence on photosynthesis, heating, radiations and vision. The volume of surface area lighted by sun is small compared to the volume of water in ocean.

**Temperature –** Ocean is the largest store house of sun's heat and thus regulates the temperature of the world. The range of temperature in sea is far less than that on the land; the extremes of temperature ranges from –3° C to 40° C.

**Pressure –** Pressure in the ocean varies from 1 atmosphere at the surface to 1000 atmosphere at its greatest depth and this has a pronounced effect on the distribution of life.

**Currents –** The sea is in continuous circulation and this is brought about by the currents. Air temperature difference between poles and equator set up strong winds, which together with rotation of earth create definite currents.

**Sea shores**

Sea shore is the place where sea meets the land. It is the littoral or intertidal zone roughly bounded by the extreme high tide mark (supra littoral fringe) and the extreme low tide mark (infra littoral fringe).

**1. Rocky shores**

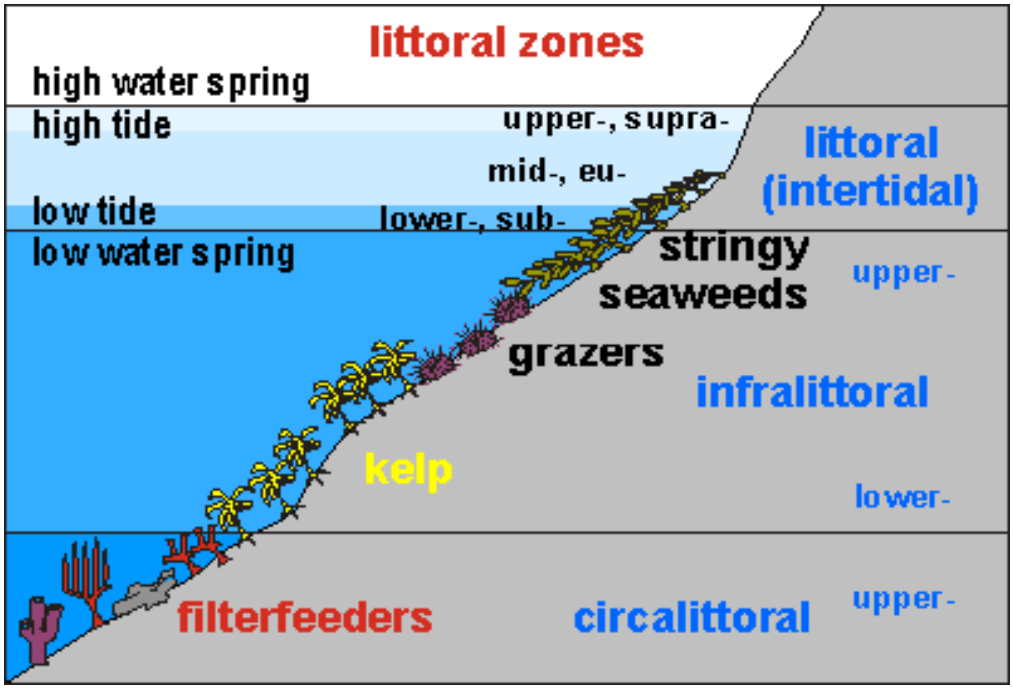
The rocky shores present solid substratum for growth of wide variety of algae and for attachment of many sessile animals. Sessile animals abound to the rocks are many sponges, colonial hydrozoans, anthozoans (e.g sea anemones) and bryozoans. The sedentary animals inhabiting the rocky shores are a variety of mollusks like limpets, mussels and oysters, barnacles and tunicates.

All rocky shores have the following three basic zones, characterized by the dominant organisms occupying them.

**Supralittoral fringe –** At the uppermost end is a zone of bare rock marking the transition between land and sea.

**Littoral zone –** It is the region covered and uncovered daily by tides and tends to be divided into subzones.

**Infralittoral fringe –** It is the zone uncovered only at the spring tides for short periods of time. This zone consists of forests of large brown alga, *Laminaria* (one of the kelps) with a rich undergrowth of other brown (*Fucus)* and red algae.




**2. Sandy shores and Mudflats**

In contrast to rocky shores which appear studded with life, both sandy shores and mudflats appear barren of life. They are also subjected to extremes of temperature, salinity, wave action etc.

Like rocky shores, sandy and muddy shores also exhibit zonation of life related to tidal influences. These zones are: supralittoral zone (dominant organisms are ghost crabs and beach hoppers), littoral or intertidal zone (abundance burrowing animals of varied groups) and infralittoral zone (predominant organisms are starfishes, sand dollars, predatory crabs and fishes).

**Open Sea**

The two major regions of sea are **pelagic** or whole body of water lying above the ocean floor, and **benthic** or the entire sea bottom. The pelagic region is further divided into two zones: **neritic zone** which is the shallow water zone on continental shelf and **oceanic zone** which is the region of open ocean beyond the continental shelf. The **continental shelf** is the underwater extension of continent. The edge of continental shelf may be within a few kilometers of the shore, or it may be several hundred kilometers from the shore. On the basis of light penetration the pelagic region is broadly divided into two vertical zones – **euphotic zone** (photosynthetic zone) that extends from surface to about 200m in which there are seasonal fluctuations and sharp gradients in light, temperature and salinity and **aphotic zone** of very little or no light penetration.

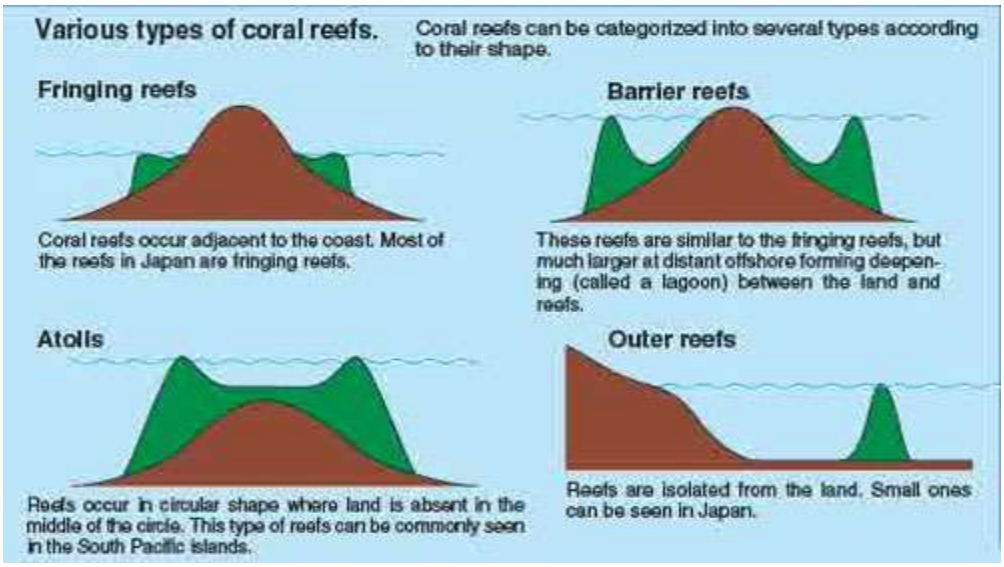
**Coral reefs**

Coral reefs are one of the most beautiful and specialized ecosystems, widely distributed in warm shallow waters of tropical and subtropical seas. They are built by carbonate-secreting organisms of which corals (coelentrata, Anthozoa) are the most conspicuous (hence the name coral reef) although other organisms like coralline red algae (Rhodaphyta, corallinaceae), foraminifera and mollusks also contribute equally to their structure.

Coral reefs are built only under water at shallow depths and need a stable foundation upon which to grow. Such a foundation is provided by shallow continentalshelves. Reef building corals grow best at waters having average annual temperature of $24^0$ C, a depth of 40-50 metres and average salinity of 35‰. Reefs are built upto the sea level.

**Coral reefs are of four types:**

- **Fringing reefs** that grow along the rocky shores of islands and continents.
- **Barrier reefs** parallel shores lines along continents.
- **Atolls** are coral islands that begin as horseshoe shaped reefs surrounding a lagoon.
- **Outer reefs** are isolated from the land




Coral reefs are complex ecosystems involving a close relationship between coral and algae. One kind of algae, the so called zooxanthellae (a symbiotic endozoic dinoflagellate algae) live in the tissues of coral polyp while other kinds of red and green coralline algae and filamentous algae live in the skeleton around or below the animal bodies.

Coral reefs are among the most highly productive ecosystems of the world; net productivity ranges from 1500 to 5000 gm $C/m^2$ /yr. In addition to abundance of light and oxygen the two major factors responsible for high productivity are (1) Efficient biological recycling of nutrients by coralline community retain nutrients within the system and (2) Coral act as trap for nutrients that come with the flowing water.

**Estuaries**

Estuaries are the areas where the freshwaters of streams and rivers meet the saltwater of ocean. It is a semi enclosed coastal body of water such as a river mouth or a coastal bay, which has a free connection with the open sea and which is strongly influenced by tidal action. The salinity of estuary is intermediate between that of seawater (salinity is about 35‰) and freshwater ( salinity ranges from 0.065% to 0.3% ). Estuary is, thus, a transition zone or ecotone between freshwater and marine ecosystems. Estauaries differ in size, shape and volume of water flow, all influenced by the geology of the region in which they occur. They normally have a high silt content.

**Current & Salinity** . Current and salinity are two important factors that influence life in the estuary. Estuarine currents are complex and highly variable in different estuaries and mainly result from the interaction of one-direction stream flow, which varies with season and rainfall, with oscillating ocean tides and with the wind. Salinity of estuaries varies vertically and horizontally and fluctuates between 0.5% to 35%.

**Biota and adaptation to estuarine environment**

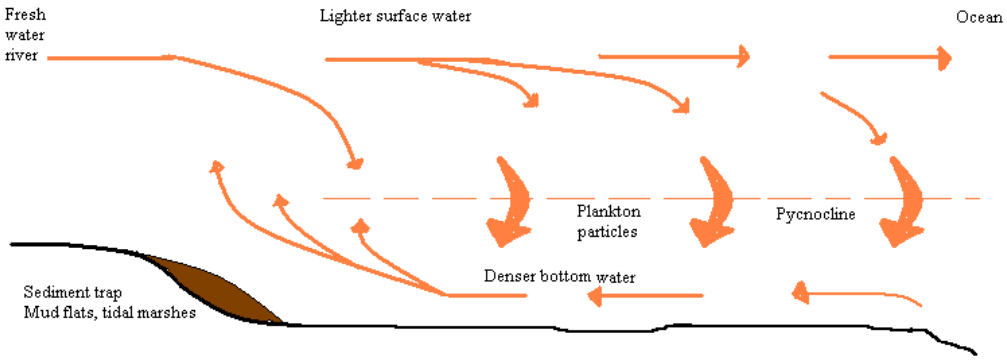
Estuary, being a transitional zone between freshwater and sea derives its biota from the adjacent marine and riverine habitats as well as typical estuarine organisms. The major components are the species restricted to estuarine situations, such as oysters and crabs, and those that come from the sea, such as shrimps. Very few species are derived from freshwater and only those that are capable of osmoregulation in saltier water.

Organisms inhabiting the estuary are faced with two problems- maintenance of postion and adjustment to changing salinity. The majority of estuarine organisms are benthic and are securely attached to the bottom, are buried in the mud or occupy crevices and crannies about sessile organisms. The dominant benthic organisms are the oysters which may be attached to hard objects or may form reefs.

**Productivity**

Estuaries are one of the highly productive ecosystems, second only to coral reefs and tropical rain forests.

An estuary is a "nutrient trap" that is partly physical and partly biological. Nutrients and oxygen are carried into the estuary by tides. If vertical mixing takes place, these nutrients are not soon swept back out to sea, but circulate up and down among organisms, water and bottom sediments. Organisms also aid in trapping and cycling of the nutrients. The retention and rapid recycling of nutrients by benthos, the recovery of nutrients from deep sediments by microbial activity and deeply penetrating plant roots or burrowing animals create a sort of self enriching system in the estuary.

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**Lecture 10**

# BIODIVERSITY AND ITS CONSERVATION - INTRODUCTION, DEFINITION, GENETIC, SPECIES & ECOSYSTEM DIVERSITY AND BIOGEOGRAPHICAL CLASSIFICATION OF INDIA- VALUE OF BIODIVERSITY: CONSUMPTIVE USE, PRODUCTIVE USE, SOCIAL, ETHICAL, AESTHETIC AND OPTION VALUES

The term biodiversity was coined as a contraction of biological diversity by **E.O. Wilson in 1985.** Biodiversity may be defined as the variety and variability of living organisms and the ecological complexes in which they exist. In other words, biodiversity is the occurrence of different types of ecosystems, different species of organisms with the whole range of their variants and genes adapted to different climates, environments along with their interactions and processes.

Biodiversity includes the genetic variability (for which different varieties of spices have appeared in the course of evolution) and diversity of life forms such as plants, animal microbes, etc. living in a wide range of ecosystems.

**Types of Biodiversity/ Levels of Biodiversity**

There are three interrelated hierarchical levels of biodiversity namely, genetic diversity, species diversity and community or ecosystem diversity.

**1. Genetic diversity:**

It describes the variation in the number and types of genes as well as chromosomes present in different species. The magnitude of variation in genes of a species increases with increase in size and environmental parameters of the habitat. The genetic variation arises by gene and chromosome mutation in individuals and in sexually reproducing organisms and it is spread in the population by recombination of genetic materials during cell division after sexual reproduction.

**Genetic diversity has the following importance:**

(i) It helps in speciation or evolution of new species;
(ii) It is useful in adaptation to changes in environmental conditions;
(iii) It is important for agricultural productivity and development.

**2. Species diversity:**

It describes the variety in the number and richness of the spices with in a region. The species richness may be defined as the number of species per unit area. The richness of a species tells about the extent of biodiversity of a site and provides a means for comparing different sites. The species richness depends largely on climatic conditions. The number of individuals of different species with in a region represents species evenness or species equitability. The product species richness and species evenness give species diversity of a region. When a species is confined entirely to a particular area, it is termed as endemic species.

**3. Ecosystem diversity:**

It describes the assemblage and Interaction of spices living together and the physical environment a given area. It relates varieties of habitats, biotic communities ecological processes in biosphere. It also tells about the diversity within the ecosystem. It is referred as Land escape diversity because it includes placement and size of various ecosystems. For example, the landscapes like grass lands, deserts, mountains etc. show ecosystem diversity. The ecosystem diversity is due to diversity of niches, trophic levels and ecological processes like nutrient cycling, food webs, energy flow, role of dominant species and various related biotic interactions. Such type of diversity can generate more productive and stable ecosystems or communities capable of tolerating various types of stresses e.g. drought, flood etc.

**According to Whittaker (1965), the community diversities (Diversity indices) are of three types:**

**(i) α-Diversity:**

It tells the species diversity in a given community.

It depends upon species richness and evenness.

**(ii) β-Diversity:**

It describes a range of communities due to replacement of species which arises due to the presence of different microhabitats, niches and environmental conditions.

**(iii) γ -Diversity:**

Gamma diversity is the overall diversity at landscape level includes both α and β diversities.

The relationship is as follows: $\gamma = \alpha + \beta + Q$

where, Q = Total number of habitats or communities, α = Average value of α diversities

**β** = Average value of β diversities

**Biogeographical regions in India:**

(i) Trans Himalayas,

(ii) Gangetic plain,

(iii) Desert,

(iv) Semiarid zone,

(v) Western Ghats;

(vi) Deccan peninsula,

(vii) North eastern zone,

(viii) Coastal lands

(ix) Himalayas,

(x) Islands.

**India is one of the seventeen mega diversity nations of the world due to the following reasons:**

(i) It has 7.3% of the global fauna and 10.88% of global flora as per the data collected by Ministry of Environment and forest.

(ii) It has 350 different mammals, 1200 species of birds- 453 different reptiles, 182 amphibians and 45,000 plants spices.

(iii) It has 50,000 known species of insects which include 13,000 butterflies and moths.

(iv) It has 10 different biogeographical regions and 25 biotic provinces having varieties of lands and species.

(v) In addition to geographical distribution, geological events in the land mass provide high level of biological diversity.

(vi) Several crops arose in the country and spread throughout the world.

(vii) There is wide variety of domestic animals like cows, buffaloes, goats, sheep, pigs, horses etc.

(viii) The marine biota includes sea weeds, fishes, crustaceans, molluses, corals, reptiles etc.

(ix) There are a number of hot spots (namely Eastern Ghats, Western Ghats, North Eastern hills etc.).

**Importance of Biodiversity**

The living organisms on earth are of great diversity, living in diverse habitats and possessing diverse qualities and are vital to human existence providing food, shelter, clothing's, medicines etc.

**1. Productive values:**

Biodiversity produces a number of products harvested from nature and sold in commercial markets. Indirectly it provides economic benefits to people which include water quality soil protection, equalisation of climate, environmental monitoring, scientific research, recreation etc.

**2. Consumptive value:**

Which may be consumed locally and do not figure in national and international market.

**3. Social value:**

The loss of biodiversity directly influences the social life of the country possibly through influencing ecosystem functions (energy flow and biogeochemical cycle). This is easily understood by observing detrimental effects of global warming and acid rain which cause an unfavorable alteration in logical processes.

**4. Aesthetic value:**

Aesthetic values such as refreshing fragrance of the flowers, taste of berries, softness of mossed, melodious songs of birds, etc. compel the human beings to preserve them. The earth's natural beauty with its colour and hues, thick forest, and graceful beasts has inspired the

human beings from their date of birth to take necessary steps for its maintenance. Similarly botanical and zoological gardens are the means of biodiversity conservation and are of aesthetic values.

**5. Legal values:**

Since earth is homeland of all living organisms, all have equal right to coexist on the surface of earth with all benefits. Unless some legal value is attached to biodiversity, it will not be possible to protect the rapid extinction of species.

**6. Ethical value:**

Biodiversity must be seen in the light of holding ethical value. Since man is the most intelligent amongst the living organisms, it should be prime responsibility and moral obligation of man to preserve and conserve other organisms which will directly or indirectly favour the existence of the man.

**7. Ecological value:**

Biodiversity holds great ecological value because it is indispensable to maintain the ecological balance. Any disturbance in the delicately fabricated ecological balance maintained by different organisms, will lead to severe problems, which may threaten the survival of human beings.

**8. Economic value:**

Biodiversity has great economic value because economic development depends upon efficient and economic management of biotic resources.

In the day to day life, human beings are maintaining their lifestyle at the sacrifice of surrounding species which come from diversity of plants and animals struggling for their existence. So, it is highly essential for the human beings to take care of their surrounding species and make optimum use of their service, for better economic development. Thus, it is rightly told, survival of the man depends upon the survival of the biosphere.

**Uses of Biodiversity:**

(i) It provides food of all types.

(ii) It provides fibers, sources for the preparation of clothes.

(iii) It provides different types of oil seeds for the preparation of oils.

(iv) It provides new varieties of rice, potato etc. through the process of hybridization.

(v) It provides different drugs and medicines which are based on different plant products.

(vi) It is very essential for natural pest control, maintenance of population of various species, pollination by insects and birds, nutrient cycling, conservation and purification of water, formation of soil etc. All these services together are valued 16.54 trillion dollars per year.

**Global Species Diversity**

| **Group** | **Number of described species** |
|---|---|
| Bacteria and blue-green algae | 4,760 |
| Fungi | 46,983 |
| Algae | 26,900 |
| Bryophytes(Mosses and Liverworts) | 17,000 |
| Gymnosperms(Conifers) | 750 |
| Angiosperms(Flowering plants) | 250,000 |
| Protozoans | 30,800 |
| Sponges | 5,000 |
| Corals and Jellyfish | 9,000 |
| Roundworms and earthworms | 24,000 |
| Crustaceans | 38,000 |
| Insects | 751,000 |
| Other arthropods and minor invertibrates | 132,461 |
| Molluscs | 50,000 |
| Starfish | 6,100 |
| Fishes(Teleosts) | 19,056 |
| Amphibians | 4,184 |
| Reptiles | 6,300 |
| Birds | 9,198 |
| Mammals | 4,170 |
| Total | **1,435,662 species** |

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## Lecture 11

# BIODIVERSITY AT GLOBAL, NATIONAL AND LOCAL LEVELS - INDIA AS A MEGA-DIVERSITY NATION - HOTSPOTS OF BIODIVERSITY - THREATS TO BIODIVERSITY: HABITAT LOSS, POACHING OF WILDLIFE, MAN-WILDLIFE CONFLICTS

**India is one of the twelve mega diversity nations of the world due to the following reasons**

i. It has 7.3% of the global fauna and 10.88% of global flora as per the data collected by Ministry of Environment and forest.
ii. It has 350 different mammals, 1200 species of birds- 453 different reptiles, 182 amphibians and 45,000 plants spices.
iii. It has 50,000 known species of insects which include 13,000 butterflies and moths.
iv. It has 10 different biogeographical regions and 25 biotic provinces having varieties of lands and species.
v. In addition to geographical distribution, geological events in the land mass provide high level of biological diversity.
vi. Several crops arose in the country and spread throughout the world.
vii. There is wide variety of domestic animals like cows, buffaloes, goats, sheep, pigs, horses etc.
viii. The marine biota includes sea weeds, fishes, crustaceans, molluses, corals, reptiles etc.
ix. There are a number of hot spots (namely Eastern Ghats, Western Ghats, North Eastern hills etc.).

**Hot Spots**

Hot spots are the richest (high density of biodiversity or mega diversity) and most threatened reservoirs of plant and animal life of the earth. They have **maximum number of endemic species**. An area is designated as a hot spot when it contains at least 0.5% of plant species as endemic. There are 25 such hot spots of biodiversity on a global level, out of which three are present in India.

**To qualify as a hot spot, a region must meet two strict criteria:**

1. **Species endemism:** the region must contain at least 1,500 species of vascular plants (> 0.5% of the world's total) as endemics, and
2. **Degree of threat:** the region has to have lost at least 70% of its original habitat.

- Each biodiversity hot spot represents a remarkable universe of extraordinary floral and faunal endemism struggling to survive in rapidly shrinking ecosystems.
- Over 50 percent of the world's plant species and 42 percent of all terrestrial vertebrate species are endemic to the 25 biodiversity hot spots.

- Some hot spots are much richer than others in terms of their numbers of endemics. Five key factors have been taken into consideration and those biodiversity hot spot that tops the list with respect to these five factors are considered as hottest hot spots.

**Factors**

1. Endemic plants,
2. Endemic vertebrates,
3. Endemic plants/area ratio (species per 100km$^2$),
4. Endemic vertebrates/area ratio (species per 100km$^2$) and
5. Remaining primary vegetation as % of original extent.

**Biodiversity Hotspots across the World**

The eight hottest hot spots in terms of the above five factors are:

1. Madagascar
2. Philippines
3. Sundaland [South East Asia]
4. Brazil's Atlantic Forest
5. Caribbean
6. Indo-Burma
7. Western Ghats and Sri Lanka
8. Eastern Arc and Coastal Forests of Tanzania/Kenya

These eight 'hottest hot spots', appear at least three times in the top ten listings for each factor.

**Indian Biodiversity Hot Spots**

There are 3 biodiversity hot spots present in India. They are:

1. **The Eastern Himalayas (Arunachal Pradesh, Bhutan, Eastern Nepal)**
2. **Indo-Burma and (Purvanchal Hills, Arakan Yoma, Eastern Bangladesh)**
3. **The Western Ghats and Sri Lanka**

   These hot spots covering less than 2% of the world's land area are found to have about 50% of the terrestrial biodiversity.

**Indo-Burma Region**

- The Indo-Burma region encompasses several countries.
- It is spread out from Eastern Bangladesh to Malaysia and includes North-Eastern India south of Brahmaputra river, Myanmar, the southern part of China's Yunnan province, Lao People's Democratic Republic, Cambodia, Vietnam and Thailand.
- The Indo-Burma region is spread over 2 million sq. km of tropical Asia.
- Since this hotspot is spread over such a large area and across several major landforms, there is a wide diversity of climate and habitat patterns in this region.

**Biodiversity of Indo-Burma Region**

- Much of this region has been deteriorating rapidly in the past few decades.
- This region is home to several primate species such as monkeys, langurs and gibbons with populations numbering only in the hundreds.
- Many of the species, especially some freshwater turtle species, are endemic.
- Almost 1,300 bird species exist in this region including the threatened white-eared night-heron (Endangered), the grey-crowned crocias (Endangered), and the orange-necked partridge (Near Threatened).
- It is estimated that there are about 13,500 plant species in this hotspot, with over half of them endemic. Ginger, for example, is native to this region.

**The Eastern Himalayas**

- The Eastern Himalayas is the region encompassing Bhutan, northeastern India, and southern, central, and eastern Nepal.
- The abrupt rise of the Himalayan Mountains from less than 500 meters to more than 8,000 meters results in a diversity of ecosystems that range from alluvial grasslands and subtropical broad leaf forests along the foothills to temperate broad leaf forests in the mid hills, mixed conifer and conifer forests in the higher hills, and alpine meadows above the tree line.

**Biodiversity of the Eastern Himalayas**

- The Eastern Himalayan hotspot has nearly 163 globally threatened species (both flora and fauna) including the One-horned Rhinoceros (Vulnerable), the Wild Asian Water buffalo (Endangered).
- There are an estimated 10,000 species of plants in the Himalayas, of which one-third are endemic and found nowhere else in the world.
- A few threatened endemic bird species such as the Himalayan Quail, Cheer pheasant, Western tragopan are found here, along with some of Asia's largest and most endangered birds such as the Himalayan vulture and White-bellied heron.
- Mammals like the Golden langur, The Himalayan tahr, the pygmy hog, Lang-urs, Asiatic wild dogs, sloth bears, Gaurs, Muntjac, Sambar, Snow leopard, Black bear, Blue sheep, Takin, the Gangetic dolphin, wild water buffalo, swamp deer call the Himalayan ranged their home.

**Western Ghats and Sri Lanka**

- Western Ghats, also known as the "Sahyadri Hills" encompasses the mountain forests in the southwestern parts of India and highlands of southwestern Sri Lanka.
- The entire extent of hotspot was originally about 1,82,500 square kms, but due to tremendous population pressure, now only 12,445 square Km or 6.8% is in pristine condition.

- The wide variation of rainfall patterns in the Western Ghats, coupled with the region's complex geography, produces a great variety of vegetation types.
- These include scrub forests in the low-lying rainshadow areas and the plains, deciduous and tropical rainforests up to about 1,500 meters, and a unique mosaic of montane forests and rolling grasslands above 1,500 meters.
- In Sri Lanka diversity includes dry evergreen forests to dipterocarpus dominated rainforests to tropical montane cloud forest.
- The important populations include Asian elephant, Niligiri tahr, Indian tigers, lion tailed macaque (All Endangered), Indian Giant squirrel (Least Concern), etc.

**World Heritage Sites**

- World Heritage Sites means "Sites any of various areas or objects inscribed on the United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage List".
- The sites are designated as having outstanding universal value under the Convention concerning the Protection of the World Cultural and Natural Heritage.
- This Convention, which was adopted by the UNESCO in 1972 (and enforced in 1975) provides a framework for international cooperation in preserving and protecting cultural treasures and natural areas throughout the world. The first list of World Heritage state was published in 1978.

**Natural heritage sites are restricted to those natural areas that**

- Furnish outstanding examples of the Earth's record of life or its geologic processes.
- Provide excellent examples of ongoing ecological and biological evolutionary processes.
- Contain natural phenomena that are rare, unique, superlative, or of outstanding beauty or furnish habitats or rare endangered animals or plants or are sites of exceptional biodiversity".
- There are ten criteria for cultural heritage and natural heritage.

**Criteria**

1. To represent a masterpiece of human creative genius;
2. To exhibit an important interchange of human values, over a span of time or within a cultural area of the world;
3. To bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;
4. To be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates a significant stage(s) in human history;

5. To be an outstanding example of a traditional human settlement, land-use, or sea-use;
6. To contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;
7. To be outstanding examples representing major stages of Earth's history;
8. To contain the most important and significant natural habitats for insists conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.
    - The UNESCO funds numerous efforts to preserve and restore World Heritage Sites in developing nations.
    - It maintains also a List of World Heritage Sites in developing nations.
    - It maintains also a List of World Heritage in danger facing threat of pollution and other natural hazards.
    - Sites subject to unusual levels of pollution, natural hazards, or other problems may be placed for restoration. Such designated sites facilitate promotion of tourism.

**International Year of Biodiversity**

- The United Nations declared 2010 to be the International Year of Biodiversity. It is a celebration of life on earth and of the value of biodiversity for our lives.

**The global hot spot and endemic species present within them are:**

(i) North East Himalayas (3,500)
(ii) Western Ghats (1,600)
(iii) Cape region of South Africa (6,000)
(iv) Upland Western Amazonia (5,000)
(v) Madagascar (4,900)
(vi) Philippines (3,700)
(vii) Boreo (3, 500)
(viii) South West Australia (2,830)
(ix) Western Ecuador (2,500)
(x) Colombian Choco (2,500)
(xi) Peninsular Malaysia (2, 400)
(xii) Californian Floristic Province (2,140)
(xiii) Central Chile (1,450)
(xiv) Eastern Arc. Mts (Tanzania) (535)
(xv) South West Srilanka (500)
(xvi) South west Tvorie (200)

**Threats to Biodiversity**

Biodiversity is considered as a reservoir of resources to be used for the manufacture of food, medicine, industrial products, etc. But with an increased demand of rapid population growth, biodiversity is gradually depleting. A number of plants" and animal species have already become extinct and many are endangered.

**Different factors responsible for causing threat to biodiversity**

**1. Habitat destruction**

The primary cause of loss of biodiversity is habitat loss or destruction which is resulted due to the large industrial and commercial activities associated with agriculture, irrigation, construction of dams, mining, fishing etc.

**2. Habitat fragmentation**

With increased population, the habitats are fragmented into pieces by roads, fields, canals, power lines, towns etc. The isolated fragment of habitats restricts the potential of species for dispersal and colonization. In addition, the habitat fragmentation also brings about microclimatic changes in light, temperature, wind etc.

**3. Pollution**

The most dreaded factor inducing loss of biodiversity is environmental pollution which include air pollution, water pollution, industrial pollution, pollution due to chemical pastes, pesticides, radioactive materials etc.

**4. Over exploitation**

The natural resources are over exploited to meet growing rural poverty, intensive technological growth and globalization of economy. All these factors together may be responsible for the extinction of a number of species.

**5. Introduction of exotic species**

**The introduction of exotic species are due to**

(i) Horticulture
(ii) Agriculture
(iii) European colonisation and
(iv) Accidental transport

It is seen that some exotic species may kill or eat the native species thereby causing its extinction.

**6. Diseases**

Since the animals are more vulnerable to infection, the anthropological activities may increase the incidence of diseases in wild species, leading to their extinction.

**7. Shifting or Jhum cultivation**

The shifting or Jhum cultivation by poor tribal people greatly affects the forest structure which is a store house of biodiversity.

**8. Poaching of wild life**

A number of wildlife species are becoming extinct due to poaching and hunting.

**9. Human induced disasters**

1. Floods
2. Major oil spills/leakage
3. Epidemics
4. Forest fires

**10. Political and policy issues**

1. Change in use / legal status
2. Civil unrest
3. Intercommunity conflict
4. 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

| Endangered and Endemic Species of India Category | Enlisted species | Highly endangered Species |
|---|---|---|
| 1. Higher plants | 15,000 | 135 |
| 2. Mammals | 372 | 69 |
| 3. Reptiles and amphibians | 580 | 22 |
| 4. Birds | 1175 | 40 |
| 5. Fishes | 1693 | – |

**Man and wildlife conflicts:**

Man-animal conflict simply refers to the interaction between man and animal and resultant negative impact on man and his resources or animal and its habitat.

**Causes:**

- Habitat fragmentation and shrinking of habitats.
- Increased disturbance due to collection of fuel wood, fodder, NTFPs, water etc.
- People have to go deeper and deeper, year by year for fetching firewood.
- Decreased prey base.

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## Lecture 12

## ENDANGERED AND ENDEMIC SPECIES OF INDIA - CONSERVATION OF BIODIVERSITY: IN-SITU AND EX-SITU CONSERVATION OF BIODIVERSITY.

### Endangered and Endemic species in India

An endangered species is a species which has been categorized as likely to become extinct. Endangered (EN), as categorized by the International Union for Conservation of Nature (IUCN) Red List, is the second most severe conservation status for wild populations in the IUCN's schema after Critically Endangered (CR). The IUCN categories, with examples of animals classified by them, include:

**Extinct** (EX) **:** Completely vanished from the world. Examples: dodo, western black rhinoceros.

**Extinct in the wild** (EW)**:** Captive individuals survive, but there is no free-living, natural population. Examples: Barbary lion, Hawaiian crow, Père David's deer.

**Critically endangered** (CR)**:** Faces an extremely high risk of extinction in the immediate future. African wild ass, Arabian leopard, black rhino, Florida panther, mountain gorilla, Northwest African cheetah, Malayan tiger, South China tiger, Sumatran elephant, Sumatran orangutan, Sumatran rhinoceros, Sumatran tiger, northern white rhinoceros, West African lion

**Endangered** (EN)**:** Faces a high risk of extinction in the near future. Examples: African penguin, African wild dog, Amur tiger, Asian elephant, Asiatic lion, blue whale, snow leopard, Sri Lankan elephant

**Vulnerable** (VU)**:** Faces a high risk of endangerment in the medium term. African grey parrot, African leopard, African lion, clouded leopard, cheetah, gaur, giraffe, hippopotamus, Indian rhinoceros, polar bear, sloth bear, yak, great white shark, king cobra

**Near-threatened** (NT)**:** May be considered threatened in the near future. Examples: American bison, jaguar, white rhinoceros

**Least concern** (LC)**:** No immediate threat to species' survival. Examples: American alligator, American crow, bald eagle

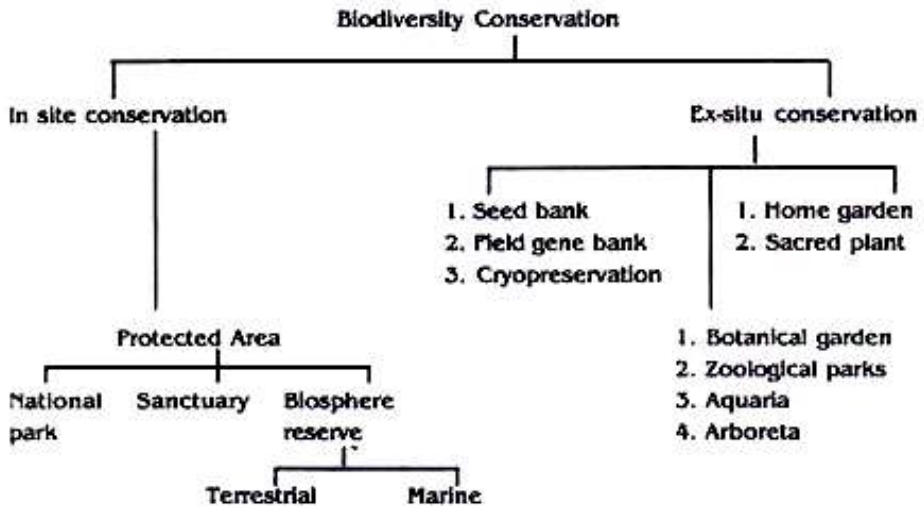
### Biodiversity and its conservation

India has 89,451 animal species accounting for 7.31% of the global faunal species. The flora accounts for 10.8% of the world flora. To conserve biodiversity there are two strategies.

**(1)** ***Ex-situ* conservation:** It means that the flora and fauna on preserved outside natural habitats. Flora and fauna are preserved as herbarium specimens, sea storage at low temperatures, as botanical gardens, zoos, deer parks, aquaria etc. Microbes are preserved as cultures. Central and State Governments together run and manage 33 botanical gardens.

**(2)** ***In-situ* conservation:** Conservation or protection of flora and fauna within natural habitat is called in-situ preservation. Around 4.2% of the total geographical area of the counts has been earmarked for extensive in-situ conservation of habitats and ecosystem. Protected area net works of 85 national parts and 448 wild life sanctuaries have been created. Around 12 biodiversity rich areas have been designed (Nilgiri, Nanda devi, Norkerk, Mans, Sunderbans, Gulf of Mannar, Great Nicobar, Similpal, Dibru-Saikhowa, Dehang-Debang, Pachmarhi, Kanchan Janga), 21 wet lands, 15 mangrove areas and 4 coral reef are being protected.

The following are the world heritage sites declared in India. 1. Sanctuaries of Rhododendrons and Orchids. 2. Project tiger. 3. Project elephant.




***In-situ* Conservation**

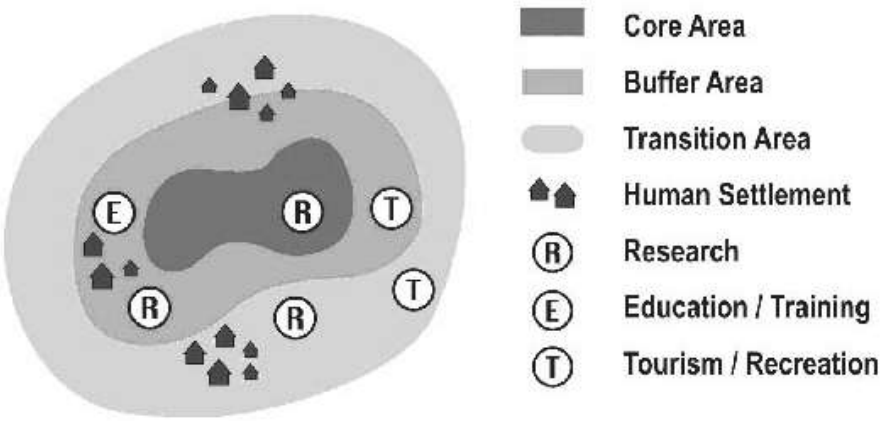
**Biosphere Reserves**

Biosphere reserves (BR) are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. The UNESCO has introduced the designation "Biosphere Reserve" for natural areas to minimize conflict between development and conservation. BRs are nominated by national government which meet a minimal set of criteria and adhere to minimal set of conditions for inclusion in the world network of Biosphere reserves under the Man and Biosphere Reserve Programme of UNESCO. Globally 621 BRs representing from 117 countries included in the network so far.

**Objectives of the Biosphere**

- To conserve biological diversity
- To maintain healthy ecosystems
- To learn about natural systems and how they are changing
- To learn about traditional forms of land-use
- To share knowledge on how to manage natural resources in a sustainable way
- To co-operate in solving natural resources problems

**Structure and function of the Biosphere:**




**Structure of a model biosphere reserve**

**Core Zone** Core zone must contain suitable habitat for numerous plant and animal species, including higher order predators and may contain centres of endemism and it is to be kept free from human pressures external to the system**.**

**Buffer Zone** The buffer zone, adjoins or surrounds core zone, uses and activities are managed in this area in the ways that help in protection of core zone in its natural condition. Human activities, if natural within BR, are likely to continue if these do not adversely affect the ecological diversity.

**Transition Zone** The transition area is the outermost part of a biosphere reserve. This is usually not delimited one and is a zone of cooperation where conservation knowledge and management skills are applied and uses are managed in harmony with the purpose of the biosphere reserve. This includes settlements, crop lands, managed forests and area for intensive recreation and other economic uses characteristics of the region.

**National parks**

A **national park** is a park in use for conservation purposes. Often it is a reserve of natural, semi-natural, or developed land that a sovereign state declares or owns. Although individual nations designate their own national parks differently, there is a common idea: the conservation of 'wild nature' for posterity and as a symbol of national pride. An international organization, the International Union for Conservation of Nature (IUCN), and its World Commission on Protected Areas, has defined "National Park" as its Category II type of protected areas.

**Wildlife Sanctuaries**

India has 515 animal sanctuaries referred to as wildlife sanctuaries category IV protected areas. Among these, the 48 tiger reserves are governed by Project Tiger, and are of special significance in the conservation of the tiger. Some wildlife sanctuaries are specifically

named bird sanctuary, e.g., Keoladeo National Park before attaining National Park status. Many National Parks were initially wildlife sanctuaries. The conservative measures taken by the Indian Government for the conservation of Tigers was awarded by a 30% rise in the number of tigers in 2015. Wildlife sanctuaries are of national importance due to some flagship faunal species, are named National Wildlife Sanctuary, like the tri-state National Chambal (Gharial) Wildlife Sanctuary for conserving the Gharial.

**Sacred Forest/ Sacred Groves**: Forest patches protected by tribal communities due to their religious beliefs. The religious values very often help to protect biodiversity. The practice of protection of patches of forests with temples in their vicinity has long been in vogue in India and a few other parts of the world. In some instances, forest patches or gardens with local floristic elements (often called *Nandavanas*) have been specially created near established temples and declared sacred to ensure their protection and conservation. About 4215 sacred groves covering an area of 39,063 hectares are estimated to be distributed in India.

***Ex-situ* (Off site) conservation**

*Ex-situ* conservation is the preservation of components of biological diversity outside their natural habitats. This involves conservation of genetic resources, as well as wild and cultivated or species, and draws on a diverse body of techniques and facilities. Gene banks, e.g. seed banks, sperm and ova banks, field banks; In vitro plant tissue and microbial culture collections; Captive breeding of animals and artificial propagation of plants, with possible reintroduction into the wild; Collecting living organisms for zoos, aquaria, and botanic gardens for research and public awareness. Eg. NBPGR, NBFGR, NBAGR.

**Field gene banks:** It is an assemblage of diverse plant species and their range of genetic diversity in an area. The plant materials are conserved and are available for breeding, reintroduction, research and other purposes. This method is useful for long living perennials trees and shrubs. Botanical gardens often have collections which are effectively field gene banks. These gardens also accommodate some endangered plants.

**Seed banks:** Seed banks are the most efficient and effective methods of or sexually reproducing seeds under long term storage. It is an effective and compact method of storage but is dependent on secure power supply, careful monitoring and testing of seed viability. In India, NBPGR, is one of the largest depositories of PGR.

**In vitro storage:** It refers to the conservation of germplasm through meristem tissues in test tubes. These methods are suited for the long term storage of propagules of species which otherwise cannot be maintained in seed banks. Cryopreservation: Storage of bio material at ultra-low temperature.

**Botanical garden:** A **botanical garden** is a place where plants, especially ferns, conifers and flowering plants, are grown and displayed for the purposes of research and education. This distinguishes them from parks and pleasure gardens where plants, usually with beautiful flowers, are grown for public amenity Botanical gardens that specialize in trees are sometimes referred to as arboreta. They are occasionally associated with zoos.

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**Lecture 13**

# ENVIRONMENTAL POLLUTION - DEFINITION, CAUSE, EFFECTS AND CONTROL MEASURES OF AIR POLLUTION AND NOISE POLLUTION

## ENVIRONMENTAL POLLUTION

### Pollution

Introduction by man, waste matter or surplus energy into the environment, which directly or indirectly causes damage to man and his environment

### Types of pollution

The various types of pollution are classified based on the environment, based on sources of pollutant and nature of pollutants.

### Based on environment

Soil pollution, water pollution, air pollution, are the three major types of pollution

### Based on sources of pollutant

**1. Point source of pollution**

Single, identifiable, *localized* source of air, water, thermal,noise or light pollution

Eg. Water pollution from an oil refinery wastewater discharge outlet

Noise pollution from a jet engine

**2. Non-point source of pollution**

Pollution that does not originate from a single source, or point

Eg. sediment , nutrients, microorganisms and toxics.

### Based on nature of pollutants

pollution is classified as pesticide pollution, plastic pollution, heavy metal pollution, radiation pollution, oil pollution, sewage pollution, noise pollution, etc.

### Pollutant

A substance or effect which adversely alters the environment by changing the growth rate of species, interferes with the food chain, is toxic, or interferes with health, comfort amenities or property values of people

(or)

waste material that pollutes air, water or soil

(or)

Environment Protection Act, 1986 (EPA, 1986) defines pollutant, as any solid, liquid or gaseous substance present in such a concentration as may be, or tend to be, injurious to environment.

**Types of pollutant**

**Based on absorptive capacity**

**1. Stock pollutants**

Pollutants that the environment has little or no absorptive capacity

e.g. , non-biodegradable plastics, and heavy metals

**2. Fund pollutants**

Are those for which the environment has some absorptive capacity.

e.g. carbon dioxide, which is absorbed by plants and oceans

**3. Notable pollutants**

Notable pollutants include the following groups:

Heavy metals
Persistant organic pollutants
PAH
VOC

**Based on Zones of influence**

**1. Horizontal zone**

The horizontal zone refers to the area that is damaged by a pollutant.

1. Local pollutants – Cause damage near the emission sources
2. Regional pollutants – Cause damage further from the emission sources

**2. Vertical zone**

The vertical zone is referred to whether the damage is ground-level or atmospheric

1. Surface pollutants – Cause damage by concentration of the pollutant accumulating near the earth surface
2. Global pollutants – Cause damage by concentrations in the atmosphere

**Based on degradation**

1. Biodegradable pollutants – The pollutants that's degrade easily by the microorganisms
   Eg. Agricultural residues, Biodegradable plastics
2. Non-Biodegradable pollutants – Not easily degrade by the microorganisms
   Eg. Polythene materials, Xenobiotic compounds

**Air Pollution**

**Definition**

Contamination of the air by noxious gases and minute particles of solid and liquid matter (particulates) in concentrations that have undesirable effect on living being.

Limited to solutions in which the outer ambient atmosphere contains materials in concentration which are harmful to man and his atmosphere - WHO

**Types of Air pollution**

1. Indoor – Caused by indoor activities
2. Out door – Mostly Caused by man made activities

**Types of Air pollutants**

**Based on nature of pollutant**

**1. Particulate pollutants**

Are solids or liquids with size < 100 microns that remain suspended in the atmosphere. Dust , Fumes , Smoke, Mist, Fog and Microbes

**2. Gaseous**

Toxic and poisonous

e.g. CO, chlorine, $NH_3$, $H_2S$, $SO_2$, $NO_2$, $CO_2$.

**Based on emission**

**1. Primary Pollutant**

Those emitted directly into air Eg. Gaseous pollutants

**2. Secondary Pollutant**

Produced by reactions between primary pollutants and natural atmospheric compound Eg. Acid rain

**Sources of Air pollution**

**Sources of Indoor pollution**

- Efficient insulation
- Bacteria
- Molds and mildews
- Viruses
- animal dander and cat saliva
- plants
- house dust
- Mites
- Cockroaches
- pollen

**Sources of Outside Air Pollution**

- Combustion of gasoline and other hydrocarbon fuels in cars, trucks, and airplanes
- Burning of fossil fuels (oil, coal, and dinosaur bones)
- Insecticides
- Herbicides
- Radioactive fallouts
- Dust from fertilizers
- Mining operations,Livestock feedlots
- Festivals like diwali

**Sources of major air pollutants**

There are five primary pollutants which together contribute to more than 90% of global air pollution. These are:

a. Carbon monoxide, CO
b. Nitrogen oxides, $NO_x$
c. Hydrocarbons, HC
d. Sulphur oxides, $SO_2$
e. Particulates

**Acid Rain**

It has been mentioned in the preceding section that much of the $NO_x$ and $SO_x$ entering the atmosphere are converted into $HNO_3$ and $H_2SO_4$ respectively. The detailed photochemical reactions in the atmosphere are summarized:

$$NO + O_3 \rightarrow HO_2 + O_2$$
$$NO_2 + O_3 \rightarrow NO_3 + O_2$$
$$NO_2 + NO_3 \rightarrow N_2O_5$$
$$N_2O_5 + H_2O \rightarrow 2HNO_3$$

$HNO_3$ is removed as a precipitate or as particulate nitrates after reaction with bases ($NH_3$, particulate lime).

$$SO_2 + 1/2\ O_2 + H_2O \xrightarrow[\text{Soot particles (metal oxide)}]{(HC,\ NO_x)} H_2SO_4$$

The presence of hydrocarbons and $NO_x$ step up the oxidation rate of the reaction. In water droplets, ions such as Mn(II), Fe(II), Ni(II) and Cu(II) catalyse the oxidation reaction. Soot particles are also known to be strongly involved in catalysing the oxidation of $SO_2$.

$HNO_3$ and $H_2SO_4$ combine with HCI emission (both by natural and anthropogenic sources) to generate acidic precipitation which is widely known as *acid rain*. Acid rain is now a major pollution problem in some areas.

Acid rain causes extensive damage to building and sculptural materials of marble, limestone, slate mortar, etc. These materials become pitted and weakened mechanically as the soluble sulphates are leached out by rainwater.

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + CO_2 + H_2O$$

Limestone

In Greece and Italy, invaluable stone statues have been partially dissolved by acid rain. The Taj Mahal in India faces the same fate at present.

In 1958, rain in Europe showed a pH of 5.0 but by 1962 it was 4.5 in Netherlands. Sweden experienced rainfall at pH 4.5 in 1996. The acid rain damaged leaves of trees and plants and retarded the growth of Swedish forests. It may be noted that these forests are important natural resources for production of wood pulp, paper and board.

In 1979, it was estimated that 20,000 lakes of Sweden were suffering loss of flora and fauna-the fish mortality was increasing. The pollution sources were emission from U.K., the Ruhr and Germany. The sulphur emission rate for Europe was up to 70 metric tonnes per year. $H_2SO_4$ and particles of Cd and Pb are deposited and lakes. This occurs at a time when fish spawning and hatching occur thereby killing the fish eggs.

**The adverse effects of acid rain**

(i) Owing to the phenomental increase in acidity of water the productivity of a lake is severely affected. Most of the animals and plants living in the water die and ultimately the lake turns dead.

(ii) Acid rain causes severe damage to the historical monuments and buildings chiefly those made of marble stones. It also causes severe corrosion in those stones, which is often referred to as stone cance. A classic example is the world famous monument Taj Mahal at Agra. Made of marble stones, it is severely affected by acid rains mainly because of the emission of sulphur dioxide from the oil refinery at Mathura.

(iii) Acid rain causes severe damage to the forest lands and a section of forests in the European countries is already destroyed by acid rain.

(iv) Acid rain leaches magnesium and calcium from the soils and subsequently aluminium, manganese and some heavy metals such as iron and calcium come into the solution, which may reach upto toxic concentrations, eventually damaging the tree roots. This decreases the plant's capacity to take up water and nutrients. This is also known to cause reakdown of mycorrhizas.

(v) Acid rain causes visibility reduction in the air.

**Possible remedy**

The suitable cures are adding of lime to the lakes and forests and to reduce the emission of $SO_2$ from the industries and especially from the thermal power plants. Besides, firm steps should be taken to reduce the emission of hydrocarbons and nitrogen oxides from the automobiles and the industries.

**Suspended particulate air pollutants**

Small solid particles and liquid droplets are collectively termed particulates. These are present in the atmosphere in fairly large numbers and sometimes pose a serious air-pollution problem. Particulates range in size from a diameter of 0.0002 $\mu$ (about the size of small molecule) to a diameter of 500 $\mu$ (1 $\mu = 10^{-6}$ metre) with lifetimes varying from a few seconds to several months.

**Effects of Air pollution**

**Effects on Humans**

| Pollutants | Sources | Effects on humans |
|---|---|---|
| Aldehydes | Thermal decomposition of fats, oil or glycerol | Irritate nasal and respiratory tracts |
| Ammonias | Dye making, explosive, fertilizers, lacquers. | Inflame upper respiratory passages |
| Arsines | Processes involving metals or acid containing arsenic soldering | Damage red cells in blood, damage kidney and cause jaundice |
| Carbon monoxide | Burning of coal, auto exhausts. | Reduce oxygen carrying capacity of blood. **(Carboxyhaemoglobin)** |
| Chlorine | Bleaching cotton and flour, paper and pulp and many other chemical processes. | Attack entire respiratory tract and mucous membranes of eyes, cause pulmonary edema. |

**Effects on plants**

| Chemical | Symptoms | Sensitive plants* | Examples of concentration for sensitivity |
|---|---|---|---|
| Sulphur-di-oxide | Bleached spots on leaf, chlorosis, early abscission, reduced yield | Barley, pumpkin, alfalfa, cotton, wheat, lettuce, apple, oats, aster, zinnia, birch, elm, white pine, ponderosa pine. | Alfalfa, barley, cotton, 0.3 ppm |
| Ozone | Raddish brown flecks on upper surface of leaf, bleaching, suppression of growth, early abscission, premature to aging | Alfalfa, barley, beans, onion, corn, apple, grape, tobacco, tomato, spinach, maple, priver, white pine, ponderosa pine. | Tomato, tobacco, 0.05ppm |
| Other oxidant gases, e.g. peroxyacetylnitrate (PAN) | Glazing, **silvering or bronzing** of lower surface of leaf | Pintobean, mustard, oat, tomato, lettuce, petunia, blue grass | Petunia, lettuce, 0.2 ppm. |
| Unsaturated hydrocarbons, e.g. ethylene | Leaf abscission, dropping of flowers, loss of flower buds, chlorosis, suppression of growth | Orchid blossom, carnation blossom, azalea, tomato, cotton, cucumber, peach | Orchids, 0.0059-ppm Tomatoes, 0.1 ppm |

**Effects on materials**

| Chemical | Primary materials attacked | Typical damage |
|---|---|---|
| Carbon di oxide | Building stones, lime stone | Deterioration |
| Sulphur oxides | Metals | |
| | Ferrous | Corrosion |
| | Copper | Corrosion to copper sulphate (green) |
| | Aluminium | Corrosion to aluminium sulphate (white) |
| | Building materials (lime stone, marble, slate, mortar) | Leaching, weakening. |
| | Paper | Embrittlement, disintegration |
| | Textiles natural and synthetic fabrics) | Reduced tensile strength, deterioration. |

**Prevention and control measures**

**It is, however, possible to prevent air pollution without under cost by:**

(a) Careful planning and sitting of industries
(b) Better design equipment, and
(c) Better operation of the equipment

**(1) Fuel selection and utilization**

In modern plants, combustion efficiency is increased by replacing sand firing with mechanical strokers. While using oil as a fuel, the air to fuel ratio is so adjusted as to provide only a slight excess of air over that required theoretically for complete combustion, in order to prevent smoke emissions. The combustion of coke is mainly affected by its size. While selecting suitable coke burning appliance, it is, therefore, necessary to take into consideration the size of the coke.

**2. Control of air pollution by process modification of equipment**

The cyclone separator is an important type of dispersoid collector, which produced a continuous centrifugal force and exerts greater inertial effects of the dispersoid. Cyclonic separators have widely been used for the control of industrial dust and gas-borne dispersoids in a number of industries, such as cement, paper and pulp, food and grain, wood-work and mineral processing industries etc. Filters and electrical precipitators are the other most effective means of controlling air pollution. Scrubbers are least used devices for removing particulate matters. These are mostly used for the removal of gaseous pollutants.

**3. Control of air pollution by site selection and zoning**

The process of locating a single industrial plant is called site selection, which results in the production of a single source of pollution as compared with a variety of emission sources.

**Zoning**

Adaptation of Control measure based on the knowledge of the mechanics of the atmosphere is called zoning.The zoning of the industries is done based on the type of industries. Zoning of the industries may be based on (a) Their functions and / or (b) performance.

**4.Air pollution control at source**

The air pollution problem can be minimized at the source by making use of the following measures.

(a) Substitution of the raw materials.
(b) Modification in the process.
(c) Alterations in the particular equipment or component.
(d) Removal of pollutants at the source

**5. Construction of high stacks or chimneys to discharge the pollutants at higher altitudes**

**5. By planting trees and growth vegetation**

| **Pollutant** | **Plants** |
|---|---|
| Fluoride | Cherry, pear, plum, strawberry |
| Nitrogen oxide | Orange |
| Chlorine | Begonia, eggplant, olive, pepper |
| Ammonia | Peach |
| Hydrogen chloride | Pear |
| Hydrogen sulphide | Apple, cherry, peach, strawberry, fern, carnation. |
| Particulate matter | Mango, litchi |

**6. Air pollution standards**
**Based on Enforcement of Air (Prevention and control) pollution act, 1981**

| Category | Limits (μg/m3) | | | |
|---|---|---|---|---|
| | SPM | SO2 | CO | NOx |
| Industrial and Mixed area | 500 | 120 | 5000 | 120 |
| Residential | 200 | 80 | 2000 | 80 |
| Sensitive area | 100 | 30 | 1000 | 30 |

**Noise Pollution**

Noise, is unwanted sound energy and is also considered as a pollutant when it exceeds certain limits. Against this scenario, in this unit, we will discuss the various effects of noise, sources and control measures of noise pollution and their impact on human beings.

**Characteristics of sound**

Sound is a form of energy giving the sensation of hearing and is produced by vibrations as longitudinal mechanical waves in materials including solids, liquid and gas and is transmitted by oscillation of atoms and molecules of matter. In physical terms, sound may be defined as fluctuations in pressure of waves in a fluid medium. This definition gives rise to the objective characteristics of sound: frequency, intensity and waveforms. The pitch of a sound wave increases as its frequency increases but, there is no one-to-one ratio. Similarly, loudness varies with intensity. Loudness is defined as the observer's auditory impression of the strength of a sound. The loudness of a sound does not depend on the frequency or pitch.

The human ear has a low sensitivity for low pitch and for extremely high pitch.

1. **The frequency (cycles/second)** of the waves determines the pitch of the sound.
2. **The amplitude or magnitude** (measured in decibel (dB) units) is a measure of loudness.

Sometimes sound intensity which is the amount of sound energy that flows through one unit area of medium in a unit time interval, is also measured in **watts per square metre ($W/m^2$).**

**Noise Pollution**

Production of unwanted sounds that are annoying, distracting or damaging to one's hearing.

**Sources of noise pollution**

**Out Side**

Construction
Road side
Air ports
Factories

**Inside**

TV/Radios
Phones
Home appliances
Power tools

**Increasing population and Urbanization**

**Noise level of various house hold equipment and appliances**

| Category | Noise level (dB) |
|---|---|
| Television | 66 |
| Refrigerator | 46 |
| Exhaust fan | 51 |
| Electric grinder | 81 |
| Vacuum cleaner | 83 |
| Stove | 74 |
| Water tap | 67 |
| Radio/tape recorder | 81 |
| Ceiling fan | 51 |
| Air conditioner | 64 |
| Pressure cooker | 68 |
| Lawn mover | 79 |
| Flush toilet | 78 |

**Noise levels of Agricultural machineries**

| Agricultural Implements | Noise level (dB) |
|---|---|
| Tractors | 90-98 |
| Thresher | 90-95 |
| Combine harvesters | 92-99 |
| Power sprayers | 93 |

**Effects of noise**

1. Repeated interference with sleep
2. Effects on communication
3. Effects on Human Health
4. Hearing loss
5. Physiological responses
6. Psychological responses
7. Effects of high intensity noise on human beings

| Noise (dB) | Effects observed |
|---|---|
| 0 | Threshold of audibility |
| 150 | Significance change in pulse rate |
| 110 | Stimulation of reception in skin |
| 120 | Pain threshold |
| 130-135 | Nausea, vomiting, dizziness, with touch and muscle sense |
| 140 | Pain in ear, prolonged exposure causing insanity |
| 140 | Extreme limit of human noise tolerance |
| 150 | Prolonged exposure causing burning of skin |
| 160 | Minor permanent damage if prolonged |
| 190 | Major permanent damage in a short time |

**Noise sources and control**

1. Traffic noise
2. Highway vehicle noise
3. Sources of noise from industry and controlling measures
4. Enclosures
5. Screen the receiver
6. Ear protection
7. Absorbing materials
8. Barriers and panels
9. Control of industrial noise source by design changes in equipment
10. Maintenance for low frictional resistance
11. Legislation

**Based on Noise Regulation Rules under the Environment (Protection) Act of 1986.**

| **Areas** | **Noise level (dB)** | |
|---|---|---|
| | **Day time (6am -9pm)** | **Night time (9pm – 6 am)** |
| Industrial area | 75 | 65 |
| Commercial area | 65 | 55 |
| Residential area | 55 | 45 |
| Silence zones | 50 | 45 |

**Acceptable level of noise for human health**

| **Activities** | **dB** |
|---|---|
| Talking | 50 |
| House holds | 40 |
| Motor cycle | 65-105 |
| Heavy vehicles | 85-100 |
| Hammer(2m distance) | 120 |
| Aero plane (50-100m height) | 90-100 |

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**Lecture 14**

# DEFINITION, CAUSE, EFFECTS AND CONTROL MEASURES OF WATER POLLUTION AND SOIL POLLUTION

## Soil Pollution

The build-up in soils with persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health.

## Types of Soil Pollution

**Agricultural Soil Pollution**

i) Pollution of surface soil
ii) Pollution of underground soil

**Soil pollution by industrial effluents and solid wastes**

**i**) Pollution of surface soil
ii) Disturbances in soil profile

**Pollution due to urban activities**

i) Pollution of surface soil
ii) Pollution of underground soil

## Sources of soil pollution

1. Industrial wastes
2. Urban wastes
3. Radioactive pollutants
4. Agricultural practices
   - Fertilizers
   - Pesticides
   - Soil conditioners, fumigants and other chemical agents
5. Chemical and metallic pollutants
6. Biological agents
7. Heavy metal pollution

## Effects of soil pollution

**1. Industrial**

- Dangerous chemicals entering underground water
- Ecological imbalance
- Release of pollutant gases
- Release of radioactive rays causing health problems
- Increased salinity
- Reduced vegetation

**2. Agricultural**

- Reduced soil fertility
- Reduced nitrogen fixation
- Increased erodibility

- Larger loss of soil and nutrients
- Deposition of silt in tanks and reservoirs
- Reduced crop yield
- Imbalance in soil fauna and flora

**3. Urban wastes**

- Clogging of drains
- Inundation of areas
- Public health problems
- Pollution of drinking water sources
- Foul smell and release of gases
- Waste management problems
- The waste including building materials (during construction and demolition), sludge, dead animal skeletons and thrown away garbage pile up at public places and cause obstruction in daily life.
- Solid wastes result in offensive odour and cause clogging of ground water filters. Suspended matter in sewage can blanket the soil, thereby interfering with the soil moisture.

**4. Heavy metals**

Heavy metals are infact toxic and are known to cause kidney damage, cardiovascular diseases, dermatitis, sterility, hypertension, growth inhibition, anaemia, neurological and behavioral disorders irreversible changes in brain and nerve cells.

**5. Environmental Long Term Effects of Soil Pollution**

- pollution runs off into rivers and kills the fish, plants and other aquatic life
- crops and fodder grown on polluted soil may pass the pollutants on to the consumers
- polluted soil may no longer grow crops and fodder
- Soil structure is damaged (clay ionic structure impaired)
- corrosion of foundations and pipelines
- impairs soil stability
- may release vapours and hydrocarbon into buildings and cellars
- may create toxic dusts
- may poison children playing in the area

**Prevention and Control of soil pollution**

**1. Collection and Disposal of wastes**

Dumping of solid waste is a popular and inexpensive way of getting rid of waste. But the disposal of waste is not free from disadvantages. Landfill seems to be the possible way of waste disposal. Landfill operation, which is a biological method of treatment, involves the depositing of refuse, compacting and covering it with a soil.

**2. Recovery of resources from wastes**

Useful product can be recovered from the wastes.

In India, about 30% of the energy consumed by public is biological in nature. Gobar gas plants based on anaerobic fermentation of organic wastes in the absence of air increase the heating efficiency of the cattle dung by about 20%, and produce organic manure which is about 43% better than the dry cattle dung itself. This manure can also reduce pressure on naphtha-based fertilizers.

**3. Incineration -** The technique involves burning of wastes to a very high temperature probably above 200°C. Incineration is most advantageous because the bulk of solid waste can be reduced to small volume of ash. The heat so produced during incineration can be used to raise steam for turbines producing electricity. However the process is not without drawbacks which are as follows.

i. For incineration to be successful the waste should contain enough things that burn creating no air pollution problems.

ii. Sometimes the bulk of wastes is as low in calorific-content an indicator of their burning ability that they do not burn at all.

**4. Thermal pyrolysis-** In thermal pyrolysis, the solid wastes are heated to a very high temperature (600-800°C) but in a very sparse air or oxygen so that they do not burn completely but only smoulder. The pyrolysis product resembles to that of charcoal. It can be used in fuel provided that is burning does not produce any harmful gas.

**5. Vitrification-** The recent technique *insitu* vitrification aims at converting the solid wastes into a sort of glass in the place where they stand. To accomplish this method electrodes are inserted into the waste-heap and a very powerful electric current is passed through it. The strong heat so produced melts glass, plastic, muck, mud and other waste into a glass like solid. It can then be dumped anywhere as it leaches very little. However, in this method care is taken to prevent mingling of radio active wastes with other organic compounds, as radioactivity remains in whatever form the waste may be converted into.

**6. Phytoremediation**

Removal of pollutants present in the soil with the use of plants

**7. Bioremediation -** This approach envisages hiring help from microorganism to convert toxic compounds into either useful industrial products or harmless wastes. Here solid waste is composted, similar to that of producing farm manure. The technique involves microbial help to turn municipal wastes into fertilizers or soil-reinforcing products.

**Diseases caused by soil pollution**

Soil inhabit distinctive flora and fauna such as bacteria, algae, fungi, protozoa, rotifers nematodes, molluscs, arthropods, earth worms, actinomycetes and several pests which make the 'biological system' of soil complex. Some organisms also help in maintenance of soil fertility while majority of the micro-organisms act as chronic pollutants. Soil has been a potential carrier of microbial growth, non-biodegradable matters and pathogens which endanger human health and life.

(1) Pathogenic soil bacteria are chronic disease carriers which are transmitted from man to soil or vice versa causing cholera, typhoid, bacillary dysentery, paratyphoid fever etc. Flies which breed or get in contaminated soil become carriers of disease organisms.

(2) The eggs of parasitic worms helminthes get incubated in the soil, these eggs and larvae are highly infective. Soil transmitted helminthes include *Trichuris trichiura* (whip worm), *Ascaris lumbricoids* and *Ancylostoma duodenale* which cause intestinal hook worm diseases.

(3) Pathogenic soil bacteria are *Mycobacterium*, *Salmonella typhosa*, *Leptospira*, and *Pasteurella* which pose a serious threat to man's health. They cause infections of intestinal tract like amoebic dysentery, cholera, typhoid, polio and hepatitis. Many of these are endemic to particular population.

(4) Geohelminthes are reported to such vitamins and proteins from the intestinal nutrients of the host. Such absorption of essential nutritional constituents results in severe malnutrition. It has been reported that loss of blood and iron in large quantities occurs due to sucking motions of hook worms which results in chronic anaemia.

(5) Viruses are infectious agents of plants and animal cells. Common viruses present in sewage added to soil are Adenoviruses, Enteroviruses, polio viruses and hepatitis Derby *et al*. have reported that about 80 viruses are most dangerous for man. Most dreadful viral disease is poliomyelitis in which body parts get paralysed due to destruction of nerve cells controlling the muscles.

(6) Fungi and actinomycetes - the saprophytes normally develop in soil or vegetation. They cause most serious subcutaneous and systemic mycoses. Their spores may either be inhaled or penetrate skin through wounded body parts. These pathogens can directly transmit to man from soil.

(7) Some of the animal's diseases are transmissible to man and soil, Leptospirosis, Anthrax and Q. fever are some of the diseases belonging to this category. Leptospirosis is a common disease of man and animals. Leptospires carried by animals are brought to the soil surface by excretion of faecal matter or urine. An estimate suggests that about 100 million leptospires are present in the urine of animals. These leptospires excreted into soil or water may survive for several weeks unaffected by climatic changes. When human beings come in contact with soil or water, these leptospires enter the body through macerated skin or mucous membrane to cause leptospirosis.

**Water pollution**

Water pollution is defined as "the addition of any substance to water or changing physical and chemical characteristics in any way that interferes with its use for legitimate purposes."

**Types of water pollution**

1. **Surface water pollution**

The emergence of industrial revolution encouraged the growth of factories which grossly polluted the surface waters of rivers, oceans, lakes, ponds and estuaries etc.

Eg. Industrial effluents discharges

2. **Sub surface water pollution**

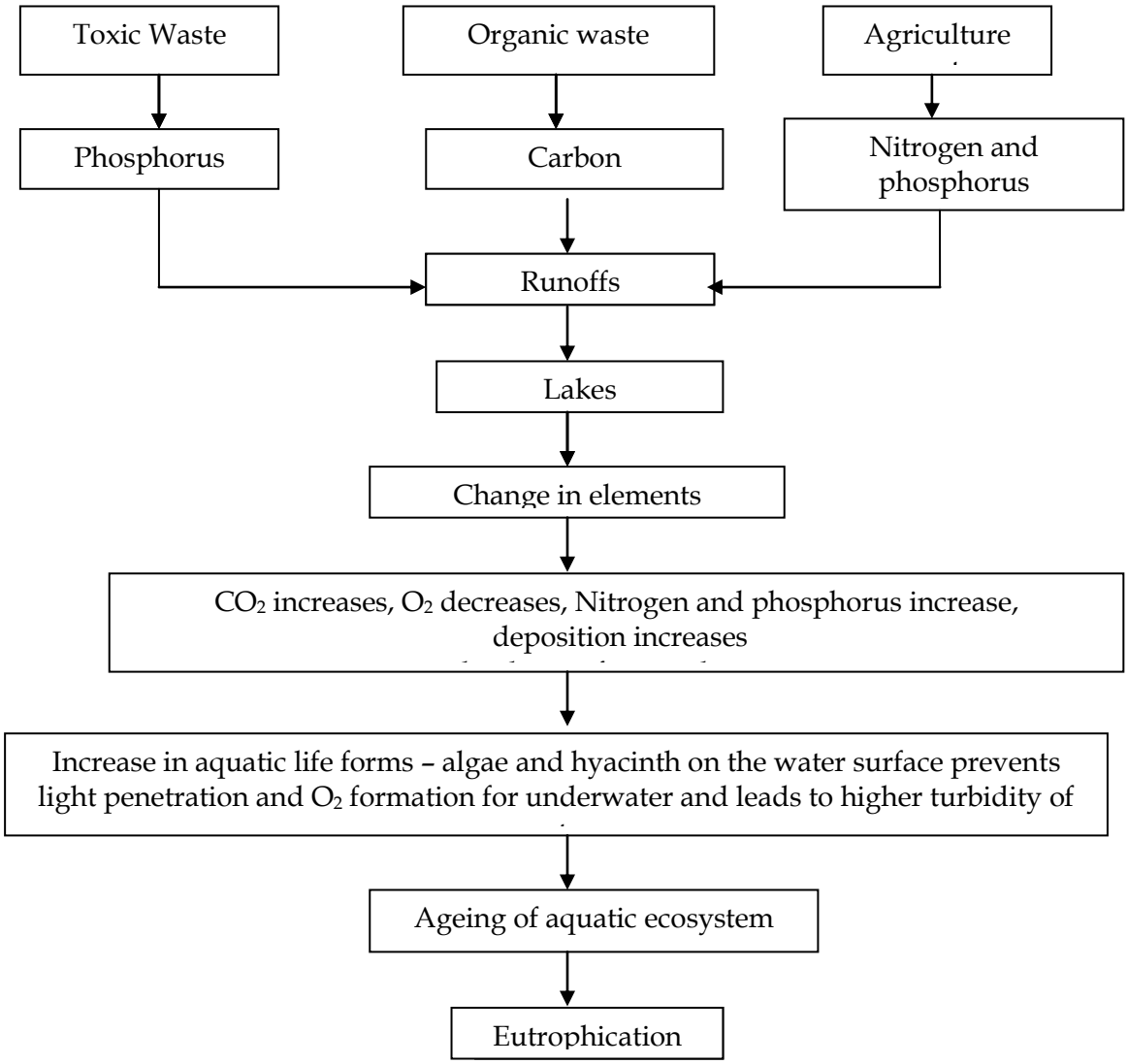
Ground water is threatened with pollution from seepage pits, refuse dumps, septic tanks, branyard manures and transport accidents. The important pollution of ground water are sewage waste water.

**Sources and effects of water pollution**

**1. Domestic wastes/sewage wastes –** Domestic wastes and methods of their disposal are of primarily concern in urban areas. Prime factors responsible for deteriorating water quality include pathogenic organisms, oxygen demand, nutrients and solids from sewage and domestic wastes. It includes human excreta, paper, cloth, soap and detergents.

**Effects**

Sewage contains large amounts of soaps and mainly phosphate based detergents. Agricultural run off also contains phosphorus from phosphorus fertilizers. The maximum amount of phosphorus is, however, supplied by the detergents which account for 30 - 40% of the total phosphorus entering the aquatic environment. This increases to about 70 - 80% in areas when human population is concentrated. The whole process can be represented as shown in Fig. 1.




This decrease in oxygen level becomes detrimental to growth of other organisms which produces a foul smell upon decay. Some decomposing plants are known to produce toxins as **Strychnine** which kills animals including cattle.

This decrease in oxygen level becomes detrimental to growth of other organisms which produces a foul smell upon decay. Some decomposing plants are known to produce toxins as **Strychnine** which kills animals including cattle.

**2. Industrial wastes –** Most industries generally produce wastes containing toxic heavy metals along with hazardous organic and inorganic effluents. These chemicals contaminate the ground water and severely pollute it.

| Various organic and inorganic pollutants of water and their sources | | |
|---|---|---|
| **Industry** | **Inorganic pollutants** | **Organic pollutants** |
| Iron and steel | Suspended solids, iron, cyanide, thiocyanate, sulphides, oxides of Cu, Cd, Hg etc. | Oil, phenols, naphtha etc. |
| Soap and detergents | Tertiary ammonium compounds, alkali | Fats and fatty acids, glycerol, polyphosphates, sulphonated hydrocarbons |
| Paper and pulp | Sulphides, sulphites, beaching liquors | Cellulose fibres, wood, bark, sugars, organic acids etc. |
| Mining | Chlorides, various metals, ferrous sulphate, sulphuric acid, ferric hydroxide, $H_2S$, surface wash offs, suspended solids, heavy metals etc | ____ |
| Food processing | ____ | Highly putrescible organic matter, pathogens etc. |
| Pharmaceuticals | ____ | Proteins, carbohydrates, organic solvents, drugs, antibiotics, intermediate products etc. |

**3. Agricultural wastes –** Fertilizers, pesticides, insecticides, insecticides, herbicides, processing wastes and animal wastes etc. are constantly added to the water. Leachates from agricultural land containing nitrates, phosphates and potash, move downward with percolating water and join the aquifers below posing danger to the ground water.

Throwing rubbish and other unwanted things into the water are not only the cause of water pollution, but a harmless activity such as farming could lead to some thing as insidious as **nitrate pollution.**

**Rising nitrate** levels have raised an alarm because of the possibility of adverse effect on human and animals. **Methaemoglobinaemia or bluebaby disease –** is caused by the reaction of nitrate with haemoglobin, the oxygen carriers in the blood, producing **methaemoglobin,** which strangles the oxygen carrying capacity of the tissue. Some claim that nitrate can wear down body's immune system while its derivatives may be carcinogenic. Nitrate also causes **eutrophication,** although in India and other tropical regions, it is through that phosphates are more to be blamed for this asphyxiation of water bodies.

**Biological magnification** or food chain concentration is the continuous increase in the concentration of a toxicant at successive trophic levels in a food chain. For instance, DDT in water may be low, but the aquatic plants may show an average value of about 5.5ppm, about 265 times increase over the concentration used in initial application of DDT. Plants and animals accumulate DDT in much higher concentration in their bodies. The herbivores,

fish and insects feeding on these plants may accumulate DDT in still higher concentrations, and at the top carnivore level, fish eating birds etc., concentration may reach at a very high value. Some shellfish as oyster accumulate DDT 70,000 times the original concentration, frogs 2,000 times and sunfish 12,000 times. The following are examples of biomagnification of DDT in aquatic ecosystem

## HEAVY METAL POLLUTION

### Xenobiotics

Xenobiotics are foreign and usually harmful substance or organism in a biological system and the word xenobiotic, derived from the Greek roots xeno, meaning "stranger" or "foreign," and bio, meaning "life," describes some toxic substances, parasites, and symbionts. Food, drugs, and poisons are examples of xenobiotic substances in individual organisms, and their toxicity is linked to the level of consumption. In communities of species, xenobiosis happens when two distinct species, such as different kinds of ants, share living space like nests. At the ecosystem level, toxic waste when bio accumulated in the food chain/web is xenobiotic.

### Groundwater Pollution

Over 98% of the fresh water on the earth lies below its surface. The remaining 2% is what we see in lakes, rivers, streams and reservoirs. Of the fresh water below the surface, about 90% satisfies the description of **ground water,** that is, water which occurs in saturated materials below the water table. About 2% water occurs as soil moisture in the unsaturated zone above the water table and is essential for plant growth. Ground water, a gift of nature**,** is about 210 billion $m^3$ including recharge through infiltration, seepage and evapotranspiration. Out of this nearly one-third is extracted for irrigation, industrial and domestic use, while most of the water is regenerated into rivers.

Today human activities are constantly adding industrial, domestic and agricultural wastes to ground water reservoirs at an alarming rate. Ground water contamination is generally irreversible i.e. once it is contaminated; it is difficult to restore the original water quality of the aquifer. Excessive mineralization of ground water degrades water quality producing an objectionable taste, odour and excessive hardness. Although the soil mantle through which water passes acts as an adsorbent retaining a large part of colloidal and soluble ions with its cation exchange capacity, but ground water is not completely free from the menace of chronic pollution.

### Heavy metals

Heavy metals include all metals with atomic numbers greater than 23 (with few exceptions) or more than 5 gm per ml. (eg. Hg, 70 gm $ml^{-1}$). Heavy metals are hazardous, not acceptable to biological system. They are toxic to man and other life forms. Most of them are slow poisons as they accumulate in the body and cause serious disorders. Mercury, lead, arsenic, chromium and cadmium are the five most common toxic heavy metals and they have serious effects on human health.

**Effect of heavy metals on human health**

| S.No. | Heavy metal (forms) | Source | Effect |
|---|---|---|---|
| 1. | Mercury:<br>$Hg^{++}$ (Mercuric)<br>$C_6H_5Hg\ CH_3COO$ | Methyl mercury fungicides, electrical and electronic industries, PVC, plastics, paint. | Irreversible neurological damage in man, Minamoto disease |
| 2. | Lead<br>$Pb^{2+}$, $Pb^{4+}$ | Automobile exhaust of leaded petrol (50%), Batteries, Pipes, Soldiering. | Cause mutation in algae and bacteria, blackening in fish, gradual paralysis in man. |
| 3. | Arsenic<br>$As^{+++}$<br>Arsenic trioxide,<br>Sodium arsenate | Herbicide, fungicide, wood Preservative – Agro chemicals (70%), industrial chemicals – paints, bullets (20%), glass and glass wares (5%). | Accumulate in hair, nail, skin lesions, act as oxidative uncoupler, cause damage to kidney, respiratory tract and nervous disorders. Arsenic poisoning such as keratosis, melanosis and kin lesions. |
| 4. | Chromium<br>$Cr^{+6}$<br>$CrO_3$ | Tanneries, electroplating and metal finishing processes, Khaki dyeing in textiles. | Toxic to aquatic organisms, absorbed through intestinal tract in man. |
| 5. | Cadmium<br>(Cd) | Pigment and stabilizer for PVC, plastics, tires, rechargeable cells, electroplating, coal, oil and phosphate rocks. | Bones become brittle – Itai itai disease in Japan, gastro enteric distress and pain. |
| 6. | Fluoride | Naturally present in soil, water and air. Mainly in Rajasthan and Nammakkal of Tamil Nadu. | Flurosis<br>Dental<br>Skeletal & Oral<br>Pain in the bones and joints and outward bending of legs from the knees – Knock knee syndrome |

**Protecting ground water from pollution -general steps**

1. The contaminant sources should be carefully surveyed.
2. Location of industrial and municipal disposal sites should be decided keeping in view the ground water levels and flow pattern in the area.
3. In case of toxic industrial effluents, steps should be taken for predisposal treatment by the industry itself.
4. Location of wells for drinking water supplies should be decided with utmost caution.
5. Surrounding contaminant's sources and flow directions should be considered.
6. It is not advisable to tap the uppermost aquifer in case of drinking water wells.

**Waste water disease transmission**

**Pathogens and parasites found in domestic waste water**

Several pathogenic microorganisms and parasites are commonly found in domestic wastewater as well as in effluents from wastewater treatment plants.

**Major waterborne bacterial diseases**

| Bacterial agent | Major disease | Major reservoir | Principal site affected |
|---|---|---|---|
| *Salmonella typhi* | Typhoid fever | Human feces | Gastrointestinal tract |
| *Salmonella paratyphi* | Paratyphoid fever | Human feces | Gastrointestinal tract |
| *Shigella* | Bacillary dysentery | Human feces Human feces | Lower intestine |
| *Vibrio cholerae* | Cholera | Human feces | Gastrointestinal tract |
| Enteropathogenie *E. coli* | Gastroenteritis | Human feces | Gastrointestinal tract |
| *Yersinia enterocolitica* | Gastroenteritis | Human / animal feces | Gastrointestinal tract |
| *Campylobacter jejuni* | Gastroenteritis | Human / animal feces | Gastrointestinal tract |
| *Legionella pneumophila* | Acute respiratory illness (legionnaire's disease) | Thermally enriched waters | Lungs |
| *Mycobacterium tuberculosis* | Tuberculosis | Human respiratory exudates | Lungs |
| *Leptospria* | Leptospirosis (Weil's disease) | Animal feces and urine | Generalized |
| Opportunistic bacteria | Variable | Natural waters | Mainly gastrointestinal tract |

**Water pollution prevention and control**

There is no any single formula or tool to control the water pollution. Various techniques, methodologies, strategies, rules and acts jointly can form a platform to reduce the level of water pollution. There are methods to check the industrial wastes, urban wastes, domestic as well as agricultural wastes.

**1. Self purification of water**

Every river, canal and stream has a self-purification capacity. It may be physical, chemical or biological in nature. Physical purification takes place when the chemicals are absorbed and the suspended particles settle down slowly. Chemical purification occurs when organic and inorganic acids are neutralized by reaction with lime (calcium carbonate). Biologically, purification occurs when microorganisms are able to degrade the organic matter that reaches water ways. Their purification depends upon their working capacity, amount of chemicals and the circumstances where they exist.

**2.Stabilization of the ecosystem**

This is most scientific way to control water pollution. The basic principle involved are the reduction in waste input, harvesting and removal of biomass, trapping of nutrients and aeration.

**3.Reutilisation and recycling of waste**

All type of waste may be recycled to beneficial use. For eg. Urban waste may be recycled to generate cheaper fuel gas and electricity.

**4.Removal of pollutants**

Various pollutants present in water body can be removed by appropriate methods such as adsorption, electrodialysis, ion exchange, reverse osmosis etc.

Eg. 1. Ammonia – Ion exchange method
2.Phenolics – Polymeric absorbents

**5.Enforcement of standards**

**Pollution control standards adopted by the Central Pollution Control Board**

| Characteristics | Sewage | Industrial effluents for discharge into | |
|---|---|---|---|
| | | Inland surface water | Public sewers |
| BOD (5 day 20°C) (mg $l^{-1}$) | 20 | 30.0 | 500.0 |
| COD (mg $l^{-1}$) | - | 250.0 | - |
| pH | - | 5.5.9.0 | 5.5.9.0. |
| Total suspended solids (mg $l^{-1}$) | 30 | 100.0 | 600.0 |
| Temperature (°C) | - | 40.0 | 45.0 |
| Oil & grease (mg $l^{-1}$) | - | 10.0 | 100.0 |
| Phenolic compounds (mg $l^{-1}$) | - | 1.0 | 5.0 |
| Cyanides (mg $l^{-1}$) | - | 0.2 | 2.0 |
| Sulphides (mg $l^{-1}$) | - | 2.0 | - |
| Fluorides (mg $l^{-1}$) | - | 2.0 | - |
| Total residual chlorine (mg $l^{-1}$) | - | 1.0 | - |
| Insecticide (mg $l^{-1}$) | - | 0.0 | - |
| Arsenic (mg $l^{-1}$) | - | 0.2 | - |
| Zinc (mg $l^{-1}$) | - | 5.0 | 15.0 |
| Chlorides (mg $l^{-1}$) | - | - | 600.0 |
| Sulphates (mg $l^{-1}$) | - | - | - |

**Drinking water standards**

| Parameters | WHO Standards (mg/l) |
|---|---|
| pH | 6.5-7.2 |
| Total Dissolved Solids | 500 |
| BOD | 3-6 |
| COD | 10 |
| Coliform count | In any sample of 100ml should be zero |
| PCB's (µg/l) | 0.2 |
| Mercury | 0.001 |
| Cadmium | 0.05 |
| Lead | 0.05 |
| Chromium | 0.05 |
| Arsenic | 0.05 |

**6. Installation of waste water treatment plants**

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## Lecture 15

## DEFINITION, CAUSE, EFFECTS AND CONTROL MEASURES OF MARINE POLLUTION, THERMAL POLLUTION AND NUCLEAR HAZARDS

### Definition, cause, effects and control measures of Marine pollution

**Marine pollution** refers to the contamination or presence of pollutants in oceans and seas. Marine pollution refers to the entry of chemicals, particles, industrial, agricultural and residential waste, noise, or the spread of invasive organisms, into the ocean. Common marine pollutants include chemicals, small plastic beads in exfoliants and also toxic bio-matter. Most sources of marine pollution are agricultural runoff and windblown debris. The increase in the use of plastic since 1940 has resulted in the increase of a huge quantity of nearly indestructible, lightweight material floating in the oceans thereby resulting in marine pollution.

### Sources and Effects of Marine Pollution

| Type | Primary Source/Cause | Effect |
|---|---|---|
| Nutrients | Runoff approximately 50% sewage, 50% from forestry, farming, and other land use. Also airborne nitrogen oxides from power plants, cars etc. | Feed algal blooms in coastal waters. Decomposing algae depletes water of oxygen, killing other marine life. Can spur algal blooms (red tides), releasing toxins that can kill fish and poison people. |
| Sediments | Erosion from mining, forestry, farming, and other land-use; coastal dredging and mining | Cloud water; impede photosynthesis below surface waters. Clog gills of fish. Smother and bury coastal ecosystems. Carry toxins and excess nutrients. |
| Pathogens | Sewage, livestock. | Contaminate coastal swimming areas and seafood, spreading cholera, typhoid and other diseases. |
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| Sediments | Erosion from mining, forestry, farming, and other land-use; coastal dredging and mining | Cloud water; impede photosynthesis below surface waters. Clog gills of fish. Smother and bury coastal ecosystems. Carry toxins and excess nutrients. |
| Pathogens | Sewage, livestock. | Contaminate coastal swimming areas and seafood, spreading cholera, typhoid and other diseases. |
| Alien Species | Several thousand per day transported in ballast water; also spread through canals linking bodies of water and fishery enhancement projects. | Outcompete native species and reduce biological diversity. Introduce new marine diseases. Associated with increased incidence of red tides and other algal blooms. Problem in major ports. |

| Type | Primary Source/Cause | Effect |
|---|---|---|
| Persistent Toxins (PCBs, Heavy metals, DDT etc.) | Industrial discharge; wastewater discharge from cities; pesticides from farms, forests, home use etc.; seepage from landfills. | Poison or cause disease in coastal marine life, especially near major cities or industry. Contaminate seafood. Fat-soluble toxins that bio-accumulate in predators can cause disease and reproductive failure. |
| Oil | 46% from cars, heavy machinery, industry, other land-based sources; 32% from oil tanker operations and other shipping; 13% from accidents at sea; also offshore oil drilling and natural seepage. | Low level contamination can kill larvae and cause disease in marine life. Oil slicks kill marine life, especially in coastal habitats. Tar balls from coagulated oil litter beaches and coastal habitat. Oil pollution is down 60% from 1981. |
| Plastics | Fishing nets; cargo and cruise ships; beach litter; wastes from plastics industry and landfills. | Discarded fishing gear continues to catch fish. Other plastic debris entangles marine life or is mistaken for food. Plastics litter in beaches and coasts and may persist for 200 to 400 years. |
| Radioactive substances | Discarded nuclear submarine and military waste; atmospheric fallout; also industrial wastes. | Hot spots of radio activity. Can enter food chain and cause disease in marine life. Concentrate in top predators and shellfish, which are eaten by people. |
| Thermal | Cooling water from power plants and industrial sites | Kill off corals and other temperature sensitive sedentary species. Displace other marine life. |
| Noise | Supertankers, other large vessels and machinery | Can be heard thousands of kilometers away under water. May stress and disrupt marine life. |

**Control Measures of Marine Pollution:**

a. Introduction of sewage treatment plants to reduce BOD of final product before discharging into sea.

b. Cleaning oil from surface waters and contaminated beaches can be accelerated through the use of chemical dispersants which can be sprayed on the oil.

c. Load on top system reduce oil pollution cleaned with high pressures jets of water.

d. Crude oil washing: The clingage is removed by jets of crude oil while the cargo is being unloaded.

e. Skimming off the oil surface with a section device.

f. Spreading a high density powder over the oil spill, so that oil can I be sunk to the bottom.

**Thermal pollution and Nuclear hazards**

**Thermal pollution:**

Thermal pollution is defined as the addition of excess of undesirable heat to water thereby making it harmful to man, animal or aquatic life. Thermal pollution may also cause significant departures from or activities of aquatic communities.

**Sources of Thermal Pollution**:

The following sources contribute to thermal pollution.

1. Nuclear power plants
2. Coal fired plants
3. Industrial effluents
4. Domestic sewage
5. Hydro-electric power

1. **Nuclear power plants:** Nuclear power plants including drainage from hospitals, research institutions, nuclear experiments and explosions, discharge a lot of heat that is not utilized along with traces of toxic radio nuclides into nearby water streams. Emissions from nuclear reactors and processing installations are also responsible for increasing the temperatures of water bodies. The operations of power reactors and nuclear fuel processing units constitutes the major contributor of heat in the aquatic environment. Heated effluents from power plants are discharged at 10 C higher than the receiving waters that affects the aquatic flora and fauna.

2. **Coal-fired power plants:** Coal fired power plants constitute a major source of thermal pollution. The condenser coils in such plants are cooled with water from nearby lakes or rivers. The resulting heated water is discharged into streams thereby raising the water temperature by 15C. Heated effluent decreases the dissolved content of water resulting in death of fish and other aquatic organisms. The sudden fluctuation of temperature also leads to "*thermal shock*" killing aquatic life that have become acclimatized to living in a steady temperature.

3. **Industrial effluents:** Industries like textile, paper, pulp and sugar manufacturing release huge amounts of cooling water along with effluents into nearby natural water bodies. The waters polluted by sudden and heavy organic loads result in severe drop in levels of dissolved oxygen leading to death of several aquatic organisms.

4. **Domestic Sewage:** Domestic sewage is discharged into rivers, lakes, canals or streams with minimal treatment or without any treatment. These wastes have a higher organic temperature and organic load. This leads to decrease in dissolved oxygen content in the receiving waters resulting in the set-up of anaerobic conditions causing release of foul and offensive gases in water. Eventually, this leads to development of anoxic conditions resulting in rapid death of aquatic organisms.

5. **Hydro-electric power:** Generation of hydroelectric power sometimes leads to negative thermal loading in water systems. Apart from electric power industries, various factories with cooling requirement contribute to thermal loading.

**Thermal pollution in streams by human activities**

1. Industries and power plants use water to cool machinery and discharge the warm water into a stream
2. Stream temperature rises when trees and tall vegetation providing shade are cut.
3. Soil erosion caused due to construction also leads to thermal pollution
4. Removal of stream side vegetation
5. Poor farming Practices also lead to thermal polloution

**Effects of Thermal pollution**

1. **Reduction in dissolved oxygen**: Concentration of Dissolved Oxygen (DO) decreases with increase in temperature.
2. **Increase in toxicity**: The rising temperature increases the toxicity of the poison present in water. A 10$^{o}$C increase in temperature of water doubles the toxicity effect of potassium cyanide, while 80$^{o}$C rise in temperature triples the toxic effects of o-xylene causing massive mortality to fish.
3. **Interference in biological activity**: Temperature is considered to be of vital significance to physiology, metabolism and biochemical processes that control respiratory rates, digestion, excretion, and overall development of aquatic organisms. Temperature changes cause total disruption to the entire ecosystem.
4. **Interference in reproduction:** In fishes, several activities like nest building, spawning,hatching, migration and reproduction depend on optimum temperature.
5. **Direct mortality**: Thermal pollution is directly responsible for mortality of aquatic organisms. Increase in temperature of water leads to exhaustion of microorganisms thereby shortening the life span of fish. Above a certain temperature, fish die due to failure of respiratory system and nervous system failure.
6. **Food storage for fish**: Abrupt changes in temperature alters the seasonal variation in the type and abundance of lower organisms leading to shortage of right food for fish at the right time.

**Control measures for thermal pollution**

The following methods can be adapted to control high temperature caused by thermal discharges:

1. **Cooling towers**: Use of water from water systems for cooling systems for cooling purposes, with subsequent return to the water way after passage through a condenser, is called cooling process. Cooling towers transfer heat from hot water to the atmosphere by evaporation. Cooling towers are of two types:

   (i) **Wet cooling tower:** Hot water coming out from the condenser (reactor) is allowed to spray over baffles. Cool air, with high velocity, is passed from sides, which takes away the heat and cools the water.

   (ii) **Dry cooling tower:** Here, hot water is allowed to flow in long spiral pipes. Cool air with the help of a fan is passed over these hot pipes, which cools down hot water. This cool water can be recycled.

2. **Cooling ponds:** Cooling ponds are the best way to cool thermal discharges. Heated effluents on the surface of the water in cooling ponds maximise dissipation of heat to the atmosphere and minimise the water area and volume. The warm water wedhe acts like a cooling pond.
3. **Spray ponds**: The water coming out from condensers is allowed to pass into the ponds through sprayers. Here water is sprayed through nozzles as fine droplets. Heat from the fine droplets gets dissipated to the atmosphere.
4. **Artificial lakes:** Artificial lakes are manmade water bodies that offer once-through cooling. The heated effluents can be discharged into the lake at one end and water for cooling purposes may be withdrawn from the other end. The heat is eventually dissipated through evaporation.

**Nuclear hazard**

**Nuclear hazard** can be defined as the Risk or danger to human health or the environment posed by radiation emanating from the atomic nuclei of a given substance, or the possibility of an uncontrolled explosion originating from a fusion or fission reaction of atomic nuclei.

The sources of radioactivity are both natural and man-made.

**The natural sources include:**

- Cosmic rays from outer space. The quantity depends on altitude and latitude; it is more at higher latitudes and high altitudes.
- Emissions from radioactive materials from the Earth's crust.

**Man-made sources include:**

- Mining and processing of radioactive ores.
- Use of radioactive material in nuclear power plants.
- Use of radioactive isotopes in medical, industrial and research applications.
- Use of radioactive materials in nuclear weapons.

**Impact of Nuclear Hazard**

Ionization radiations can affect living organisms by causing harmful changes in the body cells and also changes at genetic level.

- **Genetic damage** is caused by radiations, which induce mutations in the DNA, thereby affecting genes and chromosomes. The damage is often seen in the off springs and may be transmitted upto several generations.
- **Somatic damage** includes burns, miscarriages, eye cataract and cancer of bone, thyroid, breast, lungs and skin.
- **Physiological effects :**

  **Severe radiation sickness** (3.5 to 5.5 Gy)

  - Nausea and vomiting less than 1 hour after exposure
  - Diarrhea
  - High fever
  - About 50% fatality.

**Very severe radiation sickness (5.5 to 8 Gy)**

- Nausea and vomiting less than 30 minutes after exposure
- Dizziness
- Disorientation
- Low blood pressure
- 50% fatality
- Longer term or chronic radiation effects include genetic mutations, tumors/cancer, birth defects, cataracts, etc.

Radio-active emission is measured in "rem". One Roentgen is defined as the quantity of radiation which produces 1.6 × 1012 pairs of ions in 1 gm of air. Radioactive emission is used to destroy cancerous tumour.

**Control of radioactive pollution:** The control of radioactive pollution from **natural sources** is difficult, but efforts can be made to reduce the level of pollution from man made sources.

Protection against radiation exposure: The three factors that influence radiation protection are :

- **Distance from the source** : The exposure decrease with the square of distance from the source.

- **Time of exposure**: The time of exposure should be kept as low as possible to complete a particular task.

- **Shielding**: A shield made up of dense attenuating material may be placed between source and the surrounding.

The radioactive particles are particularly hazardous if inhaled causing irradiation. this can be minimized by using laboratory hoods, air filters, and exhaust systems, eliminating dry sweeping, wearing protective clothing and radiation indicators which show the total amount of radiation to which a person is exposed. Use of respirators, prohibition of smoking and eating where radioactive materials are used. The accessibility to areas which are susceptible for radiation exposure should be controlled by placing appropriate sign boards like "Restricted area" or "Radiation zone". Radiation resistant enclosures or barriers are to be placed for screening workers from radioactive materials.

**Example:**

- Chernobyl 1986

- Chernobyl Worst accident ever in the history of Nuclear power Released more than 100 times the radiation produced by the atom bombs of Hiroshima and Nagasaki Affected Western Soviet Union, Eastern, Central and Northern Europe, and Eastern and Northern America 336,000 people evacuated and resettled elsewhere

**Following measures can help in controlling the radioactive pollution:**

- Workers in nuclear plants should be provided with nuclear gadgets and safety measures against accidents.
- Leakage of radioactive elements from nuclear reactors, laboratories, transport, careless handling and use of radioactive fuels should be checked.
- There should be regular monitoring and quantitative analysis through frequent sampling in the risk areas.
- Preventive measures should be followed so that background radiation levels do not exceed the permissible limits.
- Waste disposal must be careful, efficient and effective.

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**Lecture 16**

# SOLID WASTE MANAGEMENT: CAUSES, EFFECTS AND CONTROL MEASURES OF URBAN AND INDUSTRIAL WASTES

## Waste- Definition & Classification

Waste is unwanted and discarded materials that have no ownership. Any material which is not needed by the owner, producer or processor.

Solid waste refers to low liquid content waste material including municipal garbage, industrial and commercial wastes, sewage sludge, agricultural and animal husbandry wastes, demolition wastes and mining wastes. Solid waste is also any unwanted or discarded material that is not a liquid or gas. The United States, with only 4.6% of the world's population, produces about 33% of the world's solid waste.

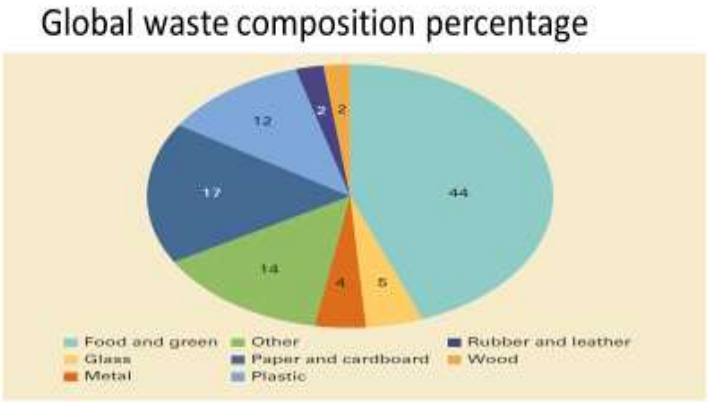
The United States and Canada were two of the highest per capita generators of municipal solid waste in the world, throwing out about 2.58 kilograms and 2.33 kilograms per day, respectively. Municipal solid waste is defined as the everyday objects thrown out by the public. Globally, humans generate a wide variety of waste types, including plastic waste, food waste, and electronic waste. In terms of e-scrap, the United Kingdom is one of the largest per capita generators in the world, reaching 21.1 kilograms. Average waste is about 450 grams of waste per person per day. However, there is much variability in per capita: daily household municipal solid waste generation ranges from 170 grams per person in small towns to 620 grams per person in large cities.

## Classification

- Domestic waste
- Factory waste
- Waste from oil factory
- E-waste
- Construction waste
- Agricultural waste
- Food processing waste
- Bio-medical waste
- Nuclear waste

7.2 million tonnes of hazardous waste are eliminated every year in India. Landfills is the common method of solid waste Management in India. Hence, one Sq km of additional landfill area is formed every-year. Around Rs 1600 crore is required for treatment & disposal of these wastes. In addition to this, industries discharge about 150 million tonnes of high volume low hazard waste every year, which is mostly dumped on open low lying land areas.

Municipal solid wastes are increasing day by day because of urbanization and over population.



**Quantity of Municipal Solid Wastes Generation in Metro Cities**

| S.No | City | Municipal solid Waste (TPD) | Per capita waste (Kg/day) |
|---|---|---|---|
| 1. | Ahmadabad | 1,683 | 0.585 |
| 2. | Bangalore | 2,000 | 0.484 |
| 3. | Bhopal | 546 | 0.514 |
| 4. | Bombay | 5,355 | 0.436 |
| 5. | Calcutta | 3,692 | 0.383 |
| 6. | Coimbatore | 350 | 0.429 |
| 7. | Delhi | 4,000 | 0.475 |
| 8. | Hyderabad | 1,566 | 0.382 |
| 9. | Indore | 350 | 0.321 |
| 10 | Jaipur | 580 | 0.398 |
| 11 | Kanpur | 1,200 | 0.640 |
| 12 | Kochi | 347 | 0.518 |
| 13 | Lucknow | 1,010 | 0.623 |
| 14 | Ludhiana | 400 | 0.384 |
| 15 | Madras | 3,124 | 0.657 |
| 16 | Madurai | 370 | 0.392 |

**Various methods of Solid Waste Management**

The materials that are highly resistant to degradation are known as Recalcitrant compounds.

The industrial wastes include, Pressmud, bagasse, flyash etc**.**

Various methods of solid wastes disposal are as follows.

**Open Land filling**

Use of solid wastes for land reclamation by filling to the original level of man-made surface dereliction such as disused surface mineral excavation.

Land-filling is the common method. In this method, the dumping of waste into depth of the ground is carried out. By this we can avoid leachate from the waste moving to the surrounding environment particularly ground water. Impermeable lining is provided to prevent leachate seepage into the ground.

**Secured land filling**

In this method, the dumping of waste into depression in the ground is carried out. By this we can avoid leachate from the waste moving to the surrounding environment particularly ground water. Impermeable lining is provided to prevent leachate seepage into the ground.

**Open burning**

- Burning of unwanted materials in a manner that causes smoke and other emissions to be released directly into the air without passing through a chimney or stack.
- includes burning of outdoor piles, burning in a burn barrel & use of incinerators which have no pollution control devices & as such release the gaseous by products directly into atmosphere

**Incineration**

Incineration thermally decomposes matter through oxidation thereby curtailing the waste and wrecking their toxicity. After incineration waste are converted to CO, $CO_2$, water and ash.

It is a common thermal treatment process.

- Used as a means of recovering energy to be used in heating or supply of electricity.
- Advantage of reducing volume of waste, rendering it harmless, reducing transportation costs & reducing production of GHG

**Ocean dumping:**

**This is a method in which the wastes are simply dumped into the ocean.**

- **Advantages**
- convenient
- inexpensive
- source of nutrients, shelter and breeding
- **Disadvantages**
- ocean overburdened
- destruction of food sources
- killing of plankton
- desalination

**Composting**

- Composting is one of the best methods of solid wastes management.
- Composting is a biochemical process during which the complex organic materials are decomposed and converted as simple, molecular compounds and used as organic manure.

**Advantage**

- Waste is converted as manure.
- Pollution of waste is reduced.
- Improvement in soil texture and augmenting of micronutrient
- Increases moisture-holding capacity of the soil
- It does not require large capital investment
- Suitable for organic biodegradable fraction containing high proportion of lignocelluloses materials, which do not readily degrade under anaerobic conditions.
- Technically proven for larger scale
- Creates fertilizer value and save land fill area

**Disadvantage**

- Not suitable for wastes that may be too wet and during heavy rains open compost plants have to be stopped.
- Land required is relatively large.
- Methane emission, odour and flies

**Co-Composting**

- Co-composting means utilization of two different organic waste materials for composting process.
- Eg: Co-composting of MSW & sewage sludge. Sewage sludge adds N, P & other elements that enrich solid waste & help composting process.

**Vermi-composting**

Vermi-composting is the natural decomposition of organic waste into organic manure by the earthworms. The excreta of earthworms is known as vermicasting which is also rich in nutrients.

**Gasification**

Gasification is a process of partial combustion of carbonaceous material to generate a combustible fuel gas affluent in carbon monoxide and hydrogen. The produced gas can be used as fuel either in boiler or cleaned up and used in combustion turbine/ generators for power generation.

**Pyrolysis**

It is a method of decomposition of wastes by heat under anaerobic condition. Thermal decomposition of organic material at elevated temperature in the absence of air or oxygen. The product of pyrolysis includes a mixture of combustible gases, liquids and solid residues. In the solid waste management, the following hierarchy may be followed.

**Reduce, Reuse and Recycle**

**Source Reduction:** Most fundamental method of reducing waste is to prevent it from being produced (Waste Prevention).

- Methods of waste reduction include manufacturing products with less packaging, encouraging customers to bring their own reusable bags for packaging, encouraging public to choose reusable products *viz.,* cloth napkins & reusable plastic, glass containers, backyard composting, sharing, donating any unwanted items rather than discarding them.

**Reuse**

- Second most important strategy of the three R's is to **reuse**, which is when an item is cleaned and the materials are used again.
- This concept can be difficult because we currently live in a world with many disposable items
- Eg: Industries implement process of reuse. Beverage companies use glass bottles to hold their products & promote consumers returning bottles.

**Advantages of Reuse**:

- Energy obtained from the biodegradable wastes are also known as Bioenergy.
- Energy and Raw material saving.
- Cost saving for business and consumers.
- Such items can be handcrafted.

**Disadvantages:**

- Requires cleaning and transport, adding to environmental cost.
- Some items can be hazardous and less energy efficient as they continue to be used.
- Sorting and preparing items for reuse is time consuming.

**Recycling**

**Recycling:**Recycling is the processing of a waste item into usable forms.

**Benefits of recycling:**

- Reduce environmental degradation
- Making money out of waste
- Save energy that would have gone into waste handling & product manufacture
- Saves money, raw materials & land.
- Encourages individual responsibility.
- Reduces pressure on disposal systems.
- Lowers demand for raw resources.
- Reduces energy consumption and air pollution.
- Plastics are recyclable, but technology differs from plastic to plastic.
- Industry is researching on new technologies.

**Disposal of Municipal solid waste**

Solid wastes dumping site is a breeding place for rats, mosquitoes and flies. This causes infectious diseases in human and animals. Burning of solid wastes lead to air pollution which is caused by carbon monoxide, Sulphur dioxide, ammonia and nitrogen oxides.

The municipal solid wastes are segregated.

Segregation is a method of separation of solid wastes. The categories are Non-Degradable, Biodegradable, Recyclable and hazardous.

Biodegradable wastes are composted and made as organic manure. Recyclable wastes are recycled through Industries. The hazardous wastes are land-filled.

**Hazardous wastes:**

Hazardous wastes are the materials which have any one or two of the following characters. Toxic, Radioactive, Highly reactive, Carcinogenic and Highly inflammable. In the household, the mosquito repellent, room refresher, insect killer, Paint and varnish wastes are hazardous wastes.

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**Lecture18**

# ROLE OF AN INDIVIDUAL IN PREVENTION OF POLLUTION - POLLUTION CASE STUDIES - SOCIAL ISSUES AND THE ENVIRONMENT - FROM UNSUSTAINABLE TO SUSTAINABLE DEVELOPMENT - URBAN PROBLEMS RELATED TO ENERGY

## Role and responsibility of individual participation in environmental pollution

At the present scenario, the most dangerous threat to the world is ozone layer depletion. On account of ozone layer depletion, many countries have to take initiative to control the ozone layer they banned the plastic system, planting more trees, reduce the chlorofluorocarbon (CFC), and they are disposing of the nuclear waste and the solid waste more carefully without harming the living creatures and the society. Environmental pollution cannot be prevented and it cannot be removed easily. The proper implementation and particularly the individual participation square measures the vital aspects that ought to tend due to importance and stress.

The individual participation is very useful in the law making processes and restraining the pollution activities and thereby the public participation plays a major role in effective environmental management. A small effort made by each individual at his own place will have a pronounced effect at the global level. It is aptly said, "Think globally act locally". Each individual ought to amendment his or her fashion in such the simplest way to cut back environmental pollution

There are plenty of responsibilities of the individual to do in his or her in the home to reduce the pollution and to save the society some of the responsibilities are mentioned in the below points of the paragraph they are;

- To plant more trees
- To help more in pollution prevention and control
- Use water, energy and other resources efficiently.
- To purchase recyclable, recycled and environmentally safe products.
- Use chlorofluorocarbon (CFC) free refrigerators.
- Use natural gas than coal.
- Reduce deforestation.
- Increase the use of renewable resources.
- Remove NOx from the motor vehicular exhaust.
- Use office machines in well-ventilated areas.

- Useless polluting substitutes for harmful clean-up agents, paints and other products.
- Use of eco-friendly products will reduce pollution.
- Don't use polystyrene cups that have chlorofluorocarbon (CFC) molecules, which destroy the ozone layer.
- Use rechargeable batteries. Rechargeable batteries will reduce metal pollution.
- Use organic manure instead of commercial inorganic fertilizers.
- Reduce garbage by recycling and reuse.
- Slow population growth.

**Pollution Case Studies**

**London Smog Disaster**

Smog has been part of London life. But the effect of the Great Smog of '52 was unprecedented. A period of cold weather, combined with an anticyclone and windless conditions, collected airborne pollutants (mostly from the use of coal), to form a thick layer of smog over the city. It lasted from Friday 5 to Tuesday 9 December 1952. It is considered the worst air pollution event in the history of the United Kingdom. Medical reports estimated that 4,000 people had died prematurely and 100,000 more were made ill because of the smog's effects on the human respiratory tract. More recent research suggests that the number of fatalities was considerably greater at about 12,000.

The weather in November and early December 1952 had been very cold, with heavy snowfalls across the region. To warm homes, people burned coal in their homes. Also, it was primary fuel in industries. In normal conditions, smoke would rise into the atmosphere and disperse, but due to anticyclone, inversion was created, which pushed air downwards. As a result, smoke from the chimneys was trapped. **Nelson column during Great Smog of 1952.**The fog finally cleared on December 9, but it had already taken a heavy toll. A series of laws were brought in to avoid a repeat of the situation. This included the Clean Air Acts of 1956 and 1968. These acts banned emissions of black smoke.

**Bhopal Gas Tragedy**

Bhopal gas tragedy accounts for most infamous incidents of industrial pollutions. On December 3 1984, more than 40 tons of methyl isocyanate gas leaked from a pesticide plant in Bhopal, India, immediately killing at least 3,800 people and causing significant morbidity and premature death for many thousands more. At around 1.00 AM, December 3, loud rumbling reverberated around the plant as a safety valve gave away, sending a plume of MIC or **Union Carbide MIC plant** gas into the early morning air. Within hours, air was full of toxic contents.

Gas circulated through the blood streams of victims, carrying toxins and causing damage to the eyes, lungs, kidneys, liver, intestines, muscles, brain, reproductive and immune systems. Soon Bhopal was full of corpse of humans and animals. Immediate loss was around 3800 human lives, with death toll increasing to 10000 in that week. As a result of aftermath, region has reported 15000 to 20000 premature deaths. These numbers can be assumed to be understated. In l985 the Indian Government sued Union Carbide for 3.3 billion dollars and in l989, case settled for a mere $470 million. This money, later deposited with RBI, has now swelled up to Rs 1,503 crore. UCC got away by paying a compensation of mere $470 million, although actual compensation was accounted to less than $10 billion as calculated by some agencies.

UCC ceased its operations at Bhopal plant, but did not take responsibility to clean the mess either. The plant continues to leak several toxic chemicals and heavy metals that have percolated into underground water. Reports suggest that underground water of the region still contain heavy metals even after around three decades. When it rains, especially in the monsoon season, rainwater washes these chemicals into puddles, streams and eventually into the ground water. Despite the horror of "that night" and the chemical terror that its survivors have endured, the people of Bhopal continue their struggle for justice, for corporate accountability, and for their basic human right to an environment free of chemical poisons.

**Fukushima Disaster**

On March 11, 2011, a powerful, 9.0 magnitude quake hit north-eastern Japan, triggering a tsunami with 10-meter-high waves that reached the U.S. west coast. It was triggered by an earthquake near Honshu off eastern coast of Japan. It was followed by horrors of tsunami, followed by after-shock of 6.7 magnitudes. Duel punch of earthquake and tsunami caused damage that led to explosions and partial meltdowns at the Fukushima Nuclear Power Plant in Japan.

Three out of six reactors failed. Radiation levels from Fukushima Nuclear Power Plant were reported as high as 1,000 mSv/h (milli sievert per hour). These were 20 times acceptable levels of nuclear radiations allowed in the US. The high levels of radiation in and around the plants hampered efforts to cool the reactors. The evacuation area around the plant was 20 kilometres (12.4 miles), while people living up to 30 kilometres (18.6 miles) from the plant have been advised to stay indoors. Other countries were even more cautious. On 3 April 2011,

two bodies were discovered in the basement turbine room most likely because the workers ran there during the tsunami.It will take decades for complete clean-up of pollutants from this disaster. A permanent exclusion zone could end up stretching beyond the plant's perimeter. Seriously exposed workers may be at increased risk of cancers for the rest of their lives. More importantly it hindered much needed rescue work for the victims of earthquake and tsunami required. Some of the areas in the temporary 19 km (12 miles) radius evacuation zone around Fukushima were found to be heavily contaminated with radio-nuclides According to a new reports released by the Japanese Ministry of Science and Education, the town of Okuma was reported as being over 25 times above the safe limit of 20 milles per year. Marine life around Japanese eastern coast will be adversely affected for years. Radionuclides in seawater were reported from the Fukushima plant's discharge canals, from coastal waters five to 10 kilometers south of the plant, and from 30 kilometers offshore, even months after the disaster.

It can be expected that the marine dispersion of seawater tagged with radio nuclides released from Fukushima will take years to reach other riparian Pacific countries. Although the immediate direct losses to life in this incident were less than other disasters the history has witnessed, long term hazards of this incident are immense.

**Social Issues and the Environment**

Human beings interact both with the social world and nature. Both, economic development and stable environment are required for the continual improvement of lifestyle and living standards. But until now, the development was human oriented and limited to rich nations. The development was achieved by damaging the environment and over exploitation of natural resources which were non renewable. That caused instability of environment and crossed the threshold limit of environmental damage. Sustainable development can be defined as eating the needs of the present without compromising the ability of future generations to meet their own needs." It is effective use of resources for economic development while preserving the environment and ecosystem .

**Causes for Unsustainable Development**

Some people argue that developing countries responsible for the degradation. Others hold Developing Countries are responsible for them.

- The important issues is not rate of increase of National Pollution, it is the rate of increase of Total Pollution. In this regard developed countries contribute much more than developing countries.

- Some people argue that raising population in the third world countries to be the crucial pollutant and it is essential to control it by all means.
- People should look at environment as not only reserve of man but of all living organism. So development has to sustain not only for man but also for all living organisms.

**True sustainable development**

It aims at optimum use of natural resources with high degree of sustainity, minimum wastage, least generation of toxic byproducts and maximum productivity**.**

i. **Inter generational equity**

We should minimize any adverse impacts on resources and environment for future generation.

ii. **Intra generational equity**

Technological development of rich countries should support economic growth of poor countries and lead to sustainability.

- Don't use high quality energy to do a job that can be done with low quality energy.

| | | |
|---|---|---|
| Electricity, very high temp(>2500C),nuclear fission, fusion, high velocity wind | Very high | To run electrical devices |
| High temp heat (1000 – 2500C), H2 gas, coal, gasoline, food | high | To move vehicles, industrial processes |
| Normal sunlight, wood, crop wastes | moderate | Cooking, hot water, 100 – 1000C |
| Low temperature heat (below 100C) | Low | Low temperature for space heating |

- Place more emphasis on pollution prevention and waste reduction.
- Recycle and reuse as many of our waste products and resources possible.
- Make more goods that last longer and easy to use, recycle and repair.
- Depend on renewable source of energy, sun wind, biomass, flowing water, geo thermal and tidal.
- Sustain Earths Biodiversity with emphasis on protecting vital habitats of the
- Wild species.
- Use potentially renewable resources such as wastes soil, plants, and animals no faster than they are renewed.

- Increase the usage of non renewable resources to minimize the resource depletion at a faster rate.
- Earth Degrading activities should be discouraged
- Reduce poverty and rate of population growth

**Measures for sustainable Development**

a) **Using appropriate technology**
It is one which is locally adaptable, ecofriendly efficient and culturally suitable. It involves local labours, less resources and produces minimum waste.the Concept is **''Design with Nature''.**

b) **3-R Approach**
Reduce,Reuse and Recycle approach.
Reduce the usage and also reduce the wastage of resource by making things that last longer and are easier to recycle, reuse and repair.

c) **Promoting environmental education awareness**
Environmental education will help in changing the thinking and attitude of people towards environment.

d) **Population stabilization**
We can achieve sustainable development by controlling population.

e) **Conservation of nonrenewable resources**
It should be conserved by recycling and reusing.

f) **Usage of renewable resources**
Usage of renewable resources should not be faster than their regeneration capacity.

**SUSTAINABLE DEVELOPMENT**

Sustainable development also looks at the equity between countries and continents, races and classes, gender and ages. It includes social development and economic opportunity on one hand and the requirements of environment on the other. It is based on improving the quality of life for all, especially the poor and deprived within the carrying capacity of the supporting ecosystems. It is a process which leads to a better quality of life while reducing the impact on the environment. Its strength is that it acknowledges the interdependence of human needs and environmental.

To ensure sustainable development, any activity that is expected to bring about economic growth must also consider its environmental impacts so that it is more consistent with long term growth and development. Many 'development projects', such as dams, mines, roads, industries and tourism development, have severe environmental consequences that must be studied before they are even begun. Thus for every project, in a strategy that looks at sustainable development, there must be a scientifically and honestly done EIA,

without which the project must not be cleared. Large dams, major highways, mining, industry, etc. can seriously damage ecosystems that support the ecological health of a region.

Forests are essential for maintaining renewable resources, reducing carbon dioxide levels and maintaining oxygen levels in the earth's atmosphere. Their loss impairs future human development. Loss of forests depletes biodiversity which has to be preserved to maintain life on earth. Major heavy industries if not planned carefully lead to environmental degradation due to air and water pollution and generate enormous quantities of waste that lead to long term environmental hazards. Toxic and Nuclear wastes can become serious economic problems as getting rid of them is extremely costly.

In order to safeguard the existence of life and future of humanity, we have to change our approach from unsustainable to sustainable development. A judicious balance between developmental activities and environmental protection should be assured. It is possible only trough sustainable development.

**Social issues and Environment**

- **Urban problems related to energy**
- **Water conservation -**
  - Rain water harvesting and water shed management,
  - Recycling of industrial wastes,
  - Construction of Storage reservoirs
  - Better Agricultural Practices

**Rain water harvesting**

The activity of collecting rain water direct ly recharging it into the ground to improve the ground water storage in the aquifer is called Rain Water harvesting. This may increase the level of ground water, reduce the ground water table depletion and arrest the sea water intrusion

Traditional methods - Temple tanks of India, Ponds

Modern methods - Absorption pit method, Absorption well method, Well cum Bore Method, Group Houses – Terrace water saving method

## Water shed management

## Principles factors influencing watershed operations

- Physiography
- Soil and Geology
- Land Use
- Criminological and meteorological information
- Design peak runoff rate
- Socio-economic factors

**Restoration and rehabilitation Techniques**

The survival of human has now become an important issue to be concentrated, as human faces many threats for his survival too. He is disturbed to a maximum and at times, he needs resettlement too. Based on the causes, resettlement activities can be broadly grouped into 2 categories.

1. ***Voluntary Rehabilitation:*** Due to natural calamities such as Political, racial, religious disturbance, floods, cyclones, famines, earthquakes etc.,

2. ***Involuntary Rehabilitation*:** Due to construction of various types of developmental projects.

**Environmental ethics**

'If there is to be a war, let it be against environmental contamination, nuclear contamination, chemical contamination of soil and water systems'. The four basic tenets of biocentrism are:

- Humans are members of Earth's living community in the same way and on the same terms as all other living things,
- Humans and other species are inter-dependent,
- Each organism is a unique individual pursuing its own way, and
- Humans beings are not inherently superior to other living things.

**Three principles** of ethical conduct are**:**

- We should not harm any natural entity that has an intrinsic worth.
- We should not try to manipulate, control, modify, manage or interfere with the normal functioning of natural ecosystems, biotic communities or individual wild organisms, and
- We should not try to deceive or mislead any animal capable of being deceived or misled.

**Some issues of concern**:

- Waste land reclamation
- Greenhouse effect
- Acid rain
- El Nino
- Ozone depletion – Ozone friendly chemicals are HFC 1349 and HCFC 22
- Other than these issues, biodiversity loss, over all pollution of water , air, noise are all typical examples for over ruling the environmental ethics.

**How to achieve sustainable development**?

The following four rules can be defined as the key mantras of sustainability. These four rules are

- Reduce our dependency on heavy metals and fossil fuels such as coal, oil and natural gas.
- Reduce our dependency on synthetic chemicals.
- Reduce our destruction of nature which includes clearing of forest and natural habitats for human needs.
- The fourth principal is to ensure that we don't stop people from meeting their needs in order to achieve environmental sustainability. We must maintain a balance between environmental and economic sustainability.

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**Lecture 19**

# WATER CONSERVATION, RAIN WATER HARVESTING, WATERSHED MANAGEMENT - ENVIRONMENTAL ETHICS: ISSUES AND POSSIBLE SOLUTIONS, CLIMATE CHANGE, GLOBAL WARMING

## Water Conservation

Conserving water has become a prime environ- mental concern. Clean water is becoming increasingly scarce globally. With deforestation surface runoff increases and the sub soil water table drops as water has no time to seep slowly into the ground once vegetation is cleared.As many areas depend on wells, it has become necessary to go on making deeper and deeper wells. This adds to the cost and further depletes underground stores of water. This could take years to recharge even if the present rate of extraction is reduced which seems hardly possible in most situations.

As deforestation and desertification spreads due to extensive changes in land use the once perennial rivers are becoming increasingly seasonal. In many areas the small streams run dry soon after the monsoon as the water table drops further and further below the surface. To this is added serious problems caused by rapid surface flow of water during the rains, which leads to extensive floods with loss of life and property. When we waste water, we do not realize that it is affecting the lives of all of us in so many different ways. Water has to be equitably and fairly distributed so that household use, agriculture and industry all get a share of the water. It's over use and misuse due to various activities that waste water or cause pollution has led to a serious shortage of potable drinking water. Thus water conservation is linked closely with overall human well being.

Traditional systems of collecting water and using it optimally have been used in India for many generations. These have been forgotten in the recent past. Conserving water in multiple small percolation tanks and 'jheels' was important untraditional forms of agriculture. Villages all over the country had one or more common 'talabs' or tanks from which people collected or used water carefully.As women had to carry water to their homes over long distances, this was a time consuming and laborious activity, thus the water could not be wasted. Many homes had a kitchen garden that was watered by the wastewater. Conservation of water was done in traditional homes through a conscious effort.

**CASE STUDY- I**

**Pani Panchayat – Pune District,Maharashtra**

Mahur village in Pune District of Maharashtra is situated in a drought prone area. People were not able to grow a good crop in most years. Clean drinking water was also scarce. Vilasrao Salunkhe initiated a movement known as Pani Panchayat, to conserve wa ter in this drought prone area. Watershed development was initiated on a barren and uncultivated piece of land belonging to a temple. Conservation of soil and water harvesting through a comprehensive micro- watershed management program gradually led to a surplus of water. Out of the 16 hectares of land in the village, 9.6 hectares were brought under irrigation, 2.4 hectares was afforested and 4 hectares was converted into percolation tanks. Wells and field bunds were built. While 200 quintals of grains were produced on 24 acres of Salunkhe's land, 40 acres in the same area yielded only 10 quintals. This made other villagers follow suit. The area rapidly turned green and productive. During the British period many dams were built across the country to supply water especially to growing urban areas. Post independence, India's policy on water changed towards building large dams for expanding agriculture to support the green revolution. While this reduced the need to import food material and removed starvation in the country, the country began to see the effects of serious water shortages and problems related to its distribution. The newer forms of irrigated agriculture such as sugarcane and other water hungry cash crops required enormous quantities of water. Finally however, such irrigated areas become waterlogged and unproductive. As excess water evaporates rapidly from the surface of heavily irrigated croplands, it pulls up subsoil water along with salts to the surface of the soil. This leads to salinization by which the land becomes unproductive. Reducing the high salinity levels in soil is extremely expensive and frequently impossible. With all these ill effects of the poorly conceived management of water at the national and local level there is a need to consider a new water policy for the country.

Saving water in agriculture: Drip irrigation sup- plies water to plants near its roots through a system of tubes, thus saving water. Small percolation tanks and rainwater harvesting can pro- vide water for agriculture and domestic use. Rainwater collected

from rooftops can be stored or used to effectively recharge subsoil aquifers.

Saving water in urban settings: Urban people waste large amounts of water. Leaking taps and pipes are a major source of loss of water. Canals and pipes carrying water from dams to the consumer lead to nearly 50% loss during transfer. Reducing the demand for water by saving it is more appropriate than trying to meet growing demands.

**Rain water Harvesting**

As our world faces serious water shortages, every drop of water we can use efficiently becomes of great value. One method is to manage rain water in such a way that it is used at the source. If as much water as possible is collected and stored this can be used after the rainy season is over. In many parts of the world especially in very dry areas this has been traditionally practiced. However the stored water has to be kept pollution free and clean so that it can be used as drinking water. Stored water can grow algae.

**CASE STUDY - II**

**Mewar, Rajasthan**

The Mewar region of Rajasthan has a rich legacy of traditional water harvesting systems to share the available water for cultivation. There are various types of rainwater harvesting systems.

**Medhbandi:** This is a stone embankment built on a hill slope to help create a level field for cultivation. It controls erosion and conserves moisture. Naada/bandha: These are stone check dams across streams or gullies that are constructed to capture runoff on a stretch of fertile land that is submerged in water during the monsoon. The land not only becomes more fertile after trapping silt, but also retains substantial quantities of water in the soil. These dams are constructed in phases over several years. The height is slowly increased up to the right height of the check dam which determines the size of the naada.

**Hembar:** These are small temporary dams constructed with stones, twigs and mud over a seasonal stream when water flows in it is reduced to a point that it cannot be taken directly to the fields for irrigation.

**Chak:** Chak is a big plot of land, usually a charnot or village pasture land, enclosed by a stone boundary wall called kot. Tree plantations, seeding of grass for fodder, contour bunds with trenches and loose stone check dams are developed in the chak. The chak is used for fodder and fuel wood. It reduces soil erosion and enhances recharge of ground water.

**Talab:** The Mewar region is well-known for its built reservoirs (talabs). Udaipur City is famous for its large number of talabs, and is called the lake city. A small reservoir of less than five bighas is called talai, a medium sized lake is called bandh or talab and a bigger lake is called sagar or samand.

**Saza kuva:** This is an open dug well which has several owners. In Mewari language, saza means partner. This is an important method for irrigation in the Aravalli hills. About 70,000 wells in the Udaipur District provide water for 80 % of the area under irrigation and provide water for their owners. These are considered common property resources.

Another way of using rooftop rainwater harvesting is to collect it so that it percolates into the ground to recharge wells instead of flowing over the ground into rivers. Thus by recharging ground water harvested from rooftops, the water table rises and the surrounding wells retain water throughout the year.

## Watershed Management

Rivers originate in streams that flow down mountains and hill slopes. A group of small streams flow down hillsides to meet larger streams in the valley which forms the tributaries of major rivers. The management of a single unit of land with its water drainage system is called watershed management. It is a technique that has several components. This includes soil and water management and developing vegetative cover. The natural drainage pattern of a watershed unit if managed appropriately can bring about local prosperity by a year round abundance of water that improves the quality of human life in the area.

As it provides water throughout the year, this improves health in the community, as clean water becomes available. Watershed management enhances the growth of agricultural crops and even makes it possible to grow more than one crop in a year in dry areas.

Watershed management begins by taking control over a degraded site through local partici- pation. People must appreciate the need to improve the availability of water both in quantity and quality for their own area. Once this is adequately demonstrated, the community be- gins to understand the project, people begin to work together in the activities that lead to good watershed management.

The first technical step is to take appropriate soil conservation measures. This is done by con structing a series of long trenches and mounds along contours of the hill to hold the rainwater and allow it to percolate into the ground. This ensures that underground stores of water are fully recharged. This is enhanced by allowing grasses and shrubs to grow and by planting trees (mainly local species) which hold the soil and prevents it from being washed away in the monsoon. Local grass cover can however only increase if free grazing of domestic animals is prevented by stall feeding.

The next measure is to make 'nala' plugs in the streams so that the water is held in the stream and does not rush down the hillside. In selected sites, several small check dams are built which together hold back larger amounts of water. All these measures constitute sound watershed management. It improves the water table and keeps the streams and nalas flowing through- out the year.

**Watershed Management Principles**

This is a land management program that looks at a region from the perspective of all its water related issues. It can be used to manage a river from its source to its termination. Watershed management could also consider the management of a single valley as a unit, based on its small streams. Saving water from its local source by allowing it to percolate into the ground by nala plugs and check dams instead of allowing it to run off rapidly along the surface during the monsoon, is a major aspect of good watershed management. This allows underground aquifers to fill so that ground water is recharged. Deforestation is a major cause of poor water supply. Afforesting such degraded areas is an important aspect of watershed management.

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**Lecture 20**

# ACID RAIN, OZONE LAYER DEPLETION, NUCLEAR ACCIDENTS AND HOLOCAUST - WASTELAND RECLAMATION- CONSUMERISM AND WASTE PRODUCTS

## Acid rain

When fossil fuels such as coal, oil and natural gas are burned, chemicals like sulfur dioxide and nitrogen oxides are produced. These chemicals react with water and other chemicals in the air to form sulfuric acid, nitric acid and other harmful pollutants like sulfates and nitrates. These acid pollutants spread upwards into the atmosphere, and are carried by air currents, to finally return to the ground in the form of acid rain, fog or snow. The corrosive nature of acid rain causes many forms of environmental damage. Acid pollutants also occur as dry particles and gases, which when washed from the ground by rain, add to the acids in the rain to form a more corrosive solution. This is called acid deposition. Damage from acid rain is widespread in North America, Europe, Japan, China and Southeast Asia. In the US coal burning power plants con- tribute to about 70% of sulfur dioxide. In Canada oil refining, metal smelting and other

**Effects:** Acid rain is known to cause widespread environmental damage.

1. Acid rain dissolves and washes away nutrients in the soil which are needed by plants. It can also dissolve naturally occurring toxic substances like aluminum and mercury, freeing them to pollute water or poison plants.

2. Acid rain indirectly affects plants by removing nutrients from the soil in which they grow. It affects trees more directly by creating holes in the waxy coating of leaves, causing brown dead spots which affect the plant's photosynthesis. Such trees are also more vulnerable to insect infestations, drought and cold. Spruce and fir forests at higher elevations seem to be most at risk. Farm crops are less affected by acid rain than forests.

3. Acid rain that falls or flows as ground water to reach rivers, lakes and wetlands, causes the water in them to become acidic. This affects plant and animal life in aquatic ecosystems.

4. Acid rain also has far reaching effects on wildlife. By adversely affecting one species, the entire food chain is disrupted, ultimately endangering the entire ecosystem. Different aquatic species can tolerate different levels of acidity. For instance clams and mayflies have a high mortality when water has a pH of 6.0, while frogs can tolerate more acidic water, although with the decline in supply of mayflies, frog populations may also decline. Land animals that are dependent on aquatic organisms are also affected.

5. Acid rain and dry acid deposition damages buildings, automobiles, and other structures made of stone or metal. The acid corrodes the materials causing extensive damage and ruins historic buildings. For instance the Parthenon in Greece and the Taj Mahal in India have been affected by acid rain.

6. Although surface water polluted by acid rain does not directly harm people, the toxic sub- stances leached from soil can pollute water supply. Fish caught in these waters may be harmful for human consumption. Acid, along with other chemicals in the air, produces urban smog, which causes respiratory problems.

**Solutions:** The best way to stop the formation of acid rain is to reduce the emissions of sulfur dioxide and nitrogen oxides into the atmo- sphere. This can be achieved by using less en- ergy from fossil fuels in power plants, vehicles and industry. Switching to cleaner burning fu- els is also a way out. For instance using natural gas which is cleaner than coal, using coal with lower sulfur content, and developing more effi- cient vehicles. If the pollutants have already been formed by burning fossil fuels, they can be pre- vented from entering the atmosphere by using scrubbers in smokestacks in industry. These spray a mixture of water and limestone into thepolluting gases, recapturing the sulfur.

In catalytic converters, the gases are passed over metal coated beads that convert harmful chemi- cals into less harmful ones. These are used in cars to reduce the effects of exhaust fumes on the atmosphere. Once acid rain has affected soil, powdered limestone can be added to the soil by a process known as liming to neutralize the acidity of the soil.

**Ozone layer depletion:**

Ozone is formed by the action of sunlight on oxygen. It forms a layer 20 to 50kms above the surface of the earth. This action takes place naturally in the atmosphere, but is very slow. Ozone is a highly poisonous gas with a strong odour. It is a form of oxygen that has three atoms in each molecule. It is considered a pollutant at ground level and constitutes a health hazard by causing respiratory ailments like asthma and bronchitis. It also causes harm to vegetation and leads to a deterioration of certain materials like plastic and rubber. Ozone in the upper atmosphere however, is vital to all life as it protects the earth from the sun's harmful ultraviolet radiation. The ozone layer in the upper atmosphere absorbs the sun's ultraviolet radiation, preventing it from reaching the earth's surface.

This layer in the atmosphere protects life on earth from the dangerous UV radiation from the sun. In the 1970s, scientists discovered that chemicals called chlorofluorocarbons or CFCs, which were used as refrigerants and aerosol spray propellants, posed a threat to the ozone layer. The CFC molecules are virtually indestructible until they reach the stratosphere, where UV radiation breaks them down to release chlorine atoms. The chlorine atoms react with ozone molecules which break down into oxygen molecules, which do not absorb UV radiations. Since the early 1980s, scientists detected a thinning of the ozone layer in the atmosphere above Antarctica. This phenomenon is now being detected in other places as well including Australia. Although the use of CFCs has been reduced and now banned in most countries, other chemicals and industrial compounds such as bromine, halocarbons and nitrous oxides from fertilizers may also attack the ozone layer.

The destruction of the ozone layer is seen to cause increased cases of skin cancer and catracts. It also causes damage to certain crops and to plankton, thus affecting nature's food chains and food webs. This in turn causes an increase in carbon dioxide due to the decrease in vegetation.

With the signing of the Montreal Protocol in 1987, a treaty for the protection of the ozone layer, the use of CFCs was to be banned by the year 2000. After 2000, the ozone layer is expected to recover slowly over a period of about 50 years.

**Nuclear accidents and holocaust**

Nuclear Accidents and Nuclear Holo- caust:

Nuclear energy was researched and discovered by man as a source of alternate energy which would be clean and cheap compared to fossil fuels. And although this did happen, along with the benefits of nuclear energy came its down- falls. In the short history of nuclear energy there have been accidents that have surpassed any natural calamity or other energy source extrac- tion in their impacts. A single nuclear accident can cause loss of life, long-term illness and destruction of property on a large scale for a long period of time. Radioactivity and radioactive fall- out leads to cancer, genetic disorders and death in the affected area for decades after, thus affecting all forms of life for generations to come CASE STUDY

**Nuclear disasters and leakages**

In 1986, the Nuclear Power Station at Chernobyl in USSR developed a problem that led to a fire and a number of explosions in its Nuclear Reactor. The radioactive dust spread over many kilometers and covered not only Europe but North America as well. Three people died in the explosion and 28 shortly after due to radiation exposure. Some 259 sick were hospitalized. As the area had to be evacuated 1, 35,000 people had to be moved immediately and another 1.5 lac by 1991. As radioactive fallout continued even more people had to be moved. An estimated 6.5 lakh people may have been seriously affected. They may get cancer, thyroid tumours, and cataracts, and suffer from a lowered immune mechanism.

As radioactivity passes from grass to herbi- vores, sheep in Scotland and Reindeer in Lapland were affected and were unfit for human consumption. Vegetable, fruit and milk were contaminated in Europe.A French Nuclear Waste Processing Center in Normandy may have affected the lives of children playing nearby. They may develop leukemia (blood cancer) in later life.

**Nuclear holocaust:**

The use of nuclear energy in war has had dev- astating effects on man and earth. The Hiroshima and Nagasaki incident during World War II, the only use of nuclear power in war in history, is one of the worst disasters in history. In 1945,

the United States dropped atomic bombs in Japan over the towns of Hiroshima and Nagasaki. These two atomic bombs killed thousands of people, left many thousands injured and devastated everything for miles around. The effects of the radiation from these nuclear bombs can still be seen today in the form of cancer and genetic mutations in the affected children and survivors of the incident.

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## Lecture 21

## ENVIRONMENTAL ACTS AND ENVIRONMENTAL STANDARDS

According to the article 48-A of the Constitution of India, it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures.

The United Nations Organization (UNO) was established on October 24, 1945.The first conference convened by UNO for the environmental protection was International conferences which was held at Stockholm in June, 1972. United Nations Conference on Environment and Development (UNCED) was conducted at Rio de Janeiro Brazil during 1992. It is also known as Earth summit.

According to Forest Act, 1927, the forests of India are classified as follows.

1. Reserve forest
2. Protected forest
3. Village forest
4. Sanctuaries

The forest produces are Timber, wood, bark, charcoal, oil resin, catechu, natural varnish, lac, mahua, seeds etc.

**Wild life Protection Act, 1972**

**Objectives of this Act**

- To maintain essential ecological processes and the life supporting systems.
- To preserve the biodiversity
- To ensure protection and conservation of wild life.

**Powers of chief wild life warden and authorized officers**

- Power of cancellation of gun license of any person who has committed offence against this act. (illegal hunting of wild animals).
- The director or forest officer or any police officer not below the rank of a sub Inspector has the power to stop any vehicle in order to conduct search and search any premises.If any people possess any captive animal, wild animal, animal article, meat etc. in his custody which is considered as offence committed against this act. Arrest such a person with warrant and detain him.

According to Wild life Protection Act, India is a signatory of Convention on International Trade in Endangered species of wild fauna and flora (CITES).

National Biodiversity Authority was established by the central Government in 2003 to implement India's Biological Diversity Act (2002) at Chennai.

Various methods are followed to assess and count the fauna of the forest area. Some methods are as given below.

Direct count, water hole count, Aerial count, Cameral trapping/Remote photography, Pugmark, Genotyping of hair and scat, Counting by signs and mark recapture.

For conservation of wildlife the projects arose and as a result, India established several projects.

The conservation projects are

1. To conserve wildlife;
2. To conserve habitats;
3. To work for the welfare of individual wild animals;
4. To protect biodiversity;
5. To sustain agricultural activities;
6. To assist eco-tourism;
7. To protect ecological stability;
8. To benefit from the medicinal value of plants;
9. To promote pollination;
10. To preserve heritage and culture; and
11. To protect livelihood and knowledge of indigenous tribes.

The various projects are launched in the following years

- Project snow leopard 1972
- Project Lion 1972
- Project Tiger 1973
- Project crocodile 1975
- Project Elephant 1992

**Water (prevention and control of pollution) Act, 1974**

Fresh water is a finite resource essential for use in agriculture, industry, propagation of wildlife & fisheries and for human existence. India is a riverine country. It has 14 major rivers, 44 medium rivers and 55 minor rivers besides numerous lakes, ponds and wells which are used as primary source of drinking water even without treatment. The parliament of India in its wisdom enacted the Water (Prevention and Control of

Pollution) Act, 1974 with a view to maintaining and restoring wholesomeness of our water bodies. One of the mandates of CPCB is to collect, collate and disseminate technical and statistical data relating to water pollution. Hence, Water Quality Monitoring (WQM) and Surveillance are of utmost importance.

**Central Pollution Control Board**

The Central Pollution Control Board (CPCB), statutory organisation, was constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974. Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.

It serves as a field formation and also provides technical services to the Ministry of Environment and Forests of the provisions of the Environment (Protection) Act, 1986. Principal Functions of the CPCB, are (i) to promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution, and (ii) to improve the quality of air and to prevent, control or abate air pollution in the country.

Air Quality Monitoring is an important part of the air quality management. The National Air Monitoring Programme (NAMP) has been established with objectives to determine the present air quality status and trends and to control and regulate pollution from industries and other source to meet the air quality standards. It also provides background air quality data needed for industrial sitting and towns planning.

Besides this, CPCB has an automatic monitoring station at ITO Intersection in New Delhi. At this station Resirable Suspended Particulate Matter (RSPM), Carbon Monoxide (CO), Ozone (O3), Sulphur Dioxide (SO2), Nitrogen Dioxide (NO2) and Suspended Particulate Matter (SPM) are being monitored regularly. This information on Air Quality at ITO is updated every week.

Some of the important functions of CPCB are given below.

- Advising Govt on prevention and control of water pollution. Coordinating activities of SPCB.
- Trainings
- Compiling technical and statistical date.
- Preparing standards.
- Lab for analysis

**Tamil Nadu Pollution Control Board**

Tamil Nadu Pollution Control Board is the governing body to monitor and control air, noise, and water pollution in the state of Tamil Nadu. It was established during the year 1982.

The objective of Tamil Nadu Pollution Control Board is to control, prevent and abate pollution of streams, wells, land and atmosphere in the State to protect the environment from any degradation by effective monitoring and implementation of pollution control legislations. Users can find information about the organisation's objectives, enforcement programmes, public hearing, etc.

General Standards For Discharge Of Environmental Pollutants Part – A : Effluents

| **Sl. No.** | **Parameter** | **Standards** | | | |
|---|---|---|---|---|---|
| | | **Inland surface water** | **Public sewers** | **Land of irrigation** | **Marine / coastal areas** |
| 1. | Suspended solids mg/l, max | 100 | 600 | 200 | === |
| 2. | pH value | 5.5 to 9.0 | 5.5 to 9.0 | 5.5 to 9.0 | 5.5 to 9.0 |
| 3. | Temperature | Shall not exceed 5°C above the receiving water | ------ | ------ | Shall not exceed 5°C above the receiving water |
| 4. | Oil and grease, Mg / l max | 10 | 20 | 10 | 20 |
| 5. | Total residual chlorine mg/l max | 1.0 | - | - | 1.0 |
| 6. | Ammoniacal nitrogen (as N), mg/l, max. | 50 | 50 | == | 50 |

| | | | | | |
|---|---|---|---|---|---|
| 7. | Total nitrogen (as N); mg/l, max. | 100 | -- | -- | 100 |
| 8. | Biochemical oxygen demand (3 days at 27oC), mg/l, max. | 30 | 350 | 100 | 100 |
| 9. | Chemical oxygen demand, mg/l, | 250 | -- | -- | 250 |
| 10. | Arsenic (as As) mg/l, max | 0.2 | 0.2 | 0.2 | 0.2 |
| 11. | Mercury (As Hg), mg/l, max. | 0.01 | 0.01 | -- | 0.01 |
| 12. | Lead (as Pb) mg/l, max. | 0.1 | 0.1 | -- | 2.0 |
| 13. | Cadmium (as Cd) mg/l, max. | 2.0 | 1.0 | -- | 2.0 |
| 14. | Hexavalent chromium (as Cr + 6), mg/l, max. | 0.1 | 2.0 | -- | 1.0 |
| 15. | Total chromium (as Cr) mg/l, max. | 2.0 | 2.0 | -- | 2.0 |
| 16. | Copper (as Cu) mg/l, max. | 3.0 | 3.0 | -- | 30 |
| 17. | Nickel (as Ni) mg/l, max. | 3.0 | 3.0 | -- | 50 |
| 18. | Cyanide (as CN) mg/l, max. | 0.2 | 2.0 | 0.2 | 0.2 |
| 19. | Fluoride (as F) mg/l, max | 2.0 | 15.0 | -- | 15.0 |
| 20. | Sulphide (as S) mg/l, max | 2.0 | -- | -- | 5.0 |

These standards shall be applicable for industries, specified in the Schedule of the Environment Protection Rules, 1989.

**Air Act, 1981**

The Following are the objectives of Air Act, 1981

- Prevention, control and abatement of air pollution.
- Maintenance of the quality of the air.
- Establishment of boards for prevention and control of air pollution.

Air Quality Monitoring is an important part of the air quality management. The National Air Monitoring Programme (NAMP) has been established with objectives to determine the present air quality status and trends and to control and regulate pollution from industries and other source to meet the air quality standards. It also provides background air quality data needed for industrial sitting and towns planning.

**Environment Protection Act, 1986**

**Objectives of this Act**

- Protection and Improvement of the environment (Air, water, land)
- Prevention of hazards to all living creatures and property (Humans, plants and animals).
- Maintenance of harmonious relationship between human beings and their environment.

**Hazardous substances**

Hazardous substances are any substance or its preparation which is liable to cause harm by its physio-chemical properties to human beings, other living organisms, property or environment.

Hazardous wastes also have any one or two of the following characters.

Toxic, Radioactive, Highly reactive, Carcinogenic and Highly inflammable. In the household, the mosquito repellent, room refresher, insect killer, Paint and varnish wastes are hazardous wastes.

In order to check the different types of pollution, the following specific acts have been enacted by the government of India.

**Environmental Acts in India**

- Indian Forest Act, 1927
- The Factories Act 1948
- Prevention of Food Adulteration Act 1954
- Wildlife Protection Act of 1972
- Water (Prevention and Control of Pollution) Act 1974
- Forest Conservation Act, 1980

- Air (Prevention and Control of Pollution) Act, 1981
- Environment (Protection) Act, 1986
- Hazardous waste Handling and management act, 1989
- Public Liability Insurance Act, 1991
- National Environmental tribunal Act, 1995
- Biomedical waste Rules, 1998
- Noise Pollution (Regulation) Rules, 2000
- Protection of Plant Varieties and Farmers' Rights Act of 2001
- Biological Diversity Act, 2002
- Wild Life (Protection) Amendment Act, 2002
- The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

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**Lecture 22**

# ISSUES INVOLVED IN ENFORCEMENT OF ENVIRONMENTAL LEGISLATION - PUBLIC AWARENESS - HUMAN POPULATION AND THE ENVIRONMENT: POPULATION GROWTH, VARIATION AMONG NATIONS, POPULATION EXPLOSION, FAMILY WELFARE PROGRAMME

## ISSUES INVOLVED IN ENFORCEMENT OF ENVIRONMENTAL LEGISLATION

In India, more than three-quarters its population depends directly for their livelihoods on activities based on natural resources and the remainder of the population relies on these resources indirectly for food, fuel, industrial output and recreation. Their economic well-being is inextricably tied to the productivity of natural resources and quality of environment. Sadly, most of the natural resources including environment in India are in a serious state of degradation. For example, agricultural lands suffer from soil erosion, water-logging, salinity and general loss of fertility, making them less productive, and water for drinking and irrigation is increasingly getting scarce and polluted. Fishery yields are falling, and air quality is deteriorating. Increasing levels of air, water and land pollution pose a serious threat to human health and longevity. Good management of natural resources and environment is essential to attain and sustain economic growth and development.

A characteristic feature of environment is the preponderance of common pool resources (CPRs), i.e., the resources which are used in common by identifiable groups of people irrespective of whether they are owned by them or not, and open access resources (OARs), i.e. the resources that are accessible to everyone without any restrictions; they are nobody's property. Examples of CPRs include village grazing lands, public lands along highways and railways, ponds, rivers, groundwater basins, community inland fisheries and marine fisheries within the Exclusive Economic Zones (EEZs) of nations. The OARs include air sheds, solar radiation and high sea marine fisheries beyond the EEZs, space, ozone layer, and biodiversity. All CPRs and OARs suffer from what Hardin (1968) called, "the tragedy of the commons".The logic of the 'tragedy' is purely economic and can be stated as: unregulated access to a CPR or OAR creates a decision-making environment in which incremental private benefits to an individual from the increased use of the resource

markedly exceed the incremental private costs associated with the increased use. Under these circumstances, each rational consumer or user of the resource is motivated to consume or use more and more of the resource till the resource is completely destroyed or degraded as a result of collective and uncoordinated use by all the individuals in the community. Thus, individual rationality leads to collective irrationality. The calculus of incremental or marginal private benefits markedly exceeding the incremental private costs follows from the fact that, in the case of a CPR or OAR, whereas an individual can appropriate all the benefits resulting from his increased use of the resource, he bears only a small fraction of the incremental costs associated with his increased use; the incremental costs are shared by all the members of the community (Singh, 1994 a: 12-14). This means that there exists an externality in the use of the CPR in question as evident from the difference between the incremental private cost and the incremental social cost; the former being less than the latter. Thus, the common pool problem is basically one of the existences of externality - a divergence between private cost and social cost of exploitation which eventually leads to either depletion or overcrowding or congestion. The problem is a manifestation of either the absence of exclusive private property rights or the breakdown of the structure of property rights (Randall, 1975: 734).

Hardin's thesis of the 'tragedy of the commons' has since become the dominant paradigm of the exploitation of CPRs and OARs. It has formed the basis of numerous policies seeking to privatize or nationalize natural CPRs in many developed and developing countries of the world. It is now widely agreed that co-users of CPRs and OARs usually fail to cooperate in using the resource optimally under the following three conditions:

1. When the perceived private costs to individuals of co-operating may exceed the perceived private benefits of cooperating;
2. When individuals feel that their own contribution to the collective goal is minuscule and would not be missed if withheld because others will continue contributing, enabling them easily to free ride on the contributions of others; and
3. When individuals have no assurance or certainty that the other members of the group will make their contributions (or cooperate) and that their lone contribution to the effort would be sufficient to produce the desired outcome.

The problem of non-cooperation of users of CPRs and OARs could also be illustrated through the Prisoners' dilemma (PD) game. Besides the pure economic logic, there are several other socio-economic factors such as population pressure, poverty, unemployment, ignorance,

and lack of incentives for using the environment in a socially optimum manner on sustainable basis. So long as the human and animal population was within the carrying capacity of locally available natural resources and local environment, there was no environmental degradation due to human actions. But as the population increased and local economies got integrated with external economies through trade, the process of degradation of natural resources and environment started. Further, the fact that many communities who depend directly on natural resources for their livelihood are very poor, ignorant, and have no alternative employment opportunities means that they are compelled by their circumstances to over-exploit and degrade the natural resources accessible to them. Illicit felling of trees from forests, hunting, encroachment of forest land, and poaching are some of the activities resorted to by the communities, partly driven by their basic needs and partly by greed. This might happen even if it is to the long-term detriment of the communities' own well being.

Another important economic reason for environmental degradation is the fact that protection and conservation of environment has a high opportunity cost, especially in developing countries like India. For instance, in the case of forests, the opportunity cost is the value that could be derived by clear-cutting the timber and using the forest land for agricultural purpose, or as a site for a hydropower project. Likewise, the opportunity cost of conservation of a marine ecosystem is the value that could be derived from depleting the entire fish stock to extinction. In view of this, local resource users do not have any incentive to protect and conserve the environment. Another major reason of environmental degradation in India is the fact that began in the mid 1960s, there have been many technological breakthroughs in the agricultural sector, which ushered in Green Revolution. For example, there has been widespread adoption of high yielding varieties of crops of a few of the major food grains crops such as rice and wheat in conjunction with increased use of water, chemical fertilizers and plant protection chemicals.

This has led to the increasing uniformity within those species and varieties of crops and hence the loss of biodiversity and increased levels of degradation of land due to excessive irrigation and pollution of water bodies due to leaching of harmful chemicals. Besides, development and wide-spread use of water extracting devices such as drilling machines and power-operated pump sets has led to over-exploitation of groundwater basins and development of mechanized trawlers to over-fishing of marine fisheries and pollution of sea water. The measures that could be used for mitigating the problems of environmental degradation could broadly be classified into four categories, namely, institutional changes, direct controls, and economic / market-based instruments and technological measures. When identifying alternatives for mitigating the problems of environmental degradation, we should aim at minimizing it, or at least restricting it to a level consistent with society's objectives, rather than trying to prevent or eliminate it altogether. A simple rule of thumb for choosing a particular measure is that its estimated social benefits must markedly exceed its estimated social costs. Creation of new institutions, modification of existing institutions, changes in existing systems of property rights, enacting new laws, imposing new taxes, and provision of newly introduced subsidies belong in the category of institutional changes.

**Institutional Instruments**

Article 48-A of the Constitution of India provides that the state shall endeavor to protect and improve the environment and to safeguard the forest and wildlife of the country. Article 51-A imposes as one of the fundamental duties on every citizen the duty to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures. The present legislative framework for environment management in India is broadly contained in the umbrella Environment Protection Act 1986, the Water (Prevention and Control of Pollution) Act, 1974, the Water Cess Act 1977 and the Air (Prevention and Control of Pollution) Act, 1981. The laws in respect of management of forests and biodiversity are contained iin the Indian Forest Act 1928, the Forest (Conservation) Act 1980, the Wild Life (Protection) Act 1972 and the Bio-diversity Act 2003. There are several other enactments, which complement the provisions of these basic enactments. Now, India has a large number of environmental acts and regulations. Pollution limits for various industries have been prescribed in the Environmental Protection Rules 1986. Environmental clearance from the Union Ministry of

Environment and Forests is mandatory for setting up new industries in many sectors. A list of major environmental acts and rules now in force in India can be found in the website: http:// www.envfor.nic.in).

As we know, most of the problems of environmental degradation arise because of the open access or common pool nature of the environment. In view of this, where technically feasible and economically viable, transforming the open access and common pool environmental resources into some sort of state or private property through the creation of property rights could resolve the problems of environmental degradation. An example of use of this measure is the privatization of degraded revenue lands (state property) and village common lands (CPRs) in West Bengal through granting of land pattas (leases) to individuals. This helped resolve the problem of their degradation and transformed those lands into productive private property (Singh, 1994 a: 149-163 and Singh and Shishodia, 2007: 221).

**Direct Controls and Regulation**

Conventionally, direct controls, or regulations are given effect through governmental orders or pronouncements by judiciary. In certain cases, laws also are enacted which stipulate that, for instance, you are not allowed to pollute the air above a certain level and if you do, you will be fined, or imprisoned, or both. This form of intervention has high costs of administration and compliance, is often inflexible and provides little incentive for innovation to reduce environmental degradation. For all these reasons, the use of regulatory instruments in isolation from other measures is unlikely to be the least-cost method of achieving environmental objectives in many cases. Control and regulation compares unfavorably with the use of market-based approaches such as taxes and emission charges. Despite its weaknesses, control and regulation is still the predominant instrument for addressing environmental problems in most countries, including India.

**Environmental Standards**

Environmental standards refer both to the acceptable levels of specified environmental quality parameters at different categories of locations (ambient standards), as well as permissible levels of discharges of specified wastes into streams by different classes of

activities (emission standards).The NEP 2006 advocates the following three specific measures to improve the effectiveness of environmental standards:

1. Set up a permanent machinery comprising experts in all relevant disciplines to review notified ambient and emissions standards in the light of new scientific and technological information as they become available, and changing national circumstances, ensuring adequate participation by potentially impacted communities, and industry association;
2. Strengthen the network for monitoring ambient environmental quality, including monitoring through participation by local communities, and public -private partnerships; and
3. Progressively ensure real -time, and on-line availability of the monitoring data.

**Economic Instruments**

This set of instruments affect costs and benefits of alternative actions open to economic agents, and thereby influence the behaviour of decision makers in such a way that alternatives are chosen that lead to an environmentally more desirable situation than in the absence of the instrument. Economic instruments aim to bridge the gap between the private and social costs by internalizing all external costs to their sources, namely, the producers and consumers of resource depleting and polluting commodities. Such instruments are often referred to as market-based instruments, as they work by using market signals such as prices,emission charges / taxes, and subsidies to encourage socially better decisions.

Pollution of water bodies and degradation of land due to excessive use of chemicals in agriculture could be mitigated through the use of organic manures, and organic pesticides and the problem of soil salinity and water-logging created by excessive irrigation could be resolved by the use of micro irrigation technologies such as sprinklers and drips. Similarly the problem of air pollution engendered by the increased use of fossil fuels could be solved through the use of renewable sources of energy such as animal power, solar energy, hydropower, and biogas. But to motivate the farmer to adopt the new eco-friendly technologies, it is necessary for policy makers to ensure that the new eco-friendly

technologies are financially superior to the old environment -depleting ones and that the farmer has access to the requisite credit facilities and technical information and guidance.

Viable and sustainable conservation of the environment requires the participation of multiple stakeholders', particularly local people's participation in planning, implementation, and monitoring of environmental projects. In seeking to realize partnerships among the diverse stakeholders, it is essential on the part of the government agencies involved to eschew the confrontational posturing adopted in many cases in the past. While it is not possible that the interests and perceptions of all stakeholders will converge on each case, nevertheless, it is necessary to realize that progress will be seriously impeded if the motives of other partners are called into question during public discourse. It is also essential that all partnerships are realized through, and are carried out in terms of the principles of good governance, in particular, transparency, accountability, cost effectiveness, and efficiency. The NEP- 2006 identifies a number of specific themes for partnerships, a few of which are stated below:

1. Public -Community Partnership: This is intended to seek the cooperation of public agencies and local communities in the management of a given environmental resource, each partner bringing agreed resources, assuming specified responsibilities, and with defined entitlements. The Joint Forest Management programme is an example of this kind of partnership.
2. Public-Private Partnerships: In this arrangement, specified public functions with respect to environment management are contracted out competitively to private providers, e.g., monitoring of environment quality.
3. Public -Community-Private Partnerships: In this system, the partners assume joint responsibility for a particular environmental function, with defined obligations and entitlements for each, with competitive selection of the private sector partner, e.g., afforestation of degraded forests.
4. Public -Voluntary Organization Partnerships: This is similar to public -private partnerships, in respect of functions in which voluntary organizations may have a comparative advantage over others, the voluntary organizations, in turn, being selected competitively, e.g. environmental awareness raising.

5. Public-Private-Voluntary Organization Partnerships: In this arrangement, the provision of specified public responsibilities is accomplished on competitive basis by the private sector, and the provision is monitored by competitively selected voluntary organizations, e.g. "Build, Own, Operate" sewage and effluent treatment plants.

**PUBLIC AWARENESS**

India experiences tropical monsoon type of climate. It is greatly influenced by the presence of the Himalayas in the north and the Indian Ocean in the south. The Tropic of Cancer divides India into two almost equal climatic zones, namely the northern zone and the southern zone.aThe warm temperate or sub-tropical climate of the northern zone gives it cold winter seasons and hot summer seasons. The southern tropical climatic zone of India is warmer than the north and does not have a clear-cut winter season.India faces environmental challenges on two fronts—poverty as well as economic development. Poverty and population pressures result in overuse of land, water, forests and other resources.

Uncontrolled economic development, urbanisation and industrialisation are equally responsible for deforestation, overuse of groundwater systems, and pollution of natural resources. However, it was only in the 1970s that the Indian government took the matter of environment seriously. In 1972, the Stockholm Conference on Human Environment propounded the concept of "eco development" implying a process of ecologically sound development of positive management of the environment for human benefit.

The same year, a committee called the National Committee on Environmental Planning and Coordination (NCEPC) was set up in India under the initiative of the then prime minister, Indira Gandhi, to coordinate environmental issues. In 1976, the constitution was amended by the 42nd Amendment Act to incorporate environmental concerns in the document, vide Articles 48A and 51A.In 1980, another committee, the high power committee of the Planning Commission, was set up for reviewing existing legislative measures and administrative machinery for ensuring environmental

protection and for recommending ways to strengthen them. Its recommendations led to the establishment of the Department of Environment (DoE) in November 1980 as a nodal agency for environmental protection and eco-development in India. The Seventh Five Year Plan was a turning point in the environment sector when serious attention was given to coastal and river pollution concerns.

The Environment Protection Act was enacted and the Ganga Action Plan was also initiated at a cost of Rs 240 crore during the plan period. A Central Ganga Authority was also constituted under the chairmanship of the prime minister. In 1985, the Department of Environment was upgraded to the Ministry of Environment and Forests at the Centre.

It is now the nodal agency for planning, promoting and coordinating environmental and forest programmes. Its main activities include:

i. Conservation and survey of flora, fauna, forests and wildlife;

ii. Prevention and control of pollution;

iii. Afforestation and regeneration of degraded areas; and

iv. Protection of environment.

These tasks are sought to be fulfilled through environmental impact assessment, ecoregeneration, assistance to organisations implementing environmental and forestry programmes, promoting research, extension training in these fields to augment the requisite manpower, dissemination of information on environmental matters, creation of environmental awareness among all sectors of the population, and cooperation at an international level. Subsequent years saw the evolution of Ganga Action Plan into the National River Conservation Programme (NRCP) and National Lake Conservation Programme (NLCP), and the creation of a number of environmental authorities. The major policy instruments with the government, set up for dealing with environmental matters, include the National Forest Policy, 1988; the National Conservation Strategy and Policy Statement on Environment and Development, 1992; and the Policy Statement for Abatement of Pollution, 1992. In 1994, the Environment

Clearance Notification came into effect. It was revised later in 2006 providing for comprehensive Environment Impact Assessment (EIA) process and clearance process for 39 development activities in eight categories. In the Tenth Plan period, the environmental processes and laws were extensively reviewed. The first National Environment Policy was put into place in May 2006. The reengineering of the environmental clearance process and EIA Notification were also undertaken to improve the quality of environmental governance.

The Eleventh Plan will integrate environment considerations into policymaking in all sectors of the economy infrastructure, transport, water supply, sanitation, industry, agriculture, and anti-poverty programmes. It also calls for strengthening the oversight and regulatory frameworks for environment management so that development decisions do not impinge adversely on sustainability.

**Environmental Legislation in India**

The earliest laws regarding control of air pollution were the Bengal Smoke Nuisance Act of 1905 and the Bombay Smoke Nuisance Act of 1912. In 1912, Wild Birds and Animal Protection Act were enacted. The River Boards Act of 1956 provided for regulation and development of interstate rivers.

In 1972, the UN conference on human environment was held. A national committee on environmental planning and coordination (NCEPC) was established to look into environmental matters. The Water (Prevention and Control of Pollution) Act 1974 was enacted to deal with water pollution.

The Water (Prevention and Control of Pollution) Cess Act, 1977 was enacted to provide for the levy and collection of cess on water consumed by specified industries and local authorities to augment the resources of the Central and State Pollution Control Boards. The existing rates of water cess were revised in 1991 as the responsibility and workload of Pollution Control Boards increased considerably and funds available with these Boards had not kept pace either with increase in costs or with the overall commitment involving heavy financial liabilities.

The Air (Prevention and Control of Pollution) Act in 1981 and the Environment (Protection) Act, 1986 empowered the government to take necessary steps towards protection of the environment. Environment (Protection) Act According to the Environment Act, environment includes water, air and land and the inter-relationships which exist among and between water, air, land and human beings and other living creatures, plants, micro-organisms and property. And pollution is the presence in the environment of any solid, liquid or gaseous substance in such concentration so as to be injurious to environment.

The Central government has the authority for the purpose of exercising powers and performing the functions provided under the Act. The officers are appointed by the Central government. There is no separate official body at state level. The functions of the authorities are: (1) plan and execute nationwide programmes, carry out and sponsor investigations and research, collection and dissemination of information, preparation of manuals, codes or guides regarding prevention, control and abatement of environmental pollution; (2) lay down standards for quality of environment; (3) lay down standards for emission or discharge of environmental pollutants; (4) lay down procedures and safeguards for prevention of accidents which may cause environmental pollution, and remedial measures for such accidents; (5) lay down procedures and safeguards for handling of hazardous substances; (6) demarcate areas in which industries can be set up; (7) examine manufacturing processes, materials and substances that are likely to cause environmental pollution. The authorities have the power to (i) give directions which include the power to direct, prohibitor regulate any industry; and stop or regulate supply of electricity or water or any other service; (ii) enter and inspect any place to perform the functions under the Act. In case of emergencies due to accidents or unforeseen events causing environmental pollution, the Board has the powers to take appropriate remedial action. Penalties under the Act could be (i) imprisonment which may extend to five months or fine up to Rs 1 lakh or both; (ii) Rs 5,000 per day in case of continuing offences.

The Wildlife (Protection) Act, 1972, provides for rational and modern wildlife management while the Forest (Conservation) Act, 1980, has been enacted to check indiscriminate deforestation/diversion of forest land for non-forest purposes. The Public

Liability Insurance Act, 1991, provides for mandatory insurance for the purpose of providing immediate relief to the persons affected by accidents occurring while handling any hazardous substances.

The National Environmental Tribunal Act, 1995, seeks to constitute a Tribunal with Benches to award compensation for damage to persons, property and the environment arising out of any activity involving hazardous substances. This legislation is the first of its kind in the world for providing relief, compensation and restitution to victims of accidents while handling hazardous substances and for environment damages. The Tribunal will have its Benches in each state and Union territory or for a group of states/union territories in a phased manner. The qualifications for the chairperson are that he or she is either a sitting judge of the Supreme Court, or a High Court, or has been working in that capacity.

A person who has held the office of vice chairperson for at least two years will also be eligible for appointment as the chairperson. The qualifications for a vice-chairperson are that the person is or has been a judge of a High Court or been a secretary to the Government of India for at least two years or an additional secretary for five years. The Tribunal shall not be bound by the procedure laid down in the Code of Civil Procedure but shall be guided by the principles of natural justice. It shall have power to regulate its own procedure; and also enjoy powers vested in a civil court while trying a suit.

Access to the Tribunals will be available to the aggrieved persons/entities and representative bodies in the field of environment by making an application. The Tribunal will entertain claims for compensation for damage if it is presented within 5 years from the occurrence of the damage. No other civil court shall have jurisdiction to entertain any claim or action which can be entertained, tried or dealt with by the Tribunal. Appeals from the Tribunal will lie with the Supreme Court. Noncompliance of Tribunal's directions or orders will be punishable with imprisonment upto 3 years or with fine which may extend upto Rs 10 lakh or both. The orders will however be passed after the accused is given an opportunity to show cause.

The appointment of the chairperson or a vice-chairperson has to be make after consultation with the Chief Justice of India. The tenure of office of the chairperson or vice-chairperson shall be for five years. They would be eligible for reappointment for another term of five years. The chairperson shall not hold office after attaining the age of 70 years and vice-chairperson, after attaining the age of 65 years. On ceasing to hold office the chairperson will not be eligible for further employment under the Government of India or the state government. Similar provision applies to the vice-chairperson with the exception that he may be appointed as the chairperson.

National Environment Appellate Authority The National Environment Appellate Authority, an autonomous body, was established on January 17, 1998 with former Supreme Court judge, Mr. N.G. Venkatachaliah as its first chairperson. Headquartered at Delhi, the NEAA would consist of a chairman, vice-chairman and upto three other members, each of whom will serve for a three-year term, renewable only once. The chairman must have been either a Supreme Court judge or a High Court chief justice; the vice-chairman must have been a union government secretary, or its equivalent, for at least two years. Members must have a knowledge of, or 'practical experience' in, conservation, environment management or law, or development.

The NEAA may hold sittings anywhere, enjoy the power of a civil court and will not have its decisions questioned in any other court. Nor will any other court have any jurisdiction on matters where the NEAA is empowered. Those who may petition it could be any person or association likely to be affected by a grant of environment clearance, governments or any local authority concerned. Appeals must be disposed within three months of filing. Environment cases from a high court and the Supreme Court cannot be transferred to the authority, but fresh appeals can be made.

**Population growth, variation among nations**

**Population**

Group of individuals of species occupying a definite geographic area at a given time Global Population Growth The population will continue to grow till equilibrium is achieved.i.e. Number of births = Number of deaths. The world population is growing by

more than 90 million per year, of which 93% is in developing countries. This will essentially prevent their further economic 'development'. In the past, population growth was a gradual phenomenon and the Earth's ability to replenish resources was capable of adjusting to this increase. In the recent past, the escalation in growth of human numbers has become a major cause of our environmental problems.

**Reasons for growth**

1. Spread of public health programmes in developing countries
2. Rise in food production after World War II
3. Every second 4-5 children are born and 2 people die

| Year | Population (in billions) |
|---|---|
| 1700 | 0.6 |
| 1850 | 1 |
| 1930 | 2 |
| 1960 | 3 |
| 1987 | 5 |
| 2000 | 6.1 |
| 2050 | 9.1 |

4. Nearly 2.5 persons gets added every second

Present projections show that if our population growth is controlled, it will still grow to 7.27 billion by 2015. However, if no action is taken it will become a staggering 7.92 billion. Maximum Carrying Capacity ( The maximum population size that can be supported by environment)

First 10 largest countries (Projected for 2050)

| Sr. No. | Country | Population (In Millions) |
|---|---|---|
| 1 | India | 1628 |
| 2 | China | 1369 |
| 3 | United States | 404 |
| 4 | Indonesia | 312 |
| 5 | Nigeria | 304 |
| 6 | Pakistan | 285 |
| 7 | Brazil | 244 |
| 8 | Bangladesh | 211 |
| 9 | Ethiopia | 188 |
| 10 | Congo | 182 |

It is not the census figures alone that need to be stressed, but an appreciation of the impact on natural resources of the rapid escalation in the rate of increase of human population in the recent past. The extent of this depletion is further increased by affluent societies that consume per capita more energy and resources, that less fortunate people. This is of great relevance for developing a new ethic for a more equitable distribution of resources.

## Population Growth Rate

- Human population growth rate is measured as annual average growth rate.

$$\text{Avg annual growth rate (\%)} = \frac{(P_2 - P_1)}{(P_1 * N)} * 100$$

Where,

$P_1$ = Population size in previous Census

$P_2$ = Population size in present Census

N = No of years between two Census

This examines the interface between the growth in human population and the environment. Given the pace at which population is increasing, an intense pressure is already mounting on the world's finite natural resources. Unless awareness is massively generated in about this pressure and the need for environmental conservation, this population pressure will only reinforce environmental degradation and can also lead to terrible conflict over the control of natural resources. The global human population at present is around 6 billion. It will cross the 7 billion mark by 2015. The world population is growing by more than 90 million per year. Present projections show that if our population growth is controlled, it will still grow to 7.27 billion by 2015. However, if no action is taken it will become a staggering 7.92 billion. It is not the demographic figures alone that need to be stressed, but an appreciation of the impact of this demographic growth on natural resources. The needs of this huge number of human beings cannot be supported by the Earth's natural resources, without degrading the quality of human life. Let us see the implications of this population growth on the availability and the condition of natural resources.

In the near future, fossil fuel from oil fields will run dry. Existing agro systems will become too overburdened and will not be able to meet the demands for food. Pastures will be overgrazed by domestic animals. The industrial growth required to meet the demands of the massively rising population will reinforce pollution of soil, water and air. Industrial gases in particular will cause greater global warming and will eventually lead to a rise in sea levels, flooding all low-lying areas and submerging coastal agriculture as well as towns and cities. The seas will experience a decline in the fish population. Larger ozone holes will develop due to the discharge of industrial chemicals into the atmosphere; this development in its turn will affect human health. The population pressure will contribute to water the depletion of fresh water and may lead to water 'famines'. The demographic pressure will also reinforce the degradation of ecosystems leading to extinction of thousands of species which have a great role in the sustainability of the planet. Dr. Sudeshna Banerjee. The environmental consequences of global population growth will also have political ramifications. The pressure on natural resources will escalate conflict between and amongst countries and will eventually make them go to war. The control over regional biological diversity, which is vital for producing new medicinal and industrial products, will lead to grave economic conflicts between biotechnologically advanced nations and the

bio-rich countries. The gravity of the situation has been heightened because the dominant development strategies of the world today have failed to address the problematic interface between population growth and the environment. These strategies focus on the economic performance of the developing countries. But the 15 per cent of the world population, who earn 79 per cent of all the incomes in the world, are based in the developed countries. This 15 percent along with the rich people in poorer countries consume per capita more energy and resources than they need.

In view of the failure of the existing development paradigms a new ethic based on the ideal of a more equitable distribution of resources needs to be formulated. We also need to create a mass environmental awareness movement, so that the ordinary people themselves can evolve informed strategies to avert environmental degradation and bring about a change in people's way of life.

In the first half of the 1900s human numbers were growing rapidly in most developing countries, including India and China. In most African countries, too, the growth rate was very high. In contrast, in the developed world population growth had slowed down. In the developing world, poverty alleviation programs have failed to solve economic problems as more and more people had to be supported on Earth's limited resources. In rural areas population growth led has to increased fragmentation of farm land and unemployment. In the urban areas it has led to inadequate housing, an increasing level of air pollution created by the burgeoning motorized traffic and water pollution deriving from sewage and unmanageable solid waste. By the 1970s most countries in the developing world had realized that if they had to develop their economies and improve the quality of life of their citizens they would have to curtail population growth. Though population growth shows a general global decline, there are variations in the rate of decline among countries. By the 1990s the growth rate was decreasing in countries such as China and India. In the 1990s it was India that registered the greatest decline. However, the birth-rate continues to remain high in the countries of sub-Saharan Africa. The differences in the rate of population control among the different countries can be variously explained in terms of cultural, economic, political differences. However, in many cases, the lack of government initiative in family planning contributes to the failure to control the birth-rate.

**POPULATION EXPLOSION – FAMILY WELFARE PROGRAM**

Population Explosion

An enormous growth of human beings is called as population explosion Causes

1. Fertility

2. Reduced Infant Mortality Rate

3. Increased food production

4. Longevity

Impacts

Pollution – increase in cars and emission of greenhouse gases into atmosphere

Deforestation –to build houses for increasing population

Freshwater availability– increase in waste production and contamination of water

Natural Resources – increase burning of fossil fuels, excessive use of coal

Global warming – overall increase in temperature and chances of natural disasters

Habitat loss – change in ecosystems affecting tropic level

**Reasons**

- Higher fertility rate due to failure of family planning
- Predominating religious or superstitious nature
- Importance of male child
- Social insecurity
- Poverty and backwardness

Response to our phenomenal population growth, India seriously took up an effective Family Planning Program which was renamed the Family Welfare Program. Slogans such

as 'Hum do hamare do' indicated that each family should not have more than two children. It how- ever has taken several decades to become effective. At the global level by the year 2000, 600 mil- lion, or 57% of women in the reproductive age group, were using some method of contraception. However the use of contraceptive measures is higher in developed countries – 68%, and lower in developing countries - 55%. Female sterilization is the most popular method of contraception used in developing countries at present. This is followed by the use of oral contraceptive pills and, intrauterine devices for women, and the use of condoms for men. India and China have been using permanent sterilization more effectively than many other countries in the developing world. The best decision for the method used by a couple depends on a choice that they make for themselves. This must be based on good advice from doctors or trained social workers who can suggest the full range of methods available for them to choose from.Informing the public about the various contraceptive measures that are available is of primary importance. This must be done actively by Government Agencies such as Health and Family Welfare, as well as Education and Extension workers. It is of great importance for policy makers and elected representatives of the people – Ministers, MPs, MLAs at Central and State levels – to understand the great and urgent need to support Family Welfare. The media must keep people informed about the need to limit family size and the ill effects of a growing population on the world's resources.

The decision to limit family size depends on a couple's background and education. This is related to Government Policy, the effectiveness of Family Welfare Programs, the educational level, and information levels in mass communication. Free access to Family Welfare information provided through the Health Care System, is in some cases unfortunately counteracted by cultural attitudes. Frequently misinformation and inadequate information are reasons why a family does not go in for limiting its size.

The greatest challenge the world now faces is how to supply its exploding human population with the resources it needs. It is evident that without controlling human numbers, the Earth's resources will be rapidly exhausted. In addition economically advanced countries and rich people in poorer countries use up more re- sources than they need. As population expands further, water shortages will become acute. Soil will become unproductive.

Rivers, lakes and coastal waters will be increasingly polluted. Water related diseases already kill 12 million people every year in the developing world. By 2025, there will be 48 countries that are starved for water. Air will become increasingly polluted. Air pollution already kills 3 million people every year. The first 'green revolution' in the '60s produced a large amount of food but has led to several environmental problems. Now, a new green revolution is needed, to provide enough food for our growing population, that will not damage land, kill rivers by building large dams, or spread at the cost of critically important forests, grasslands and wetlands. The world's most populous regions are in coastal areas. These are critical ecosystems and are being rapidly destroyed. Global climate change is now a threat that can affect the very survival of high population density coastal communities. In the sea, fish populations are suffering from excessive fishing. Once considered an inexhaustible resource, over fishing has depleted stocks extremely rapidly. It will be impossible to support further growth in coastal populations on existing fish reserves.

Human populations will inevitably expand from farm lands into the remaining adjacent forests. Many such encroachments in India have been regularised over the last few decades. But forest loss has long-term negative effects on water and air quality and the loss of biodiversity is still not generally seen as a major deterrent to human well-being. The extinction of plant and animal species resulting from shrinking habitats threatens to destroy the Earth's living web of life.

Energy use is growing, both due to an increasing population, and a more energy hungry lifestyle that increasingly uses consumer goods that require large amounts of energy for their production, packaging, and transport. Our growing population also adds to the enormous amount of waste. With all these linkages between population growth and the environment, Family Welfare Programs have become critical to human existence.

**Planning for the future**

How Governments and people from every community meet challenges such as limiting population size, protecting the natural environment, change their consumer oriented attitudes, reduce habits that create excessive waste, elevates poverty and creates an effective balance between conservation and development will determine the world's future.

**The Urban Challenge**

Population increases will continue in urban centers in the near future. The UN has shown that by 2025 there will be 21 "megacities" most of which will be situated in developing countries. Urban centers are already unable to provide adequate housing, services such as water and drainage systems, growing energy needs, or better opportunities for income generation.

**Methods of Sterilization**

India's Family Welfare Program has been fairly successful but much still needs to be achieved to stabilize our population. The most effective measure is the one most suited to the couple once they have been offered all the various options that are available. The Family Welfare Program advocates a variety of measures to control population.

**Urbanization**

In 1975 only 27% of the people in the developing world lived in urban areas. By 2000 this had grown to 40% and by 2030 well informed estimates state that this will grow to 56%. The developed world is already highly urbanized with 75% of its population living in the urban sector. Nearly half the world's population now lives in urban areas. The high population density in these areas leads to serious environmental issues. Today, more than 290 million people live in towns and cities in India. There were 23 metros in India in 1991, which grew to 40 by 2001. Urban population growth is both due to migration of people to towns and cities from the rural sector in search of better job options as well as population growth within the city.As a town grows into a city it not only spreads outwards into the surrounding agricultural land or natural areas such as forests, grasslands and wetlands but also grows skywards with high rise buildings. The town also loses its open spaces and green cover unless these are consciously preserved. This destroys the quality of life in the urban area. Good urban planning is essential for rational land use planning, for upgrading slum areas, improving water supply and drainage systems, providing adequate sanitation, developing effective waste water treatment plants and an efficient public transport system. Unplanned and haphazard growth of urban complexes has serious environmental impacts. Increasing solid waste, improper garbage disposal and air and

water pollution are frequent side effects of urban expansions. While all these issues appear to be under the preview of local Municipal Corporations, better living conditions can only become a reality if every citizen plays an active role in managing the environment. This includes a variety of "Dos and Don'ts" that should become an integral part of our personal lives.

Apart from undertaking actions that support the environment every urban individual has the ability to influence a city's management. He or she must see that the city's natural green spaces, parks and gardens are maintained, river and water fronts are managed appropriately, road- side tree cover is maintained, hill slopes are afforested and used as open spaces and architectural and heritage sites are protected. Failure to do this leads to increasing urban problems which eventually destroys a city's ability to maintain a healthy and happy lifestyle for its dwellers. All these aspects are closely linked to the population growth in the urban sector. In many cities growth outstrips the planner's ability to respond to this in time for a variety of reasons.

| **Mega cities in India** | **Population (in millions) in 2001** | **Projection (in millions) for 2015** |
|---|---|---|
| Mumbai | 16.5 | 22.6 |
| Kolkata | 13.3 | 16.7 |
| Delhi | 13.0 | 20.9 |

Small urban centers too will grow rapidly during the next decades and several rural areas will require reclassification as urban centers. India's urban areas will grow by a projected 297 mil- lion residents. In India people move to cities from rural areas in the hope of getting a better income. This is the 'Pull' factor. Poor opportunities in the rural sector thus stimulates migration to cities. Loss of agricultural land to urbanisation and industry, the inability of governments to sustainably develop the rural sector, and a lack of supporting infrastructure in rural areas, all push people from the agricultural and natural wilderness ecosystems into the urban sector. As our development strategies have focused attention mostly on rapid industrial development and relatively few development options are offered for the agricultural rural sector, a shift of population is inevitable.

Megacities – Over 10 million inhabitants.

1950 – there was only 1 – New York.

1975 – there were 5.

2001 – there were 15 (with Mumbai, Kolkata, and Delhi, being added to the list from India).

2015 – there will be 21 megacities.

Cities over 1 million in size:

In 2000 there were 388 cities with more than 1 million inhabitants.

By 2015 these will increase to 554, of which 75% are in developing countries. As population in urban centers grows, they draw on resources from more and more distant areas. The "Ecological footprint" corresponds to the land area necessary to supply natural resources and disposal of waste of a community. At present the average ecological footprint of an individual at the global level is said to be 2.3 hectares of land per capita. But it is estimated that the world has only 1.7 hectares of land per individual to manage these needs sustainably. This is thus an unsustainable use of land.

The pull factor of the urban centers is not only due to better job opportunities, but also better education, health care and relatively higher living standards. During the last few decades in India, improvements in the supply of clean water, sanitation, waste management, education and health care has all been urban centric, even though the stated policy has been to support rural development. Thus in reality, development has lagged behind in the rural sector that is rapidly expanding in numbers. For people living in wilderness areas in our forests and mountain regions, development has been most neglected. It is not appropriate to use the development methods used for other rural communities for tribal people who are dependent on collecting natural resources from the forests. A different pattern of development that is based on the sustainable extraction of resources from their own surroundings would satisfy their development aspirations.

In general the growing human population in the rural sector will only opt to live where they are if they are given an equally satisfying lifestyle.

**The wilderness – rural-urban linkage**

The environmental stresses caused by urban individuals covers an 'ecological footprint' that goes far beyond what one expects. The urban sector affects the land at the fringes of the urban area and the areas from which the urban center pulls in agricultural and natural resources. Urban centers occupy 2% of the worlds' land but use 75% of the industrial wood. About 60% of the world's water is used by urban areas of which half irrigates food crops for urban dwellers, and one third goes to industry and the rest is used for household use and drinking water. The impact that urban dwellers have on the environment is not obvious to them as it happens at distant places which supports the urban ecosystem with resources from agricultural and even more remote wilderness ecosystems.

**Urban poverty and the Environment**

The number of poor people living in urban areas is rapidly increasing. A third of the poor people in the world live in urban centers. These people live in hutments in urban slums and suffer from water shortages and unsanitary conditions. In most cases while a slum invariably has unhygenic surroundings, the dwellings them- selves are kept relatively clean. It is the 'common' areas used by the community that lacks the infrastructure to maintain a hygienic environment.During the 1990s countries that have experienced an economic crisis have found that poor urban dwellers have lost their jobs due to decreasing demands for goods, while food prices have risen. Well paid and consistent jobs are not as easily available in the urban centers at present as in the past few decades. One billion urban people in the world live in inadequate housing, mostly in slum areas, the majority of which are temporary structures. However, low income groups that live in high rise buildings can also have high densities and live in poor unhygienic conditions in certain areas of cities. Illegal slums often develop on Government land, along railway tracks, on hill slopes, riverbanks, marshes, etc. that are unsuitable for formal urban development.

On the riverbanks floods can render these poor people homeless. Adequate legal housing for the urban poor remains a serious environmental concern.

Urban poverty is even more serious than rural poverty, as unlike the rural sector, the urban poor have no direct access to natural resources such as relatively clean river water, fuelwood and non-wood forest products. The urban poor can only depend on cash to buy the goods they need, while in the rural sector they can grow a substantial part of their own food. Living conditions for the urban poor are frequently worse than for rural poor. Both outdoor and indoor air pollution due to high levels of particulate matter and sulphur dioxide from industrial and vehicle emissions lead to high death rates from respiratory diseases.

Most efforts are targeted at outdoor air pollution. Indoor air pollution due to the use of fuel wood, waste material, coal, etc. in 'chulas' is a major health issue. This can be reduced by using better designed 'smoke- less' chulas, hoods and chimneys to remove in-door smoke. With the growing urban population, a new cri- sis of unimaginable proportions will develop in the next few years. Crime rates, terrorism, un- employment, and serious environmental health related issues can be expected to escalate. This can only be altered by stabilizing population growth on a war footing.

**Problem of human rights**

Alarmed by the horrors of the holocausts, the United Nations had adopted 'Universal Declaration on Human Rights' in 1948, motivated by the desire to recognize that the same rights belong to all people and every individual. And since then, the UN has been actively monitoring human rights violations in various parts of the world.But many countries have protested against the UN declaration saying that it is discriminatory in nature as it is used to condemn underdeveloped countries. Many of the developing countries have even accused the West of practicing double-standards. For instance, the US is quite willing to forget China's human rights violations (e.g., political dissidents are detained, and freedom of speech and expression are kept under considerable restraint in China) in return for a lucrative market. The US has even given China the status of 'Most Favoured Nation'. The Malaysian former Prime minister, Dr. Mahathir Mohammad, has even launched a campaign for a review of the 'Universal Declaration on Human Rights'. He is of the opinion

that the Declaration should take into account the Asian cultures in which the interests of the nation and society take precedence over those of the individuals.

## POPULATION GROWTH AND VARIATIONS AMONG NATIONS

There are 5 main concepts that our students struggle with when learning about population growth and the relationship of population to geological resource use:

- ✓ overpopulation is a leading environmental problem,
- ✓ exponential population growth and development leads to faster depletion of resources,
- ✓ population grows exponentially,
- ✓ why population prediction is difficult,
- ✓ population is not evenly distributed throughout the world.

### A leading environmental problem: Overpopulation

Students do not understand that overpopulation is the cause of many other environmental problems. To help students understand this, one of my colleagues asks her students to list three important local and global environmental issues as part of a survey on the first day of class. During this lecture, we will present overpopulation as the top environmental problem:

Pollution (unspecified):14.7%, Global warming:14.5%, Air pollution:13.5%, Habitat destruction:13.1%, Resource depletion/degradation:11.8%, Population growth/Overpopulation:7.9%, Natural disasters:6.2%, Water pollution:6.6%, fossil fuels (oil spills/ANWR):6.0%, Waste management:3.5%, Miscellaneous (famine, poverty, ignorance, etc):2.3%

How many of these problems are the direct or indirect result of overpopulation? Would we have such a problem with the top three – pollution, global warming and habitat- if world population was not so large? Other than some of the natural disasters, most of these other environmental problems are due to overpopulation.

More people = More babies

Students may have a hard time understanding that population growth is controlled not only by birth and death rates but also by the present population. The mathematics of

exponential growth govern the prediction of population growth. In some cases, you may want to point out that students may have heard of exponential growth in other contexts, such as compound interest or the spread of viral disease. The rate of population growth at any given time can be written: where N0 is the starting population; N is the population after a certain time, t , has elapsed, r is the rate of natural increase expressed as a percentage (birth rate - death rate) and e is the constant 2.71828... (the base of natural logarithms).

A plot of this equation looks something like the plot on the right. Population grows exponentially - if the rate of natural increase (r) doesn't change. The variable r is controlled by human behavior as described below. Essential to understanding the mathematics of population growth is the concept of doubling time. Doubling time is the time it takes for population to double and it is related to the rate of growth. When the population doubles, N = 2N0. Thus the equation becomes

ln 2/r = tor 0.69/r = t; where r is the rate and t is the doubling time. In many ways, it is similar to half-life. But instead of the time it takes for half the isotopes to decay, it is the time it takes for a known quantity to double."Birth control" was advanced as alternative to the then-fashionable terms "family limitation" and "voluntary motherhood." Family limitation referred to deliberate attempts by couples to end childbearing after the desired number of children had been born. Voluntary motherhood had been coined by feminists in the 1870s as a political critique of "involuntary motherhood" and expressing a desire for women's emancipation. Advocates for voluntary motherhood disapproved of contraception, arguing that women should only engage in sex for the purpose of procreation and advocated for periodic or permanent abstinence. In contrast the birth control movement advocated for contraception so as to permit sexual intercourse as desired without the risk of pregnancy. By emphasising "control" the birth control movement argued that women should have control over their reproduction and the movement had close ties to the feminist movement. Slogans such as "control over our own bodies" criticised male domination and demanded women's liberation, a connotation that is absent from family planning, population control and eugenics. Though in the 1980s birth control and population control organisations co-operated in demanding rights to contraception and abortion, with an increasing emphasis on "choice."The societal acceptance of birth control required the separation of sex from

procreation, making birth control a highly controversial subject in the 20th Century. Birth control has become a major theme in feminist politics that cited reproduction issues as examples of women's powerlessness to exercise their rights. In the 1960s and 1970s the birth control movement advocated for the legalisation of abortion and large scale education campaigns about contraception by governments. In a broader context birth control has become an arena for conflict between liberal and conservative values, raising questions about family, personal freedom, state intervention, religion in politics, sexual morality and social welfare. The effectiveness of a birth control method is generally expressed by how many women become pregnant using the method in the first year of use. Thus, if 100 women use a method that has a 0 percent first-year failure rate, then 0 of the women should become pregnant during the first year of use. This equals 0 pregnancies per 100 woman-years, an alternative unit. Sometimes the effectiveness is expressed in lifetime failure rate, more commonly among methods with high effectiveness, such as vasectomy after the appropriate negative semen analysis. The most effective methods in typical use are those that do not depend upon regular user action. Surgical sterilization, Depo-Provera, implants, and intrauterine devices (IUDs) all have first-year failure rates of less than one percent for perfect use. In reality, however, perfect use may not be the case, but still, sterilization, implants, and IUDs also have typical failure rates under one percent. The typical failure rate of Depo-Provera is disagreed upon, with figures ranging from less than one percent up to three percent. Other methods may be highly effective if used consistently and correctly, but can have typical use first-year failure rates that are considerably higher due to incorrect or ineffective usage by the user. Hormonal contraceptive pills, patches or rings, fertility awareness methods, and the lactational amenorrhea method (LAM), if used strictly, have first-year (or for LAM, first-6-month) failure rates of less than 1%. In one survey, typical use first-year failure rates of hormonal contraceptive pills (and by extrapolation, patches or rings) were as high as five percent per year. Fertility awareness methods as a whole have typical use first-year failure rates as high as 25 percent per year; however, as stated above, perfect use of these methods reduces the first-year failure rate to less than 1%. Intrauterine devices (IUDs) were once associated with health risks, but most recent models of the IUD, including the ParaGard and Mirena, are both extremely safe and effective, and require very little maintenance. Condoms and cervical barriers such as the diaphragm have similar typical use first-year failure rates (14 and 20 percent, respectively), but perfect

usage of the condom is more effective (three percent first-year failure vs six percent) and condoms have the additional feature of helping to prevent the spread of sexually transmitted diseases such as the HIV virus. The withdrawal method, if used consistently and correctly, has a first-year failure rate of four percent. Due to the difficulty of consistently using withdrawal correctly, it has a typical use first-year failure rate of 19 percent, and is not recommended by some medical professionals. Combining two birth control methods, can increase their effectiveness to 95% or more for less effective methods. Using condoms with another birth control method is also one of the recommended methods of reducing risk of getting sexually transmitted infections, including HIV. This approach is one of the dual protection strategies

**Stage 1. An early period of hunters and gatherers**

This period ranges between the first evolutions of humans on this planet to the beginning of agriculture. During this period, it is estimated that the total population was probably less than a million, population density was about 1person per 130-260 sq km in the most habitable areas, and the average rate of growth was perhaps less than 0.00011% per year.

**Stage 2. Early, per-industrial agriculture**

This period began sometime between 9,000 BC and 6,000 BC and lasted approximately until the 16th century AD. The first major increase in population came during this period. The total human population of the world was approximately 100 million by 1AD that further increased to about 500 million by 1600 AD. The population density increased greatly to about 1 or 2 people per sq km or even more. The average rate of growth was probably about 0.03%.

**Stage 3. The age of industrial revolution**

The second and much more rapid increase in population started about 400 years ago with the industrial revolution associated with the advances in medicines and health care. Experts are of the opinion that Renaissance in Europe, (beginning about 1600 AD) marks the transition from agricultural to liberate societies, when medical care and sanitation were factors responsible in reducing the death rate. The total human population of about 900

million in 1800 AD almost doubled in the next century and again doubled to approximately 3 billion by 1960. The average rate of growth by 1600 AD was about 0.1% per year, which increased about one-tenth of a percent every 50 years until 1950. The main reasons of this rapid increase in population were discovery of the causes of diseases, invention of vaccines, improvement in sanitation, and advances in agriculture that led to a great increase in the production of food, shelter and clothing.

**Stage 4. The modern era**

Though the rate of population growth has slowed down in developed countries, but population still continues to increase rapidly in many parts of the world, particularly developing countries. At mid 2002, the world population stood at 6.215 billion. The average rate of growth reached 2% in the middle of the 20th century and has declined to 1.3% in 2002 AD. According to projections, the global population will be Approximately 8 billion by 2025 and 10 billion by 2050 AD.

According to World Bank projections, the world population may stabilize between 10.1 to 12.5 billions. Developed countries would only increase from 1.2 billion today to 1.9 billion, but developing countries would increase from 5 billion to 9.6 billion. In these projections, the developing countries using by 95%

**Variation of Population Among Nations**

The distribution of world population densities show that while the great majority of the land surface is sparsely or moderately populated, but some limited areas are densely populated. The densely populated areas include Western Europe, the Indian subcontinent, the plains and river valleys of China, and north-eastern USA. High concentrations of people are also found in some relatively smaller areas, for example—the Nile valley of Egypt, the Islands of Java in Indonesia and the Southern part of Japan.

In terms of continents and countries, the world's population is very ill-balanced. More than half of the world's people live in Asia (approximately 3.7 billion), which accounts for only one-fifth of the world's land area; while North, Central and South America together occupying more than a quarter of the land surface, have only one-fifth of the population (1.3

billion).

The African continent also accounts for a quarter of the land surface but has just over one-eighth (840 million) of the world population. On the other hand, Europe whose area is only one twenty-fifth of the total has about one-ninth (729 million) of the world's people.

The distribution within the continents is also uneven. In Asia, China alone, with about 1.29 billion people, accounts for one-third Asian and one-fifth of the world population. The Indian subcontinent has a further 1.3 billion people—India, 1.05 billion; Pakistan, 143.5 million; Bangladesh, 133.6 million; Nepal , 23.9 million; Sri Lanka , 18.9 million; Bhutan, 0.9 million; and Maldives, 0.3 million. In Europe too, the population is an evenly distributed. Far less people live in Northern European countries than in other European countries .The most populous European countries are Russia (143.5 million), Germany (82.4 million), United Kingdom (60.2 million), France (59.5 million); Italy (58.1 million), Ukraine (48.2 million), Spain (41.3 million) and Poland (38.6 million). In Africa and Americas people are for the most part spread very thinly across the land, leaving large sections such as Northern Canada, Southwest USA, the Sahara desert and the Amazon forest practically uninhabited.

**Factors discouraging settlement**

They are usually climatic or relief factors. The main factors are—cold, altitude, heat, drought, poor soils, inaccessibility, etc.

**Factors encouraging settlements**

They are –good land, flat or undulating terrain, the existence of mineral resources, a good climate suitable for a wide range of crops or a less equable climate suitable to the cultivation of specialized crops which have a good market, etc. Other factors include extension of roads, railways and other modes of transportation.

**Population Explosion**

The rapid growth of population is perhaps the most obvious factor affecting the present and future national and regional development, but it is by no means the only population problem in the world today. The main problem is that of 'Population Explosion'.

Population explosion doesn't mean overpopulation or population density. Infact, overpopulation or population density is not the major problem. The problem arises when the economic developments fails to maintain pace with population growth. So the most important factors regarding population are how fast population is growing; and most important is where it is growing. For example, Japan has a high population density but it ranked first on the human development index formulated by U.N.D.P. On the other hand low population density areas of Africa or S. America are unable to support the existing population. Thus, the size, distribution and structure of the population within a country must be viewed in relation to its natural resources and the techniques of production used by its population. The extent to which they are used and the way in which they are utilized determine whether an area/country is under-or over-populated and hence witnessing population explosion or not. A country is said to have an "optimum population" so long as the number of people is in balance with the available resources of the country. If in a country the process of industrialization accompanied by urbanization is not fast and education is not widespread, then this is really a grave situation called as Population Explosion.

**Effects of population explosion**

The effect of population explosion is numerous with far reaching consequences. Some of them are enumerated as under:

**Unemployment**

Low living standard of people,
Hindrance in the process of development of economy
Pressure on agriculture land,
Low per capital income,
Lack of basic amenities like water supply and sanitation, education, health, etc.,
High crime rate
Environmental damage,
Migration to urban area in search of job,
Energy crisis,
Overcrowding of cities leading to development of slums.

**Population explosion in Indian context**

The population explosion, though a worldwide phenomenon, poses a serious threat to India as it has to maintain 16.9% of world's population on only 2.4%of the world's area. The present growth rate of 1.7% is much higher than the world population growth rate of 1.3%, which is of great concern.n order to overcome this problem of population explosion, a sound Population Policy is required with the following objectives:

- Quick economic development and raising the per capital income.
- Significant reduction in birth rate, which is more fundamental and important than the first, by providing legal and fiscal motivations like raising age of marriage, legalization abortion etc.
- The planning of population must not aim merely at controlling the rate of multiplication but it should also include the improvement of the quality of the population as well by providing better facilities in education, health, etc.
- The death rate should be brought down further, as high death rate results in waste of human energy and resources.
- Integrating population planning with economic planning.

We are thus facing a population explosion of crisis dimensions which has largely diluted the fruits of the remarkable economic progress that we have made over the last few decades.

It is clear that simply to wait for education and economic development to bring about a desirable drop in fertility is not a practical solution. The time factor is so pressing and the population growth so formidable that we have to get out of this vicious circle through a direct assault upon the population problem as a national commitment.

**Methods of birth control**

The effectiveness of a birth control method is generally expressed by how many women become pregnant using the method in the first year of use. Thus, if 100 women use a method that has a 0 percent first-year failure rate, then 0 of the women should become pregnant during the first year of use. This equals 0 pregnancies per 100 woman-years, an alternative unit.

The most effective methods in typical use are those that do not depend upon regular user action.

a) Surgical sterilization, Depo-Provera, implants, and intrauterine devices (IUDs) all have first-year failure rates of less than one percent for perfect use. In reality, however, perfect use may not be the case, but still, sterilization, implants, and IUDs also have typical failure rates under one percent. The typical failure rate of Depo-Provera is disagreed upon, with figures ranging from less than one percent up to three percent.

b) Other methods may be highly effective if used consistently and correctly, but can have typical use first-year failure rates that are considerably higher due to incorrect or ineffective usage by the user. Hormonal contraceptive pills, patches or rings, fertility awareness methods, and the lactational amenorrhea method (LAM), if used strictly, have first-year (or for LAM, first-6-month) failure rates of less than 1%. In one survey, typical use first-year failure rates of hormonal contraceptive pills (and by extrapolation, patches or rings) were as high as five percent per year. Fertility awareness methods as a whole have typical use first-year failure rates as high as 25 percent per year; however, as stated above, perfect use of these methods reduces the first-year failure rate to less than 1%. Intrauterine devices (IUDs) were once associated with health risks, but most recent models of the IUD, including the ParaGard and Mirena, are both extremely safe and effective, and require very little maintenance.

c) Condoms and cervical barriers such as the diaphragm have similar typical use first-year failure rates (14 and 20 percent, respectively), but perfect usage of the condom is more effective (three percent first-year failure vs six percent) and condoms have the additional feature of helping to prevent the spread of sexually transmitted diseases such as the HIV virus. The withdrawal method, if used consistently and correctly, has a first-year failure rate of four percent. Due to the difficulty of consistently using withdrawal correctly, it has a typical use first-year failure rate of 19 percent, and is not recommended by some medical professionals.d) Combining two birth control methods, can increase their effectiveness to 95% or more for less effective methods. Using condoms with another birth control method is also one of the recommended methods of reducing risk of getting sexually transmitted infections, including HIV. This approach is one of the dual protection strategies.

**Aim of 'Family Welfare Programme'**In the year 1952, India launched a nation-wide family planning programme making it the first country in the world to do so. Unfortunately, family planning in India is associated with numerous misconceptions one of them is its strong association in the minds of people with sterilization, while others equate it with birth control. The recognisation of its 'welfare concept' came only when the family planning programme was named as 'Family Welfare Programme' in the year 1977. The concept of welfare is very comprehensive and is basically related to quality of life. The Family Welfare Programme aims at achieving a higher end- that is, to improve the quality of life of the people.

Although the performance of the programme was low during 1977-78, but it was a good year in the sense that it moved into new healthier directions. The 42nd Amendment of the Constitution has made "Population Control and Family Planning" a concurrent subject. The acceptance of the programme is now purely on voluntary basis. The launching of the Rural Health Scheme in 1977 and the involvement of the local people (e.g., trained Dais and Opinion leaders) in the family welfare programmes at the gross-root level were aimed at accelerating the pace of progress of the programme. India was a signatory to the Alma Ata Declaration, 1978. The acceptance of the primary health care approach to the achievement of 'Health For All by 2000 AD' led to the formulation of a 'National Health Policy' in 1982. The policy laid down the long-term demographic goal of Net Reproduction Rate (NRR)=1 by the year 2000-which implies a 2-child family norm-through the attainment of a birth rate of 21 and a death rate of 9 per thousand population, and a couple protection rate of 60% by the year 2000. The successive Five Year Plans were accordingly set to achieve these goals. The Government of India envolved a more detailed and comprehensive National Population Policy in 1986, to promote it on a voluntary basis as a 'movement of the people, by the people, for the people'. It has given family planning the broadest possible dimensions which include not only health and family welfare but also child survival, women's status and employment, literacy and education, socio-economic development and anti-poverty programmes. The current approach in favour today is one of involvement and integration. The idea is to value those who stand to benefit from the programme and integrate the various attempts to propagate the same. Family Welfare Programme with such an approach can reduce the population growth to more manageable levels. Presently, the

Family Welfare Programme seeks to promote on a voluntary basis, responsible and Planned Parenthood with one child norm, male or female,through independent choice of family welfare methods best suited to acceptors.

**Problems of family welfare programme**

The two major problem of Family Welfare Programme are:

1. Generally women are the major targets of family planning programmes .according to National Family Health Survey, the most widely used method of family planning in India is female sterilization. This shows that family planning has largely remained a women-centered programme. Due to reluctance of men to use permanent methods, women are forced to accept family planning methods. Gender specificity or gender subordination has to be eliminated in the approach in the family planning programmes as far as possible.

2. The imbalance in the sex ratio (female/1000 male) across the nation, which is 933, is another worrisome factor. In states like Haryana (SR=861), Punjab (SR=874), U.P. (S.R=898), Delhi (SR=821), Sikkim (SR=875) and others, the girl-child is being discriminated against even before birth. The instance of female infanticide in these and other states has brought down the sex ratio to an all time low. Though there is a law banning the determination of the sex of the child in the womb, unscrupulous medical practitioners and short-sighted parents connive to prevent the birth of female children. There is, thus, an urgent need to prevent the misuse of technology through education and awareness.

**WOMEN AND CHILD WELFARE**

**Various Problems Affecting the Women and Welfare**

**Malnutrition**

Pregnant women, nursing mothers and children are particularly vulnerable to the effects of malnutrition. The adverse effects of malnutrition on women are-maternal depletion,

low birth weight, anaemia, toxemias of pregnancy, post-partum haemorrhage, all leading to high mortality and morbidity. Measures to improve the nutritional status of women and

children may be broadly divided into two-direct and indirect nutrition interventions. Direct interventions cover a wide range of activities, such as, supplementary feeding programmes, distribution of iron and folic acid tablets, fortification and enrichment of foods, nutrition education, etc. indirect interventions include control of communicable diseases through immunization, improvement of environmental sanitation, provision of clean drinking water, family planning, food hygiene, education and primary health care.

**Infections**

Women or maternal infections can cause a variety of adverse effects such as threatened abortions, foetal growth retardation, low birth weight, embryopathy and puerperal sepsis. Women of under-developed nations are at high risk. Infections in the child may begin with labour and delivery and increase as the child grows older. Children may be ill with debilitating diarrhoeal, respiratory and skin infections, or the situation is further aggravated by the chronic infections, such as, malaria and tuberculosis. The children also suffer from the severe protein-energy malnutrition and anemia. Prevention and treatment of infections in women and children is being done by adopting the WHO Expanded Programme on Immunization.The children in the developing countries are being immunized against tuberculosis, diphtheria, pertusis (whooping cough), tetanus, measles and polio.

**Uncontrolled reproduction**

The severe health hazards for the women and children resulting from the unregulated/uncontrolled reproduction have been well recognized, viz., increased prevalence of low birth weight babies, severe infections and a high maternal and perinatal mortality. Statistics have shown that in most countries, a birth rate is associated with a high infant mortality rate and child death rate.

**Education and socio-economic status**

The dropout rate (from schools) of girls is much higher than the boys. In under-developed nations the educational preference, both at the primary level and at secondary level, is given to the male child as compared to the female child. This also indirectly affects the

socio-economic status of the women. This problem is very much under control by making the female education free at the primary level by the several under-developed nations. In India too, the female literacy rate has gone upto 50% from 39.3%.

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**Lecture 23**

# ENVIRONMENT AND HUMAN HEALTH: HUMAN RIGHTS, VALUE EDUCATION, HIV/AIDS - WOMEN AND CHILD WELFARE - ROLE OF INFORMATION TECHNOLOGY IN ENVIRONMENT AND HUMAN HEALTH - CASE STUDIES

## ENVIRONMENT AND HUMAN HEALTH

### Introduction

It is an established fact that environment has a direct impact on the physical, mental and social well-being of those living in it. The environmental factors range from housing, water supply and sanitation, psychosocial stress and family structure through social and economic support systems, to the organization of health and social welfare services in the community. In fact the occurrence, prevention and control of disease lies in the environment. If the environment is favourable to the individual, he or she can make full use of his or her physical and mental capabilities. On the contrary, if the environment is polluted it can affect the human health and his susceptibility to illness. Thus, protection and promotion of 'environment health' is one of the major global issues today. It includes the issues of urban environmental health, water quality and health, air quality and health, industry and health, and energy and health. **Urban Environment Health**

Environmental degradation is especially serious around crowded urban centers. In cities around the world, the living conditions of hundreds of millions of people (especially poor people in developing nations) threaten their health, impose misery, have potentially catastrophic social consequences and contribute to illness, accidents and crime. The crises in the urban environment are causing more immediate effects on human health than the current changes in the natural environment. In the developing nations, the current rural exodus has led to a rapid increase in the pre-urban populations living in overcrowded conditions with inadequate provisions of infrastructure and services. Though average rate of disease and death for many cities are lower than those of surrounding rural areas because of the presence of a high proportion of the nation's middle- and upper-income classes who enjoy a relatively good standard of health; but, in contrast, the poor in urban areas usually suffer the same or even high rates of disease and death as their rural counterparts.Good housing and suitable physical and social environments promote good

mental and physical health. The most serious psychosocial health problems are depression, alcohol and drug abuse, suicide, child and spouse abuse, delinquency and target violence (e.g. rape, teacher assault, etc.). However, strong social networks and a sense of community organization can have a mitigating effect on the level of psychosocial health problems. Studies have shown a higher prevalence of mental illness in low income, rundown areas. Deteriorating inner city areas or urban area with declining economies are characterized by social disorganization and disintegration. They are inhabited by high- risk populations such as migrants, the homeless and street children. It has now been recognized that the environment plays an important role in violent behavior and that the public health sector has a legitimate role within the justice, social and education sectors in reducing the problem or urban environmental health.

**Effect of water quality on human health**

Water quality can have a significant effect on public health as a result of waterborne diseases. Inadequate supplies of water increase the problem of maintaining water quality, especially when there are multiple sources of water pollution such as sewage, industrial effluents, urban and agricultural runoff. According to an estimate about 170 million urban inhabitants and 770 million rural inhabitants lack access to safe and adequate water supplies. Most urban centers in Africa and Asia have no sewerage system at all; even where there is sewage disposal system, the system rarely serves more than a small proportion of the population. This means that human excrement and household wastes end up untreated in water sources. The problem of maintaining water quality is particularly acute in the more urbanized areas in developing countries due to two main reasons-failures to enforce pollution control and inadequacy of sanitation system and garbage collection and disposal system. Waterborne diseases are the largest single category of communicable diseases contributing to infant mortality in developing countries (about 1500 million cases of diarrhea and some 4 million deaths per year). It is estimated that safe and sufficient water supplies can reduce infant and child mortality by more than 50 per cent.

**Effect of air pollution on human health**

Air pollution is a growing menace to health throughout the world. The problem of air pollution was first brought to sharp focus when air pollution epidemics took place in Los Angeles (1948), Donora (1948) and London (1952).In the London epidemic of 1952,

thousands of people became ill and some 4000 people died within 12 hours. According to an estimate more than 1000 million urban residents worldwide are exposed to outdoor air pollution levels higher than those recommended by WHO. In many cities, the concentrations of air pollutants are already high enough to cause morbidity in susceptible individuals and premature mortality in the aged, particularly in those with respiratory problems. Fossil fuels are the largest source of air pollution. The major sources of urban air pollution are overwhelmingly coal-fired (or oil-fired) power stations, motor vehicles, domestic cooking and heating (particularly when coal or biomass fuel is used) and industries. The symptoms are usually referable to the respiratory system. Health may be affected if acidified water (due to Acid Rains) is used untreated in water supplies. Depletion of ozone layer, due to the release of specific air pollutants, increases the incidence of skin cancer and cataracts. The indirect health effects, however, are likely to be more significant, such as changes in rainfall that may decrease agricultural production and the spread of diseases such as malaria to currently unaffected areas.

**Effect of industrialization on human health**

Industrialization has made many positive contributions to health. By and large, as countries move towards industrialization and generate wealth and employment, improved health should follow for their people. However, there are two exceptions to the general correlation between industrialization and human health. One exception is in some developing countries where there has been remarkable success in reducing mortality and improving the health of the poor. The second exception is where industrialization has itself led to significant adverse health effects through failure to properly plan for, and prevent the release of chemical, physical or biological pollutants into the environment. A number of major accidents in developing countries due to release of chemicals or to explosions have caused adverse health effects.

Industrial effluents have polluted many rivers, lakes and coastal environments, especially in developing countries where pollution control is seldom enforced. Furthermore, hazardous wastes are sometimes exported from developed countries to developing countries because the cost of export is lower than the cost of disposal in the country of origin. Usually, there is little concern for the health of the local populations. Some of the common occupation

diseases are silicosis, pneumoconiosis, lead and mercury poisoning, and skin diseases. Continued and frequent exposure to noise, especially in industry, give rise to serious health problems.

**Impact of energy on human health**

Energy is a pre-requisite for socio-economic development and has direct and indirect benefits for health. The WHO Commission on Health and Environment's Panel of Energy has identified four major environmental health issues related to energy:

Urban air pollution resulting from fossil fuel combustion and vehicular exhausts;

- Indoor air pollution resulting from domestic use of coal and biomass fuels for cooking and heating;
- Accident prevention and control; and
- Possible consequences of climate change.

People in developed countries use about ten times more commercial energy than those in developing countries and burn approximately 70% of all the fossil fuel used globally.

The combustion of fossil fuels, accounting for about 90% of global commercial energy production, is the largest source of greenhouse gases and atmospheric pollution. Vehicle emissions also contribute to the formation of tropospheric ozone, photochemical smog and acid rain. Though it is possible to mitigate the environmental health effects of fossil fuel combustion, but the technologies are expensive.Indoor air pollution from the combustion of coal or unprocessed biomass fuels represents the biggest energy-related cause respiratory disease with long-term cardiovascular effects, particularly among women and children especially in developing countries.In case of nuclear power plants, there are risks to health for present and future generations from accidents and unsafe disposal of nuclear wastes.Indirect health effects from climatic changes result from increased levels of greenhouse gases produced by the combustion of fossil fuels.

Women are part and parcel of environment. Women have direct relationship with their immediate environment. Regularly they collect water, fuel wood, foods like nuts,

fruits, leaves, roots etc. So women have closer vicinity with the flora and fauna of that region by living with them. Women as a social category, perform multiple role. Certain roles have been recognized universally. The physical differentiation between men and women necessitates certain social arrangements for procreation and rearing of children. Man created practices and customs which tied woman to motherhood in a familial social responsibility. A set of norms were created to curb her freedom, creative potential and suppress her in society.

Women experienced depending syndrome particularly dependency on father during childhood, dependency on the husband in adulthood and dependency on the son in old age. This made her position subordinate to man and easy exploitation women bear and rear children but no proper care for her role of motherhood. Neglect of mother and motherhood lead to maternity deaths, in human custom of female in infanticide etc. Because of poor stimulation of living and economic backwardness, women suffer from nutritional deficiency, during pregnancy and lactation. So it is necessary that there women should be educated to bring them out and should be provided with proper training to create suitable awareness and insight into the new demands in the physical and social environment.

**Woman welfare and development**

Even through, the first five '' Five year plans'' were focusing on women's welfare, only from the sixth 'Five year plan' (1980-1985) on wards, women were recognized as separate target group involving developmental planning activities. The 1991 census revealed that women constitute 48.1 percent of the country's population. Hence it is understood that for the development of the nation backwardness of women has to be taken care.

**Women rights and privileges**

The constitution of India not only guarantees equality for women, but also empowers state to adopt measures of positive discrimination in favours of women in order to overcome their disadvantages in socio economic, educational and political fields. There are many articles in the constitution specifically encourages the development of woman in the society.

- **Article 14 -** States that equal rights and opportunities for men and women in the political, economic and social spheres.
- **Article 15 -** Prohibits discrimination against any citizen on the grounds of religion, caste and sex.
- **Article 15(3) -**Makes a special provision enabling the state to make positive discrimination in favour of women.
- **Article 15(A) (e) -** Condemn the practices derogatory to the dignity of women.
- **Article 16**- Provides for equal opportunities in matter of public appointments.
- **Article 39(a) -** States that state shall direct its policy towards securing all citizens, men and women equally the right to means of livelihood.
- **Article 39(c) -** Confirms that equal pay for equal work.
- **Article 42 -** Directs the state to provide the citizens the just and human conditions at work and maternity relief.

**Policies concerning women's development**

Various policies advocating women's welfare and development have been evolved by the government. Some of them are given below.

a) The national plan of action for women (NPA) 1976.
b) The national perspective plan for women (NPP) 1988-2000.
c) Sharam shakti 1988.
d) The national nutritional policy (NNP) 1993.
e) The national plan and action for the girl child (NPA) 1991-2000.
f) National commission for women's act (new) 1990.

**Child welfare and development**

The future of a nation depends on the way in which the children are growing nutritionally, educationally and socially. Many children suffer from malnutrition and die for want of immunization. The national policy for children was formulation in the year 1974.

- Children are '' a supremely important asset'' of the nation.
- It is duty of the state '' to provide adequate services to the children both before and after birth and through the period of growth''.

Provision of early childhood services especially to the weaker and more vulnerable section of the community could help , prevent or minimize infant mortality, morbidity, malnutrition and stagnation in schools.

India has the world's largest integrated child development services (ICDS) program started in the year 1975, which involves supplementary nutrition, immunization, health care, growth monitoring, pre-school education and health and education. ICDS provides health checkup service like antenatal care for pregnant women, post-natal care for nursing mothers and healthcare for children less then 6 years of age. Children less than 6 years in the village are periodically examined, weighed, immunized at prescribed times and treated for ailments. Provision for nutrition and health education has been made for women 40-45 years of age with priority given to pregnant and lactation mothers. ICDS provide the facilities like

- Foundation for personality.
- Reduction of deprivation.
- Effective Co ordination for policy implementation.
- Maternity and motherhood care through education and health care.

According to the Indian constitution that free and compulsory education for all children would be provided until they complete the age of fourteen years. There has been special emphasis in monitoring the drop outs in primary education.

**National policy for children**

The children population of India is nearly 300 million and the majority of the children live under socially and economically under privileged conditions that can lead to deterioration of the child's physical and mental development. The national policy for children (NPC) 1974 was founded on the conviction that child development programmes can ensure equality of opportunity to the poor children.

**Various organizations towards child welfare**

**i) UN conventions on rights of child or international law:** It formulated a set of international standard and measures to promote and protect the well being of children in our society.

**Rights of the child**

The international law defines right of the child to survival, participation, development and protection.

a) **The right to survival:** It emphasis on good standards of living, good nutrition and health.
b) **The right to participation:** It means freedom of thought and appropriate information to child.
c) **The right to development:** It ensures access to education, child hood care and support, social security and recreation.
d) **The right to protection:** It means freedom from exploitation in human treatment and neglect.

**ii) World summit on child:** It had focused agenda for the well being of the children targeted to be achieved in the beginning of the new millennium.

**iii) Ministry of Human Resource Development (MHRD):** It concentrates on child's health, education, nutrition, clean and safe drinking water, sanitation and environment.

**Acquired Immune Deficiency Syndrome (AIDS)**

AIDS is caused by virus called HIV (Human Immune deficiency Virus). HIV breaks down the body's immune system leaving the patient to a number of life threatening infections. The AIDs patient will be getting different kinds of severe infections including cancer, neurological disorders, skin diseases finally leading to death. As HIV infected person receives a diagnosis of AIDS after developing one of the AIDS indicator illnesses. A positive HIV test result does not mean that a person has AIDS. A diagnosis of AIDS is made by a physician using certain clinical criteria, AIDS illness indicator.

AIDS was discovered in 1983, though sufficient knowledge has been gained about the disease, yet a definite source of this virus could not be identified, but some of the sources are

1) Through African monkey

Most of the evidences have suggested that the AIDS has spread from Africa. It has been believed that the HIV has transferred to humans from African monkey or chimpanzees.

2) Through Vaccine programmes

- HIV has spread in Africa through HIV contaminated polio vaccine prepared from monkey's kidney

- It had spread through Hepatitis – B viral vaccine in Los Angels and New York.
- It had also spread through small pox vaccine programme of Africa

**World Scenario**

HIV/AIDS is the fourth leading cause of death in the world. Globally the AIDS epidemic has crossed over 20 million deaths and orphaned more than 14 million children. Nearly 90 % of the people who are infected with AIDS live in developing countries. 13 % of world's population lives in Africa, almost all states of African countries were affected by HIV. About 3 million people so far died due to HIV/AIDS in 2003. AIDS is rapidly spreading in Eastern Europe and Asia. India ranks second in the world with 5.1 million HIV/AIDS affected people. The percentage is lower than Thailand, Myanmar and South Africa.

**Scenario in India**

The largest numbers of infected cases have been found in Maharastra and TamilNadu, followed by Delhi, UP, Karnataka and Goa. In Tamil Nadu alone, till September 2008 a total of 24,667 cases of AIDS have been found out. The first HIV +ve case was identified in Chennai in 1986.

**Mode of transmission of AIDS**

Some of the key factors responsible for the spread of the deadly disease AIDS are

- Prostitution
- Homosexual activity
- Use of contaminated syringe or needle in blood transfusion.
- Maternal-fetal transmission i.e. a mother infected with AIDS can give birth to baby with AIDS.
- Other factors such as saliva, breast milk etc are also the mediums of transmittance of this disease. These body fluids have been proven to spread HIV

  Blood
  Semen
  Vaginalfluid
  Breast milk
  Other body fluids containing blood.

- These are additional body fluids that may transmit the virus that healthcare workers may come into contact with
- Fluid surrounding the brain and spinal cord.

- Fluid surrounding the bone joints.
- Fluid surrounding an unborn baby.

**HIV tests**

The most commonly used test is ELISA. Most of the hospitals are insisting of HIV test nowadays. If the sample shows positive results even after duplication, the results are confirmed using a second test called" Western blot''. In addition the following other test also used nowadays.

- Radioimmunoprecipitation assay ( RIPA).
- Dot Blot Immunobinding Assay.
- Immunoflourescence assay.
- Nucleic acid testing.
- Polymerase Chain Reaction.

**Functions of HIV in human body**

AIDS itself does not kill humans. The death occurs due to the attack by diseases because of the weakening of immune system, white blood cell (WBC) responsible in the formation of antibodies are called T-helper cells. T-helper cells are the key infection fighters in the immune system. The HIV enter into the human body and destroys the T-cells, as a result of which various types of infection disease occur. Even cancer can easily develop in the HIV infected persons.

**Various stages of HIV infection**

The HIV infection stages can be divided into four stages clinically.

1) The first stage is the initial infection in the blood the destruction of T-4 cells or lymphocytes or white blood corpuscles.
2) The second stage is the symptomatic carrier stage.
3) The third stage is the AIDS Related complex (ARC).
4) The final stage is the fully infected AIDS patient receiving different kinds of infections.

**Symptoms for HIV/AIDS**

**Minor symptoms**

- Persistent cough for more than one month
- General skin disease
- Viral infection
- Fungus infection in mouth and throat
- Frequent fever, head ache, fatigue

**Major symptoms**

- fever for more than one month
- diarrhea for more than one month
- cough and TB for more than 6 months
- fall of hair from the head
- 10% of body weight get reduced within a short period

**Screening test**

The antibodies to HIV virus can be easily detected through blood tests. Hence the presence of HIV antibodies in the blood sample can confirm the HIV infection of HIV positive. One of the HIV test "ELISA, western blot " is a highly reliable test for HIV. HIV can be isolated from cultured lymphocytes, but it is an expensive and time consuming test.

**Control of AIDS**

1) **Safe sexual activity and sex**

Since AIDS is a sexually transmitted disease due to mainly prostitution and homosexual activity. Proper moral education as well as sex education using good condoms etc., should be given to the illiterate as well as the public at large.

2) **AIDS education and educating the AIDS patients**

The Public should be educated regarding the severity of the disease. For AIDS there is no vaccine or no remedial medicines have been so far successfully discovered. The AIDS patients have to undergo a gradual deterioration process to death. Since the

HIV affects the immune system by destroying the lymphocytes (White Blood Corpuscles) count, the AIDS patient is highly vulnerable to any kind of infection from cough, cold etc., to cancer, typhoid etc, and cannot be treated through any kind of antibiotics or any other kind of drugs due to his shattered immunity system. Finally the AIDS patient will become a prey to any one of the severe kind of infections.

The public should also be educated to treat AIDS patients with sympathy and concern. Since AIDS patients with sympathy and contact, people should be educated not to isolate them. Clinical and social workers should be specially trained for the welfare activities of AIDS patients. In the high school level itself, proper education regarding the prevention of AIDS and the clinical and social aspects of AIDS should be taught in the class rooms.

**3) Educating illiterates as well as the educated public about AIDS prevention measures using different medias**

Various Medias such as radio, television, wall posters, pamphlets, booklets, etc should be efficiently made use for educating the public to be cautions about AIDS. The public should be educated regarding the various ways of transmission of the disease.

**Role of Information Technology In Environment and Human Health**

Today is an information age and tremendous flow of information is emerging in all fields throughout the world. Information in this competitive era is more precious than life and without information one cannot live at all. India is endowed with rich natural resources while facing the problems of poverty, illiteracy, population growth , environmental degradation etc. It is creating new possibilities to tackle these problems.

Information technology has tremendous potential in the field of environmental education and health as in any other field like business, economics, politics, or culture. Development of internet facilities, World Wide Web, geological information system (GLS) and information through satellites, has generated a wealth of up-to-date information on various aspects of environment and health. A number of software have been developed for environment and health studies which are user friendly and can help an early learner in knowing and understanding the subject. Nowadays the volume of data being generated from the environment is increasing manifold. The whole process of data collection, storage, processing and retrieved has

become an easy task due to computerization. Lot of time saved and reduces his work through automation of many tasks.

**Applications of IT in global environment**

One of the important fields of IT for environmental studies is Geometrics. Geometrics is a science and technology for collecting, analyzing, interpreting, distributing and using geographic information. Geometrics involves the following,

- Surveying and mapping
- Remote sensing
- Geographic information system(GIS)
- Global positioning system(GPS)

One of the important applications of IT in the study of global environment is the satellite remote sensing technology. Satellite remote sensing technology helps in the evolution of its data and interpretations offer potentially valuable information for assisting human dimensions of global environmental changes are grouped into five major categories,

1. Fossil fuel consumption
2. Biomass consumption
3. Land use change
4. Agricultural activities
5. Halocarbon production and release.

These five categories of interactions has created concern about the possible effects on the global physical , chemical and biological systems. The extra ordinary large scale in land use is frequently accompanied by changes in land cover i.e. forest and vegetation that can cause ecological imbalance.

Satellite remote sensing technologies that provide satellite image data intervals which can be interpreted to study the land surfaces at repetitive intervals allow mapping and monitoring of changes is land cover of various types, amount, arrangement and the rate of change.

Satellite image products can assist the planning and co-ordination of global change research and the implementation of methodologies that contribute to a global

understanding of human dimension activities which relates with the impacts of human activity in land use and land cover.

The remote sensing technology using satellite also play a major role in the environmental studies of water bodies such as lakes, rivers, estuaries, etc. as well as ocean and coastal areas. The major techniques for deriving information from satellite images are

- Image interpretation
- Digital image classification
- Data transformation
- Change detection

**Remote satellite sensors**

- US land state Multispectral scanner(MSS)
- French SPOT
- Indian Remote Sensing Satellite
- The Environment Information System - The ENVIS was started by MOEF in 1982 as a decentralized information network for collection, storage, retrieval and dissemination environmental information. ENVIS network presently consist of 25 subject oriented centres known as ENVIS centres.

**Role of information technology in human health**

Information technology plays a key role in human health. It has changed the human life style completely. Many health organizations are turning to package solution of IT to streamlining service oriented work in an effective manner.

The health service technology mainly involves three systems. They are

- Finance and accounting
- Pathology
- Patient administration-clinical systems

**Application of IT in heal services**

- With the help of IT packages, the data regarding birth and death rates, immunization and sanitation programme are maintained more accurately.
- It helps the doctor to monitor the health of the people effectively- tools like CT scans ,ultrasound Sonography uses IT for diagnosis
- The information regarding the outbreak of epidemic diseases can be conveyed easily.
- On-line-help of export doctors can be consulted to provide better treatment and services to the patient-through Video conferencing
- With central control system the hospital can run effectively- Most of the ICUs are now using computers to monitor the progress and condition of the patient undergoing treatments.
- Drugs and its replacement can be administered effectively.

**Definition of Values**

According to **Dictionary of Philosophy,** "In relation to the subject (man), values represent the objects of his interest, while in his consciousness they serve as reference points in the daily substantive and social realities and as symbols of his various practical attitudes to surrounding objects and phenomena".

**Inculcation of Values**

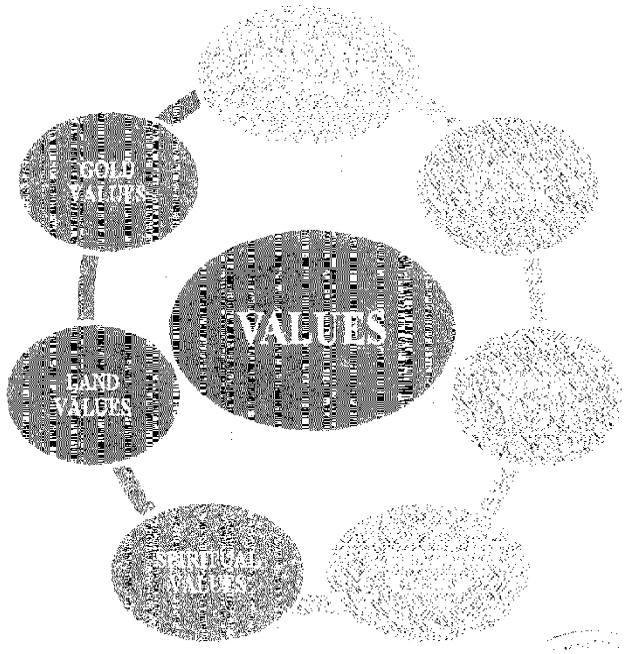
The inculcation of values is by no means a simple matter. Value education with all its comprehensiveness involves developing sensitivity to values; an ability to choose the right values, internalizing them, realizing them in one's life and living in accordance with them. Therefore, it is not a time-bound affair. It is a life long quest. In inculcating values, all human faculties such as head, heart and hand should play a creative role. Thus, the role education covers the entire domain of learning, cognitive, affective and psychomotor. A complex network of environmental factors such as home, school, peer group, community, media and society influences inculcation of values. Home takes the higher position in the hierarchy followed by school.

Values **in Normal Sense**

- Human Values
- Money Values
- Property Values
- Mental Values
- Spiritual Values
- Land Values
- Gold Values and so on ...these are all hereunder in the chart of radial cycle.

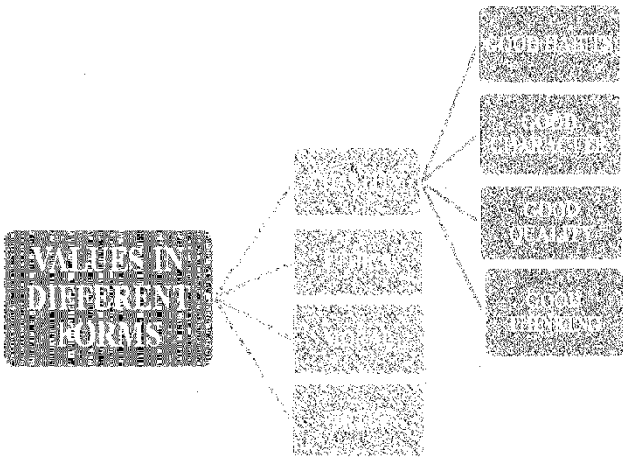
**Values in Normal Sense in the Chart of Radial Cycle**

Figure-1



**Values in Different Forms in the Chart of Horizontal Hierarchy**
Figure-2

Meaning of value education



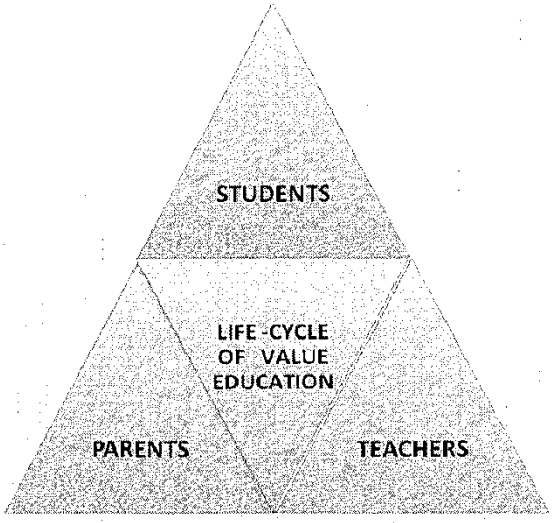

Value education is education for "becoming". It is an encounter with the total personality of the individual, keeping in view all aspects of personality development - - the intellectual, social and emotional, will and character. It involves developing, sensitivity to awareness of what is right, what is good and what is beautiful. Ability to choose the right values in accordance with one's conception of the highest ideals of life and internalizing and realizing them in thought and action.

Definition of Value Education

"Value education means inculcating in the children a sense of humanism, a deep concern for the well-being of others and the nation. This can be accomplished only when we instill in the children, a deep feeling of commitment to values that would build this country and bring back to the people pride in their work that brings order, security and assured progress".

**The Fundamental** Life **Cycle of Value Education in Triangle Chart**

Figure-3




Students (children), parents and teachers, as illustrated in the above triangle, are the fundamental participants in the life cycle of value education. These are very important dimensions of this research on value based non-formal education for rural children. Students, parents and teachers, together, can create a good atmosphere for the entire humanity.

**Methods or Types of Value Education**

The methods or types of value education have the formal, internal, and non-formal method of teaching. All of them play the vital role to inculcate value education for the students. They are as follows:

❖ **Direct And Indirect Methods of Teaching Values**

- **Direct Method of Teaching**

When there is a separate subject, there will be scope for undertaking direct method of teaching the values in the periods allotted. To be the subject of direct method of teaching has it own defects, sometimes, it may be result in reaction formation or contra-suggestions being form. This will be detecting the purpose of instruction.

- **Indirect Method of Teaching**

Indirect method of instruction will be fruitful many a time; students will learn the related values as concomitant learning. The desired values have to be inferring because of stories, story-poems, or anecdotes that have taught.

❖ **Curricular, Co-curricular and** Extra **Curricular, Approaches To Teaching Values**

- **Curricular Approach**

In this, there will be separate syllabus prepared for value education. Definite number of teaching hours will be allots to it as in the case of all academic subjects. Here the subject will have its own identity. The curricular approach may also involve incorporating the contents either in the language subjects or in non-language subjects. This is an integrated approach, where the subject will not have individual identity.

- **Co-curricular Approach**

The co-curricular approach activities can be well exploit for the development of secular, moral and social values. Debates and essay writing competitions, story telling and writing story-poems can be associated with the teaching of values. Dramas, songs, dances can also be associated with value education.

- **Extra-Cu rricular Approach**

Extra curricular activities like organization of social service, common celebration of different religious festivals in the schools, mutual greeting on the different religious celebrations, organization of visits to temples, mosques, churches, guruduwaras will be helpful for developing some of these values.

♦♦♦ **Formal, Informal and Non-Formal Methods of Teaching of Values**

- If the values have taught through classroom teaching, directly with the help of textbooks or supplementary reading materials, it comes under the **Formal Method of Teaching Values.**

- If the students learn about different values incidentally by their own experiences by living in the community or school programs in and out -of school hour's casually, it becomes an **Informal Method of teaching** values.
- If the students have taught values through non-formal methods like utilizing leisure periods for studying books on values in the library. Alternatively, by organizing discourses by eminent scholars on the subject or through Radio and T.V. lessons. On other hand, utilizing other Mass Media, organizations of story telling like., Ramayana, Mahabharatham, Burra kathas, Hari Kathas, or Folk ballads representing secular, moral and social values, it comes under **Non- Formal Method of** teaching **values.**

**Advantages of value education**

- To develop self-discipline
- To eliminate stress by proper concentration methods (yoga, meditation)
- To increase decision making capacity
- To gain problem solving techniques
- To imbibe punctuality
- To transform a diseased or prejudice mind into healthy mind
- To grow rational power
- To become a successful person
- To increase helping tendency and tolerating capacity
- To ensure the qualities of truth, sincerity and justice
- To enhance the power of kindness, non-violence and prayer
- To promote physical and mental health
- To identify self-correction (who am I?)
- To reinforce ours good thinking and good behaviors
- To be a perfect or a full-fledged man with good values

**Contrasts between 'Formal' and 'Non-Formal' Programmes**

Simkins (1976) analyzed non-formal education program in terms of purposes, timing, content delivery systems and control, and contrasted these with formal educational programs. The resulting ideal-types provide a useful framework - and bring out the extent to which non-formal education initiatives, while emphasizing flexibility, localness and responsiveness remain located within a curricular form of education (in contrast with those forms driven by conversation).

**Ideal-Type Models of Formal and Non-Formal Education**

Figure-4

| | FORMAL | NON-FORMAL |
|---|---|---|
| PURPOSES | • Long-term & general<br>• Credential-based | • Short-term & specific<br>• Non-credential-based |
| TIMING | • Long cycle / preparatory / full-time | • Short cycle / recurrent / part-time |
| CONTENT | • Standardized / input centered<br>• Academic<br>• Entry requirements determine clientele | • Individualized / output centered<br>• Non Academic<br>• Practical clientele determines entry requirements |
| DELIVERY SYSTEM | • Institution-based, isolated from environment.<br>• Rigidly structured, teacher- centered and resource intensive | • Environment-based, community related.<br>• Flexible, learner- centered and resource saving |
| CONTROL | • External / hierarchical | • Self Governing/Democratic |

(Adapted by Fordham 1993 from Simkins 1977: 12-15)

**Recommendations of Various Commissions and Policies on Value - Based Education**

The misconception about the notion of modernity and violent strides of science and technology has been causing a speedy erosion of our moral, social and cultural values. This concerns and attracts the attention of various authorities. UNESCO has accepted value education. It forms an essential part of the school curriculum in most countries of the world. In this country also it has been an objective right from the first five years plan period. It is gratifying to note that all the committees and commissions on education appointed by the union government made a categorical recommendations in favor of value-based (oriented) education. Eminent educationist gave their unstinting support to this worthy cause. The following were examining the views expressed by some of them.

**Kothari Commission (1964-66)** has very rightly observed -"A serious defect in the school curriculum is the absence of provision of social, moral and spiritual values in education".

**Wardha Education Conference (1937)** - under the Chairmanship of Mahatma Gandhi Adopted the following Resolution: "That the truth, which is common to all religions; can and should be taught to all children". "The truth that all religions are the same in essentials and that we must love and respect others" faith as we respect our own, is a very truth, and can easily be understood and practiced by children of seven. However, of course, the first essential is that the teacher himself must have this faith.

**Dr. S. Radhakrishnan Commission (1948-49)**

"The fundamental principles of our constitution call for spiritual training. There is no state religion. The state must not be partial to any one religion. All the different forms of religions have given equal place, provided they do not lead to corrupt practices. Each person is at liberty to approach the unseen as it suits his capacity and inclination. This is the basis of our secular state; to be secular is not to be religiously illiterate. It is to be deeply spiritual and not narrowly religious".

**Dr. A.L. Mudaliar Commission (1952-53)**

"Moral instruction or value-based (oriented) education in the sense of inspiring talks given by suitable persons selected by the headmaster and dwelling on the lives of great personages of all times and of all claims will help to drive him the lessons of morality".

**Shri. Sri Prakash Commission (1959)**

"Suitable books should be prepared for all stages from primary to university which should describe briefly in a comparative and sympathetic manner, the basis ideas of all religions as well as the essence of the lives and teachings of the great religions leaders, saints, mystics, and philosophers. These books will be suitable to the various age groups in different classes of schools and colleges, and should be a common subject of study for all. Collections of poems and selected passages from Sanskrit, Persian, English and the religious languages should be made available for young people".

**New Education Policy (1986)**

It is heartening to note that our education policy stresses the acculturating role of education and totally endorses the program of value-based (oriented) education. In pursuance of this desirable scheme, the universities in Andhra Pradesh have already introduced two new subjects for the degree classes: 1) India's Cultural Heritage and 2) Modem Science. It has also proposed to introduce moral instruction at high school level. For this purpose, writing books for students and teacher's guidance should be commission.

**The National Policy on Education 1986**

Document has given the following justification for value education:

- The growing concern over the erosion of essential values and an increasing cynicism in society has brought to focus the need for readjustment in the curriculum in order to make education a forceful tool for the cultivation of social and moral values.

- In our culturally plural society, education should foster universal and eternal values oriented towards the unity and integration of our people. Such value-oriented education should help to eliminate obscurantism, religious fanaticism violence and superstition.

* Apart from this combative role, education has a profound positive content based on our heritage, national goals and universal perceptions.

Various committees and commissions set-up by government of India before and after independence have been highlighting the urgent need for incorporating appropriate programs in our educational system that has directly or indirectly develop among the students an integrated growth of body mind and spirit.

**Value Education System in Ancient India Gandhian Views**

The entire spectrum of Mahatma Gandhi's social, spiritual and educational outlook have primarily founded on the basic principles of Hinduism as practiced in Ancient India. The earliest recorded documents on these take us to the Vedic period, as early as 2000 B.C., stretching over to 600 B.C. That was the age of the Vedas, the Upanishads and the Sarandakos. They are the three Sacred Scriptures of Hindu religion and Indian philosophy. We know these constitute 'Sruti Literature', the supposed to be divinely revealed scriptures of Hinduism, revealed to the ancient sages. The next important 'Smriti literature' of Hinduism consists of the two Epics that are popular in the whole world: Ramayana and Mahabharata, the Puranas and the Darsanas. Among the sacred books of Hinduism that exercised the greatest influence on Gandhi, the most important is the Bhagavad-Gita that has known as "the quintessence of Hindu literature". Every aspect of the Gandhian thought has permeated in essence by the teachings of Gita. The central religious message of the Gita is, "that Bhagavan, the highest god, is all and comprises all the perfections of the Atman and Brahman that are described in Upanishad.

He is the origin of all beings; he demands supreme devotion and the dedication of all actions of men to him". Education in a variety of kinds imparted during the Vedic period has known as Vedic or Brahmanic education.

Knowledge of the Brahman through the Vedic Scriptures and directions to the attainment of Brahman through the practices of the Vedic injunctions were central to this period of education. Life and education have not conceived of as separate identities; the two have interwoven into one ultimate aim. The purpose of life and that of education were to attain the Brahman. Gandhi calls this the ultimate aim of education in all respects.

According to Bhatia, "The ultimate aim of Gandhiji is related to the ultimate Goal of life- the aim of self-realization, the knowledge of Truth and God in one's life". Having this Goal of salvation or self- realization in mind, the Vedic students have given training in learning the verses of the scriptures. The early Vedic period allowed only the Brahmacharis (Bachelors) of the Brahmins to receive education of the Vedic scriptures. Listening to and recitation of the scriptures were their exclusive prerogative. Education during the Vedic period has characterized by the Gurukula system. The pupils depended on the guru for everything. It was not a mere intellectual experience. It was an integral development of the pupil's personality. The teacher taught and guided the pupils. The pupils lived in the teacher's family, participated in his day-to-day life, and rendered him the kind of help they could. It was learning by experience, which Gandhi was so fond of advocating in his Swaraj. The Gurukula provided not the modem school of anarchy, revolt, restlessness and aimlessness but "a Gandhian world of simplicity and harmony". The Gurukula searched for the refinements of truth and love which Gandhi later made the central principles of his life. It has a natural process of discovering truth in the details of daily life that the pupils learned from the teacher.

The Gurukula in all details emphasized the spiritual aspects of the pupil's life. This was a principle that Gandhi never ceased to drive it home. He always wanted students to keep their eyes on the ultimate goals of life even amidst pleasures and enjoyment. He wrote in young India, "The ancient conception of a student was that a brahmachari, because the goal of thus learning and activities was the search of Brahman. Therein life has built on the foundation of self-control and simple life that

all religions have advocated I do not mean that you should be away from all enjoyment and shut yourself in a room. But all your enjoyment and activities should have the nobility of a dedicated life". In all involvements in the gurukula, the students maintained the integrity of the brahmachari and kept the noble goal in mind.

Education in ancient India under the Vedic period has influenced and shaped by the Ashrams, the stages of a man's life: brahmacharya (as a student), grahastha (as a householder), vanaprestha (as a recluse) and sanyasa (as a religious mendicant). The four stages were integrally woven path consisted in the brahmachari's entire approach to life and God. Therefore, his introduction to the Vedic scriptures and all the learning he did of the Brahmanic mantras and sutras (sacred formulae and texts) had much significance. Thus, Education was not a thing to end with the first stage but was only an introduction to the other stages of life. It was a gradual and lingering process of unfolding the spiritual personality to the ultimate goal of self-realization. It is from the same point of view that Gandhi envisages education. Education during the Vedic period provided training in a definite set of learning methods. They are sharvana (listening), manana (memorizing) and dhyana (meditation or reflection). That was a major contribution of the Vedic period to education. It was the primary duty of students to listen to recitation of the Vedic Scriptures. More relevant for us to consider in this context is, the training in craft and skills provided in the Vedic period.

That has specially designed to develop technical hands for use in the community and to provide to students, the necessary physical involvement as part of the formation of character. The later Vedic period taught guilds and crafts and equipped students for one occupation or other. In connection with Vedic education, mention should be made of two most advanced centers of learning: **Nalanda** and **Takshasila,** two centers, later developed into ancient Universities. These Universities of ancient India taught languages, arts and humanities, fine arts of all sorts, medicine, architecture and astronomy. Students and scholars from all parts of India lived and studied in these ancient universities, which received the

patronage of kings of different ages. Education in Vedic India as described above had a number of important characteristics.

It was idealistic by nature, because the entire set up of education has founded on the philosophy of Hindu religion, just as the western idealistic education has based on philosophy of Christianity. Religion and education became so integrated that, the two could not be separate with reference to this goals and principles. Education had the absolute and ultimate goal of self-realization or liberation and union with the Supreme Deity. All immediate goals of learning, acquisition of knowledge and character formation and so on were well amalgamate with this one single ultimate aim of education. Under the idealist framework, automatically Vedic education held on to the absolute principles of **Hindu philosophy:** Dharma and everything that went with it. The absolutism was again an idealist character. Gandhi has found attaching the absolute sense to all the **moral principles and values** that he believed in and practiced. This aspect is important in understanding Gandhian education in its full significance. **Discipline** was an important factor in Vedic education. In fact, discipline controlled the success of all other elements in the formation of the character of Vedic student. Gandhi considers discipline as the foundation of the Swaraj: "students require the drive for action. They should not be mere imitators.

They should learn to think and act for themselves and at the same time behave with full discipline and obedience". Discipline was the living pulse of Gurukula system, when the small group of dedicated truth-seekers conjoined themselves to their guru in complete self-surrender and discipline. The students considered it a privilege to be there surrendered to the teacher in obedience. Even after dissemination of the gurukula education towards the end of the Vedic period, we find discipline having still a major role in the formation of the student's character. Discipline was central also in the western idealistic tradition. Discipline in the Vedic system has considered basic in the formation of the student's character, for the development of the finer virtues of obedience, humility, self- control, sense of sacrifice and all those that a life of dharma aims at.

The teacher was the focus of attention and in him was endowed the success or the failure of the education process. He was the giver of knowledge emanated from his experienced lips and students had to listen, learn and reflect. Discipline was the result of this dimension of education. The teacher had to give, show and provide the examples. He could not afford to be like the teachers of the present-day classrooms who may teach one thing in the classroom and do just the opposite outside. The principal learning consisted in the teacher's way of life. The teacher being "an experimenter in life" with Vedic education, the teacher-centered way remained beneficial to the students, because learning took place not by mere provision of knowledge, but by life-involvements and by living the principles of dharma. In the western context of idealism, education boiled down to mere provision of knowledge about the world, man and god, without concrete life-experiences, giving the framework for learning. An analysis of Vedic education as above becomes quite necessary and significant, because Gandhian educational thoughts lead us all, the way back from 20th century to the B.C's. Vedic education constituted the very groundwork of Gandhian thoughts.

Vedic education integrated the goals of life and education, and it has the same for Gandhi. He envisaged no education that had nothing to do with the religious goals one-way or other. Even Gandhi's "bread and butter aim of education" came down to the spiritual foundation. No ethics or religion can be preaches to the man who starves; the first thing is to show him a way to earn his daily bread before he can digest ethical or spiritual values for himself.

**Need of Value Education**

In the present scenario, the entire human behavior has totally changed due to improper guidance to the children, to mould them into good citizens with all moralities like, truth, hard work, honesty, love, helping others, sympathy, ethics, etc.... Even though we are talking about Liberalization, Globalization,

Privatization, Policies and Programs, high priority has to be giving to value education. Some of the emerging problems have listed hereunder:

- The present generation is self-centered: they dominate others and have very little social responsibility.
- Honesty and motivation towards social service is very poor among school going children.
- Students do not have respect for elders, parents and teachers.
- Students have lost their faith in religious practice.
- Values like love, goodness, compassion, hospitality and kindness to animals are slowly disappearing from the entire human society.
- The present education is only job-oriented, competition based, money based lack of service mind and the overall development of children have neglected.
- Violence, dictatorship, inhuman activities and criminal attitude are present in our society.

As a result, the family, the society and the nation as well as the world are loosing the values. These major problems are threatening human life. When ancient India's Vedic Education has compared to the education of the 21st century, we see a vast difference between them. Many changes may take place in the future. In order to live in peace, we can determine the desired changes. This is the appropriate time for inculcating values through non-formal method in students, teachers, parents and the entire community. "Education in values is essential in helping each one of us to directly encounter the values that we hold, and understand them completely, so that we may order our relationships to the environment that lies outside us".

In the traditional or the ancient period, elderly people, especially grandparents, shouldered many responsibilities within the joint family circle. Since they lived together, they were able to express and transfer the good values of life to their children. Each and every one should have good values, that is, good

mutual understanding, helping tendency, tolerance, obedience, doing good to others, spirituality, sincerity, faithfulness, moral behavior, etc. Nevertheless, in later periods, people have started giving importance to acquiring money, gold and being slaves to foreign culture, fast culture in everything such as drinks, smoking and luxurious life. Hence, people never mind the human life. Therefore, humanity is in great danger. Therefore, we must act urgently and try to establish human dignity, honesty, integrity and social responsibility. We need value education to rejuvenate the culture and restore humanity. This research study may find the answer for the above-mentioned problems.

**Value education for all**

Value education is not only for children (students), parents and teachers but also for everyone, that is, administrators, educationists, social workers, philosophers, doctors, engineers and lawyers. A detailed explanation of its character has described below in a simple chart form:

**Value education for all - The simple chart in three different levels**
Figure-5

| ACADEMIC LEVEL | GENERAL LEVEL | CRIMINAL LEVEL |
|---|---|---|
| • Students<br>• Teachers<br>• Administrators<br>• Doctors<br>• Engineers<br>• Lawyers<br>• Collectors<br>• Educationists<br>• Environmentalists<br>• Economists<br>• Sociologist<br>• Psychologist<br>• Counselors<br>• Professionals<br>• Business people<br>• Social well-wishers | • Parents<br>• Illiterates<br>• Poor people<br>• Drivers<br>• Conductors<br>• Police<br>• Politicians<br>• Public servants<br>• Preceptors<br>• Philosophers<br>• Painters<br>• Patients<br>• Disables<br>• Farmers<br>• Laborers<br>• SHGs<br>• NGOs<br>• Social workers<br>• Activists<br>• Voluntary organizations<br>• Thirunangaikal (Hermaphrodites)<br>• Widows/Widowers<br>• Journalists<br>• Writers<br>• Singers<br>• Dancers<br>• Speakers/orators | • Terrorists<br>• Thieves<br>• Killers<br>• Psychopaths<br>• Smugglers<br>• Criminals<br>• Social delinquents<br>• Juvenile delinquent<br>• Others |

**Thirty wonderful values of non-formal education**

The following 30 wonderful values can be considering and constituting the smaller list for value based non-formal education for rural children. Each value has included pictures, songs, conversation, stories and beautiful quote. It may be the better training module. It is very useful guide to teach value education to the rural children. In addition, it may treat as a good curriculum to inculcate values to the children. It is not only for students. It is for all. All values are hereunder in a table format:

**Thirty Wonderful Values**

Figure-6

| | |
|---|---|
| 1. Care of the aged | 16. Peace |
| 2. Communal harmony | 17. Physical exercise |
| 3. Concentration | 18. Prayer |
| 4. Courage | 19. Punctuality |
| 5. Do-good-to-others | 20. Rationality |
| 6. Environment | 21. Respect |
| 7. Happiness | 22. Responsibility |
| 8. Health | 23. Self-confident |
| 9. Honesty | 24. Self-correction |
| 10. Living together | 25. Self-discipline |
| 11. Love | 26. Sharing |
| 12. National integration | 27. Sympathy |
| 13. Non-stealing | 28. Tolerance |
| 14. Non-violence | 29. Truth |
| 15. Obedience | 30. Unity |

Some of the most important values have mentioned above in phrases rather than in one-word form in order to show that they are kins. This also makes the expanse or scope of those values more clear. Everyone will find these values of great relevance and help, for each one of these values has a special connotation in the context of each profession besides having a general meaning.

**ROLE OF INFORMATION TECHNOLOGY (IT) IN ENVIRONMENT**

Some of the areas in which information technology is playing a vital role in environmental management are briefly discussed as under:

Use of GIS (Geographic Information System) and Remote Sensing can help in determining the rates, causes and scale of biodiversity loss. Information on deforestation and land use change can be integrated with data on the distribution of biodiversity and existing information on climate, topography, soil, etc. to obtain a comprehensive picture. Not only the existence of flora and fauna can be detected, even counting of animals like elephants, tigers, etc. can be done with the help of GIS. The IUCN (International Union for Conservation of Nature) Red Database acts as an aid in appreciating the degree of danger that a species is in.GIS can help in the selection of optimum highway or railway routes, dam or reservoir sites, waste disposal sites, major industrial sites, etc. that can cause minimal disturbance to ecosystems.

Remote sensing data can be effectively used for obtaining near real time information on areas affected by earthquakes, cyclones, floods, landslides, volcanic eruptions, forest fires and other such disasters. Disaster prone areas can be identified where appropriate action can be taken up to reduce the losses and also disasters like cyclones, floods, etc. can be predicted well in advance.Satellite data depict the nature of problem, degree of salinity, sodicity and spatial extent of the problem in each mapping unit. The information is extensively used to plan for the reclamation of salt affected soils and for adopting post-reclamation production technology.

Remote sensing data proved effective in inventorying, monitoring and managing both surface and ground water resources to augment the water use efficiency. Satellite data serves as a unique tool for extracting information on geology, geomorphology, drainage, land use and soils, which are essential in identifying not only the potential segments of agricultural resources, but also the sites suitable for site selection of recharge structures.

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**Lecture 24**

# DISASTER MANAGEMENT - NATURAL DISASTERS - MEANING AND NATURE OF NATURAL DISASTERS, THEIR TYPES AND EFFECTS - FLOODS, DROUGHT

## What is disaster?

The term ‗Disaster' owes its origin to the French word *desastre*, which is a combination of two words ‗des' meaning bad and ‗aster' meaning star. Thus, the term disaster' refers to ‗Bad or Evil Star'. In earlier days disasters were considered to be an outcome or outburst of some unfavorable star.

**Disaster** is a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.

**WHO has defined Disaster as-** Any occurrence that causes damage, ecological disruption, loss of human life, deterioration of health and health services on a scale sufficient to warrant an extraordinary response from outside the affected community.

## What are we talking about?

**A Disaster is …**

- a sudden calamitous event bringing great damage, loss or destruction Webster dictionary)
- some rapid, instantaneous or profound impact of the natural environment upon the socio-economic system" (Alexander, 1993)
- an event, concentrated in time and space, which threatens a society or a relatively self - sufficient subdivision of a society with major unwanted consequences as a result of precautions which had hitherto been culturally accepted as unwanted (Turner, 1976).
- an extreme event as any manifestation of the earth's system (lithosphere, hydrosphere, biosphere or atmosphere) which differs substantially from the mean (Alexander, 1993).
- an event that results in death or injury to humans, and damage or loss of valuable good, such as buildings, communication systems, agricultural land, forest, natural environment etc.

**Types of Disaster**

Generally, disasters are of two types – **Natural** and **Manmade**. Based on the devastation, these are further classified into major/minor natural disaster and major/minor manmade disasters. Some of the disasters are listed below:

**Major natural disasters:**

- Flood
- Cyclone
- Drought
- Earthquake

**Minor natural disasters:**

- Cold wave
- Thunderstorms
- Heat waves
- Mud slides
- Storm
-

**Major man-made disaster:**

- Setting of fires
- Epidemic
- Deforestation
- Pollution due to prawn cultivation
- Chemical pollution
- Wars

**Minor man-made disaster:**

- Road / train/ air accidents, riots
- Food poisoning
- Industrial disaster/ crisis
- Environmental pollution

**Risk:**

Risk is a measure of the expected losses due to a hazardous event of a particular magnitude occurring in a given area over a specific time period. Risk is a function of the probability of particular occurrences and the losses each would cause. The level of risk depends on:

- Nature of the Hazard
- Vulnerability of the elements which are affected
- Economic value of those elements

**Vulnerability:**

It is defined as -the extent to which a community, structure, service, and/or geographic area is likely to be damaged or disrupted by the impact of particular hazard, on account of their nature, construction and proximity to hazardous terrain or a disaster prone area.

**Hazards:**

Hazards are defined as -Phenomena that pose a threat to people, structures, or economic assets and which may cause a disaster. They could be either manmade or naturally occurring in our environment.

The extent of damage in a disaster depends on:

1) The impact, intensity and characteristics of the phenomenon and
2) How people, environment and infrastructures are affected by that phenomenon

This relationship can be written as an equation:

**Disaster Risk = Hazard +Vulnerability**

**Difference between an emergency and a disaster situation**

An emergency and a disaster are two different situations:

- An ***emergency*** is a situation in which the community is capable of coping. It is a situation generated by the real or imminent occurrence of an event that requires immediate attention and that requires immediate attention of emergency resources.
- A ***disaster*** is a situation in which the community is incapable of coping. It is a natural or human-caused event which causes intense negative impacts on people, goods, services and/or the environment, exceeding the affected community's capability to respond; therefore the community seeks the assistance of government and international agencies.

**Natural Disasters**

A natural disaster is an event caused by natural forces of nature that often has a significant effect on human populations. Typically the human populations either are displaced (left homeless) or killed. **Natural disasters** are the effect of a natural hazard (e.g. flood, tornado, hurricane, volcanic eruption, earthquake or landslide) that affects the environment, and leads to financial, environmental and/or human losses.

Natural disasters occur due to the activities of nature:

- Weather disasters occur due to changes in atmospheric conditions
- Land disasters are primarily due to changes in the earth's crust. For example volcanoes and earthquakes.
- Water disasters: often are combination of both at above

**Tornado**

**Flood**

**Volcano Eruption**

**Man made hazard** is a threat having an element of human intent, negligence, or error, or involving a failure of a man-made system. **Man-made disasters** are disasters resulting from the same factors.

**Chemical disaster** **Fire**

1. **Flood:** The term = flood'is a general or temporary condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waters or from the unusual and rapid accumulation or runoff of surface waters from any source. Flooding and flash flooding are the deadliest of natural disasters. Floodwaters claim thousands of lives every year and render millions homeless. One of the more frightening things about flooding is that it can occur nearly anywhere, at any time. It can result from excess water jams on rivers, even moderate rain, or a single very heavy downpour as it occurred in Himachal Pradesh recently.

**Floods**

Many states in our country are flood prone due to heavy rain or otherwise. The flood causes loss to human life and wide spread damage to property. Unimaginable damage to agriculture takes place affecting the States planning and upset the financial budgeting there by slowing down the whole economy of the country.

People not affected by the flood tend to ignore the event thinking that it does not affect them so why bother?

Flood is not unique to our country. Floods come in different parts of the world. Floods are the biggest cause of loss of life every year through out globe. Majority of countries do not document or map floods methodically. People are generally taken by surprise by the floods as they may come in the night when every body is asleep, giving very little time for evacuation. Water remains stag anent after the flood recedes, source of drinking water get polluted and the food get spoiled. People are left with no resource to combat the natural calamity that has take place. Floods are ugly part of our system we cannot ignore or wish them away. The only way to fight the floods is to try to predict the flood, prepare for it, train and educate people. Identify those areas, which are flood prone.

2 **Flash Flood:** Flash flood is a rapid flooding of geomorphic low-lying areas - washes, rivers, dry lakes and basins. Flash flooding occurs when a barrier holding back water fails or when water falls too quickly on saturated soil or dry soil that has poor absorption ability.

**Flash Flood**

It may be caused by heavy rain associated with a storm, hurricane, or tropical storm or melt water from ice or snow flowing over ice sheets or snowfields. Flash can also occur after

the collapse of a natural ice or debris dam, or a human structure such as a man- made dams. Flash floods are distinguished from a regular flood by a timescale less than six hours.

3. **A cloudburst** is an extreme form of rainfall, sometimes mixed with hail and thunder, which normally lasts no longer than a few minutes but is capable of creating flood conditions. Basically it is an intense and very heavy rain that lasts a relatively short time.

**Cloud Burst**

The usual reason is that the updraft in the storm initially holds up a lot of the rain and hail, but after a time the updraft weakens, allowing all this rain and sometimes hail to suddenly fall to the ground. Cloud bursts are a result of sudden collisions of two or more clouds it results in a very heavy rain fall (its called so because the rainfall is not expected at that moment).

Cloudbursts descend from very high clouds, sometimes with tops above 15 kilometers. Meteorologists say the rain from a cloudburst is usually of the shower type with a fall rate equal to or greater than 100 mm per hour.

During a cloudburst, more than 2 cm of rain may fall in a few minutes. When there are instances of cloudbursts, the results can be disastrous. Rapid precipitation from cumulonimbus clouds is possible due to so called Langmuir precipitation process in which large droplets can grow rapidly by coagulating with smaller droplets which fall down slowly.

**Record Cloudbursts**

| Duration | Rainfall (mm) | Location | Date |
|---|---|---|---|
| 1 minute | 38.10 | Barst, Guadeloupe | 26 November, 1970 |
| 5 minutes | 61.72 | Port Bells, Panama | 29 November, 1911 |
| 15 minutes | 198.12 | Plumb Point, Jamaica | 12 May, 1916 |
| 20 minutes | 205.74 | Curtea-de-Arges, Romania | 7 July, 1947 |
| 40 minutes | 234.95 | Guinea, Virginia, USA | 24 August, 1906 |

**Cloudbursts in the Indian subcontinent**

In the Indian subcontinent, a cloudburst usually occurs when a pregnant monsoon cloud drifts northwards, from the Bay of Bengal or Arabian Sea across the plains, then onto the Himalaya and bursts, bringing rainfall as high as 75 mm per hour.

An example was the sudden cloud burst over the Indian city of Mumbai and other regions of western India, on 26 July 2005, during the 2005 Maharashtra floods. Approximately 950 mm of rainfall was recorded in Mumbai over a span of eight to ten hours; the deluge completely paralyzed India's largest city and financial centre.

Cloudbursts frequently occur in Himachal Pradesh during the monsoon. The monsoon rains during July and August put a lot of water into the Himalayan soil. On 5th August, 2010, sudden overnight rains due to cloud burst caused flash floods in the town of Leh, the administrative center of the mountainous northern Ladakh region that borders China and Pakistan, killing more than 100 people and leaving hundreds injured. IMD described it as a ‗disastrous weather event' in which -rate of rainfall may be of the order of 100 mm per hour.

**Many buildings crumbled after sudden rains and flash floods in Ladakh**

**4 .Drought:**
**Drought Occurs When Human Demand for Water Exceeds the Available Supply**

Droughts can be of four kinds:

**(i) Meteorological drought:** This happens when the actual rainfall in an area is significantly less than the climatological mean of that area. The country as a whole may have a normal monsoon, but different meteorological districts and sub-divisions can have below normal rainfall. The rainfall categories for smaller areas are defined by their deviation from a meteorological area's normal rainfall-

- Excess: 20 per cent or more above normal
- Normal: 19 per cent above normal - 19 per cent below normal
- Deficient: 20 per cent below normal - 59 per cent below normal
- Scanty: 60 per cent or more below normal

**(ii) Hydrological drought:** A marked depletion of surface water causing very low stream flow and drying of lakes, rivers and reservoirs

**(iii) Agricultural drought:** Inadequate soil moisture resulting in acute crop stress and fall in agricultural productivity

**(iv) Economic drought:** Type of drought when a period of below-average precipitation of sufficient magnitude to have substantial impacts on the local and regional economy.

**Drought consequences**

- During the year (2001-02), 19 per cent of India's land area experienced 'moderate drought' ; 10 per cent suffered 'severe drought'
- Rainfall in July (most important for agriculture) was 49 per cent 'deficient'. The last time this figure fell below 45 per cent was in 1911
- When there is more than 10 per cent rainfall deficiency, and more than 20 per cent of the area of the country is under drought, the situation is called "all-India drought"
- In 2002, rainfall deficiency was 19 and 29 per cent of India was under drought.

| Meteorological Sub-Division | Rainfall (% below normal) |
|---|---|
| **SEVERE DROUGHT** | |
| West Rajasthan | -71 |
| East Rajasthan | -60 |
| **MODERATE DROUGHT** | -36 |
| Haryana | -36 |
| Chandigarh | -36 |
| Delhi | -36 |
| Punjab | -26 |
| Coastal Andhra Pradesh Rayalseema | -33 |
| North Interior Karnataka | -31 |
| South Interior Karnataka | -44 |
| Coastal Karnataka | -30 |
| Tamil Nadu | -45 |
| Kerala | -35 |
| Lakshadweep | -45 |

*Source:* Down to Earth, January 15, 2003

**Drought 2000-2001**

During the drought of 2000-2001, a total of eight states have fallen foul of the rain gods. These included Gujarat, Madhya Pradesh, Orissa, Rajasthan, Chattisgarh, Himachal Pradesh, Maharashtra and Tehri Garhwal districts in Uttaranchal. Some states were in their second, or third consecutive year of drought.

**Frightening figures: States hit by drought**

- Chhattisgarh: 10,252 villages in 12 of 16 districts, 9,400,000 people affected.
- Gujarat: 12,240 villages in 22 of 25 districts, 29,100,000 people, 107,00,000 cattle.
- Madhya Pradesh: 22,490 villages in 32 of 45 districts, 12,700,000 people, 8,570,000 cattle.
- Orissa: 15,000 villages in 28 of 30 districts, 11900,000 people, 39900,000 cattle.
- Rajasthan: 31,000 villages in 31 of 32 districts, 33,000,000 people, 39,900,000 cattle.
- Himachal Pradesh: All 12 districts affected, 4600,000 people, 88,000 hectare of crop area.
- Maharashtra: 20,000 villages in 26 of 35 districts, 45,500,000 people, 258,000 cattle.
- Uttaranchal: One district affected.

In the 70 important water reservoirs in India, the storage position is officiallydescribed as the lowest in a decade. Ground water levels have fallen considerably in the eight drought hit states. In a number of districts, says the nodal agriculture ministry, the fall in water levels is at the rate of over 2 meters a year- this includes eight districts in Chattisgarh, 13 in Gujarat, 30 in Madhya Pradesh, 18 in Orissa and 15 in Rajasthan.

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## Lecture 25

## CYCLONES, EARTHQUAKES, LANDSLIDES AND AVALANCHES

### Cyclones

Winds may be classified into four major types: the prevailing winds, the seasonal winds, the local winds and the cyclone and anticyclonic winds, including cyclones, typhoons, hurricanes and tornadoes.

Typhoon comes from the urdu and Chinese word meaning great wind. Typhoons occur in the northwestern Pacific Ocean and move towards East Asia. Cyclone comes from the Greek word kyklon, meaning moving in a 'circle, whirling around.

In meteorology, Cyclone is an area of low atmospheric pressure surrounded by a wind system blowing in an anticlock wise direction. A wind system blowing around a corresponding high-pressure area with clockwise winds is known as anticyclone. In the southern hemisphere these wind directions are reversed. Cyclones are normally called as lows and anticyclones highs. The term cyclone has often been more loosely applied to a storm and disturbance attending such pressure systems, particularly violent tropical hurricanes and typhoons, which center on areas of unusually low pressure. The eye is a region of mostly calm weather at the center of strong tropical cyclones. The eye of a storm is a roughly circular area, typically 30–65 kilometers (19–40 miles) in diameter. It is surrounded by the eyewall, a ring of towering thunderstorms where the most severe weather and highest winds occur. The climate of Bengal is humid and tropical. The mean annual temperature is about 25oC.Rainfall is heavy, ranging from about 1270mm to more than 3050mm annually. During the rainy season, from June to October, cyclones from the Bay of Bengal and floods are common. Ganges has been adversely affected by the deforestation of valleys in its upper course, causing flooding and an increase in sedimentation.

Cyclones are strong spiraling winds characterized by a low pressure and numerous thunderstorms. Here is the list of strong tropical cyclones in India including Cyclone Thane, Cyclone Mora, Cyclone Megh, Cyclone Jal, Cyclone Roanu, Cyclone Lehar, Cyclone Nargis, Cyclone Mala and Cyclone Giri.

**Recent Cyclone in India 2018 and 2019**

Year 2018 was the Indian Ocean cyclone season and the most tropical cyclones form in the northern Indian Ocean.

**Kyarr and Maha 2019 ( Vayu and Hikka)**

Kyarr and Maha are the 2 cyclones at same time developed over the past 10 days in the Arabian Sea. Cyclone Kyarr moved towards the towards the Gulf of Aden from Indian coast while cyclone Maha is coming to the west coast of India, There have been four cyclones in the Arabian in 2019 – Vayu, Hikka, Kyarr and now Maha.

**Cyclone Vayu**

Cyclone Vayu in northwestern India caused moderate damage in the states, form in the Arabian Sea and did damage in the state of Gujarat.

**Cyclone Fani – 2019**

Cyclone Fani is Extremely Severe cyclone and storm in the shape of hood of a snake, threatening Indian states of Odisha and Andhra Pradesh and the first severe cyclonic storm of the 2019 in India.

**Cyclone Phethai – 2018**

Cyclone Phethai is part of the ongoing 2018 North Indian Ocean cyclone season over the Bay of Bengal

**Cyclone Gaja – 2018**

Cyclone Gaja hit the Tamil Nadu, Andhra Pradesh and some parts of coastal Puducherry with heavy rainfall in Cuddalore and Pamban.

**Cyclone Titli – 2018**

Very severe cyclonic storm Titli was part of the 2018 North Indian Ocean cyclone season and makes landfall in Odisha's Gopalpur and Srikakulam of Andhra Pradesh.

**Cyclone Fani – 2019**

Severe cyclone hits and damages the Orissa state.

**Earthquakes**

An **earthquake** is a sudden movement or trembling of the ground caused by the abrupt displacement of rock masses. It is also caused by the release of energy that has accumulated over a long time. Most earthquakes occur at the boundaries where the plates of the Earth's outer layer meet. In fact, the location of earthquakes and the kind of ruptures they produce help scientists define the plate boundaries. Most destructive quakes, however, are caused by dislocations of the crust. The crust may bend and then, when the stress exceeds the strength of the rocks, break and "snap" to a new position.

It is a sudden shake of the Earth's crust caused by the tectonic plates colliding. The vibrations may vary in magnitude. The underground point of origin of the earthquake is called the "focus". The point directly above the focus on the surface is called the "epicenter". Earthquakes by themselves rarely kill people or wildlife. It is usually the secondary events that they trigger, such as building collapse, fires, tsunamis (seismic sea waves) and volcanoes, that are actually the human disaster. Many of these could possibly be avoided by better construction, safety systems, early warning and evacuation planning. Earthquakes are caused by the discharge of energy accumulated along geologic fault.

Natural earthquake is caused by endogenic forces like volcanic, tectonic, isostatic and plutonic.

**Causes of earthquake**

The causes of earthquake include the volcanic eruption, faulting and folding, upwarping and downwarping, hydrostatic pressure of water bodies and the plate movements.

**Magnitude of the earthquake:**

The magnitude or intensity of energy released in the earthquake is measured by Richter scale derived by Charles F.Richter (1935).

**Earthquake Prediction**

From a geologic perspective we can predict where most earthquakes will occur: along the plate boundaries. We can also predict the average rate of occurrence (over millions of years). Such predictions are not terribly useful for society, although they are not without

value since they indicate our understanding of the basic processes of earthquakes. However, although predicting the exact time of an earthquake would be valuable, it does not solve all of our problems.

The best preparation for earthquakes is adequate building construction. The information scientists try to provide is the level of shaking expected in a given region. We try to map the surficial geology, the potential size and location of earthquakes. In essence, long-term preparation guided by predictions of the potential level of shaking in a region is the best way to prepare for earthquakes.

Earthquakes may occur in an area before, during, and after a volcanic eruption, but they are not the cause or result of volcanic activity; rather they are the result of the active forces connected with the volcanic eruption. The vibrations produced by earthquakes are detected, recorded, and measured by instruments called seismographs. The jagged line made by a seismograph—called a seismogram—reflects the changing intensity of the vibrations by responding to the motion of the ground surface beneath the instrument. From the data expressed in seismograms, scientists can determine the time, the epicenter, the focal depth, and the type of faulting of an earthquake and can also estimate how much energy was released.

The Richter scale is the best-known scale for measuring the magnitude of earthquakes.

The scale is logarithmic, so a recording of 7, for example, indicates a disturbance with ground motion 10 times as large as a recording of 6.

A quake of magnitude 2 is the smallest quake normally felt by people.

Earthquakes with a magnitude of 6 or more are considered major; great earthquakes have magnitudes of 8 or more.

Initial effects of an earthquake are violent ground motions which can produce cracks or fractures in the ground and liquefaction, where loose sandy soils with a high moisture content separate and give the surface a consistency much like that of quicksand. As destructive as earthquakes are, the resulting secondary effects such as landslides, tsunamis, fires, and floods can be even more devastating.

**Some of the significant earthquakes**:

The Latur (Killari), Maharashtra, earthquake of September 30, 1993 is the most devastating SCR earthquake in the world. Its epicentre was located in a region considered to be aseismic. This earthquake occurred in the typical rural setting of India. The severity of the destruction was compounded by the nature of 4 village settlements. While most of the engineered structures survived the earthquake, the non-engineered ones were totally damaged.

Over 10,000 lives were lost in this earthquake and several villages were destroyed. With a magnitude 6.3 and focal depth less than 10 km, this earthquake is similar to other moderate events in the Australian and Canadian shields. It is suggested that the repeat time of moderate SCR earthquakes are of the order of hundreds of thousands of years. The recurrence interval at Latur may also be of the same order, and the recorded human history may not document any previous earthquakes. Thus, we have very little information about the earthquake history of such regions and the earthquakes occur as a total surprise. This event led to several studies, giving a new perspective to seismic hazard assessment in the peninsular India. It also led to strengthening of the seismic network, upgrading several existing facilities. The worst earthquake in the world poses little risk if no one lives in or uses the region that is affected. The consequences of earthquake activity in December 2003 exemplify this point. On December 22 of that year, a magnitude 6.5 earthquake in central California killed two people and severely damaged 40 buildings. Four days later, a magnitude 6.6 earthquake near Bam, Iran, killed 30,000 people, injured another 30,000 and damaged approximately 85% of all buildings and infrastructure.

The 2004 Indian Ocean earthquake, the third largest earthquake in recorded history, registering a moment magnitude of 9.1-9.3. The huge tsunamis triggered by this earthquake cost the lives of at least 229,000 people.

- The 7.6-7.7 2005 Kashmir earthquake, which cost 79,000 lives in Pakistan.
- The 7.7 magnitude July 2006 Java earthquake, which also triggered tsunamis.
- The 7.9 magnitude May 12, 2008 Sichuan earthquake in Sichuan Province, China. Death toll at over 61,150 as of May 27, 2008.
- Bhuj earthquake occurred during the year 2001

**Landslides**

Landslides are downward flows of rock, dirt, and other materials. Landslides can cause a great deal of damage, especially when they are large, and they are a geological hazard of concern around the world, as they can happen anywhere and at any time. A number of steps can be taken to prevent landslides and reduce their severity, and these steps are often used in areas where landslides are common, such as the infamous Devil's Slide in California.

In a landslide, the materials are dry, and can include rocks, dirt, trees, and structures which happen to be pulled along with the falling material. Landslides are second only to earthquakes in terms of financial loss. Landslides are a part of natural erosion processes, but can also be influenced by human design and construction. Landslides can be caused by earthquake, destabilization as a result of water flowing underground, the collapse of overhanging rocks, and the simple battle with gravity. Human activities such as heavy construction, undermining of the earth, and stripping groundcover like plants and trees can also trigger landslides. When a landslide involves mud and wet material, it is known as a mudslide; mudslides can follow storms and floods.

The steepness of a slope is the most significant factor that contribute to land-sliding. Other factors such as soil type, water content, rock type, and bedding orientation (sedimentary rocks) can influence the tendency to slide. Human landscaping can also upset the stability of a slope. We must be careful when altering the slope of hills (where we like to build) and insure that the region is well drained and well supported.

**Surface Subsidence**

In some regions, the extraction of groundwater (or petroleum) has produced tens of feet of subsidence. If you recall, much of the available fresh water is stored beneath Earth's surface, in the pore-spaces of rocks. We often tap those resources and drain the water for drinking, irrigation, etc. If we pull something out of the ground, and don't replace it the weight of the overlying material will cause subsidence.

Another cause of surface subsidence is the natural dissolution of limestone. Limestone (which is very common in this area) slowly dissolves in water. The result is the formation of caves. At times, the collapse of the cave roof may cause near-surface subsidence called **sink holes**. Sink holes can be large and form suddenly, swallowing human structures in the process. Most often the process is slow and the features are more stable (on our time scales).

**Effects of landslide**

The effects of landslide include the killing of human, Destruction of structure, Blockage of roads, Cutting of supply lines, Blockage of river passage causing flood and the Denudation of land.

**Landslides in India**

Landslides are one of the natural hazards that affect at least 5% of land area in India exceeding 0.49 million km2. Landslides of different types occur frequently in geodynamically active domains in Himalaya, Northeastern India as also in stable domains in Western Ghats and Nilgiri Hills of southern India. Some of the worst landslides happened in India are Great Malpa Rock Avalanche of 1998, the Alaknanda Tragedy of 1970 and Amboori landslide of Kerala of 2001, which are still fresh in the minds of people as nightmares.

Uttarakhand and Himachal Pradesh Starting August 4,2012 incessant rain battered the Northern states Of Uttarakhand, Himachal Pradesh and Jammu, triggering landslides, cloud bursts and flash floods At least 34 people were killed and hundreds made homeless as reported in Times of India dated 6, August 2012. A large number of people have been affected after flash flooding of the river Bhagirathi triggered by a cloudburst near Uttarkashi town in India's hilly Uttarakhand state. More than 200 families living near the river were evacuated. In Uttarkashi alone, 31 people were killed and six were still missing following heavy rains," Twenty three workers of the state-run UJVN Ltd's Assi Ganga hydel project were missing following a cloudburst in the upper hills of Uttarkashi district and were declared dead. Landslides are most common in the state of Uttarakhand.

**Avalanches**

Avalanche is a type of snow slide. The mass of snow, ice, and rocks falling rapidly down a mountainside. Technically, an avalanche is any amount of snow sliding down a mountainside. It can be compared to a landslide, only with snow instead of earth.

Another common term for avalanche is “snowslide”. As an avalanche becomes nearer to the bottom of the slope, it gains speed and power, this can cause even the smallest of snowslides to be a major disaster.

There are four types of avalanches namely Slab Avalanche, Loose Snow Avalanche, Cornice Fall Avalanches and wet avalanche. Badrinath a holy town of uttarkhand is prone to Avalanches.

Avalanches have always occurred in the mountainous regions of the world though with the growth of winter-time recreations, fatalities have been on the rise since the 1950s. Avalanches claim over 150 lives each year worldwide and hundreds more are injured or trapped following an avalanche.9Ninety percent of all avalanches occur on moderate slopes with an angle of 30° to 45° (snow tends not to accumulate on steeper slopes). Avalanches occur when the gravity pushing the collection of snow at the top of the slope is greater than the strength of the snow itself. Conditions affecting stability include the gravitational force component of the snow and resisting forces, such as the frictional resistance of the slope or the anchoring effect of shrubs. In general, avalanches are caused when this balance is lost and when the forces exceed the resistance. Avalanches are rarely observed closely since they normally occur during a short time period of one or two minutes. A change in temperature, a loud noise, or vibrations are all that are necessary to trigger one of these snowfalls that begin at a "starting zone." The avalanche continues downslope along the "track" and ultimately the avalanche fans out and settles in the "runout zone."

**Major Causes** - Major causes of avalanches can be classified into fixed (prime factors) and variable factors (exciting factors), such as weather conditions and the weight of the snow cover, Avalanches occur when these factors are combined. The types and scale of avalanches can differ depending on the combination of these various factors and their scale. Major prime factors and exciting factors are shown in the following table.

Internationally, the Alpine countries of France, Austria, Switzerland, and Italy experience the greatest number of avalanches and loss of life annually. The states of Colorado, Alaska, and Utah are the deadliest.

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**Lecture 26**

# VOLCANIC ERUPTIONS, HEAT AND COLD WAVES, CLIMATIC CHANGE: GLOBAL WARMING, SEA LEVEL RISE, OZONE DEPLETION

Volcano is a burst or rupture in the earth's crust, that allows hot lava, volcanic ash, and gases to escape from a magma chamber below the surface. Earth's volcanoes occur because its crust is broken into 17 major, rigid tectonic plates that float on a hotter, softer layer in its mantle. The term *volcano* means the vent from which magma and other substances erupt to the surface. Volcanoes are closely connected with plate tectonic activity.

Regions prone to volcanic eruptions includes: Japan, Iceland, Hawaiian Islands

Volcanic eruptions occurs through three major mechanism

- ✓ Magmatic eruptions - gas release under decompression
- ✓ Phreatomagmatic eruptions - thermal contraction from chilling on contact with water
- ✓ Phreatic eruptions - Ejection of entrained particles during steam eruptions

Based on the activity, they are categorized into two

- ✓ Explosive eruptions – Characterized by gas-driven explosions that propels magma and tephra
- ✓ Effusive eruptions - Characterized by the outpouring of lava without significant explosive eruptions

**Types of volcanoes**

- ✓ Strombolian
- ✓ Vulcanian
- ✓ Peléan
- ✓ Vesuvian
- ✓ Hawaiian
- ✓ Phreatic
- ✓ Plinian

**Primary Volcanic Hazards -** Lava flows; Pyroclastic flows

**Secondary Volcanic Hazards –** Lahars; Ash falls; Landslides

**Heat waves and Cold waves**

**Heat waves** are characterized by temperatures of 35°C (95°F) or higher, although lower temperatures accompanied by high humidity levels can also be considered a heat wave. Heat waves are the result of trapped air. Normally air circles the globe in large

prevailing winds, however if it is trapped over one region it is allowed to warm to uncharacteristic temperatures due to sunlight. The air is often trapped due to high-pressure systems. The health effects of heat waves includes

- **Heat Cramps:** Ederna (swelling) and Syncope (Fainting) generally accompanied by fever below 39*C i.e.102*F.
- **Heat Exhaustion:** Fatigue, weakness, dizziness, headache, nausea, vomiting, muscle cramps and sweating.
- **Heat Stoke:** Body temperatures of 40*C i.e. 104*F or more along with delirium, seizures or coma. This is a potential fatal condition

**Heat wave incidences**

| S.No | Year | Place of Incidence |
|---|---|---|
| 1 | 1995 | Chicago Heat wave |
| 2 | 2003 | European heat wave |
| 3 | 2003 | French Heat wave |
| 4 | 2006 | North American Heat wave |
| 5 | 2013 | London Heat wave |
| 6 | June 2019 | European Heat wave |
| 7 | July 2019 | United States Heat wave |

**Cold waves**

A **cold wave** (known in some regions as a **cold snap** or **cold spell**) is a weather phenomenon that is distinguished by a cooling of the air. A cold wave can cause **death** and injury to livestock and wildlife. Exposure to cold mandates greater caloric intake for all animals, including humans, and if a cold wave is accompanied by heavy and persistent snow, grazing animals may be unable to reach needed food and die of hypothermia or starvation.

**Incidences of cold waves for past one decade**

| S.No | Year | Place |
|---|---|---|
| 1 | 2012 | European cold wave |
| 2 | 2013 | UK Spring 2013 cold wave |
| 3 | 2014 and 2015 | North American cold wave |
| 4 | 2016 | East Asia Cold wave |
| 5 | 2017 | Canada; Northeastern and central areas of U.S |
| 6 | December 2018 | Central Russia and Kazakhstan |
| 7 | November 2019 | North American cold wave |
| 8 | May 2020 | Eastern United States |

**Heat and Cold waves - India**

A Heat Wave usually occurs during the summer season in the North-Western parts of India. The extreme temperatures and resultant atmospheric conditions adversely affect people living in these regions as they cause physiological stress, sometimes resulting in death. A cold wave can cause death and injury to **livestock and wildlife**. Exposure to cold mandates **greater caloric intake** for all animals, including humans, and if a cold wave is accompanied by heavy and persistent snow, grazing animals may be unable to reach needed food and die of hypothermia or starvation.

Heat waves periods in India: 2007, 2010, 2002, 2006, 2003, 2007, 1998, 2004, 1999

Cold Waves periods in India: 2007 and 2012

**Climatic Change: Global warming, Sea Level rise, Ozone Depletion**

Over the past 50 years, humans have changed natural ecosystems more rapidly and extensively than in any comparable period in human history. This transformation of the planet has contributed to substantial net gains in health, well-being and economic development. But, not all regions and groups of people have benefited equally from this process.

Approximately 60% of the benefits that the global ecosystem provides to support life on Earth (such as fresh water, clean air and a relatively stable climate) are being degraded or used unsustainably. In the report, scientists warn that harmful consequences of this degradation to human health are already being felt and could grow significantly worse over the next 50 years.

Global Warming is caused by trapping of infrared radiation by green house gases (GHG).Human induced global warming is real and increasing. Over 100 years, mean surface temperature of earth has increased by $0.6^0$C.The issues like global climate change and stratospheric ozone depletion and acid rain are due to the effect of air pollution. The effect of air pollutants become dangerous when the atmospheric conditions lead to Atmospheric Inversion (Temperature inversion) wherein occurs temperature increase with increase in altitude unlike normal lapse rate in temperature with altitude. Such conditions favour concentration of pollutants instead of dilution.

Sea level rise will devastate the low-lying coastal areas of the entire world. Mainland India, endowed with a long coast line of 5,700 km will not escape the wrath of the seas. The total length of the Indian coast line is actually much longer at 7,500 km when all the island territories of Andaman and Nicobar, and Lakshadweep are taken into account.

A 1 m rise in sea level say by 2100 AD will practically submerge the entire Lakshadweep group of islands and absolutely nothing can be done to save them. Let me therefore concentrate on the threats to the mainland of India, where in the absence of any preventive measures, a 1 m rise in sea level would inundate 5,763 square km of coastal land, and render 7 million people homeless.

IPCC estimates around 18 cm rises - 2030 year; 58 cm rise - 2090 year

The countries going to be affected due to rise in sea levels are Bangladesh, Egypt, Thailand, China, Denmark, Louisiana, Indonesia etc. Overall the effects are going to be complex.

Stratospheric ozone depletion is a concern because the ozone layer in the stratosphere keeps 95-99% of the sun's ultraviolet radiation from striking the earth. A number of consequences can result from increased levels of UV (ultraviolet radiation) striking the earth, including: genetic damage, eye damage and damage to marine life. Increased UV radiation in the lower atmosphere, called the troposphere, can result in increased amounts of photochemical smog. Photochemical smog is already a health hazard in many of the world's largest cities.

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## Lecture 27

# MANMADE DISASTER - BUILDING FIRE, COAL FIRE, OIL FIRE, FOREST FIRE AND DEFORESTATION

## MANMADE DISASTER

Many kinds of human-induced hazards and disasters arise from accidents *viz.,* industrial, road, air, rail, on river or sea, building collapse, fires, mine flooding, oil spills, etc.

### Fire Risk

Fires can occur due to natural or man -made activities. Forest fires can occur due from either natural causes or human activity or combination of both. The most common fires are the residential and non-residential structural fires caused usually by human activities. Most industrial and chemical fires are triggered by human activity.

Fire can also be the secondary effect of a disaster like earthquake. Damage to natural gas and electrical systems, during an earthquake can lead to major fires and explosions.

### Building Fires

Accumulations of combustible or inflammable articles or hazardous material add to the danger. Lack of water or equipment for firefighting allows the fires to burn fiercely. Hot and dry seasons add to the possibility of fires as also the careless use of electrical equipment, naked wires and loose joints. An electric short-circuit or a spark is often responsible for large-scale fire disasters are reported every summer from many cities. A large number of building fires owe their origin to the residents smoking in bed and falling asleep while smoking. Accidents in kitchens are also among the major causes of fire in buildings.

### Coal Fires

Coal fires generally get started through negligence or ignition of combustible gases. Sometimes, soft coal (especially in deep mines or big dumps) gets so hot due to gases that it may itself start a coal fire (without an external source of fire or ignition) particularly when the atmosphere around is very hot and dry. Such occurrences are called "self- ignition".

In many areas of coal mines (e.g., Jharia in Bihar), there are underground fires burning in coal mines for decades and travelling along the coal-bearing areas below the ground. Such instances transmit considerable heat to the ground surface which often cracks and emits gases and smoke which heat and pollute the area and make it unfit for living.

**Oil Fires**

Oil fires is the term given to the category or the group of inflammable liquids such as kerosene oil, diesel, petrol, spirit, liquor, ghee, other oils, paints, tar and certain chemicals when are prone to fires. Such liquids catch fire easily through naked flame or an electric spark. Then they burn on the surface and spread out, thus spreading the flame's as well.

**Oil well fire**

Oil well fires are oil wells, commonly oil gushers that have caught on fire, and burn uncontrollably. Oil well fires can be the result of human actions, such as accidents or natural events, such as lightning. They can exist on a small scale, such as an oil field spill catching fire, or on a huge scale, as in geyser-like jets of flames from ignited high pressure oil wells.
Examples: Kuwaiti oil fires (1991); Jaipur Oil Depot Fire, 2009; Surat, Jan 5, 2013

**Gas Fires**

The increasing use of cooking gas in houses and hotels both in cylinders and through pipes is indeed a fire hazard. This gas is also used in cars, public buses in some cases.. These gases are mostly supplied in compressed form and transported by trucks. Some industrial gases are also inflammable. All these constitute a widespread fire hazard.

**Forest Fires**

Forests fires pose a threat not only to the forest wealth but also to the entire bio-diversity and the ecology of a region. During summer, when there is no rain for months, dry senescent leaves and twinges littered in the forests could burst into flames ignited by the slightest spark.

**Causes of Forest Fire**

Forest fires are caused by Natural causes as well as Manmade

**Types of Forest Fire**

There are two types of forest fire

i) Surface Fire and
ii) ii) Crown Fire

**Surface Fire**

A forest fire may burn primarily as a surface fire, spreading along the ground as the surface litter (senescent leaves and twigs and dry grasses etc) on the forest floor and is engulfed by the spreading flames.

**Crown Fire**

Here the crown of trees and shrubs burn, often sustained by a surface fire. A crown fire is particularly very dangerous in a coniferous forest because resinous material given off burning logs burn furiously. On hill slopes, if the fire starts downhill, it spreads up fast as heated air adjacent to a slope tends to flow up the slope spreading flames along with it.

Impacts of Forest Fires on Biological Environment

Forest fires also pose serious health hazards by producing smoke and noxious gases, as the events in Indonesia after the forest fires on the islands of Sumatra and Borneo in 1977 have shown. The burning of vegetation gives off not only carbon dioxide but also a host of other, noxious gases (Green house gases) such as carbon monoxide, methane, hydrocarbons, nitric oxide and nitrous oxide, that lead to global warming and ozone layer depletion. Consequently, thousands of people suffered from serious respiratory problems due to these toxic gases. Burning forests and grasslands also add to already serious threat of global warming. Recent measurement suggest that biomass burning may be a significant global source of methyl bromide, which is an ozone depleting chemical.

**Wild fire**

A **wildfire** is any uncontrolled fire that occurs in the countryside or a wilderness area. Other names such as **brush fire**, **bushfire**, **forest fire**, **grass fire**, **hill fire**, **peat fire**, **vegetation fire**, and **wildland fire** may be used to describe the same phenomenon depending on the type of vegetation being burned. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, and its ability to change direction unexpectedly and to jump gaps, such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

**Types of Wild fires**

**Ground** fires are fed by subterranean roots, duff and other buried organic matter. This fuel type is especially susceptible to ignition due to spotting. Ground fires typically burn by smoldering, and can burn slowly for days to months, such as peat fires in Kalimantan and Eastern Sumatra, Indonesia, which resulted from a rice land creation project that unintentionally drained and dried the peat.

**Crawling** or **surface** fires are fueled by low-lying vegetation such as leaf and timber litter, debris, grass, and low-lying shrubbery.

**Ladder** fires consume material between low-level vegetation and tree canopies, such as small trees, downed logs, and vines. Kudzu, Old World climbing fern, and other invasive plants that scale trees may also encourage ladder fires.

**Crown**, **canopy**, or **aerial** fires burn suspended material at the canopy level, such as tall trees, vines, and mosses. The ignition of a crown fire, termed *crowning*, is dependent on the density of the suspended material, canopy height, canopy continuity, and sufficient surface and ladder fires in order to reach the tree crowns. For example, ground-clearing fires lit by humans can spread into the Amazon rain forest, damaging ecosystems not particularly suited for heat or arid conditions.

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## Lecture 29

## ROAD ACCIDENTS, RAIL ACCIDENTS, AIR ACCIDENTS, SEA ACCIDENTS

### ROAD ACCIDENTS

Deaths due to road accidents in 2009 were reported to be 126,896 and in 2010 it increased to 133,938 which is about 5.5% over and above the previous year's deaths. Tamil Nadu, Andhra Pradesh, Maharashtra, Karnataka, and Rajasthan have accounted for 11.5%, 10.5%, 7.1%, and 6.8%, respectively, of total "Road Accident" deaths in the country. The trend is alarming and is leading to a frightening situation day by day.

| S.No | Causes of road accidents | Percentage |
|---|---|---|
| 1. | Fault of the driver | 78.5 |
| 2. | Fault of the pedestrian | 02.2 |
| 3. | Defect of motor cycle | 01.8 |
| 4. | Defect of the road | 01.3 |
| 5. | Fault of the cyclist | 01.2 |
| 6. | Weather condition | 00.8 |
| 7. | All other causes | 14.2 |

**Preventive measures for road accident**

**Vehicles**

1. Well-maintained vehicles with good breaks, lighting, tyres etc. will reduce accidents.
2. Older vehicles and highly polluting vehicles should be phased out.
3. Vehicles should be provided with seat belts and other necessary safety provisions (like airbags).

**Condition of roads**

1. Roads should be well maintained with frequent relaying of road surfaces and markings of road safety signs.
2. Provide proper footpaths for pedestrians and pedestrian crossings at intersections.
3. Provide separate lanes for slow-moving and fast-moving vehicles.
4. Roads and junctions should be wide and well lit so that visibility is good.

**Human factor**

1. Drivers can significantly contribute to reducing accidents.
2. Issuing of the driving license should be strictly based on the minimum proficiency acquired by the learners from designated driving schools.
3. Minimum qualifications should be fixed for different categories of drivers.
4. All drivers should be properly trained and should possess a valid driving license.
5. Educate the drivers and traveling public about traffic rules.
6. Carry out periodic medical checkup especially vision and hearing for the drivers.
7. Training on first aid should be compulsory along with health education and traffic education for the general public to prevent accidents.
8. Indiscriminate honking to be avoided, except as a means of greeting or in dire emergencies.

**Legislation**

1. Rules for compulsory wearing of helmets by two-wheelers and seat belts by four-wheelers must be implemented.
2. Enforce traffic rules by the concerned authorities strictly.
3. Removal of stray animals like cattle and removal of encroachments on footpath and road margins will enable smooth flow of traffic.
4. Preventing haphazard parking of vehicles on busy roads and intersections to ensure the free flow of traffic.

**Impact of road accident**

A Study conducted in 2016 by the UN Economic and Social Commission for Asia and Pacific (UNESCAP) revealed that India loses $58 billion annually due to road accidents which are worth about three per cent of the GDP. If we consider only the estimated monetary loss which is spent by the patient and his/her family in the hospital it adds up to about 2,000 crores annually.

## RAIL ACCIDENTS

Railway accidents, like accidents in the factories, in the mills, in the mines, in the streets, and in the homes, result largely from carelessness, or, perhaps, admitting ourselves to be a nation of chance-takers, we might better call it thoughtlessness. A few of the accidents result from defective track equipment, tools, machinery, or bad conditions or methods; a few, but only a few, are train accidents, such as collisions and derailments.

India wishes to create a network that will be free of train accidents by 2020 and this is a part of that aim. India has the third biggest rail network in the world. It covers at least 115,000 km in distance and has 7112 stations and 131,200 railway bridges.

**Causes of train accidents**

Train accidents occur; people are often seriously injured or even killed. Accidents involving trains are often the result of mechanical failures and human error, and often it's a combination of both. There are a variety of different reasons that these railroad accidents occur, and some of these include:

- Train conductor negligence
- Train derailment
- Improper maintenance of the train tracks
- Faulty equipment
- Collision with another train
- Collision with a car, bus or truck trying to cross train tracks
- Collapsed bridges
- Faulty train crossings

**Major train accidents in India**

- *November 20, 2016* – Over 124 people were killed and 260 injured after Indore-Rajendra Nagar Express.
- *March 20, 2015* – Dehradun-Varanasi Janta Express killed 58 people and injured 150.
- *December 28, 2013* – More than 24 people were killed when Nanded-Bangalore express train near Kothacheru railway station in Anantapur district caught fire.
- *November 27, 2013* – 26 people were killed and 13 injured when an air-conditioned coach of the Bangalore-Nanded Express train caught fire.
- *June 30, 2012* – A coach of the Delhi-Chennai Tamil Nadu Express caught fire, killing 35 passengers and injuring 25 others.

**Anti-collision devices:**

It works primarily on positioning updates provided by GPS. In this system, information is exchanged by way of radio frequency transmissions so that automatic brakes can be initiated and collisions can be prevented.

## AIR ACCIDENTS

Four major causes of accidents have been identified:

**(1) Human errors:** About 70% of accidents in aviation are attributed to human error. Inadequate supervision leads to half of the preconditions of an accident caused by human error, the other half is dependent on individual behavior and capabilities.

**(2) Mechanical failures:** Second most recurrent source of aircraft accidents is mechanical failure. (a) Pilot errors, (b) ground crew inadequacy or (c) aircraft manufacturers mistakes can bring upon mechanical failures. Mechanical failures by pilot error result due to misjudgment or ignorance of an occurrence or failing to report difficulties encountered with the aircraft.

**(3) Weather:** Weather conditions can cause aircraft accidents. Accidents due to weather circumstances are rare compared to the previous two causes. The most common variables playing a role in weather-related accidents are wind, visibility and turbulence. Training, experience and equipment of pilots are keys to success in dangerous meteorological situations

**(4) Hijacking:** An act of terrorism is, unanimously considered an act of violence against civilization to attain ideological goals. In aviation four tactics can bring upon terrorist attacks: (1) hijacking, referring to the forceful seizure of an aircraft by individuals or a group of individuals (2) suicide attack on aircraft, (3) external weapons attacking the aircraft and (4) explosive on aircraft.

**Worst accidents in Air-Travel history**

1. Tenerife Airport Disaster (1977)
2. Japan Airlines Flight 123 (1985)
3. Charkhi Dadri Mid-Air Collision (1996)
4. Turkish Airlines Flight 981 (1974)
5. American Airlines Flight 191 (1979)
6. Air India Flight 855 (1978)
7. Air India Express Flight 812 (2010)
8. American Airlines Flight 587 (2001)
9. Malaysia Airlines Flight 370 (2014)
10. China Airlines Flight 140 (1994)

## SEA ACCIDENTS

The term "marine incident" is used to denote undesirable marine events, i.e. marine accidents, incidents and near missing events. An accident is an undesired event that results in adverse consequences, for example, injury, loss of life, economic loss, environmental damage, and damage to or loss of property. Accidents are due to an unexpected combination of conditions or events.

**There may be several causes for shipping accidents**

• Natural conditions could be natural phenomena such as current, tide and tidal stream, severe wind, reduced visibility (fog, heavy snow and rain), stormy seas, darkness etc. affecting the ship or those controlling her.

• Technical failures are shortcomings within the ship, such as corrosion, steering failure, engine failure, or hull failure arising from defective materials or construction, or by the shore-based installations, such as aids to navigation.

• Route conditions may include navigational error like over-reliance on inaccurate nautical charts, charts of suspect reliability or based upon old surveys, narrow channels with abrupt and angular windings, allowing for very limited maneuverability and exposed to dense marine traffic, such as the Turkish Straits, anchorage contiguous to traffic separation lanes, confined marine areas with insufficient sea- room as well as navigational hazards such as shoals, reefs, wrecks etc.

• Ship-related factors could be the weakness of a ship, associated with her larger size, hence less maneuvering capability and stability or draught constraints.

• Human errors may include, inter alia, a lack of adequate knowledge and experience, technical inability, bad look-out, not paying proper attention to procedures and rules, carelessness in commanding a ship, misinterpretations of radar information, fatigue and lack of alertness, overworking, tiredness, insufficient rest periods, etc.

• Cargo-related factors mostly include dangerous goods and heavy cargoes; i.e. their hazardous characteristics (oils, chemicals, nuclear substances), the place/compartment they are stowed onboard ships (on deck or under deck), and degree of diligence that such cargoes need (grain, timber), all of which are related to ships' seaworthiness.

Oil may impact an environment by one or more of the following mechanisms;

- Physical smothering with an impact on physiological functions;
- Chemical toxicity giving rise to lethal or sub-lethal effects or causing impairment of cellular functions;
- Ecological changes, primarily the loss of key organisms from a community and the takeover of habitats by opportunistic species;
- Indirect effects, such as the loss of habitat or shelter and the consequent elimination of ecologically important species.

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**Lecture 30**

# DISASTER MANAGEMENT - EFFECT TO MITIGATE NATURAL DISASTER AT NATIONAL AND GLOBAL LEVELS

## Disaster Management

As per Disaster Management Act, 2005, "disaster management" means a continuous and integrated process of planning, organizing, coordinating and implementing measures which are necessary or expedient for:

(i) Prevention of danger or threat of any disaster

(ii) Mitigation or reduction of risk of any disaster or its severity or consequences

(iii) Capacity-building

(iv) Preparedness to deal with any disaster

(v) Prompt response to any threatening disaster situation or disaster

(vi) Assessing the severity or magnitude of effects of any disaster; evacuation, rescue and relief

(vii) Rehabilitation and reconstruction

## Disaster Management Cycle

The traditional approach to disaster management has been to regard it as a number of phased sequences of action or a continuum. These can be represented as a disaster management cycle. The basic disaster management cycle consist of six main activities There are no standardized rules defining the different phases of the disaster management cycle. Below figure illustrates the phases of the disaster management cycle, which are described as follows:

**The Disaster Management Cycle**

**Mitigation:** any activity that reduces either the chance of a hazard taking place or a hazard turning into a disaster.

**Risk reduction:** anticipatory measures and actions that seek to avoid future risks as a result of a disaster.

**Prevention:** avoiding a disaster even at the eleventh hour.

**Preparedness:** plans or preparations made to save lives or property, and help the response and rescue service operations. This phase covers implementation/operation, early warning systems and capacity building so the population will react appropriately when an early warning is issued.

**Response:** includes actions taken to save lives and prevent property damage, and to preserve the environment during emergencies or disasters. The response phase is the implementation of action plans.

**Recovery:** includes actions that assist a community to return to a sense of normalcy after a disaster.

**Disaster Management in India**

**Disaster Management Act:**

The States have been advised to enact Disaster Management Acts to provide for authorities coordinating mitigation, preparedness and response as well as for various mitigation/preparedness measures required to be undertaken.

The Disaster Management Act was enacted on 23rd December, 2005. The Act provides for establishment of

- NDMA (National Disaster Management Authority)
- SDMA (State Disaster Management Authority)
- DDMA (District Disaster Management Authority)
- NIDM (National Institute of Disaster Management)
- NDRF (National Disaster Response Force)

**National Disaster Management Authority**

The **National Disaster Management Authority** (NDMA), headed by the Prime Minister of India, is the Apex Body for Disaster Management in India. The setting up of the NDMA and the creation of an enabling environment for institutional mechanisms at the State and District levels are mandated by the Disaster Management Act, 2005.

**Roles and responsibilities**

- Lay down policies on disaster management;
- Approve the national plan;
- Approve plans prepared by the ministries or departments of the government of India in accordance with the national plan;
- Lay down guidelines to be followed by the state authorities in drawing up the state plan;
- Lay down guidelines to be followed by the different ministries or departments of the Government of India for the Purpose of integrating the measures for prevention of disaster or the mitigation of its effects in their development plans and projects;
- Coordinate the enforcement and implementation of the policy and plan for disaster management;
- Recommend provision of funds for the purpose of mitigation;
- Provide such support to other countries affected by major disasters as may be determined by the central government;
- Take such other measures for the prevention of disaster, or the mitigation, or preparedness and capacity building for dealing with the threatening disaster situation or disaster as it may consider necessary;
- Lay down broad policies and guidelines for the functioning of the National Institute of Disaster Management.

**KEY NATIONAL LEVEL DECISION MAKING BODIES FOR DISASTER MANAGEMENT**

| S.No | Name | Composition | Vital role |
|---|---|---|---|
| **1.** | Cabinet Committee on Security (CCS) | Prime Minister, Minister of Defence,<br><br>Minister of Finance, Minister of Home Affairs, and Minister of External Affairs | • Evaluation from a national security perspective, if an incident has potentially security implications<br><br>• Oversee all aspects of preparedness, mitigation and management of Chemical, Biological, Radiological and Nuclear (CBRN) emergencies and of disasters with security implications |
| **2.** | National Crisis Management Committee (NCMC) | • Cabinet Secretary (Chairperson)<br><br>• Secretaries of Ministries / Departments and agencies with specific DM responsibilities | • Oversee the Command, Control and Coordination of the disaster response<br><br>•Give direction to the Crisis Management Group as deemed necessary<br><br>• Give direction for specific actions to face crisis situations |

| | | | |
|---|---|---|---|
| **3.** | National Disaster Management Authority (NDMA) | • Prime Minister (Chairperson)<br>• Members (not exceeding nine, nominated by the Chairperson) | • Lay down policies, plans and guidelines for disaster management<br>• Coordinate their enforcement and implementation throughout the country<br>• Approve the NDMP and the DM plans of the respective Ministries and Departments of Government of India |
| **4.** | National Executive Committee (NEC) | • Union Home Secretary (Chairperson)<br>• Secretaries to the GOI in the Ministries / Departments of Agriculture, Atomic Energy, Defence, Drinking Water and sanitation, Environment, Forests and Climate Change Finance (Expenditure), Health and Family Welfare, Power, Rural Development, Science and Technology, Space, Telecommunications, Urban Development, Water Resources, River Development and Ganga Rejuvenation, The Chief of the Integrated Defence Staff of the Chiefs of Staff Committee, ex officio as members. | • To assist the NDMA in the discharge of its functions<br>• Preparation of the National Plan<br>• Coordinate and monitor the implementation of the National Policy<br>• Monitor the implementation of the National Plan and the plans prepared by the Ministries or Departments of the Government of India<br>• Direct any department or agency of the Govt. to make available to the NDMA or SDMAs such men, material or resources as are available with it for the purpose of emergency response, rescue and relief<br>• Ensure compliance of the directions issued by the Central Government<br>• Coordinate response in the event of any threatening disaster situation or disaster<br>• Direct the relevant Ministries / Departments of the GoI, the State Governments and the SDMAs regarding measures to be taken in response to any specific threatening disaster situation or disaster. |
| **5.** | National Disaster Response Force (NDRF) | Specially trained force headed by a Director General Structured like para military forces for rapid deployment | Provide assistance to the relevant State Government/District Administration in the event of an imminent hazard event. |
| **6.** | National Institute of Disaster Management (NIDM) | Union Home Minister; Vice Chairman, NDMA; Members including Secretaries of various nodal Ministries and Departments of Government of India and State Governments and heads of national levels scientific, research and technical organizations, besides eminent scholars, scientists and practitioners. | • Human resource development and capacity building for disaster management within the broad policies and guidelines laid down by the NDMA<br>• Design, develop and implement training programmes<br>• Undertake research<br>• Formulate and implement a comprehensive human resource development plan<br>• Provide assistance in national policy formulation, assist other research and training institutes, state governments and other organizations for successfully discharging their responsibilities |

| | | | |
|---|---|---|---|
| | | | • Develop educational materials for dissemination<br>• Promote awareness generation |
| **7.** | Crisis Manage -ment Group | Central Relief Commissioner senior officers (called nodal officers) from various concerned Ministries. | The CMG's functions are to review every year contingency plans formulated by various Ministries/Departments/Organizations in their respective sectors, measures required for Indian dealing with natural disasters coordinate the activities of the Central Ministries and the State Governments in relation to disaster preparedness and relief and to obtain information from the nodal officers on measures relating to above. |
| **8.** | Control Room (Emergen -cy Operation Room) | Central Relief Commissioner | collection and transmission of information concerning natural calamity and relief<br>keeping close contact with governments of the affected States, interaction with other Central Ministries/Departments/Organizations in connection with relief<br>maintaining records containing all relevant information relating to action points and contact points in Central Ministries etc.,<br>keeping up-to-date details of all concerned officers at the Central and State levels. |

**GLOBAL LEVELS STRATEGY FOR DISASTER MANAGEMENT**

The International Strategy for Disaster Reduction (ISDR) is an umbrella "movement" that aims to more effectively reduce the risk of disasters. Governments, non-governmental organizations, UN agencies, regional organizations, development banks, bilateral donors, academic institutes and the private sector use the ISDR to coordinate their efforts to reduce disaster risks. They share information, establish priorities and common approaches, work together to develop methods and tools, and to advocate for action globally.

The ISDR has a secretariat based in Geneva and New York, and principal regional units in Bangkok, Cairo, Nairobi and Panama. The main role of the ISDR secretariat is to promote and support the implementation of the *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters* and to support and coordinate the efforts of ISDR system partners to implement risk reduction in their areas of competence.

Secretariat activities include advocacy, network and partnership development and information generation and dissemination. The Secretariat does not directly implement programmes in countries but it encourages and assists partners to do so. The ISDR system helps to bring all parties to the table and to focus on country needs and coherent approaches, in line with what the UN reform wants to achieve.

Natural disasters are the production of variation on the earth surface. They contain characters as well as commonness and have an affiliation with each other. The origins, occurrence of natural disasters, objects damaged and the damage degree etc. are complicatedly connected with nature, technique and social-economic system. With the quick development of the economy, there is more and more damage caused by natural disaster. The new concept and strategy recently introduced in disaster prevention and mitigation by summarizing historical experiences of natural disaster management in the world are called the **Integrated Natural Disaster Risk Management (INDRM)**. This concept has been introduced to mark the last decade as the **International Decade for Natural Disaster Reduction (IDNDR)** incorporating the International Strategy for Disaster Reduction (ISDR) with other related endeavors. The Integrated Natural Disaster Risk Management means that people can recognize and assess many kinds of natural disaster risk, and deal with the risk they may meet so as to receive the biggest safe guarantee by using the lowest cost. It is a comprehensive and integrated approach that embraces the management of all types of natural disasters and all phases of disaster management cycle, focuses on disaster hazard and vulnerability, i.e. the underlying conditions of disasters, and emphasizes a multi-level, multi-dimensional, multi-disciplinary coordination among stakeholders.

During primitive age when a disaster occurred people perished in a larger scale. Mass movements in the Shaanxi Province, China during the year 1556 killed 8,30,000 people and again in the year 1920 killed 2,00,000 people. In this modern age also as was in the past, the Global wind pattern affects the landscape and people of both the northern and southern hemispheres. Climate often changes dramatically and over 99 percent of all species that have ever lived are extinct. Severe weather causes about 75% of the yearly deaths and damages from natural disasters. The people in the earth know that the existence of earth is unstable as its surface is a shell, capable of being broken and disordered by the violent movements of the fluid on which it rested. The earth is in a delicate balance, in the event of a total change in the surface happens. Knowing the dynamics of Geosphere, again and again, the people revamp as such all modern cities in the Globe are founded on ancient ruins.

Increased vulnerability is reflected in current disaster trends. In addition, the activities of Human beings in the Globe also become a cause because of which nature at times changes its routine course. All these Geological Disasters, biological and other manmade disasters affect people of various regions or nations. There is a danger that these disasters may one or other day destroy the Globe or all the life in the Globe. In such circumstances, every Government has the responsibility to plan on issues, strategy, etc., for ensuring the well beings of its citizens. As such there is a need for the United Nation to plan on issues, strategy, etc., for ensuring the well beings of people in the earth: as such there is a need for a global policy to ensure coordination among various stakeholders and also to provide **International Disaster Management Plans (IDMP)**. The policy needs to address the following:

- Developing an International Disaster Management Policy and Strategy
- Strengthening human and financial resources for Disaster Management and
- Ensuring strong Disaster Management Structures.

Therefore this study is made to take stock of the efforts of Human beings on disaster issues for a safe and secure life in the Globe.

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**Lecture 31**

# INTERNATIONAL STRATEGY FOR DISASTER REDUCTION, CONCEPT OF DISASTER MANAGEMENT, NATIONAL DISASTER MANAGEMENT FRAMEWORK; FINANCIAL ARRANGEMENTS

## Disaster Risk Reduction (DRR)

**A conceptual framework consisting of ways and means:**

- **To minimize vulnerabilities and disaster risks.**
- To avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards within the broad context of sustainable development.

## Distribution of natural disasters

- 17 July 2014; Malaysia Airlines 777-200ER; 9M-MRD; flight MH17; near Grabovo, Ukraine: The aircraft was on a scheduled international flight between Amsterdam, the Netherlands and Kuala Lumpur, Malaysia. All 283 passengers and 15 crew members were killed.
- Cyclone arrived in Khulna, Bangladesh, July2013.
- Tsunami devastated Tohoku district, Japan and other regions. Damages were inflicted in East Kanto district, too. The number of deaths is 13,802, the number of injured is 4,928, and the number of missing is 14,129 (as of April 17 at 18:00 according to the National Police Agency), 2013.
- Flood occurred in Darchula district in Nepal,2013

## International Strategy for Disaster Reduction (ISDR)

In 2005 the United Nations (UN) initiated the International Strategy for Disaster Reduction (ISDR) and adopting the Hyogo Framework for Action 2005-2015: 'Building the resilience of nations and communities to disasters'. Through these initiatives, the UN recognizes that disaster response and humanitarian relief efforts alone will not suffice. Unless the root causes of disaster impacts are recognized and addressed, adaptation is improved, and public awareness is elevated, the risks will impact beyond all possible humanitarian response and resources. Raising disaster risk awareness, promoting a culture of prevention and mobilizing adequate resources to build resilience are both an imperative and an investment in the future, with substantial returns for all.

- The International Strategy for Disaster Reduction (ISDR) aims to pursue the initiatives, co-operation, developing new mechanisms as well as pushing for further commitments from policy-makers. The overriding goal is to reduce human, social, economic and environmental losses due to natural hazards (and related technological and environmental disasters). The building of disaster resilient communities is a main objective.

**People working for the ISDR**

"The ISDR has a secretariat based in Geneva with a total of 30 people and a couple of offices in Africa, the America, Europe and a liaison office in New York, this system include UN agencies, governments, civil societies, private sector media and more all over the world."

**Objectives of the ISDR**

The ISDR promotes the following four objectives as tools towards reaching disaster reduction for all:

- Increase public awareness to understand risk, vulnerability and disaster reduction globally.
- Obtain commitment from public authorities to implement disaster reduction policies and actions
- Stimulate interdisciplinary and inter- sectoral partnerships including the expansion of risk reduction networks
- Improve scientific knowledge about disaster reduction

**Disaster Reduction : An agenda in International Progress**

- 1989: International Decade for Natural Disaster Reduction (IDNDR) 1990-1999 – promotion of disaster reduction, technical and scientific buy-in
- 1994: Yokohama Strategy and Plan of Action – Mid-review IDNDR, first blueprint for disaster reduction policy guidance (social & community orientation)
- 2000: International Strategy for Disaster Reduction (ISDR) – increased public commitment and linkage to sustainable development, enlarged networking and partnerships. Mechanisms:
- 2002: Johannesburg Plan of Implementation- Includes a new section on "An integrated, multi-hazard, inclusive approach to address vulnerability, risk assessment and disaster management…"
- 2005: Hyogo Framework for Action 2005-2015 Building the Resilience of Nations and Communities to Disasters:

**International decade for natural disaster reduction** (IDNDR)

The United Nations General Assembly designated the 1990s as the International Decade for Natural Disaster Reduction. Its basic objective was to decrease the loss of life, property destruction and social and economic disruption caused by natural disasters, such as earthquakes, tsunamis, floods, landslides, volcanic eruptions, droughts, locust infestations, and other disasters of natural origin.

**Steps carried out by ISDR**

1. Preparedness
2. Response
3. Recovery
4. Mitigation

**1. Ways for Disaster Preparedness**

- Community awareness and education.
- Proper warning system.
- Mutual aid arrangement.
- Mock drill, training practice.

**2. Disaster Response**

- Implementing the disaster management plan
- Setting up medical camps and mobilizing resources
- Providing adequate shelter and sanitary facilities
- Development of search and rescue team

**3. Disaster Recovery**

- Counseling programme for those who lost the near ones.
- Restoring services like roads, communication link.
- Providing financial support employment.
- Reconstructing damaged buildings.

**4. International strategies for disaster management (Mitigation)**

1. Change of Focus from Relief Centric to Holistic Approach.
2. Mainstreaming Disaster Management into international Developmental Programmes.
3. Empowerment of the Community to face the Disaster.
4. Emphasis on Training, Development of Human Capital and Capacity Building.
5. Key Role of Educational and Professional Institutions for Mass Education and Awareness.

6. Upgradation of the Key Responders.

7. Supporting and Enabling Mechanisms for the countries states and districts.

8. Failsafe Early Warning & Communication Systems.

9. Coordinated, Timely and Effective Response.

10. Involvement of NGOs & Corporate Sectors.

11. Time Bound Action Plan for Earthquakes, Floods & Cyclones.

12. Pro-active Participation at the Regional and International Level.

**Implementation**

- Conduct a national audit or assessment process of existing functions necessary for a comprehensive and integrated national strategy of hazard, risk and disaster prevention, projected over 5-10 and 20 year time periods.
- Conduct dynamic risk analysis with specific consideration of demographics, urban growth, and the interaction or compound relationships between natural, technological and environmental factors.
- Build, or where existing, strengthen regional/sub-regional, national and international approaches, and collaborative organizational arrangements that can increase hazard, risk and disaster prevention capabilities and activities.
- Establish coordination mechanisms for greater coherence and improved effectiveness of combined hazard, risk and disaster prevention strategies at all levels of responsibility.
- Promote and encourage know-how transfer through partnership and among countries with particular attention given in the transfer of experience amongst those countries most exposed to risks.

**National disaster management framework 2005**

- The National Disaster Management Framework-2005 has been developed by the Union Ministry of Home Affairs (MHA), the nodal agency for disaster management in India.
- NDM Framework -2005 seeks to promote a proactive approach to disaster preparedness, mitigation, and prevention.
- The framework focuses on integrating disaster management in the development agenda, establishing/enabling institutional arrangements, creating awareness for risk reduction.

- The GOI-UNDP National Disaster Risk Management Program, formulated under this framework aims to reduce vulnerabilities of communities at risk to sudden disaster in 169 of most multi-hazard prone districts spread over 17 states.
- This framework is aimed to enhance capabilities of Government institutions, communities and civil societies.

**Sections of framework**

National Disaster Management Framework -2005 comprises these sections:

- Institutional Framework
- Legal Framework
- Financial Framework
- Operational Framework

**1. Institutional framework**

Institutions under this framework sections:

- NDMA, NEC, NIDM, NDRF, National Civil Defence College, National Fire Service College, SDMA, SEC, DDMA, State Disaster Response Force, Home Guards
- A permanent and institutionalized set up began in the decade of 1990s with set up of a Disaster Management Cell under Ministry of Agriculture, following the declaration of decade of 1990 as the "International Decade for Natural Disaster Reduction (IDNDR) by United Nation".
- Disaster Management Division has been shifted under Ministry of Home affairs in 2002 and a hierarchical structure for disaster management evolved in India.

**ORGANIZATION STRUCTURE OF DISASTER MANAGEMENT:**

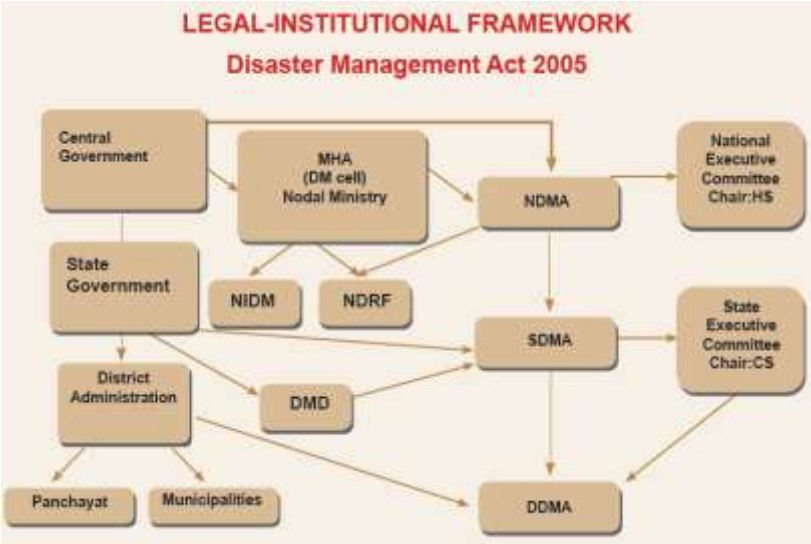
- The disaster management division is headed by Joint Secretary (DM) in Ministry of Home Affairs (MHA), who is assisted by three (3) Directors, Under secretaries, Section Officers, Technical Officers, Senior Economic Investigator, Consultant and Other Supporting Staffs
- The upper echelon of structure consists of Secretary (Border Management), Home Secretary, Ministry of State in Charge & Home Minister.

## LEGAL FRAMEWORK

**Legal Framework Section Set up & addresses:**

1. National Policy on Disaster Management
2. State Policy on Disaster Management
3. State Disaster Management Code
4. Relief Manual
5. Building Bye-laws and adoption

- Legal Framework refers to the framework of Laws, Executive Orders, and other legal instruments that sets ground rules for Government and Non-Governmental activities.
- Legal Framework defines authorities, responsibilities, and role of officials & organizations as they relates to Disaster Management.
- Legal Framework is comprised of Statutes, Executive acts/orders and implementing regulations that establishes legal authority for programs & organizations.




## FINANCIAL FRAMEWORK

Financial Framework covers these, Budgetary allocation for NDRF and SDRF Grants and Aid Project Funding Monitoring of expenditure from relief funds.

- Budgetary provision of relief funds is dealt with by Ministry of Finance, the processing of request of State Government for these funds are done by the Ministry of Home Affairs (DM Division).
- The present schemes of State Disaster Response Fund (SDRF) and National Disaster Response Fund (NDRF) are based on the recommendation of 14th Finance Commission. Further, NITI Ayog will deal with the same.

**Funds/Schemes/Projects Mandated by National Disaster Management Framework are:**

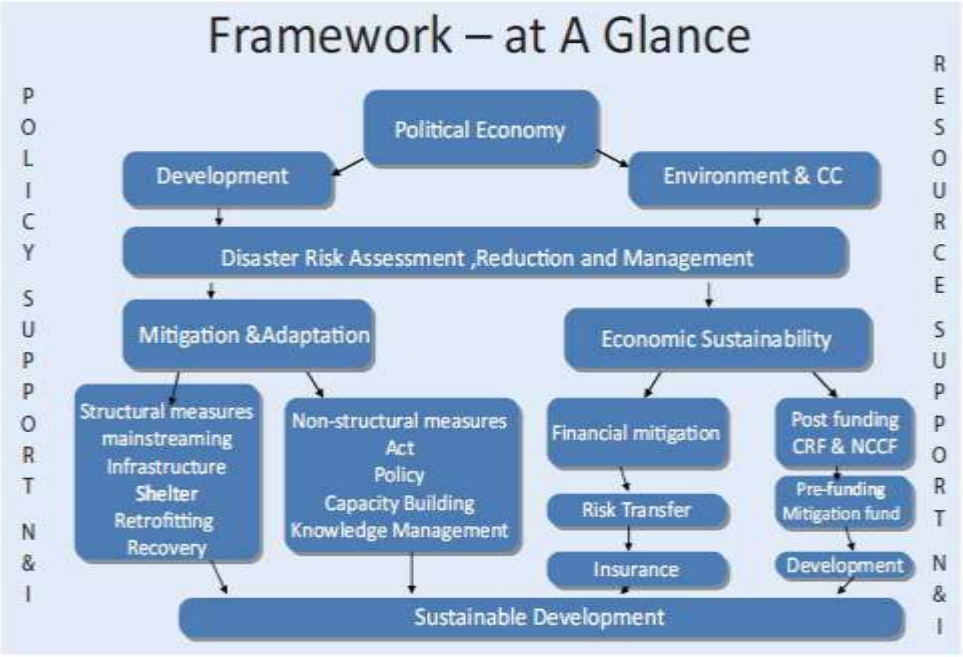
- National Disaster Response Fund
- State Disaster Response Fund
- Disaster Response Reserve
- Capacity Building Grant
- Environment Relief Fund
- Immediate Relief as per the Schedule of PLI Act 1991
- National Cyclone Risk Mitigation Project.
- UNDP-GoI Disaster Risk Reduction Program
- SAID-GoI Disaster Management Support Project

**OPERATIONAL FRAMEWORK**

Operational Framework deals with:

Preparedness, Response, Emergency Operation System, Capacity Building, SOP, Research and Knowledge Management

- Operational Framework deals with setting up of early warning system, emergency operation centers, specialist response team, regional response team, Standard Operating Procedures.
- Operational Framework also outlines roles and responsibilities of various agencies, institutions, NGOs etc.




Source: NIDM

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**Lecture 32**

# ROLE OF NGOS, COMMUNITY - BASED ORGANIZATIONS AND MEDIA IN DISASTER MANAGEMENT

## ROLE OF NON-GOVERNMENT ORGANIZATIONS IN DISASTER MANAGEMENT

### Introduction

- "NGO"s are Non – profit organizations or associations of private citizens with a common interest to assist the disaster affected people".
- NGOs play and important role in disaster response, mitigation, disaster reduction and recuse, coordination indifferent regions.
- NGO response focused on emergency food relief, temporary shelter, emergency medical aid, debris removal and habitat restoration, trauma counseling, and raising families.
- The shift is from a relief centric approach to a multidimensional endeavor involving diverse scientific, engineering financial and social processes to adopt a multi-disciplinary and multi-sectoral approach.
- Provides support like health, education, water supply and sanitation, shelter and infrastructure, NGOs are active in responding to various disasters in different phases.
- In the pre – disaster phase should include awareness generation, education, training, and formation of village level Task Force. Disaster Management Committees and Teams, development of Disaster Management Plans, conduct of mock drills, vulnerability assessment and coordination with Government and non-government agencies.
- Play a key role in the immediate aftermath of disasters by extending assistance in rescue and first aid, sanitation and hygiene, damage assessment and assistance to external agencies bringing relief materials.
- During the post disaster phase, the NGOs can take a lead by providing technical and material support for safe construction, revival of educational institutions and restoration of means of livelihood and assist the government in monitoring the pace of implementation for various reconstruction and recovery program me.
- Restoration of livelihood, food security and nutrition, environment, etc.,

- NGOs have also started to collaborate with corporate entities in Public-Private Partnership (PPP) projects and Corporate Social Responsibility (CSR) initiatives in the field of DM at State, District and Sub-district levels.
- NGOs are organizations registered under various Indian laws such as the Societies Registration Act, 1860, Section 25(1) of Companies Act, 1956 meant for non-profit companies, or Statespecific Public Charitable Trust Acts.
- NGOs have also come together through networks, coalitions and alliances so as to offer value added humanitarian services, notable examples being Voluntary Health Association of India (VHAI), Voluntary Action Network India (VANI), Sphere India, Alliance for Adaptation and Disaster Risk Reduction (AADRR), and Confederation of Voluntary Associations (COVA).

**Objective and importance of NGOs with regard to disaster**

NGOs can be different size, with different area of operation and different fields of expertise. Though organised in nature and unorganised in character, the NGO sector covers a whole range of activities, through its various types of organization. Some major types of NGOs are given as under.

**NGOs with dedicated field operations and resource backup**

These are large organization, such as the international national Red Cross society have specific areas in which they carry out field operations. They have access to large resource bases and have the capability to extend material, financial, as well as technical support and resource from all over the world and come to the rescue of the affected persons almost immediately.

**Development technology related NGOs**

These are involved in developing and propagating development technologies, such as Sulabh international, which has renowned activities in the field of low cost sanitation. These NGOs are active in times of peace, carrying out their development projects, and can be called upon at times of emergency due to natural disaster for providing the affected community with immediate physical infrastructure that they may require. When in non-disaster times their services are useful for retrofitting in areas of building technology, so as to minimize death and destruction in future disaster.

**Opportunities**

Numerous opportunities that are provided by the NGOs, as given below, which need to be optimally utilized.

- **Setting up a Functional NGO Coordination Platform during non – emergency times** will ensure that appropriate coordination happens during response operations and development interventions.
- **NGO institutional arrangements** need to be made in order to collaborate in developing the roadmap for short, medium and long term operational strategies and plans.
- **Common accessibility to disaster affected areas** can become a reality if NGOs engage with local bodies, district and State level disaster management focal points right from developing DM planning and operational strategies.
- **Focus on the most vulnerable** needs to be the approach for responding to disasters as well as reducing disaster risks. Updated information should be maintained to support this.
- **Setting and Committing to Minim um standards by NGO**: Ready and user – friendly instruments for humanitarian standards need to be adopted and contextualized as a collective initiative, along with transparency and accountability principles to be institutionalized at all levels.

**Challenges**

Key challenges and opportunities in disaster management need to be identified and steps taken for building synergy among Government and Non – Governmental Organizations (GO-NGO). Some of the challenges encountered while responding to disaster are the following:

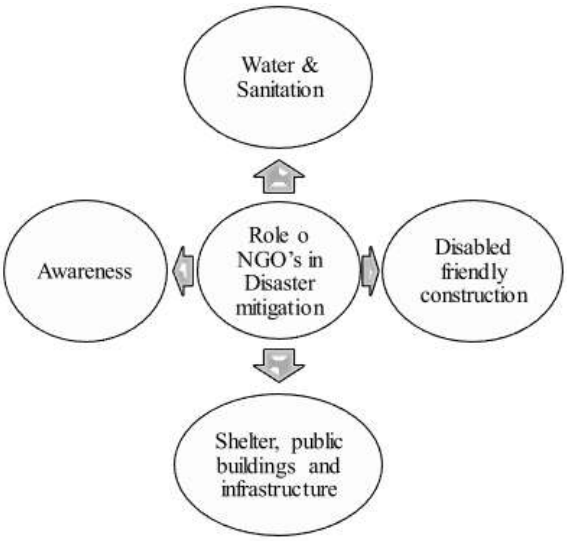
- **Weak Coordination**: Inadequate coordination among government officials and Civil Society humanitarian personnel results in weak response and suboptimal performance, as well as differences in the quality of inputs provided by different NGOs.
- **Brief time - spans for relief interventions**: Many NGOs provide relief in the first 15 to 60 days, shut down the operations and move away without any linkage to long term rehabilitation and recovery of the disaster – affected communities.
- **Neglect of remote and inaccessible disaster - affected areas**: Inadequate physical access to the affected communities and officials hampers assessments, information coordination, convergence and sustained operations.
- **Tendency to rush to the epicenter of disasters**: While the epicenters require special attention, it is also equally important to ensure that the peripheral areas impacted by disasters are not neglected or ignored while formulating intervention strategies.
- **Inadequate adherence to humanitarian standards and good practices**: In general, there is a growing realization the global instruments setting minimum standards in disaster response have not been contextualized to India.
- **Inadequate transparency and accountability to donors and disaster affected communities**: The process of disaster relief is sometimes seen as a charitable humanitarian activity which does not require the practice of transparency and accountability towards donors and disasters affected communities.
- **Neglect of Rural Urban Diversity and Primacy of Attention to Rural Areas**: The humanitarian assistance is still primarily targeted towards rural areas and the diverse needs of vulnerable urban poor are often not addressed adequately.
- **Lack of clear exit strategy during transition**: Most often, the scope and timeline of the response is not defined. When an NGO withdraws from the area, the communities are left to fend for themselves.

- **Advocacy Role of NGOs – "Do No Harm Approach"**: Development projects, if not formulated with a comprehension of disaster risk and vulnerability profiles at the local levels, can increase disaster risk and vulnerability of people, assets, environment and their livelihoods.

**Fundamental Principles of Disaster Response**

The following principles of ideal humanitarian response are largely aspirational and they reflect the good practices in humanitarian response in disaster contexts. Most governments and international, national and local level NGOs try to adhere to these principles while responding to disasters in their jurisdictions.

- Humanitarian Imperative
- Neutrality
- Transparency and openness are key neutrality
- Impartiality (non-discrimination),
- Do no harm,
- Accountability,
- Participation of affected populations.



**Water and Sanitation**

Water and sanitation are critical infrastructure elements that are needed to mitigate disasters, and are also priority needs of a community in the aftermath of a disaster. Water and sanitation needs are more critical for women, as they are directly related to reproductive health. Major areas of work in the water and sanitation sector are based in the local context, and can be addressed by NGOs to a very significant extent.

Systems should be promoted that help reduce vulnerabilities arising from poor access to water, poor water quality, poor access to toilets, vector problems, and inadequate solid waste management, sewerage and drainage. Excreta disposal is a significant source of water and sanitation related problems in the disaster context, and needs to be addressed. All these measures will be achievable in a sustainable manner only through adequate attention to the development of local human resource capacity through appropriate sensitization, education and training.

**Shelter, Public Buildings and Infrastructure**

Making existing houses and public buildings safe from disasters is a crucial component of disaster mitigation, NGOs can play pivotal role in this by sensitizing local communities and training masons and construction workers, who are mostly in the informal sector, in multi – hazard resilient construction techniques.

The first step has to be rapid assessment of structural safety of buildings, followed by retrofitting of vulnerable public buildings. Special strengthening of lifeline buildings such as hospitals, health centers, schools, disaster shelters, and buildings and infrastructure of emergency response agencies, including the restoration of amenities like power, water supply, etc., requires special attention.

At the same time, ensuring future safety of new houses and public buildings will require research, documentation and communication of appropriate materials and technologies for disaster resistant construction. Promotion of transferable indigenous technologies with appropriate adaptation and promotion of local materials and skills, and low tech, low cost technologies is very important in this process.

**Disabled – friendly Construction**

During rehabilitation and reconstruction phases, NGOs should take care of the needs of PWDs. Basic design standards for designing and planning buildings and utilities for PWDs, as per prevailing Bureau of Indian Standards (BIS) codes, must be adopted while

constructing new buildings and utilities by NGOs. Non-structural mitigation is also a very important aspect of building safety, and can avoid a very large percentage of losses and casualties. This should include heavy and hazardous building content, hazardous materials stored or used in buildings, and material with potential of falling, dislodging, flying or floating that can cause injury and damage.

**Awareness, Education and Capacity Building**

Information for mitigation purposes at community level has to be delivered in different forms, level of details and packaging for the various stakeholder groups, with a special focus on frontline workers. NGOs have a direct role in the sensitization, orientation, education and training of most of the local stakeholders, and an indirect role through advocacy for promoting education in higher and specialized levels. It should be designed to address the specific vulnerabilities of the local area, identify vulnerabilities and capacities, link local disaster management plans with development plans, and ensure disaster risk reduction mainstreaming in all development projects.

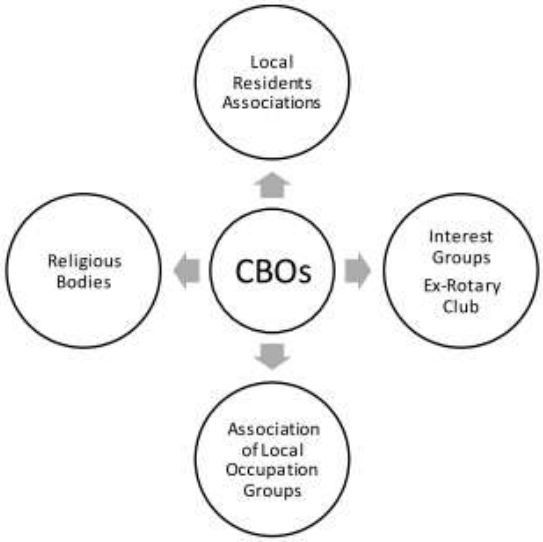
Basic awareness and sensitization of the general public is also a primary need under disaster mitigation capacity building, and is a key area of work for NGOs. Awareness campaigns on safe construction and habitat development and on sustainable development and environment friendly lifestyles are important. Sensitization events, mass media campaigns, rallies, public advertisements, messages have to be used to reach out with these issues. Special messages on radio, television, and print media are also effective and should be used. The electronic and print media can play an extremely important role in this sensitization process by raising public awareness and also by providing accurate information about alert and early warning messages issued by the concerned nodal agencies.

Education and sensitization of school children has widely been recognized as the basic building block for future risk reduction. This has to include understanding disasters, kinds of disasters, causes and impacts, vulnerability and capacity, and appropriate actions before, during and after disasters. Children also need to understand the role of various stakeholders and the steps to school safety and community safety. NGOs can influence formal education streams, and can take up informal education programmes to address this need.

Education to higher – level students is also significant and needs to include specific disaster management education relevant to the stream of higher education. Disaster mitigation inputs need to be mainstreamed in study of architecture, urban and rural

planning, natural resource management, different branches of engineering, different branches of medicine and health, social sciences, social work, media and communications, and NGOs can take up advocacy and technical support work where needed and possible.

Training to special skill holders is a context specific need that can be met very effectively by NGOs. Special skill training on disaster resistant technologies to masons and other construction workers, and health and education workers is very important. Attention needs to be paid to the inclusion of the women's work force within all these sectors. Training to community volunteers, particularly those related to development fields such as education, livelihoods, health, water and sanitation is also very important and should be taken up by NGOs in the respective areas.




NGOs will have a direct role in mobilizing, creating public awareness, providing capacity building interventions like imparting training to most of the local stakeholders including general public on DRR. NGOs will also play a major advocacy role for promoting education in DRR at higher and specialized levels. NGOs should also influence formal education streams, and take up informal education programmes for educating school children in disaster risk reduction. NGOs should complement and supplement the role of NIDM and the State.

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## Lecture 32

## ROLE OF SOCIAL MEDIA IN DISASTER MANAGEMENT

**Social Media**

- Forms of electronic communication
- Acts as a platform where people connect with each other
- Social media platforms are now a major source of news and information

**Disaster Management**

- Pre Disaster
- During Disaster
- Post Disaster

**Pre Disaster**

1. Disseminating Likely Risk Information
2. Finding DM Professionals
3. Campaigns
4. Introducing New Services for Disaster Response
5. Mainstreaming Disaster Management

**During Disaster**

1. Early Warning Dissemination
2. Search and Rescue
3. Listing Down Possible Victims
4. Crisis Response

**Post Disaster**

1. Damage Assessment
2. Finding Service Providers for Reconstruction
3. Seeking attention for Reconstruction
4. Awareness

**Application of Social Media tools across Crisis Management Phases**

Crisis management can be broadly divided into three phases:
(1) Crisis preparedness
(2) Crisis response and
(3) Crisis recovery

1. During the **crisis preparedness** phase, the focus is on preventive activities that seek to reduce known risks that could lead to a crisis. Recognising that not all crises can be averted, there would be an equal focus in this phase on crisis management planning and training of the crisis management team;
2. During **crisis response**, the focus will be on the speed and effectiveness of the initial response. There will be a need for quick situational awareness to help authorities respond effectively after the crisis hits. The effective use of social media tools will be critical during this phase to engage community networks in order to gather, analyse and disseminate information in a timely manner;

3. While the immediacy of response has passed, the **crisis recovery** phase requires longer term planning and support to restore the situation back to normalcy. Across these three stages, social media tools can be used for
    (1) Information dissemination,
    (2) Disaster planning and training,
    (3) Collaborative problem solving and decision making, and
    (4) Information gathering.

This is illustrated in Figure 1 and elaborated in the ensuing paragraphs.

Figure 1: Social Media Functions for Crisis Management

**a. Information dissemination:** Information dissemination through social media tools is an effective means to provide reliable information quickly to the public to enable them to better prepare for and respond to crises. However, the effectiveness is dependent on the reach and penetration of social media platforms across technological know-how, education, age, language and culture. As an example, the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) is able to provide early warning for rapid response to complex humanitarian emergencies based on information gathered because of OCHA's multimedia platforms such as Relief Web and the IRIN news service, which are aimed at providing more detailed analysis to a wider audience;

**b. Disaster planning and training**: Gamification leverages social media for disaster planning and training to promote personnel training, scenario planning and collaboration between various crisis management agencies from the public sector, private sector and civil society organizations. Gamification can enhance current crisis management practices through sustained stakeholder training and collaboration. In this respect, the Kenyan Red Cross and the World Bank bring together disaster relief experts and software engineers to work on identifying key challenges and to develop possible solutions through interactive discussions to overcome a range of possible scenarios related to natural disaster risk and response.

**c. Collaborative problem solving and decision making**: Crowd-sourcing using social media facilitates collaborative problem solving and decision making by integrating various streams of information from mobile and web-based technologies to fill the perceived sense-making and information gaps as well as to aggregate, analyse and plot data about urgent humanitarian needs. As the knowledge base grows, authorities become better positioned to manage and respond to a range of possible crisis-related scenarios. As an illustration, responders from the United States Institute of Peace collect information to improve their situational awareness so as to make more informed decisions on the allocation of resources based on emerging trends

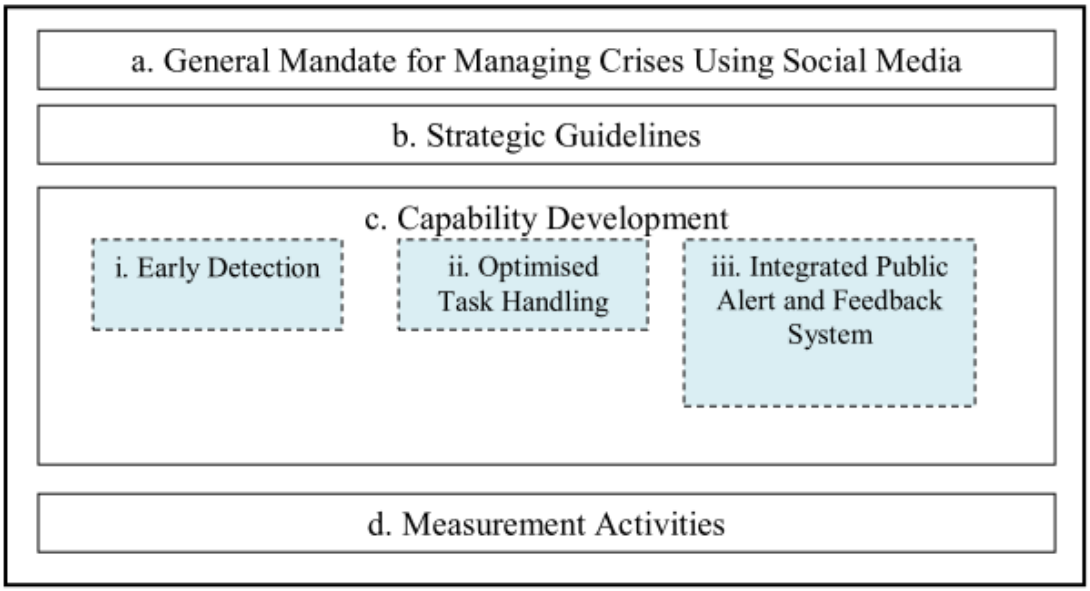
**d. Information gathering:** On-the-scene footage, citizen journalism and disaster assessment are central to information gathering for coordinating crisis response. Al Jazeera uses a community platform that leverages on email, mobile text messages and smart phone applications, to allow the public to voice their concerns, perceptions, and thoughts regarding on-going developments.

Various international organisations and government agencies have used social media platforms and technologies to enhance their capabilities in crisis management. The New York City's Office of Emergency Management for example, uses **Sahana** to manage its all hazards sheltering plan involving over 500 shelters capable of housing over 80,000 persons during a crisis. The Dutch Government, on the other hand, operates the **www.crisis.nl** as a focal point for public dissemination of information during an emergency. **Ushahidi,** downloadable software that enables people to submit eyewitness reports during a disaster that can then be displayed onto a map has been successfully deployed during the Haiti Earthquake (2010) to crowdsource data from people on the ground to aid relief efforts. **Sense Place 2** is another map-based web application that integrates multiple text sources (news, RSS, blog posts) that can then be translated onto a map to allow emergency responders to easily filter through by place or time, so as to analyse changing issues and perspectives.

## Framework to Enhance Social Media Capabilities for Crisis Management

To guide the development of capabilities in harnessing social media for crisis management, a framework to foster a more systematic and coordinated approach outlined

**Framework for Whole of Government Crisis Management using Social Media**




**The framework comprises the following elements:**

a. **General Mandate for Managing Crises Using Social Media**: Obtaining senior management buy-in on the value of harnessing social media tools as a complementary approach to Whole-of-Government (WOG) crisis management is essential to send a strong and consistent message to agencies involved in crisis-related work;

b. **Strategic Guidelines**. Establishing clear and consistent guidelines for ministries on the use of social media tools for crisis management are needed. A different and more expedited process may be needed to ensure information is put out onto the social media in a timely manner either for reassurance or to obtain critical intelligence. However, as social media is only one of the channels that may be used in a crisis and do not in any way replace existing means of communication, such process and protocols need to be harmonised;

c. **Capability Development**.

Three capabilities are identified:

i. **Early Detection.** Pre-emptive and early detection mechanisms need to be in place so that early signs of a brewing crisis can be discovered. This will require an active sense-making platform where social networks, blogs and forums are regularly monitored. Active dialogue and engagement with community and active groups on social media are also needed so that these relationships can be leveraged on during a crisis;

**ii. Optimised Task Handling**. Dedicating resources to support information dissemination, disaster planning and training, collaborative problem solving and decision making as well as information gathering within the organisation could help ensure that tasks are handled optimally from the onset of a crisis. The targeted use of social media tools could serve to complement existing analytical processes residing within ministries to enhance crisis preparedness, response and recovery efforts;

**iii. Integrated Public Alert & Feedback System**. An integrated public alert and feedback system that incorporates social media tools that allow for a seamless and straightforward communication from the government to the public and for the public to send relevant information to enhance government operations during a crisis is needed.

**d. Measurement Activities**. The use of appropriate leading indicators to monitor the application of social media tools can help guide ministries in the evaluation of existing crisis management plans that leverage on social media tools. Developing leading indicators in areas such as operational efficiency and utilization of public perspectives could provide insights into existing organizational practices and how these may be improved to enhance crisis management. Measurement approaches should be consistent within government to aid benchmarking efforts.

With increasingly more individuals using their mobile phones to go online worldwide, surpassing time spent on traditional media such as television, radio and print, it would be essential to carefully consider how social media applications can be incorporated into an integrated crisis management platform for effective crisis management. Leveraging social media technologies for crisis management provide citizens with a greater role in preparing for and managing crises which will help build resilient communities. Embracing resilience as a civic value and a social norm should ultimately be the way forward to encourage citizens to take the actions necessary to help themselves and others during times of crisis.

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## Lecture 33

## CENTRAL, STATE, DISTRICT AND LOCAL ADMINISTRATION IN DISASTER MANAGEMENT

### Disaster Management Act

The government have enacted and notified the Disaster Management Act, 2005 on December 26, 2005 to provide for institutional mechanisms for drawing up and monitoring the implementation of the disaster management plans, ensuring measure by various wings of government for prevention and mitigating effect of disaster and for undertaking a holistic, coordinated and prompt response to any disaster situation.

The Act provides for setting up of a National Disaster Management Authority (NDMA) under the chairmanship of the Prime Minister. The Union cabinet is headed by the Prime Minister, the empowered Group of Minsters Headed by the Deputy Prime Minister. National Crisis Management Committee under the chairmanship of the Cabinet Secretary. The Crisis Management Group under the chairmanship of the Central Relief Commissioner, who is also Joint Secretary. It meets at the event of a disaster, meets frequently to review the relief operation and extend all possible assistance required by the affected state to overcome the situation effectively. National Contingency Action plan becomes operation, on the onset of a disaster that facilitates the relief and resource operation, It outlines the action to be taken by various central Ministers and Department and determined focal points in the administrative machinery.

**The following are the list of nodal agencies for disaster management**

Floods – Ministry of Water resources, CWC
Cyclones – Indian Meteorological Department
Earthquakes – Indian Meteorological Department
Epidemics – Minister of Health and Family Welfare
Avian flu – Ministry of Health, Ministry of Environment, Ministry of Agriculture and Animal Husbandry
Chemical Disasters – Ministry of Environment, Forests and climate change
Industrial Disasters – Ministry of Labour
Rail Accidents – Ministry of Railways
Air Accidents – Ministry of Civil Aviation
Fire – Ministry of Home affairs
Nuclear Incidents – Department of Atomic Energy
Mine Disasters – Department of Mines

State Disaster Management Authorities under the chairmanship of Chief Ministers and the District disaster management authorities (DDMAs) under the chairmanship of district magistrate.

**Role of Central and State Governments**

Basic responsibility for rescue, relief and rehabilitation with the State Governments. Central Government supplement the efforts of State Governments by providing financial and logistic support in case of major disasters. The logistic support includes deployment of aircrafts and boats, specialist teams of Armed Forces, Central Para Military Forces and personnel of National Disaster Response Force (NDRF), arrangements for relief materials and essential commodities including medical stores, restoration of critical infrastructure facilities including communication network and such other assistance as may be require by the affected States to meet the situation effectively.

**Funding Mechanisms**

As per the existing scheme, expenditure on immediate relief to the victims of natural calamities can be met by the State Governments through the following Funds: Calamity Relief Fund constituted for each State with pre-determined annual allocations for each of the five year period. The Central Government contributes 75 % and the State Government 25 %. When the calamity is of a severe nature and the Calamity Relief Fund is not sufficient, the States may approach Central Government for addition assistance from the National Calamity Contingency Fund which is financed by levy of a special surcharge on Central taxes for a limited period.

**Government approach to Disaster management**

Change in orientation from a primarily relief-centric approach to a holistic approach emphasizing mitigation, prevention and preparedness besides strengthening response, relief and rehabilitation mechanisms. Creation of institutional mechanism at the National and State levels to provide appropriate coordinating platforms keeping in view the multi-disciplinary nature of the activities required to be undertaken to reduce and manage the risk form natural hazards.

The Government of India, after considering the recommendation of the Expert Group, approved revision of items and norms of assistance from calamity relief fund or National calamity contingency fund. The revised items and norms of assistance were circulated to all the States and concerned Central Ministers earlier.

**Mitigation Measures**

Core Groups comprising eminent experts or administrators set up to guide and facilitate formulation of strategies and programmes for mitigation of earthquakes, cyclones and landslides. Emphasis on adherence to prescribed standards for seismically resistant building design and construction. Programmes for sensitization/ training of Engineers, Architects and Masons in these aspects being implemented. Model building bye laws or regulations developed and interaction with State level authorities in progress to facilitate adoption and enforcement of appropriate techno legal regime for hazard resistant construction.

Evaluation of existing building stock and infrastructure, particularly life-line buildings and vital installation, for seismic safety, to carry out retrofitting/reconstruction. Sensitization and training of elected representatives, Civil servants / Police / Forest Service Officers and other public officials in disaster risk management.

Awareness generation to inform and educate the general public on hazard risks, vulnerability and basic do's and don'ts. Community level preparedness through programmes involving preparation of village / Block / District level Disaster Management plans, constitution and training of Disaster Management Committees/teams. Strengthening of disaster warning systems for cyclones, floods and landslides. Drawing up project proposal for construction of multi-utility cyclone shelters, coaster shelter belt plantations.

Emphasis on drawing up and period rehearsing of on-site and off-site hazard management plans by Industries stocking / producing hazardous materials. Incorporating disaster management basics in school education. Disaster management / mitigation aspects being incorporate din Engineering / Architecture / Medical Education curricula

**Other National level initiative in India for disaster management are as follows**:

A National Disaster Mitigation Fund will be administered by NDMA. States and districts will administer mitigation funds.

A National Disaster Response Fund will be administered by NDMA through the National Executive Committee. States and Districts will administer State Disaster Response Fund.

Eight battalions of National Disaster Response Force (NDRF) are being trained and deployed with Collapsed structure search and rescue (CSSR) and Medical First Responder (MFR) requirements and tools in eight strategic locations.

A National Disaster Management Policy and National Disaster Response Plan will also be drawn up.

**Disaster management at the state level**

In the state level disaster management it is the responsibility of the Chief Minister or the Chief Secretary of the state. All decisions on relief operation are taken by them. Work is further delegated to the Relief commissioner who is in charge of relief and rehabilitation measures. He functions under the directive of the state level committee. The secretary of the department of Review is sometime in charge of relief measures.

**Disaster management at the district level**

Government plans for disaster management are implemented by the district administration. The actual ground work for relief is the responsibility of the district magistrate, the district collector and the deputy commissioner they coordinate and supervise the relief work. The district disaster management committee is headed by the district magistrate. Officers from the health, irrigation, veterinary, police, fire services and the water and sanitation departments are members of this committee. The district disaster management committee takes decision on the relief measure and those decisions are carried out by the disaster management committee. Trained persons from all the departments carried out the relief measures.

The disaster management committee prepares the district disaster management plan for the state Administration. The committee trains members of the disaster management Team in rescue and relief operations. The committee carries out mock rescue drills as a preparation for disaster management.

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## Lecture 34

## ARMED FORCES IN DISASTER RESPONSE - DISASTER RESPONSE; POLICE AND OTHER ORGANIZATIONS

**Role of armed forces in disaster management**

Armed forces include army, navy and air force who served as the military force of the nation. Armed forces symbolize the defence of the nation. For this, they trained, equipped and prepared themselves for all operations expected to be carried out during any unwanted circumstances. With the increasing threat created by terrorism and localized disturbances, armed forces have had to adapt and train themselves in order to carry out operations. Disaster management and the response are one of these activities.

The role of armed forces in disaster management is very important.

The Disaster Management Act 2005 is a vital instrument which explains the role and functions of various agencies. It is also a tool to bring in a sense of accountability and responsibility. This act mentions the deployment of naval, military and air forces and other Armed forces of the Union or any other civilian personnel as may be required for the purposes of this Act.

Theoretically, the Armed Forces are called upon to assist the civil administration only when the situation is beyond their coping capability. But, in practice, the armed forces form an important part of the Government's response capacity and are immediate responders in all serious disaster situations. On account of their vast potential to meet any adverse challenge, the speed of operational response and the resources and capabilities at their disposal, the armed forces have historically played a major role in emergency support functions. These include search and rescue operations, health and medical facilities, and transportation, especially in the immediate aftermath of a disaster. It can be said that armed forces played a vital role in disaster management as part of an overall national strategy to cope with disaster in India. The main role of armed forces is to coordinate the employment of forces and conduct relief operation in disaster management. Various roles of armed forces are discussed below:

- Rescue operation as it is the main work for every organization at the time of any disaster. In the rescue operation, the armed forces play an important role as they are well trained and well equipped as compare to the other civil organizations.

- Evacuation of people as in disaster management one of the most important parts is to safely evacuate the people to a safer place.
- Provide essential needs like foods, shelter and clothing etc.
- Immediate restoration of essential services like electricity, water and telephone lines etc.
- Set up emergency hospitals
- Repair of roads and bridges

**Challenges faced by armed forces in disaster management**

In India, the armed forces have played an important role in disaster management as a force of the nation. If any disaster may be natural or manmade breaks out the Government called them to help and rescue the people. But, when they are helping the people they are also facing many challenges, some of the main challenges are followed:

- Preparedness for disaster response as most of the disaster comes without any intimation, especially manmade disasters.
- Conducting relief operations a huge challenge in case of disaster with grave magnitudes.
- Increasingly uneven frequency of disasters in recent years in both types; natural as well as manmade.
- Always the first respondent in any disaster is the main challenge for the armed forces as they have to face the unknown situation.
- Resource constraint is also a huge challenge for armed forces and in the situation of disaster they have to use their limited resources which even cause them mental distress.

**Suggestions:**

Armed forces, which are a frontline defence of any nation, are expected to carry out all directives that are assigned to them. And they are playing a very big role in disaster management in our country. Their dedication and training are proving a valuable asset for disaster planners. But, there are still some areas like coordination with other agencies which needs to be improving for better disaster management, some suggestions are given below:

- Disaster managers need to understand and analyze how armed forces operate during a disaster response exercise. There should be proper coordination between the armed forces and other civilian authorities such as the police, fire services and first aid providers, to prepare for how to organize a successful response to any disaster.

•The skills that are specialized in armed forces should be disbursed within the disaster response community to better prepare them for disaster management processes.

•To overcome coordination issues, simulation and training must be conducted on a regular basis.

• The National, State and District level and the local representatives of disaster management authority should include the armed forces in their executive committees to ensure closer coordination.

•There should clear distinction between the respective roles of armed forces and other civil authorities paying particular attention to disaster management.

While the primary responsibility for disaster response lies with civilian agencies at local, state and federal levels, only the armed forces have the manpower, equipment, training and organization necessary to gather the relief effort required during any disaster situation.

**Role of armed forces in international disaster response**

The Indian armed forces have, in the last decade, been involved in disaster response at the international level, especially in South Asia. With growing regional and global cooperation on the issue, many countries look up to India in case of emergencies. Recent instances of rendition of aid further underline the international dimension of the Indian armed forces' response and relief capacity:

**Katrina disaster:** In the aftermath of Hurricane Katrina, approximately 25 tonnes of disaster relief supplies were dispatched in an IL- 76 sortie to the USA on September 9, 2005.

**Philippines mudslide:** In the aftermath of extensive mudslides in Leyte (East Philippines) on February 17, 2006, approximately 30 tonnes of disaster relief supplies, including medicines, were dispatched in an IL-76 sortie to the Philippines on February 22, 2006.

**Indonesia earthquake:** In the aftermath of the extensive earthquake in Jakarta (Indonesia) on May 27, 2006, approximately 86 tonnes of disaster relief supplies, including medicines, were dispatched in two IL-76 sorties and INS TABAR to Indonesia in May / June 2006.

**Lebanon:** Similarly, during the recent crisis in Lebanon, 3,200 blankets and 225 tents were dispatched to Lebanon on August 18, 2006.

## POLICE FORCE

**Role of police before disaster-prevention and preparedness phase:**

**Emergency traffic plan**:- Police should prepare emergency traffic plan including detail mapping with a focus on strategic points, which may be used at the time of the incident for safe transporting of personnel, resources and relief goods to and from the affected area.

**Detail communication plan: -** Police has a robust and effective Communication system. It can also be used to propagate information and warning of threatening disaster. Thus police can develop communication protocols for responding during disasters eg designate separate channels for rescue, relief for example. Chaukidars who are present at the village level could play an important role to collect sensitive information and disseminate emergency warning and other information.

**Identification of building**:- PS personnel travel in their area frequently. They can be of great help in identifying buildings and campus which are easy to access and could be used as relief centres/relief camps and go down for storage of food grains and other rescue and relief materials.

**Security plan:-** At the time of any serious incident it becomes inevitable to provide security to victims, responders and to relief materials at storage point and during transit. Resources deployed too may require security.

**Resource mapping:-** It is very important to locate essential resources at the very beginning of search and rescue works. It has been experienced during the Kosi flood 2008 that in rescue and relief works even small and tiny elements become very important. So local police could identify, locate and document general essential elements useful for different kind of disasters. These resources may have to be operated under the guidance and protection of police as done during operation of boats in Kosi disaster of 2008.

**Training:** -Men in uniform (Police) are the most visible and reliable government agency nearest to the people in difficult times. Police should conduct mock exercises with various stakeholders and should test and update their different plans.

**Role of police during the disaster-emergency response phase:**

**1. Isolate disaster sites and control site** access for the safety of victims, the general public and efficiency of incident operation

**2. Camp management:-** Security of camp inmates, officials and volunteers engaged in the running of camps including health workers is a core function. Hundreds of government and non-government employees/volunteers are engaged in running of kitchens, medical centers, sanitation units etc. They require protection all the time.

**3. Emergency transportation and traffic regulation:** Police has to facilitate the movement of rescue, medical, fire and other essential services.

**4. Media management:-** During any disaster situation information flow through the audio-visual as well as print media. The reports from the need to be verified as soon as possible for the quick response. The police can not only verify the facts of the information but also play an important role in briefing the media regarding the actual situation.

This can help in checking the spread of rumors. In certain countries, Police officers play the role of the Police Press Officer at the scene of any major emergency to coordinate the response to all media enquiries.

**5. VIP Security:-** VIPs visit the affected area and relief camps frequently. Many times, politically opposed/ dissatisfied resort to protests thereby posing threat to VIP and law and order. This must be handled by the police.

**6. Crowd management:** Both at disaster site as well as at the relief distribution centre a large number of people gather as onlookers as well as the kith and kin of the victims. Sometimes the dissatisfied people disrupt the traffic road and rail. The police can play an important role in the management of the crowd.

**7. Casualty information/ Disposal of the dead:-** The identification of people involved in accidents/emergencies is a Police responsibility. All enquiries could be handled by police station staff.

- Tracing of missing persons and notification to their next of kin could be another area of work allotted to police.
- Disposal of dead bodies and documentation of dead and the missing for the benefit of next of kin to claim the compensation and ex-gratia.

**Role of police after disaster-restoration face:**

(i) In long term operation of evacuation shelters, the issues over the shelters would change and if they are not addressed soon they would create law and order problem. Therefore it is important to find the causes of the problems as soon as possible, access the situation and reviews the previous ways.

(ii) Accommodation of persons with special meds in evacuation shelters such as small children, pregnant women and mothers with nursing infants etc. requires utmost care. In a limited shelter space, it is very important to provide special rooms for them. Police can play a very important role in this respect.

(iii) At the time of relief distribution and primary accommodation of victims support for the disabled and issues related to hygiene, the infectious disease should be looked after carefully otherwise it creates serious problems to restoration face.

(iv) Police can play an important role in the selection of beneficiaries of houses and other assets to the victims to avoid complications and litigation.

(v) Restoration of critical infrastructure: Disaster usually affects the critical infrastructure such as road, telecommunication, health centers, school, electricity supply etc. Police can provide protection to the agencies which are involved in the restoration of such infrastructure because people who are rendered jobless after a disaster may hinder the process.

(vi) The safe exit of the personnel involved in disaster management: After the disasters due to fatigue laxity might seep into the system. Although the overall law and order situation is monitored and maintained by the police, it becomes very important after the disaster for the safe exit of the personnel from outside agencies involved in the management of the disaster i.e People from NGOs, INGOs, medical teams etc.

(vii) Feedback/assessment: Since the police are the key factor in managing the disaster, their feedback/ assessment is very important in updating the plans for the future.

(viii) Contingency planning: The police familiar with the local terrain and the resources available in the locality. They can plan the actions taken at the time of the disaster beforehand.

## ORGANIZATIONS INVOLVED IN DISASTER MANAGEMENT

**Food and Agriculture Organisation** of the UN (FAO) provides early warning of impending food crises and assesses global food supply problems.

**International Organisation for Migration (IOM)** is an intergovernmental agency which helps transfer refugees, internally displaced persons and others in need of internal or international migration services.

**Office of United Nations High Commissioner for Human Rights (OHCHR)** provides assistance and advice to governments and other actors on human rights issues, sets standards and monitors rights violations.

**United Nations Development Programme (UNDP)** assists disaster-prone countries in contingency planning and with disaster mitigation, prevention and preparedness measures.

**United Nations High Commission for Refugees** **(UNHCR)** provides international protection and assistance for refugees, stateless persons and internally displaced persons, particularly in conflict-related emergencies.

**United Nations Children's Emergency Fund** **(UNICEF)** works to uphold children's rights, survival, development and protection by intervening in health, education, water, sanitation, hygiene and protection.

**World Food Programme** **(WFP)** is the principle supplier of relief food aid.

**World Health Organization** **(WHO)** provides global public health leadership by setting standards, monitoring health trends, and providing direction on emergency health issues. WHO's role is to reduce avoidable loss of life and the burden of disease and disability. A range of technical guidelines for health action in crises and pre-deployment training courses are available. A set of technical hazard sheets on earthquakes, drought, floods and landslides, is also available.

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# ENS 101/201
# Environmental Studies and Disaster Management

# MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES - DEFINITION, SCOPE AND IMPORTANCE - NATURAL RESOURCES: RENEWABLE AND NON-RENEWABLE RESOURCES - NATURAL RESOURCES AND ASSOCIATED PROBLEMS

# Introduction to Environment

- The word environment was derived from the ***French word environner,*** which means to **surround** or **encircle** and literally it means surroundings.

- *Thus it deals with the study of physical, chemical and biological conditions surrounding the living organisms which influence them internally or externally.*

**Environment**

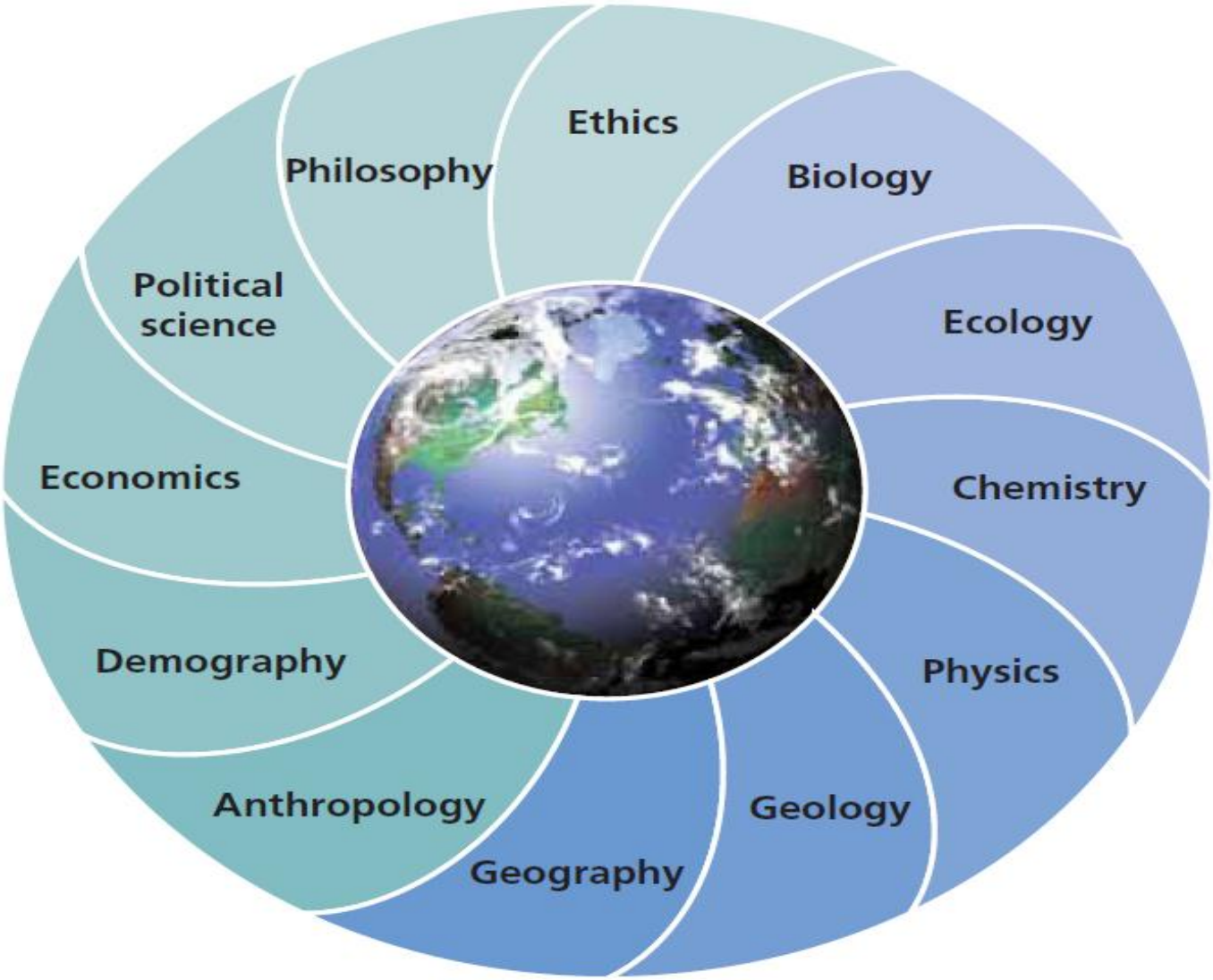
***Natural environment***

e.g. Air, water, soil, forests, wildlife

***Man-made Environment***

work environment, housing, technology, transportation, utilities, settlements,

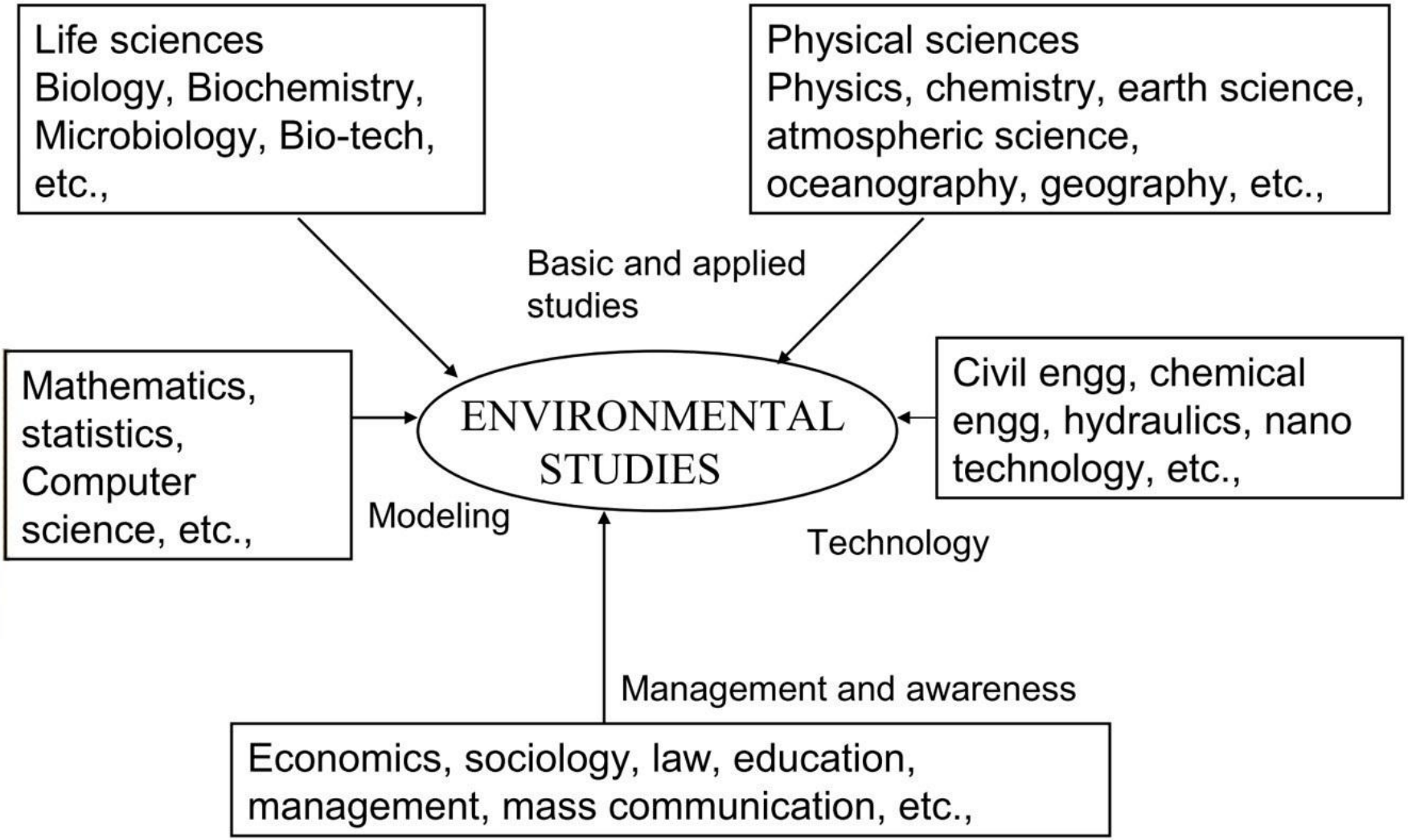
# Interrelationship with other sciences



## Major Fields of Study Related to Environmental Science

| Major Fields | Subfields |
|---|---|
| **Biology:** study of living things (organisms) | **Ecology:** study of how organisms interact with one another and with their nonliving environment |
| | **Botany:** study of plants |
| | **Zoology:** study of animals |
| **Chemistry:** study of chemicals and their interactions | **Biochemistry:** study of the chemistry of living things |
| **Earth science:** study of the planet as a whole and its nonliving systems | **Climatology:** study of the earth's atmosphere and climate |
| | **Geology:** study of the earth's origin, history, surface, and interior processes |
| | **Hydrology:** study of the earth's water resources |
| | **Paleontology:** study of fossils and ancient life |
| **Social sciences:** studies of human society | **Anthropology:** study of human cultures |
| | **Demography:** study of the characteristics of human populations |
| | **Geography:** study of the relationships between human populations and the earth's surface features |
| | **Economics:** study of the production, distribution, and consumption of goods and services |
| | **Political Science:** study of the principles, processes, and structure of government and political institutions |
| **Humanities:** study of the aspects of the human condition not covered by the physical and social sciences | **History:** study of information and ideas about humanity's past |
| | **Ethics:** study of moral values and concepts concerning right and wrong human behavior and responsibilities |
| | **Philosophy:** study of knowledge and wisdom about the nature of reality, values, and human conduct |

# How different sciences shapes Environmental Studies?



# Scope

- The science most close to Nature is environmental science.
- This field today's parlance is encompassing issues of pollution, waste water treatment, solid waste management, wildlife, study of air, water and land, global warming, climate change and so on.
- Provides the knowledge about ecological systems and biodiversity richness
- Enables one to understand the causes and consequences due to natural and man induced disasters
- Exposes the problems of over population, health, hygiene, etc. and the role of arts, science and technology in eliminating/ minimizing the evils from the society.
- Enables theoretical knowledge into practice and the multiple uses of environment.

- Without scientific approach we cannot understand nature and without awareness among the people, we cannot sustain Nature.

- The main role of environmental scientist is to understand the nature and its components, eliminate disturbing factors which are pressuring sustainability and natural living.

- Helps to evaluate alternative responses to environmental issues

- To identify and develop appropriate and indigenous eco-friendly skills and technologies to various environmental issues.

- Teaches the citizens the need for sustainable utilization of resources

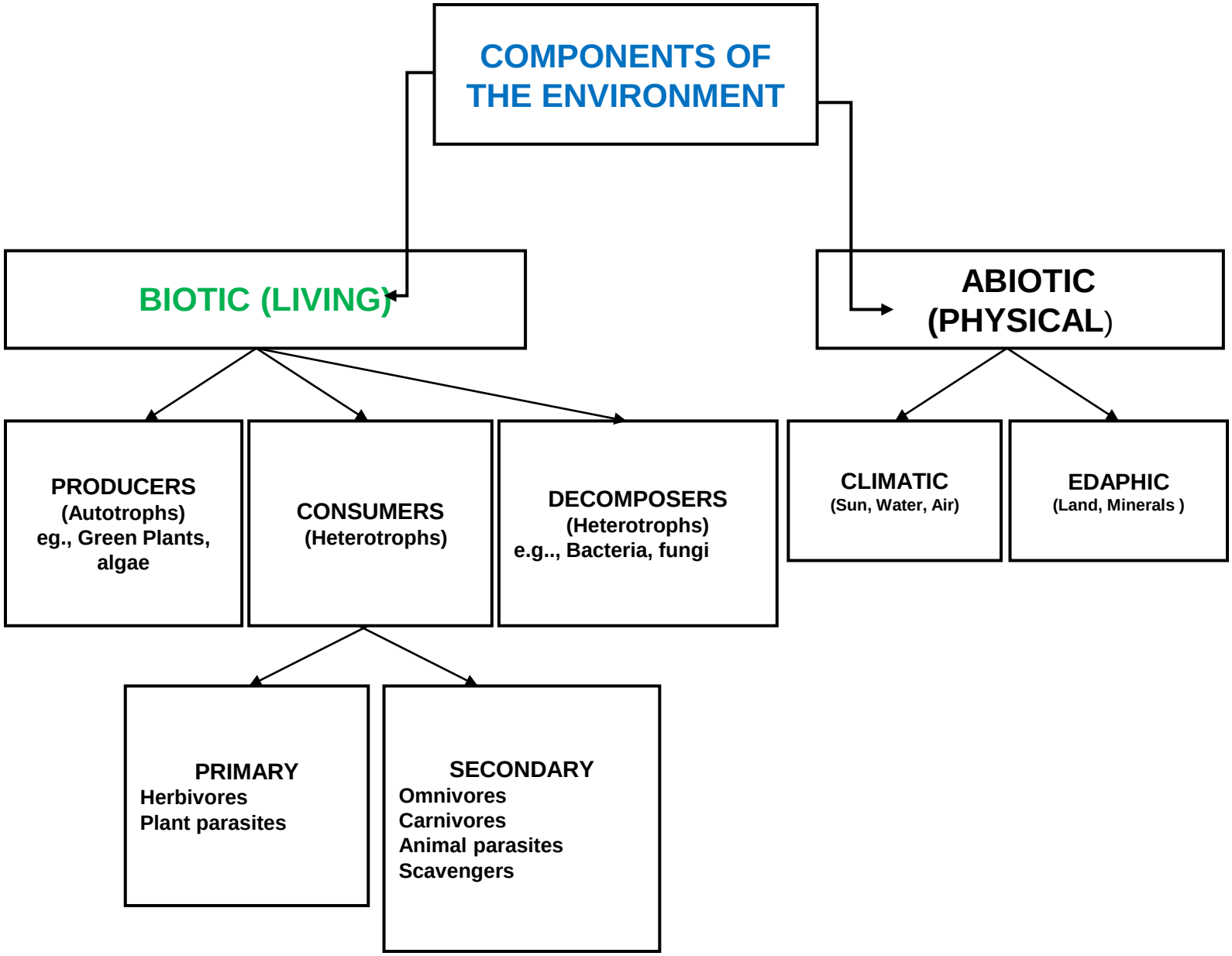
- Environmental science provides job opportunities as environmental scientist, environmental engineer, consultant, teacher, analyst, pollution control officer etc.

# Objectives of Environmental Sciences

- The study enables the people to understand the complexities of the environment and need for the people to adapt appropriate activities and pursue sustainable development, which are harmonious with the environment.

- The study motivates students to get involved in community action, and to participate in various environmental and management projects.

- Environmental study is a key instrument for bringing about the changes in the knowledge, values, behaviors and lifestyles required to achieve sustainability and stability within and among countries.


COMPONENTS OF THE ENVIRONMENT
BIOTIC (LIVING)
ABIOTIC (PHYSICAL)
PRODUCERS (Autotrophs) eg., Green Plants, algae
CONSUMERS (Heterotrophs)
DECOMPOSERS (Heterotrophs) e.g.., Bacteria, fungi
CLIMATIC (Sun, Water, Air)
EDAPHIC (Land, Minerals )
PRIMARY Herbivores Plant parasites
SECONDARY Omnivores Carnivores Animal parasites Scavengers

**(A) Physical/abiotic/nonliving components**

Various physico-chemical components of the ecosystem constitutes the abiotic structure

(i) Physical components include sunlight, solar intensity, rainfall, temperature, wind speed and direction, water availability, soil texture etc.

(ii) Chemical components include major essential elements like C, N, P, K, $H_2$, $O_2$, S etc. and micronutrients like Fe, Mo, Zn, Cu etc., salts and toxic substances like pesticides.

These physico-chemical factors will interact with water, air and soil and also utilized by the living organisms , thus playing an important role in ecosystem functioning.

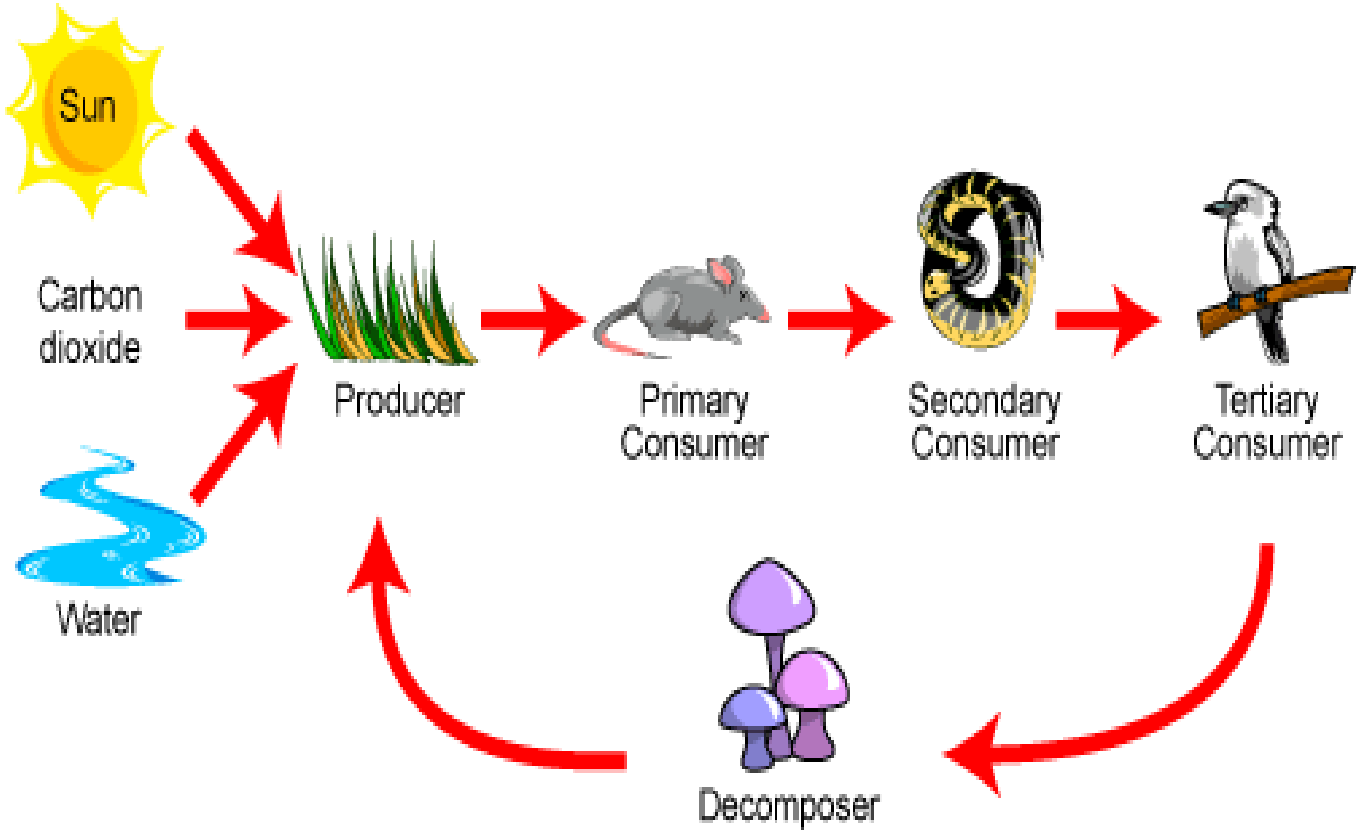
## (B) Living or biotic components

The live component of an ecosystem comprises plants, animals, and microorganisms (Bacteria and Fungi). They carry out different functions and based on their role they are classified into three main groups. They are:

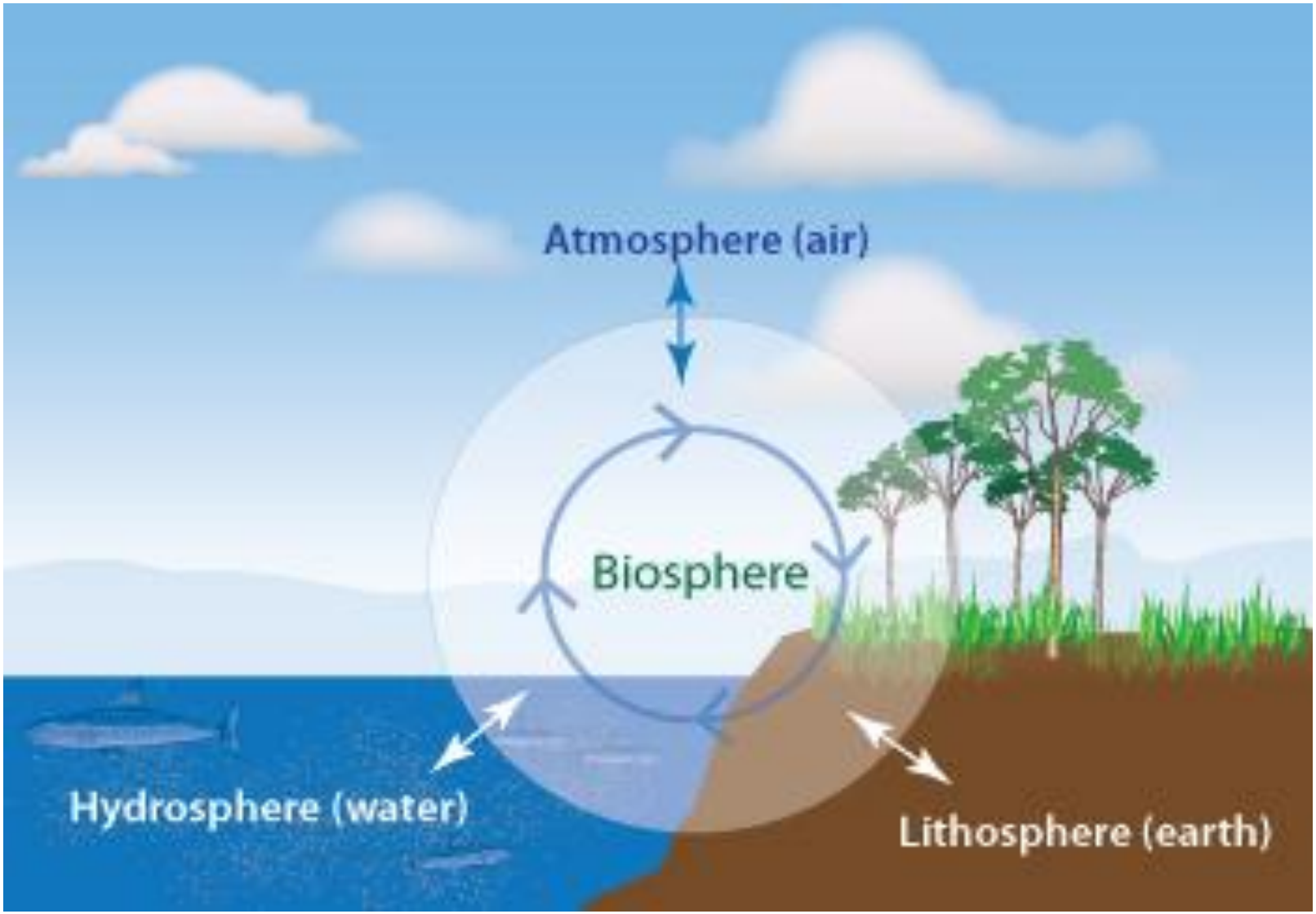
(1) Producers

(2) Consumers

(3) Decomposers



# VARIOUS SPHERE OF EARTH



# Lithosphere

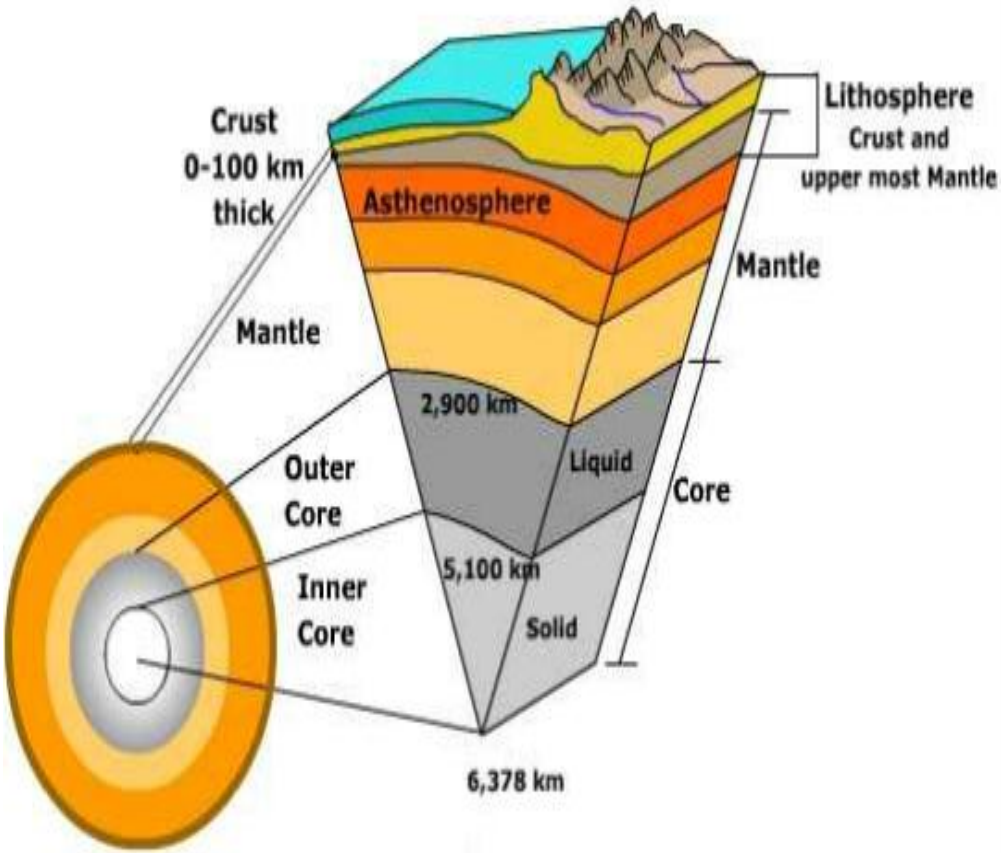
❖Lithosphere is the outer mantle of the solid earth. It consists of minerals occurring in the earth's crusts and the soil *e.g.* minerals, organic matter, air and water

❖In general the earth crust is composed of granitic rocks in silicon-aluminium and with a mean density of 2.8

❖Oceanic crust which is basaltic in composition, consisting of more basic minerals and has a mean density of 3.0

❖Overall, the average density of the earth is 5.5 gm/c.c.

❖Crustal rocks are broken down by weathering processes and are transferred to fine porous crustal layer called soil



Earth Structure

# ATMOSPHERE

- Earth’s atmosphere, a complex fluid system of gases and suspended particles, did not have its origin in the beginning of the planet

- Gases like Nitrogen, Oxygen, Argon, Carbon dioxide and water vapour etc. together make up the total volume of atmosphere.

# Composition of atmosphere

| Constituent | Volume percent |
|---|---|
| Carbon dioxide | 0.03 |
| Nitrogen | 78 |
| Oxygen | 20.9 |
| Water vapor | 0.1-0.5 |
| Argon | 0.9 |
| Trace constituents | Helium,Neon, Methane, Xenon, etc., |

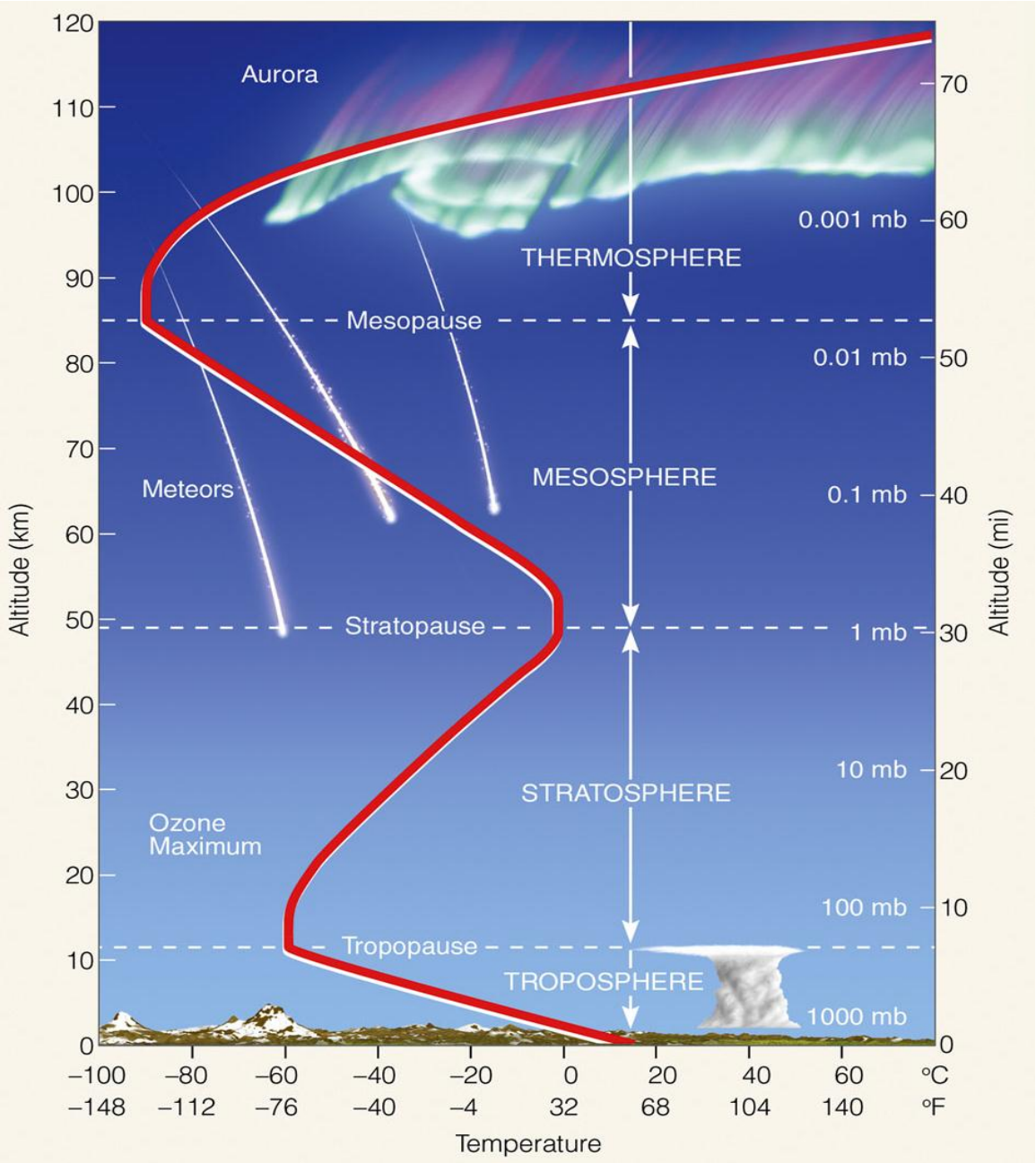
# ATMOSPHERE- LAYERS

**Thermosphere 85 – 500 km**
**Temp : -92 to 1200 $^0$C**
**$O_2^+$, $O^+$, $NO^+$**

**Mesosphere 50 - 85 km**
**Temp : - 2 to -92$^0$C**

**Stratosphere 11 - 50 km**
**Temp : -56 to - 2$^0$C**
**$O_3$**

**Troposphere 0-11 km**
**Temp : 15 to -56$^0$C**
**$N_2$, $O_2$, $CO_2$, $H_2O$**



- *Troposphere* is the air layer nearest to the ground.
- Temperature decreases with the height.
- The average temperature drops from $15^0$C at sea level to -56.5$^o$C at 11,000m above sea level.
- Most of the **weather occurs in the troposphere**
- Between the troposphere and the stratosphere is the *tropopause*

*Stratosphere*

- It is the layer of air above troposphere where temperature increases with the height
- The average temperature rises to -2.5$^{o}$C at 50,000m above sea level
- **Ozone is found in higher concentrations between 20 and 30 km above the surface.**
- *Stratopause* is the top of the stratosphere, which is a transition layer between stratosphere and mesosphere

- *Mesosphere* is the layer of air above the stratosphere where temperature decreases with height
- The average temperature decreases to -90$^0$C at 90,000m
- This is the **coldest layer** of atmosphere
- Mesopause is the top of the mesosphere, which is the transition layer between mesosphere and thermosphere

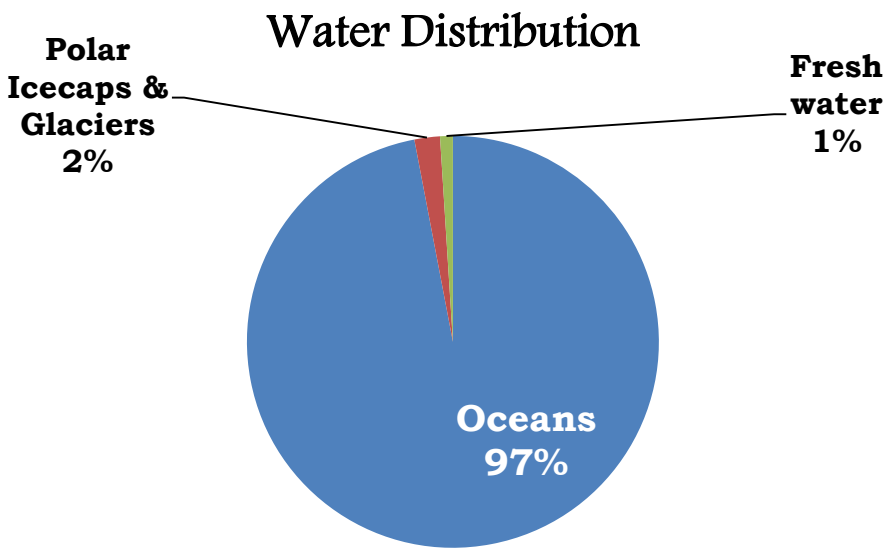
- The average height of this is usually given as 11 km, but this varies over the earth.
- In tropical latitude its average height is 16 km and in polar latitude it is only 10 km.
- There is one further zone of heating, above the mesosphere and more than 90 km from the Earth's surface, where shortwave ultraviolet radiation is absorbed by any oxygen molecules present at this height.
- This is referred to as *thermosphere.*

# Contd..

- Within this layer, ionization occurs which produces charged ions and free electrons. Beyond the thermosphere, at a height of approximately 700 km, lies the *exosphere* where the atmosphere has an extremely low density.
- At this level there are increasing numbers of ionization particles which are concentrated into bands referred to as the *Van Allen radiation belts.*

# Hydrosphere

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



We Can't Re-Freeze the Greenland Ice Sheet

# HYDROSPHERE

- Water occurs in all its forms – ice, liquid, and water vapour
- Water possesses a number of physical and chemical properties that help the molecule to act as best suited medium for life activities.
- The movement of water from earth surface to atmosphere through hydrological cycle appears to be a close system.
- Water is the most abundant substance on the Earth's surface.

# Biosphere

- The biosphere occupies those parts of the atmosphere, hydrosphere, and lithosphere where life exists.

- This thin layer of the earth extends from about 9 kilometers (6 miles) above the earth's surface and 20kilometers (12miles) down to the bottom of the deepest ocean,

- If the earth were an apple, the biosphere would be no thicker than the apple's skin.

# BIOSPHERE

- The biosphere encompasses all the zones on the Earth in which life is present. *i.e.,* entire bio- resources of the earth.
- It developed on earth since 4.5 billions year through evolutionary processes.
- Life on Earth requires water, a source of energy (sunlight) and various nutrients found in the soil, water and air.

# Contd..

- Suitable combinations of these essentials cannot be found high in the upper atmosphere or deep underground.
- They exist only in a narrow layer near the surface of the Earth.
- This zone of life also extends about 8 km up into the atmosphere (air-borne biota) and as much as 8 km down into the depths of the sea.

# Resources

Any material which can be transformed in a way that it becomes more valuable and useful can be termed as a **resource.**

**Nonrenewable resources**

- Fixed quantity and renewed only by very long-term natural process.
- Eg.Oil, metals

**Perpetual resources**

- Resources that are rapidly replaced through short-term natural processes (inexhaustible)
- Eg.Solar or wind energy

# PRINCIPAL NATURAL RESOURCES

(i) Forests

(ii) Water

(iii) Minerals

(iv) Food

(v) Energy

(vi) Land

**Natural Resources**

**Inexhaustible (Perpetual)**

- Solar energy
- Wind power
- Rainfall
- Power of tides
- Hydro-power

**Exhaustible**

**Renewable**

- Water
- Soil fertility
- Natural vegetation
- Wild life
- Aquatic animals
- Humans

**Non-renewable**

Biological species

- Minerals

## Potentially renewable resources

- Resources can be renewed themselves over the short term.
- Fresh water or wildlife

| | ***Renewable*** | ***Non-renewable*** |
|---|---|---|
| (i) | These resources are renewed or replenished by nature in a short span of time. | These resources may not be replenished by nature or take very long geological time to be formed again. |
| (ii) | Often these are available continuously like, solar energy, water etc. | These resources are exhausted after use, Ex-fossils etc. |
| (iii) | Renewable resources can be divided into continuous or flow. | Non-renewable resources can be recyclable or non-recyclable. |

# Natural resources and associated problems

- Rapid population increase
- Pollution
- High consumption of resources
- Deterioration of land
- The unequal consumption of natural resources
- Planning land use
- The need for sustainable lifestyles

# FOREST RESOURCES: USE AND OVER-EXPLOITATION, DEFORESTATION, CASE STUDIES - TIMBER EXTRACTION, MINING, DAMS AND THEIR EFFECTS ON FOREST AND TRIBAL PEOPLE

# Forest Resources

- Forests are one of the most important natural renewable resources on this earth.

- Covering the earth like a green blanket these forests not only produce innumerable material goods, but also provide several environmental services which are essential for life.

## Productive functions

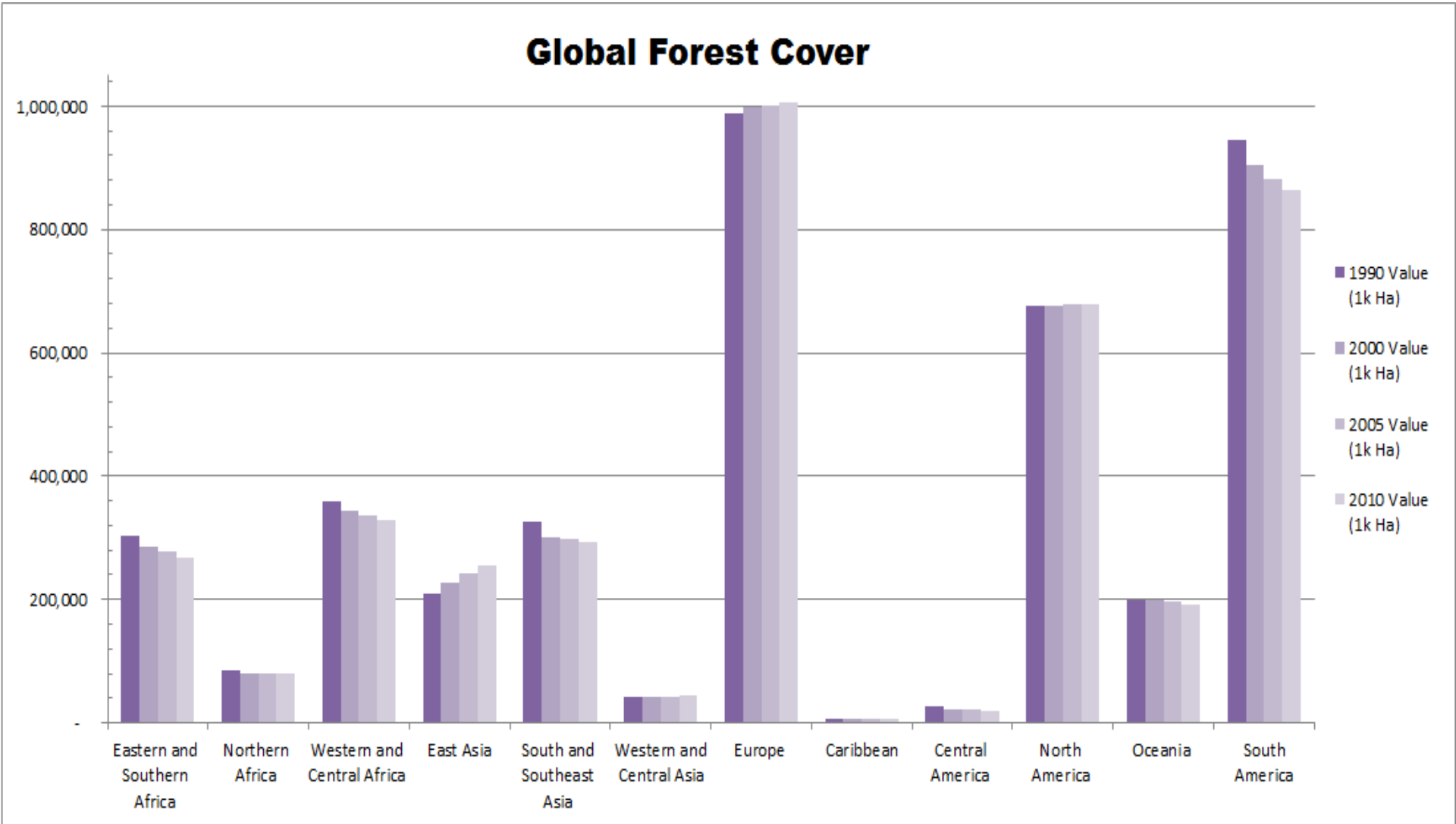
- Wood, fruits, resins, alkaloids, essential oils, latex, pharmaceuticals, fodder for animals, firewood, timber, honey, wax, gum, lac, resins and food

## Protective functions

- Conservation of soil and water; preventing drought, sheltering against wind, cold, radiation, noise, sights and smells, etc.

## Regulative functions

- Absorption, storage and release of gases ($CO_2$, $O_2$), water, mineral elements and radiant energy
- Forests effectively regulate floods and drought, and the global biogeochemical cycles, particularly of carbon.




**Source:** FAO - Global Forest Resources Assessment 2010 at www.fao.org/docrep/013/i1757e/i1757e.pdf

# Forest area in India

- At the beginning of the 20th century about 30% of land in India was covered with forests. But by the end of the 20th century the forest cover was reduced to 19.4%. This is considerably less than the optimum 33% forest area recommended by the National Forest Policy (1988) for the plains and at least 67% for the hills.

Forest classes

1. Dense forest (Canopy cover > 40% of land)
2. Open forest (Canopy cover 10-40% of land)
3. Mangrove (Canopy < 10% of land)
4. Scrub

## Different types of forests

India has a diverse range of forests: from the rainforest of Kerala in the south to the alpine pastures of Ladakh in the north, from the deserts of Rajasthan in the west to the evergreen forests in the north-east. Climate, soil type, topography, and elevation are the main factors that determine the type of forest. Forests are classified according to their nature and composition, the type of climate in which they thrive, and its relationship with the surrounding environment.

Forests can be divided into six broad types, with a number of sub types.

| | |
|---|---|
| **Moist tropical** | **Montane sub tropical** |
| Wet evergreen | Broad leaved |
| Semi-evergreen | Pine |
| Moist deciduous | Dry evergreen |
| Littoral and swamp | |
| **Dry tropical** | **Montane temperate forests** |
| Dry deciduous | Wet |
| Thorn | Moist |
| Dry evergreen | Dry |
| **Sub alpine** | **Alpine** |
| | Moist |
| | Dry |

**Uses of Forests:**

The direct benefits from forests are:

(a) Fuel Wood: Wood is used as a source of energy for cooking purpose and for keeping warm.

(b) Timber: Wood is used for making furniture, tool-handles, railway sleepers, matches, ploughs, bridges, boats etc.

c) Bamboos: These are used for matting, flooring, baskets, ropes, rafts, cots etc.

(d) Food: Fruits, leaves, roots and tubers of plants and meat of forest animals form the food of forest tribes.

(e) Shelter: Mosses, ferns, insects, birds, reptiles, mammals and micro-organisms are provided shelter by forests.

(f) Paper: Wood and Bamboo pulp are used for manufacturing paper (Newsprint, stationery, packing paper, sanitary paper)

(g) Rayon: Bamboo and wood are used in the manufacture of rayon (yarns, artificial silkfibres)

(h) Forest Products: Tannins, gums, drugs, spices, insecticides, waxes, honey, horns, musk, ivory, hides etc. are all provided by the flora and fauna of forests.

The indirect benefits from forests are:

- (a) Conservation of Soil: Forests prevent soil erosion by binding the soil with the network of roots of the different plants and reduce the velocity of wind and rain — which are the chief agents causing erosion.
- (b) Soil-improvement: The fertility of the soil increases due to the humus which is formed by the decay of forest litter.
- (c) Reduction of Atmospheric Pollution: By using up carbon dioxide and giving off oxygen during the process of photosynthesis, forests reduce pollution and purify the environment.
- (d) Control of Climate: Transpiration of plants increases the atmospheric humidity which affects rainfall and cools the atmosphere.
- (e) Control of Water flow: In the forests, the thick layer of humus acts like a big sponge and soaks rain water preventing run-off, thereby preventing flash-floods. Humus prevents quick evaporation of water, thereby ensuring a perennial supply of water to streams, springs and wells.

**Commercial uses:**

Forests provide us a large number of commercial goods which include timber, firewood, pulpwood, food items, gum, resins, non-edible oils, rubber, fibers, lac, bamboo canes, fodder, medicine, drugs and many more items, the total worth of which is estimated to be more than $ 300 billion per year. Many forest lands are used for mining, agriculture, grazing, and recreation and for development of dams.

**Ecological uses :**

- Production of oxygen: The trees produce oxygen by photosynthesis which is vital for life on this earth.
- Reducing global warming: The main greenhouse gas carbon dioxide (CO2) is absorbed by the forests as a raw material for photosynthesis. Thus forest canopy acts as a sink for CO2 thereby reducing the problem of global warming caused by greenhouse gas CO2.
- Wild life habitat: Forests are the homes of millions of wild animals and plants. About 7 million species are found in the tropical forests alone.
- Regulation of hydrological cycle: Forested watersheds act like giant sponges, absorbing the rainfall, slowing down the runoff and slowly releasing the water for recharge of springs. About 50-80 %of the moisture in the air above tropical forests comes from their transpiration which helps in bringing rains.
- Soil Conservation: Forests bind the soil particles tightly in their roots and prevent soil erosion. They also act as windbreaks.
- Pollution moderators: Forests can absorb many toxic gases and can help in keeping the air pure. They have also been reported to absorb noise and thus help in preventing air and noise pollution.

# Deforestation

- Deforestation rate is relatively low in temperate countries than in tropics
- 90% tropical forest get reduced in coming six decades
- For ecological balance 33% area should be under forest cover but our nation has only 20.6% forest cover.

# Main causes responsible for deforestation

- Felling of trees to meet the ever increasing demand of the cities.
- Grazing by the local cattle, goats, sheep etc. They not only destroy the vegetation but also pull out the roots of plants.
- Meeting out the growing hunger for land. It has hit the ecology of the country badly very soon India is likely to have more of wasteland than productive land.
- The increase in shifting (jhum) cultivation in North east and Orissa has also laid large forest tracts bare.
- Another major cause of deforestation has been the construction of hill roads. Road construction damages the protective vegetation cover both above and below roads.

# Major effects of deforestation

- Soil erosion and loss of soil fertility
- Decrease of rain fall due to affect of hydrological cycle
- Expansion of deserts
- Climate change and depletion of water table
- Loss of biodiversity, flora and fauna
- Environmental changes and disturbance in forest ecosystems

# Prevention of Deforestation

These steps can be adopted to prevent deforestation to a maximum extent :

- Expansion of forest area can be achieved by implanting trees in forest with people's participation.
- Strengthening the central and state forestry administration and institutions.
- Celebrate Environment day to create awareness among people about how forestation can help in improving environment.
- Use of pesticides to reduce damages to forest from pests.
- Encouraging reduce, recycle and reuse of forest products.
- Encouraging afforestation and reforestation.
- Using alternate sources of energy like cooking gas instead of wood.

# Timber extraction and its effect on forest and tribal people

Timber is used as raw materials for various wood based industries like pulp and paper, composite wood, furniture etc. Timber is also used for various developmental activities like railways, boats, road construction etc. However due to unsustainable extraction of timber, there are adverse effects on forest and tribal people.

Some of which are :

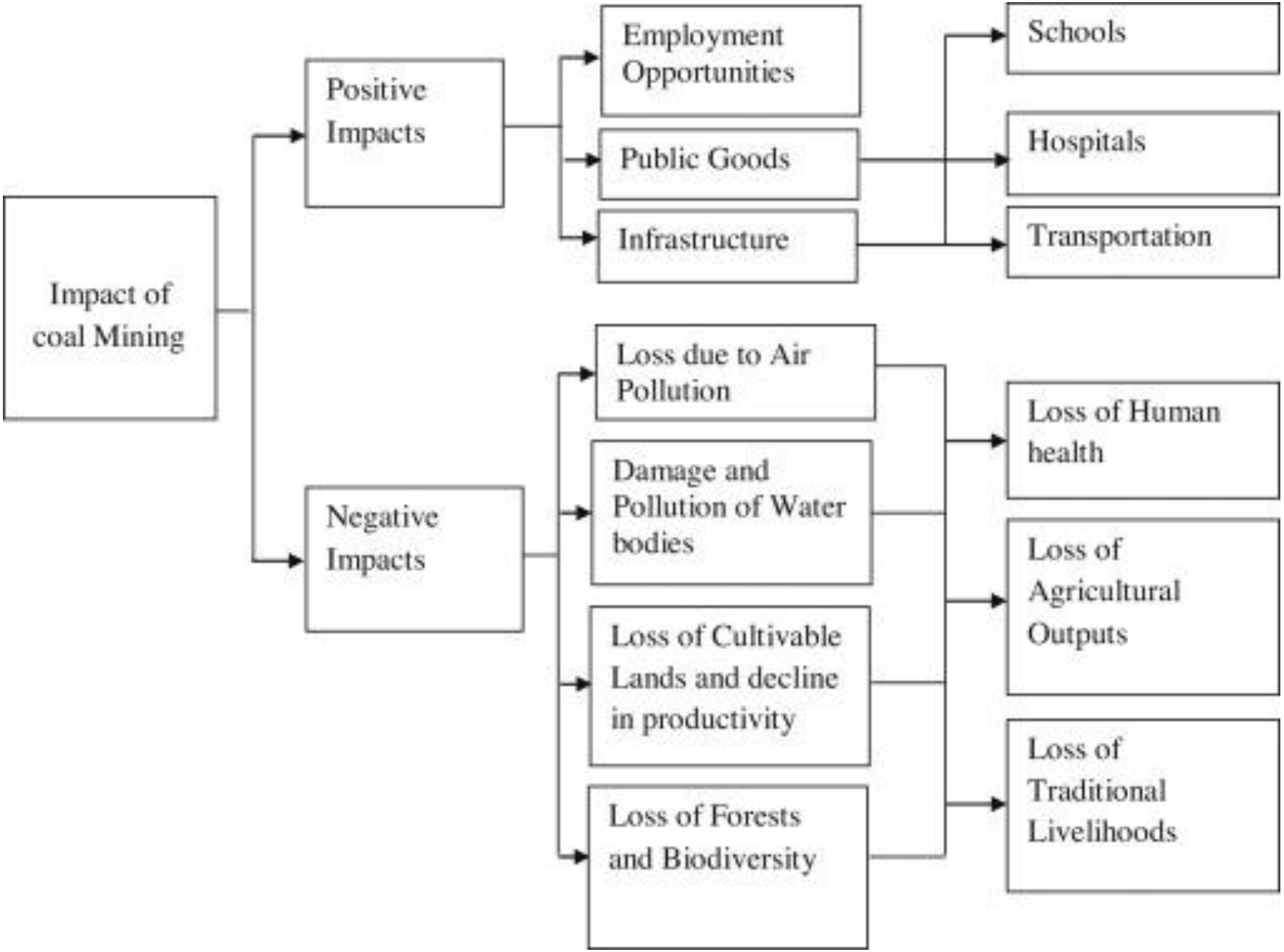
- Loss of biodiversity.
- Climate change such as lower precipitation.
- Poor logging results in a degraded forest.
- Floods may be intensified by cutting of trees or upstream watersheds.
- Exploitation of tribal people by the contractors.
- Soil erosion especially on the slopes occur extensively.

# Mining and its effect on forest

Mining is the extraction of valuable minerals or other geological materials from the earth, usually from an orebody, lode, vein, seam, reef or placer deposits.

The adverse effects of mining on forest are as follows :

- Vast areas of forest are directly cleared to accommodate mining sites, construction of roads, processing units and townships for workers. Destruction is vast in case of open cast mines.
- Forest land is also used to store the waste materials that remain after the extraction of usable ores.
- Mining also facilitates soil erosion, thereby decreasing the fertility of land leading to land degradation.
- Pollution of both air and water is a common effect of mining.


Impact of coal Mining
Positive Impacts
Negative Impacts
Employment Opportunities
Public Goods
Infrastructure
Schools
Hospitals
Transportation
Loss due to Air Pollution
Damage and Pollution of Water bodies
Loss of Cultivable Lands and decline in productivity
Loss of Forests and Biodiversity
Loss of Human health
Loss of Agricultural Outputs
Loss of Traditional Livelihoods

# Dams and their effect on forest and tribal people

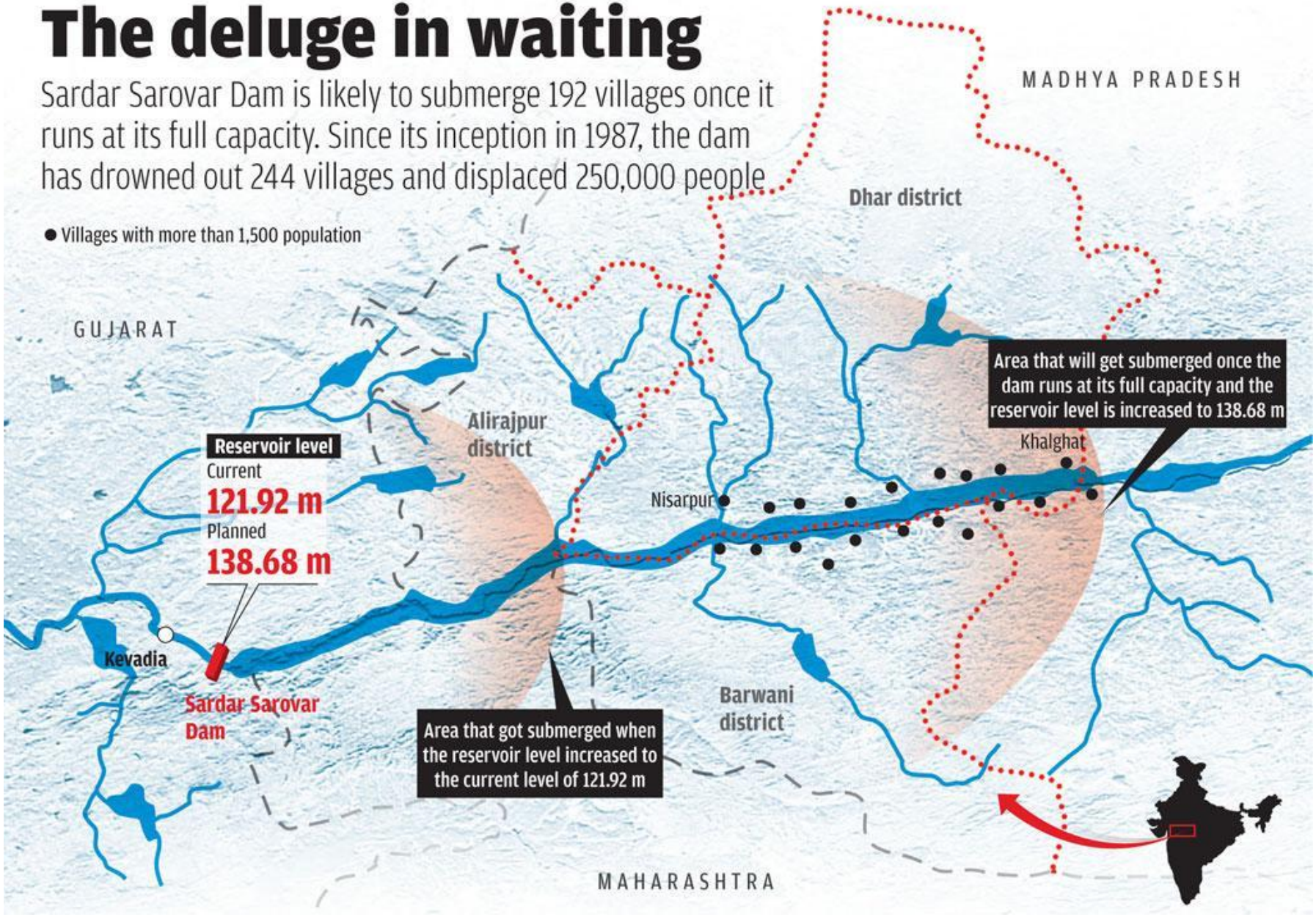
When a dam is constructed across any river a huge artificial lake is developed in the catchment area of that dam. Covering a large surface area it creates a lot of ill effects on the living environment.

They are as follows :

- It creates the loss of forest which are submerged under the back waters of the dam.
- It creates danger to the habitat of wildlife. The wildlife are forced to migrate.
- It also affects the land under cultivation in the catchment area, as the crops get submerged under water.
- The road already under existence submerges under-water thus disrupting the road network.
- Water logging and salinisation affects the canal irrigated land, with varying degrees of severity.
- Diseases like malaria spread rapidly in the command areas of reservoirs which severely affect the health condition of tribals living nearby forest areas.

# The deluge in waiting

Sardar Sarovar Dam is likely to submerge 192 villages once it runs at its full capacity. Since its inception in 1987, the dam has drowned out 244 villages and displaced 250,000 people



# Forest and wildlife laws

Several legal provisions exist in our country to safeguard the national interests related to forests and wildlife. Notable amongst them are listed below.

Forest Act 1927:

This act aims to consolidate the law relating to forests, and its basic objectives are:

- Setting up and managing reserved forests, protected forests and village forests;
- Protection of non-government forests and forest land;
- Control of movement of forest produce;
- Control of cattle grazing.

Wildlife (Protection) Act 1972, (Amended 1991):

This act provides for protection of wild animals, birds and plants, and includes the following objectives:

- Restriction and prohibition on hunting of animals;
- Protection of specified plants;
- Setting up and managing sanctuaries and national parks;
- Empowering zoo authority with control of zoos and captive breeding;
- Control of trade and commerce in wildlife, wildlife products and trophies.

# Forest conservation and management

- Conservation of forest is a national problem, thus it should be tackled with perfect coordination between concerned government departments.
- People should be made aware of importance of forest and involved in forest conservation activities.
- The cutting of trees in the forests for timber should be stopped.
- Afforestation programmes should be launched
- Grasslands should be regenerated.
- Forest conservation act should be strictly implemented to check deforestation.
- Awards should be instituted for the deserving.

# WATER RESOURCES: USE AND OVER-UTILIZATION OF SURFACE AND GROUND WATER FLOODS, DROUGHT, CONFLICTS OVER WATER, DAMS - BENEFITS AND PROBLEMS

# WATER RESOURCES

- Water is the most abundant, inexhaustible renewable resource.
- It covers 70% of the globe in the form of oceans, rivers, lakes, etc.
- Of this 70%, only 3% is available as freshwater. From this 3%, roughly 2% is frozen in polar icecaps and only a fraction of the remaining 1% is used as drinking water (potable).
- 90% of the water is utilized for agricultural purposes in India.

# USE OF SURFACE AND GROUND WATER

- **Consumptive use:** water is completely utilized and cannot be reused.

Ex: Domestic, industrial and irrigation

- **Non-consumptive use:** Iwater is not completely utilized and is reused

Ex: Hydropower plant

**other uses**:

- Water is used for domestic purposes like drinking, bathing, cooking, washing. etc.
- Water is used in commercial establishments like hotels, theaters, educational institutions, offices, etc.
- Almost 60-70% of fresh water is used for irrigation
- 20-30% of water is used for industrial operations by refineries, iron & steel industries, paper & pulp industries, etc.
- Water plays a key role in sculpting the earth's surface, moderating climate and diluting pollutants.

# OVER-UTILIZATION OF SURFACE & GROUND WATER

- The rapid increase in population and industrial growth led to severe demand on water resources.
- After using all available surface water resources to the maximum, human beings began using groundwater to meet their needs.
- The increased extraction of groundwater far in excess of the natural recharge led to decreased groundwater level.
- The erratic and inadequate rainfall caused reduction in storage of water in reservoirs. This also led to decrease of groundwater.
- Building construction activities seal permeable soil zone and reduce the area for percolation of rainwater thereby increasing surface runoff.
- If groundwater withdrawal rate is higher than recharge rate, sediments in aquifers get compacted resulting in sinking of overlaying land surface. This is called land subsidence which leads to structural damage in buildings, fracture in pipes and reverses the flow of canals leading to tidal flooding.

# Contd..

- Over-utilization of groundwater in arid and semi-arid regions for agriculture disturbs equilibrium of reservoir in the region causing problems like lowering of water table and decreased pressure in aquifers coupled with changes in speed and direction of water flow.
- Over utilization of groundwater in coastal areas leads to rapid intrusion of salt water from the sea thereby rendering it unusable for drinking and agriculture.

Over-utilization of groundwater leads to decrease in water level thereby causing earthquake, landslides and famine.

Over-utilization of groundwater leads to drying-up of dug wells as well as bore wells.

- Due to excess use of groundwater near agricultural fields, agricultural water that contains nitrogen as a fertilizer percolates rapidly and pollutes the groundwater thereby rendering the water unfit for potable use by infants. (Nitrate concentration exceeding 45 mg/L).

# Conservation of water resources

- **"Natural Water Policy"** – April 2002 – Government of India which emphasis the conservation of water in different parts of the country.

- Water shed management and appropriate adoption of irrigation technologies are the two prime action needed for water conservation. Conservation of lakes or other categories of wetlands are the prime requisite of rainwater storage.

- At household level, rain water also harvested by a number of techniques like

– Construction of traditional ring wells.

– Roof – top rainwater harvesting and storage.

- Wastewater treatment and reuse for irrigation, aquaculture or even industrial purposes in also a part of water conservation strategies.

- The major objective of multi – purpose river valley projects is to impound huge amount of rainwater for various purpose.

# Natural resources-Floods

- A flood is an overflow of water, whenever the magnitude of flow of water exceeds the carrying capacity of the channel within its banks.

**CAUSES OF FLOODS:**

- Heavy rainfall, melting of snow (ice), sudden release of water from dams often causes floods in the low lying coastal area.
- Prolonged heavy rainfall can also cause the overflowing of lakes and rivers resulting in floods
- Reduction in carrying capacity of river channels due to accumulation of sediments or obstructions built on flood ways.
- Deforestation, overgrazing, mining increases the run-off from rains causing floods.
- Removal of dense and uniform forest cover over the hilly zones leads to occurrence of floods.

## EFFECT OF FLOODS:

- Water spreads in the surrounding areas and submerges them
- Plain surfaces get eroded and silted with mud and sand thereby affecting cultivable land areas.
- Extinction of civilization in some coastal areas also occurs.

## FLOOD MANAGEMENT:

- Floods can be controlled by constructing dams or reservoirs
- Channel management and embankments also control floods
- Encroachment of flood ways should be banned
- Flood hazard may be reduced by forecasting or flood warning
- Flood hazard may be reduced by reduction of runoff and this can be achieved by increasing infiltration through appropriate afforestation in the catchment area.

# DROUGHT

Drought is scarcity of water. Drought occurs due to:

- inadequate rainfall
- late arrival of rains and
- excessive withdrawal of groundwater
- Scarcity of water for normal needs of agriculture, livestock, industry or human population may be termed as drought.
- Drought is understood from dry weather which persists long enough to produce a serious hydrological imbalance, leading to damage of plants, animals and human life.

# TYPES OF DROUGHT

- **Meteorological Drought** occurs when the total amount of rainfall is less than 75% of normal rainfall. This drought will be severe if the rainfall is less than 50% of the normal rainfall

- **Hydrological Drought** occurs when the total amount of rainfall is less than the average rainfall. It is generally associated with reduction of statistical average of water reserves available in the source such as aquifers, lakes and reservoirs.

- **Agricultural Drought** occurs due to the shortage as well as the timing of overall rainfall. This form of drought reduces groundwater and reservoir levels. Agricultural Drought affects cropped plants.

- **Socio-economic Drought** occurs due to reduction in the availability of food and social security of people in the affected areas. Socio-economic drought leads to famine.

# CAUSES OF DROUGHT

- When annual rainfall is below normal and less than evaporation, drought occurs
- High population also leads to drought. Population growth leads to poor land use and worsens the situation
- Intensive cropping pattern and over-exploitation of scarce water resources by digging wells or bore-wells for high productivity has turned drought prone areas into desert. Ex:- Over exploitation of water resources for sugarcane in Maharashtra has prevented the state from drought recovery for the past 30 years.
- Deforestation leads to desertification and drought. Deforestation leads to the top soil exposed to erosion by heavy rains, wind and the sun. Thus the top layer of soil rich in nutrients gets washed away making the soil unproductive. Eroded soils exhibit a droughty tendency.

# EFFECTS OF DROUGHT

- Drought causes hunger, malnutrition and scarcity of drinking water. It also degrades the quality of drinking water
- Drought causes widespread crop failures leading to acute shortage of food thereby adversely affecting human and livestock populations
- Drought indicates the initiation of desertification
- Raw materials for agro-based industries are critically affected during drought thereby retarding industrial and commercial growth.
- Drought accelerates degradation of natural resources
- Drought leads to large scale migration to urban areas thereby creating slums.

# DROUGHT MANAGEMENT

- Indigenous knowledge in control of droughts and desertification is very useful for dealing with drought problems
- Rainwater harvesting program is very useful technique used to conserve water and control drought
- Construction of large capacity reservoirs is essential in drought prone areas
- Modern irrigation techniques (drip irrigation) is very useful to conserve water and avoid wastage
- Afforestation activities improve the potential of water in drought prone areas
- Mixed cropping and dry farming are suitable methods that minimize the risk of crop failure in dry and drought prone areas.

# DAMS - BENEFITS AND PROBLEMS

Dams are built across rivers to store water for irrigation, hydroelectric power generation and flood control. The dams built to serve more than one purpose are called "multi-purpose dams". These dams were called the "temples of modern India" by the country's first Prime Minister, Jawaharlal Nehru.

## BENEFITS OF DAMS

- Dams are built to control flood and store flood water
- Sometimes dams are used for diverting part or all of the water from river into a channel.
- Dams are used mainly for drinking and agricultural purposes.
- Dams are built for generating electricity
- Dams are used for recreational purposes
- Navigation and fishery can be developed in the dam areas

# PROBLEMS OF DAMS

## Upstream problems

- Displacement of tribal people
- Loss of non-forest land
- Loss of forests, flora and fauna
- Landslides, sedimentation and siltation occurs
- stagnation and waterlogging around reservoirs retards plant growth
- Breeding of vectors and vector-borne diseases
- Reservoir Induced Seismicity (RIS) causes earthquakes
- Navigation and aquaculture activities can be developed in the dam area and it leads to pollution and accidents

# Downstream problems

- Water logging and salinity due to over irrigation
- Reduced water flow and silt deposition in rivers
- Salt intrusion at river mouth
- Since the sediments carrying nutrients gets deposited in the reservoir, the fertility of the land along the river gets reduced
- Due to structural defects or faulty design of the dam may cause sudden dam failure leading to collapse and destruction to life and property.

# Conflicts over water

- Water is essential for our existence and is fast becoming scarce.
- Rapidly increasing population and limited water resources give rise to conflicts over water.
- Conflict through use: Unequal distribution of water leads to inter-state or international disputes.

# Examples

## International conflicts

- Conflict over water from the Indus between India and Pakistan
- Conflict over water from the Colorado river between Mexico and USA
- Conflict over water from the Shatt-al-Arab between Iran and Iraq
- Conflict over water from the Bhramaputra between India and Bangladesh

## National conflicts

- Sharing of Cauvery water between Karnataka and Tamilnadu
- Sharing of Krishna water between Karnataka and Andhra Pradesh
- Sharing of Siruvani water between Tamilnadu and Kerala
- Sharing of Palar water between Tamilnadu and Andhra Pradesh
- Sharing of Mullai Periyar water between Tamilnadu and Kerala

## Construction of dams or power stations:

- For hydroelectric power generation, dams are built across the rivers, and this initiates conflicts between the states.

## Conflict through pollution:

- Rivers are also used for industrial purposes. They act as reservoirs for supply of fresh water and also a receptor of waste water and rubbish from the industry. Water crossing borders that has been polluted by wastes from one country develops into an international conflict.

# Management of water conflicts

- Concerted efforts are required to enforce laws that check these practices to control water pollution
- In order to overcome the problem of sharing river water in a country, the concept of interlinking of rivers has been suggested
- Rivers should be nationalized, the National Water Authority and River Basin Authority should be given powers to ensure equitable distribution of basin water.

# Modern agriculture & Energy resources

# AGRICULTURE

Agriculture is an art, science and industry of managing the growth of plants and animals for human use. Agriculture includes preparation of soil for cultivation of crops, harvesting crops, breeding and raising livestock, dairying and forestry.

The two major types of agriculture are:

- Traditional agriculture and
- Modern or Industrialized agriculture

# MODERN AGRICULTURE

Modern agriculture makes use of hybrid seeds of single crop variety, technologically advanced equipment, fertilizers, pesticides and water to produce large amounts of single crop.

**Problems using fertilizers:**

- Micronutrient imbalance
- Nitrate pollution
- Eutrophication

**Problems in using Pesticides:**

In order to improve crop yield, pesticides are used indiscriminately in agriculture.

Pesticides are of two types:

- First generation pesticides that use Sulphur, Arsenic, Lead or Mercury to kill pests
- Second generation pesticides such as Dichloro Diphenyl Trichloroethane (DDT) used to kill pests. These pesticides are organic in nature.

**Pesticide resistance:**

Some pests that survive the pesticide generate highly resistant generations that are immune to all kinds of pesticides. These pests are called "superpests"

# WATER LOGGING

If water stands on land for most of the year, it is called water logging.

**CAUSES OF WATER LOGGING**

- Excessive water supply to the croplands
- Heavy rain
- Poor drainage

**MEASURES TO PREVENT WATER LOGGING**

- Avoid and prevent excessive irrigation
- Sub-surface drainage technology
- Bio-drainage by trees like Eucalyptus

# SALINITY

Water not absorbed by soil, is evaporated leaving behind a thin layer of dissolved salts in the top soil. This is called salinity of the soil.

Saline soils are characterized by accumulation of soluble salts like sodium chloride, calcium chloride, magnesium chloride, sodium sulphate, sodium carbonate and sodium bicarbonates.

Saline conditions are exhibited when pH is greater than 8.0

# PROBLEMS IN SALINITY

- Saline soils yield less crop
- In order to remedy the condition of saline soils the following two techniques may be used:
- Salt deposit is removed by flushing with good quality water
- By using a sub-surface drainage system, the salt water is flushed out slowly.

# ENERGY RESOURCES

Energy may be defined as "**any property which can be converted into work**“. Energy is defined as "**the capacity to do work**“.

Energy is available on earth in a number of forms and some forms may be used immediately while others might require some transformation.

It is difficult to imagine Life without energy.

# TYPES OF ENERGY

Based on continual utility, natural resources can be classified into two types:

- **Renewable energy sources:** These resources can be generated continuously and are inexhaustible.

Ex: Wood, Solar energy, Wind energy, Hydro power, tidal energy, Geo-thermal energy, etc

***Merits of Geo-thermal energy*:**

- Unlimited supply
- Provides energy security
- Fits in the concept of sustainable development
- Reliable and devices are modular in size
- Decentralized energy production

➢ **Non-renewable energy sources:**

Non-renewable energy sources are natural resources, that cannot be regenerated once they are exhausted. They cannot be used again.

Ex: Coal, Petroleum, Natural gas and Nuclear fuels

# LAND RESOURCES, LAND DEGRADATION, SOIL EROSION AND DESERTIFICATION

# LAND DEGRADATION

Land degradation is the process of deterioration of soil or loss of fertility of soil.

**EFFECTS OF LAND DEGRADATION**

- Soil texture and structure are deteriorated
- Loss of soil fertility due to loss of valuable nutrients
- Increase in water logging, salinity, alkalinity and acidity problems
- Loss at a social, economic and biodiversity level

# CAUSES OF LAND DEGRADATION

- Population
- Urbanization
- Fertilizers and Pesticides
- Damage to top soil
- Water-logging
- soil erosion
- salination and
- contamination of the soil with industrial waste

# LANDSLIDES

Landslides are the downward movement of a slope composed of earth materials such as rock, soil or artificial fills.

Landslides are also called rock-slide, debris-slide, slump, earth-flow or soil-creep.

These land masses weaken the already fragile mountain slopes leading to man-induced landslides.

# EFFECTS OF LANDSLIDES

- Landslides increase the turbidity of nearby streams, thereby reducing their productivity
- Destruction of communicative links
- Loss of habitat and biodiversity
- Loss of infrastructure and economic loss

# CAUSES OF LANDSLIDES

- Removal of vegetation - Deforestation in slopes creates soil erosion leading to landslides
- Underground mining activities cause subsidence of the ground
- Movement of heavy vehicles in areas with unstable slopes causes landslides.
- Addition of weight by construction on slopes causes landslides.
- Over exploitation of groundwater also leads to landslides

# SOIL EROSION

- Soil erosion is the process of removal of superficial layer of soil. Soil erosion removes soil components and litter.

**HARMFUL EFFECTS OF SOIL EROSION**

- Soil fertility is lost
- Loss of soil ability to hold water and sediment
- Sediment runoff can pollute water courses and kill aquatic life

# TYPES OF SOIL EROSION

**Normal erosion:**

This is caused by the gradual removal of topsoil by natural processes. The rate of erosion is slow.

**Accelerated erosion:**

This is caused by man made activities. In this case, the rate of erosion is much faster than the rate of formation of soil.

# CAUSES OF SOIL EROSION

- Water
- Wind
- Biotic agents
- Landslides
- Construction of dams, buildings and roads

# SOIL CONSERVATION PRACTICES

- Conservational till farming or no-till farming
- Contour farming
- Terracing
- Alley cropping or Agro forestry
- Wind breaks or shelter belts

# Role of an individual in conservation of natural resources

**Conservation of energy:**

1. Switch off light, fan and other appliances when not in use.
2. Use solar heater for cooking.
3. Dry the cloth in the sun light instead of driers.
4. Use always pressure cookers
5. Grow trees near the house to get cool breeze instead of using AC and ai cooler.
6. Ride bicycle or just walk instead of using scooter for a short distance.

**Conservation of water:**

1. Use minimum water for all domestic purposes.
2. check the water leaks in pipes and repair them properly.
3. Reuse the soapy water, after washing clothes for washing courtyard, carpets etc.
4. Use drip irrigation.
5. Rain water harvesting system should be installed in all the houses.
6. Sewage treatment plant may be installed in all industries and institution.
7. Continuous running of water taps should be avoided.
8. Watering of plants should be done in the evening.

**Conservation of soil:**

1. Grow different type plants i.e trees, herbs and shrubs.
2. In the irrigation process, using strong flow of water should be avoided.
3. Soil erosion can be prevented by sprinkling irrigation.

**Conservation of food resources:**

1. Cook required amount of food.
2. Don’t waste the food, give it to some one before spoiling.
3. Don’t store large amount of food grains and protect them from damaging insects.

**Conservation of forest:**

1. Use non timber product.
2. Plant more trees.
3. Grassing must be controlled
4. Minimise the use of paper and fuel.
5. Avoid the construction of dam, road in the forest areas.

**Equitable use of resources for sustainable life style:**

**Sustainable development:**

Development of healthy environment without damaging natural resources.

**Unsustainable development:**

Degradation of the environment due to over utilisation of natural resources.

**Life style in more developed countries**:

22% of world population, 88% of it's natural resources and 85% of total global income. Consumption is more and pollution is more.

**Life style in less developed countries:**

78% of world population, 12% of it's natural resources and 15% of total global income. Consumption is less and pollution is less.

**Causes of unsustainability:**

Main cause – difference between MDCs and LDCs.

**Sustainable life style:**

MDCs should have to reduce the utilisation of natural resources, that should have to be diverted to LDCs.

This will reduce the gap between MDCs and LDCs, leads to sustainable development of the entire world.

# Ecosystem

**Ecology**

All living organism, whether plant or animal or human being is surrounded by the environment, on which it derive its needs for its survival.

Each living component interacts with non –living components for their basic requirements form different ecosystem.

**Definition**

Ecology is the study of interactions among organism or group of organisms with their environment. The environment consists of both biotic components (living organisms) and abiotic components (non – living organisms). or Ecology is the study of ecosystems.

Ecosystem is the basic functional unit of ecology. The term ecosystem is coined form a Greek word meaning study of home.

# TYPES OF ECOSYSTEM- Natural ecosystem

Natural ecosystems operate themselves under natural conditions. Based on habitat types, it can be further classified into three types.

**1.Terrestrial ecosystem**

This ecosystem is related to land.

Example

Grassland ecosystem, forest ecosystem, desert ecosystem, etc.,

**2.Aquatic ecosystem**

This ecosystem is related to water. It is further sub classified into two types based on salt content.

•Fresh water ecosystem

(i)Running water ecosystems.

Rivers, Streams

**(ii) Standing water ecosystems**

Pond, lake

**(iii) Marine ecosystem**

Seas & Seashores

**Man – made (or) Artificial ecosystems**

Artificial ecosystem is operated (or) maintained by man himself.

**Example**

Croplands, gardens

**STRUCTURE (or) COMPONENTS OF AN ECOSYSTEM**

The term structure refers to the various components.

So the structure of an ecosystem explains the relationship between the abiotic (non –living) and the biotic (living) components.

An ecosystem has two major components

- Biotic (living) components
- Abiotic (non living) components

**Biotic components**

The living organisms (or) living members in an ecosystem collectively form its community called biotic components (or) biotic community.

**Examples**

•Plants (producers),

•animals (consumers),

•microorganisms (decomposers).

**Members of components of an ecosystem (or)**

**Classification biotic components**

The members of biotic components of an ecosystem are grouped in to three based on how they get food.

- Producer (plants)
- Consumer (Animals)
- Decomposers (Micro-organisms)

**1.Procedures (Autotrophs)**

Procedures synthesize their food themselves through photosynthesis

**Example :**

All green plants, trees.

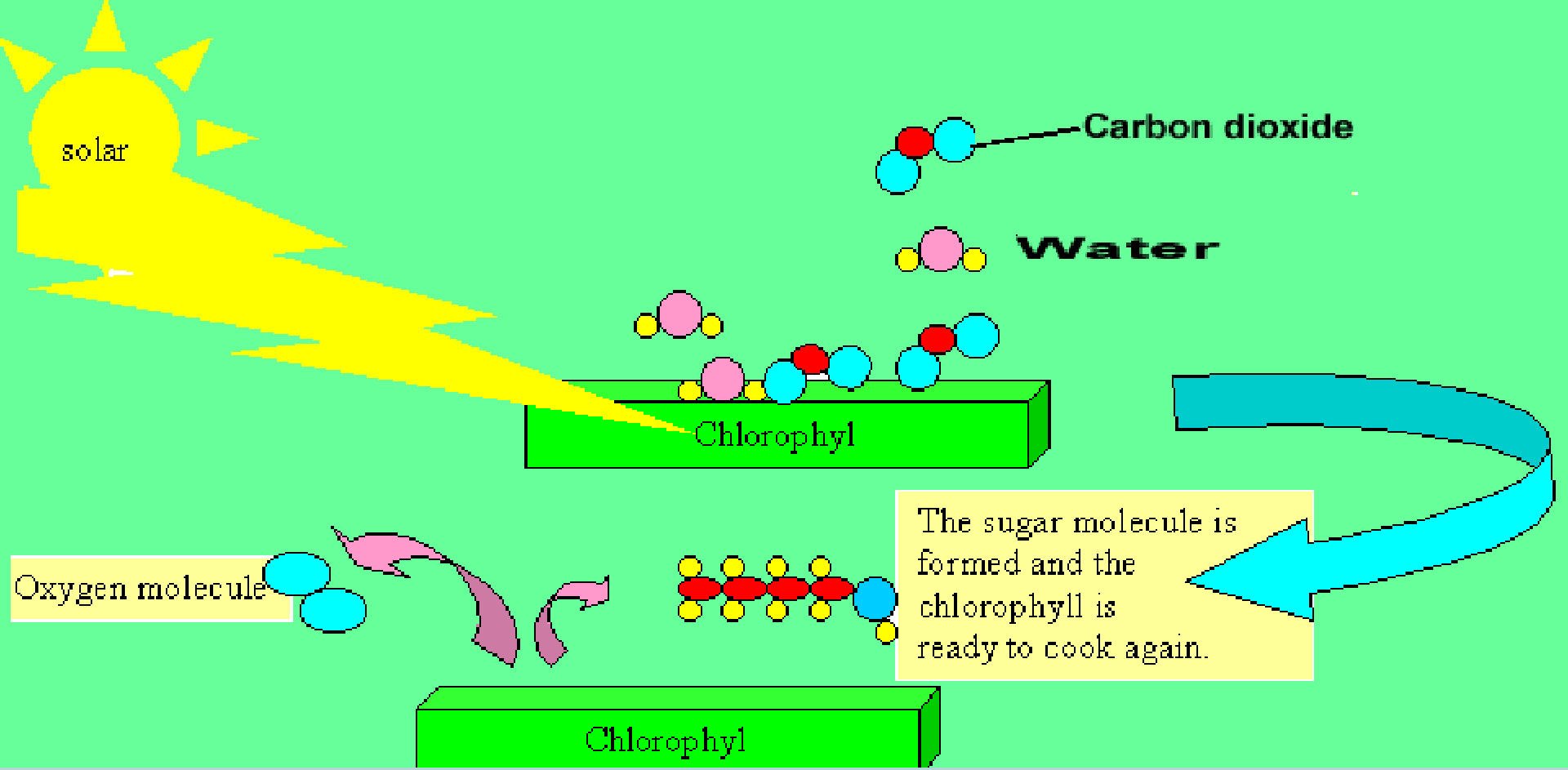
**Photosynthesis**

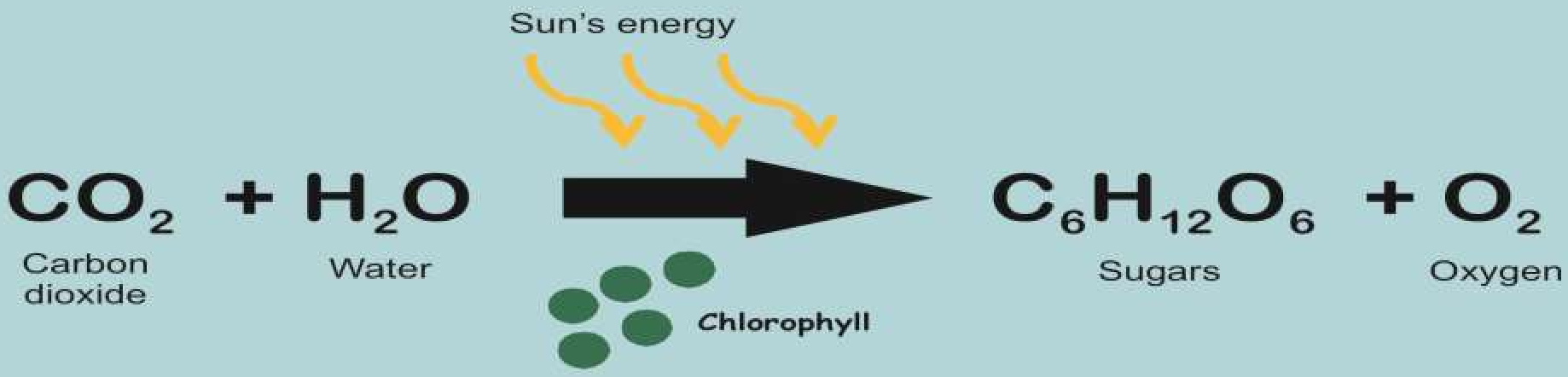
The green pigments called chlorophyll, present in the leaves of plants, converts $CO_2$ and $H_2O$ in the presence of

sunlight into carbohydrates.

$$6CO_2 + 12H_2O \text{ ----> } C_6H_{12}O_6 + 6O_2 + 6H_2O$$

This process is called photosynthesis


solar
Carbon dioxide
Water
Chlorophyl
The sugar molecule is formed and the chlorophyll is ready to cook again.
Oxygen molecule
Chlorophyl


Sun's energy
$CO_2$ + $H_2O$ → $C_6H_{12}O_6$ + $O_2$
Carbon dioxide
Water
Chlorophyll
Sugars
Oxygen

**Consumers (heterotrophs) Examples**

**Plant eating species**

Insects, rabbit, goat, deer, cow, etc.,

**Classification of consumers**

Consumers are further classified as

(i) **Primary consumers** (Herbivores) (Plant eaters)

Primary consumers are also called herbivores, they directly depend on the plants for their food. So they are called plant eaters.

**Examples :**

Insects, rat, goat etc.,

(ii) Secondary consumers (primary carnivores) (meat eater) Secondary consumers are primary carnivores, they feed on primary consumers. They directly depend on the herbivores for their food.

**Example**

Frog, cat, snakes, foxes, etc.,

**(iii) Tertiary consumers** (Secondary carnivores) (Meat-eaters) Tertiary consumers are secondary carnivores, they feed on secondary consumers. They depend on the primary carnivores for their food.

**Examples**

Tigers, lions, etc.,

**3. Decomposers Examples**

Microorganisms like bacteria and fungi. Decomposers attack the dead bodies of producers and consumers and decompose them into simpler compounds. During the decomposition inorganic nutrients are released.

The inorganic nutrients together with other organic substances are then utilized by the procedures for the

synthesis of their own food.

**Abiotic (non-living) components**

The non-living components (physical and chemical) of ecosystem collectively form a community called abiotic components (or) abiotic community.

**Examples**

Climate, soil, water l air, energy, nutrients, etc.,

**1. Physical components**

They include the energy, climate, raw materials and living space that the biological community needs. They are useful for the growth and maintenance of its member.

**Examples**

Air, water, soil, sunlight, etc.,

## 2. Chemical Components

They are the sources of essential nutrients

**Examples**

•Organic substances : Protein, lipids, carbohydrates, etc.,

•Inorganic substances: All micro (Al, Co, Zu, Cu) and macro elements (C,H, O, P, N, P, K) and few other elements.

**Types of Functions**

Functions of an ecosystem are of three types.

**1.Primary function**

The primary function of all ecosystem is manufacture of starch (photosynthesis).

**2.Secondary function**

The secondary function of all ecosystem is distribution energy in the form of food to all consumers.

**Tertiary Function**

All living systems diet at a particular stage. These dead systems are decomposed to initiate third function of ecosystems namely “cycling”.

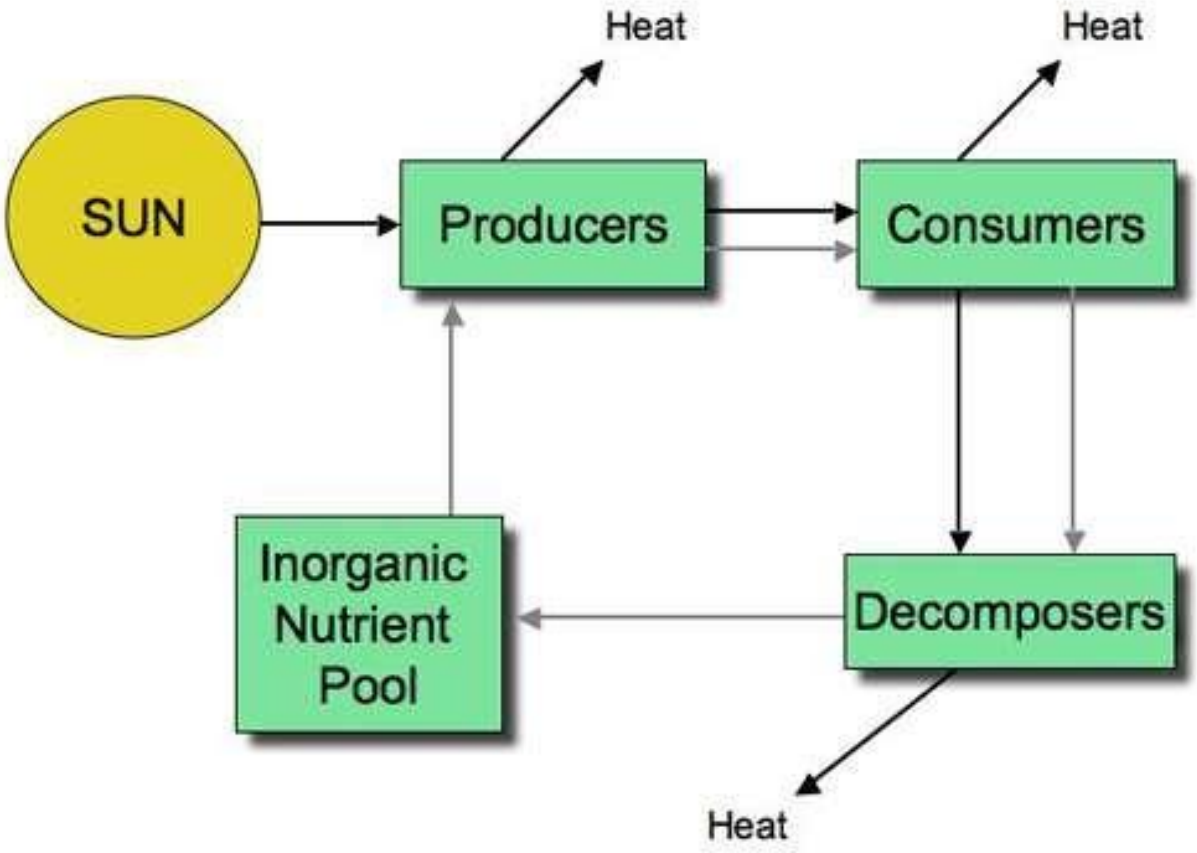
The functioning of an ecosystems may be understood studying the following terms.

- Energy and material flow.
- Food chains
- Food webs
- Food pyramids

## ENERGY FLOW IN THE ECOSYSTEMS

Energy is the most essential requirement for all living organism. Solar energy is the only source to our planet earth. Solar energy is transformed to chemical energy in photosynthesis by the plants (called as primary producers).

This is the most essential step to provide energy for all other living organisms in the ecosystem. Some amount of chemical energy is used by the plants for their growth and the remaining is transferred to consumers by the process of eating.


Heat
Heat
SUN
Producers
Consumers
Inorganic Nutrient Pool
Decomposers
Heat

**ECOLOGICAL SUCCESSION**

In an area one community may be replaced by another community or by a series of communities.

Thus the progressive replacement of one community by another till the development of stable community in a particular area is called ecological succession.

**Types of ecological succession**

Ecologists recognize two types of ecological succession, used on the conditions present at the beginning of the process.

**1.Primary succession**

It involves the gradual establishment of biotic communities on a lifeless ground.

a. Hydrarch (or) Hydrosere

Establishment starts in a watery area like pond and lake.

b. Xerarch or Xerosere

Establishment starts in a dry area like, desert and rock

**2. Secondary succession**

It involves the establishment of biotic communities in the area, where some type of biotic community is already present.

# FOOD CHAINS

## Definition

***"There sequence of eating and being eaten in an ecosystem is known as food chain"***

***(or)***

***"Transfer of food energy from the plants through a series of organisms is known as food chain"***

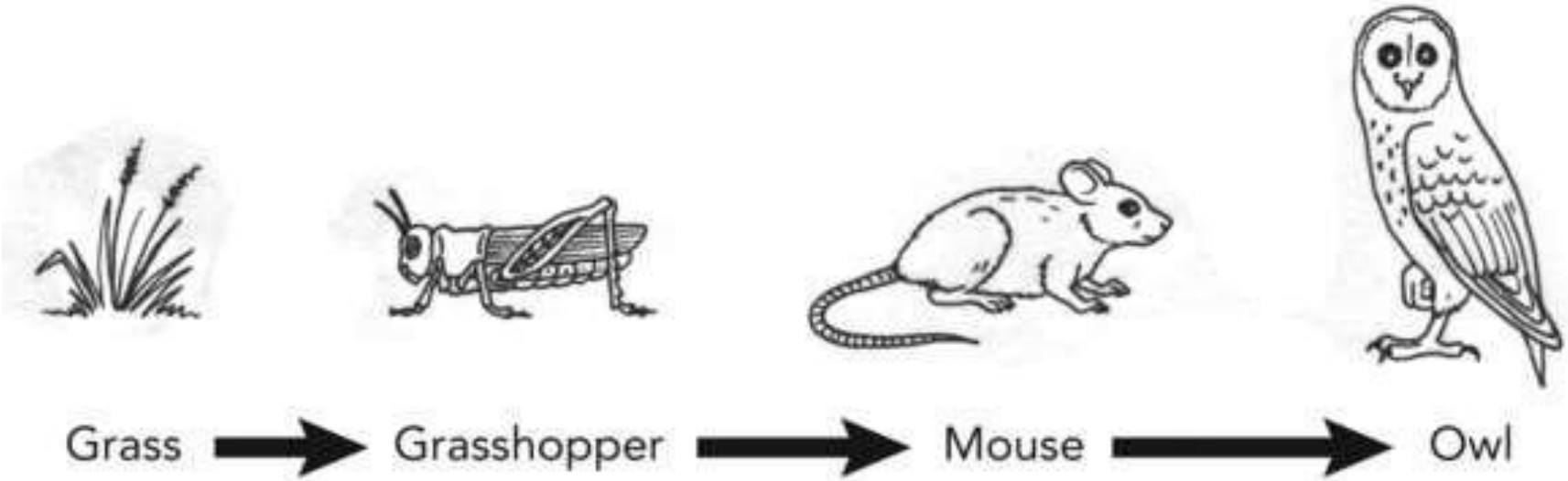
When the organisms die, they are all decomposed by microorganism (bacteria and fungi) into nutrients that can again be used by the plants. At each and every transfer, nearly 80-90% of the potential energy gets lost as heat. A food chain always starts with plant life and ends with animal.

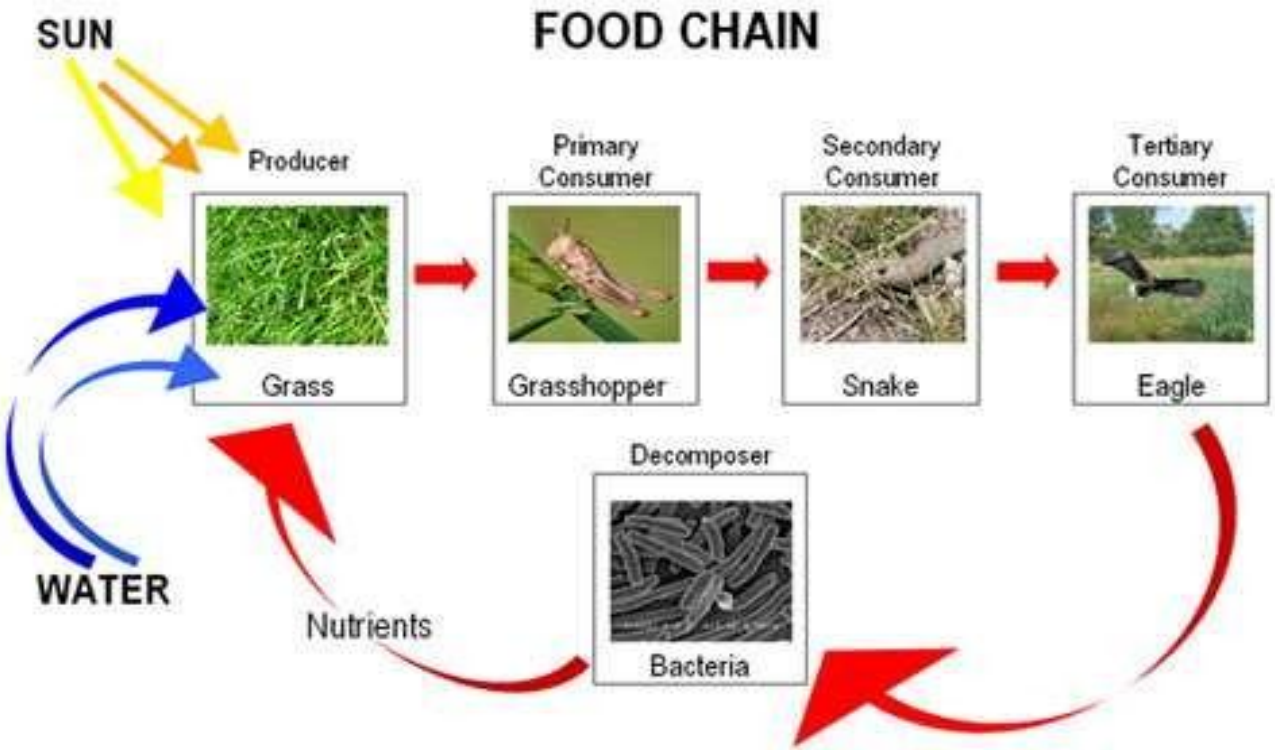
## Herbivores

Animal that eat only plants are called herbivores.

## Carnivores

Animals that eat other animals are called carnivores.


Grass
Grasshopper
Mouse
Owl


FOOD CHAIN
SUN
Producer
Grass
Primary Consumer
Grasshopper
Secondary Consumer
Snake
Tertiary Consumer
Eagle
Decomposer
Bacteria
WATER
Nutrients

# FOOD WEB

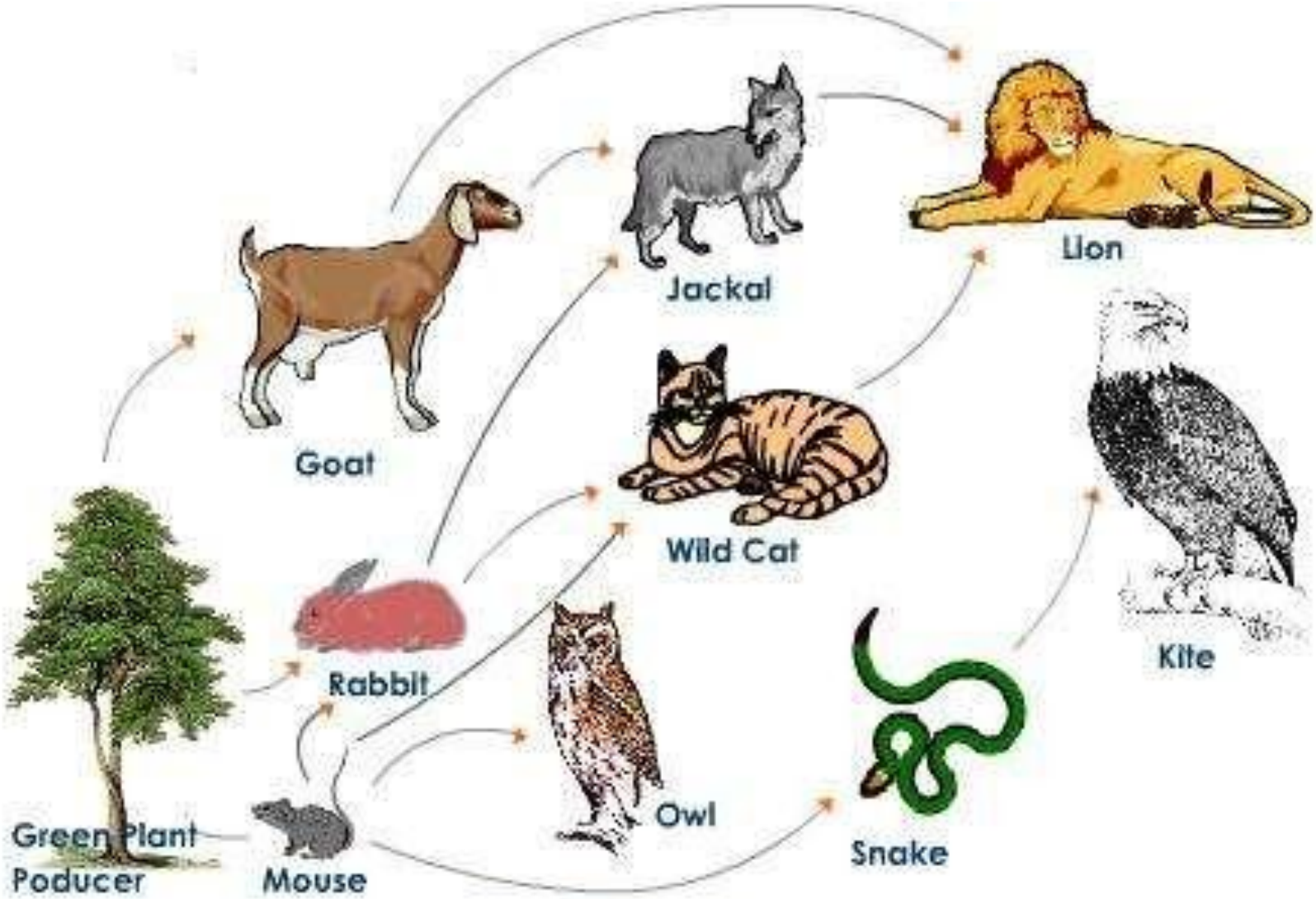
## Definition

The interlocking pattern of various food chains in an ecosystem is known as food web. In a food web many food chains are interconnected, where different types of organisms are connected at different tropic levels.

## Example

Grass may be eaten by insects, rats, deer's, etc., these may be eaten by carnivores (snake, tiger).

Thus there is a interlocking of various food chains called food webs.




Food Web in a Forest

# ECOLOGICAL PYRAMIDS

## Definition

“Graphical representation of structure and function of tropic levels of an ecosystem, starting with producers at the bottom and each successive tropic levels forming the apex is known as an ecological pyramids.”

## Types of Ecological pyramids

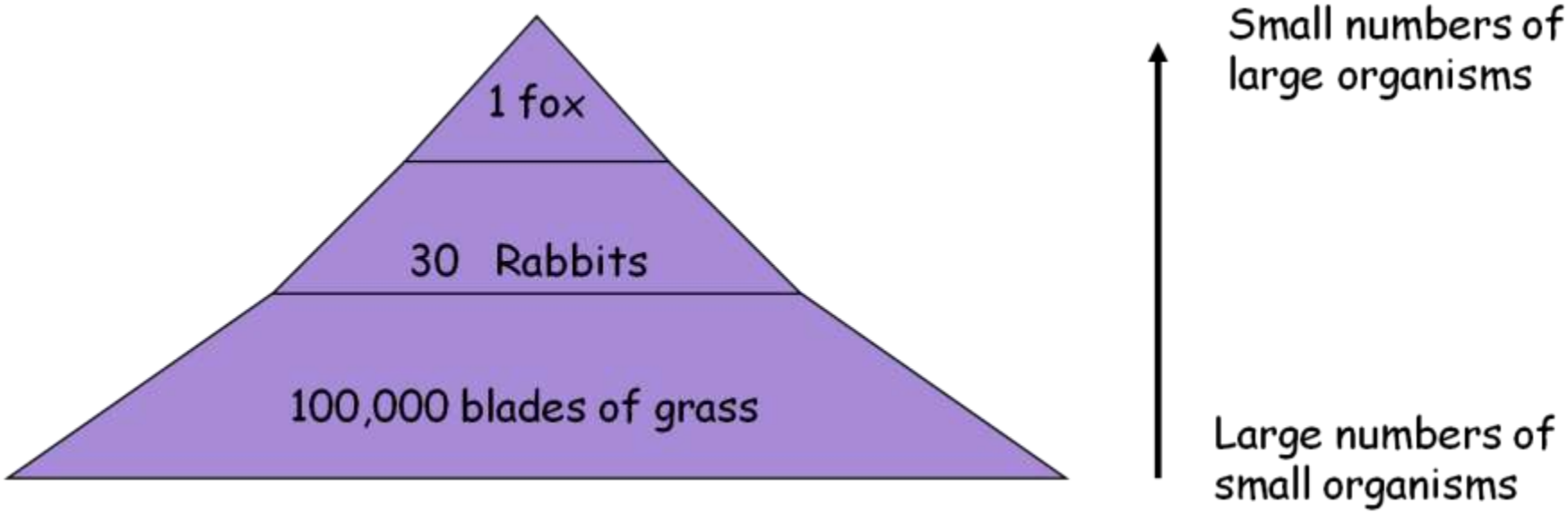
1.Pyramid of numbers.

2.Pyramid of energy.

3.Pyramid of biomass.

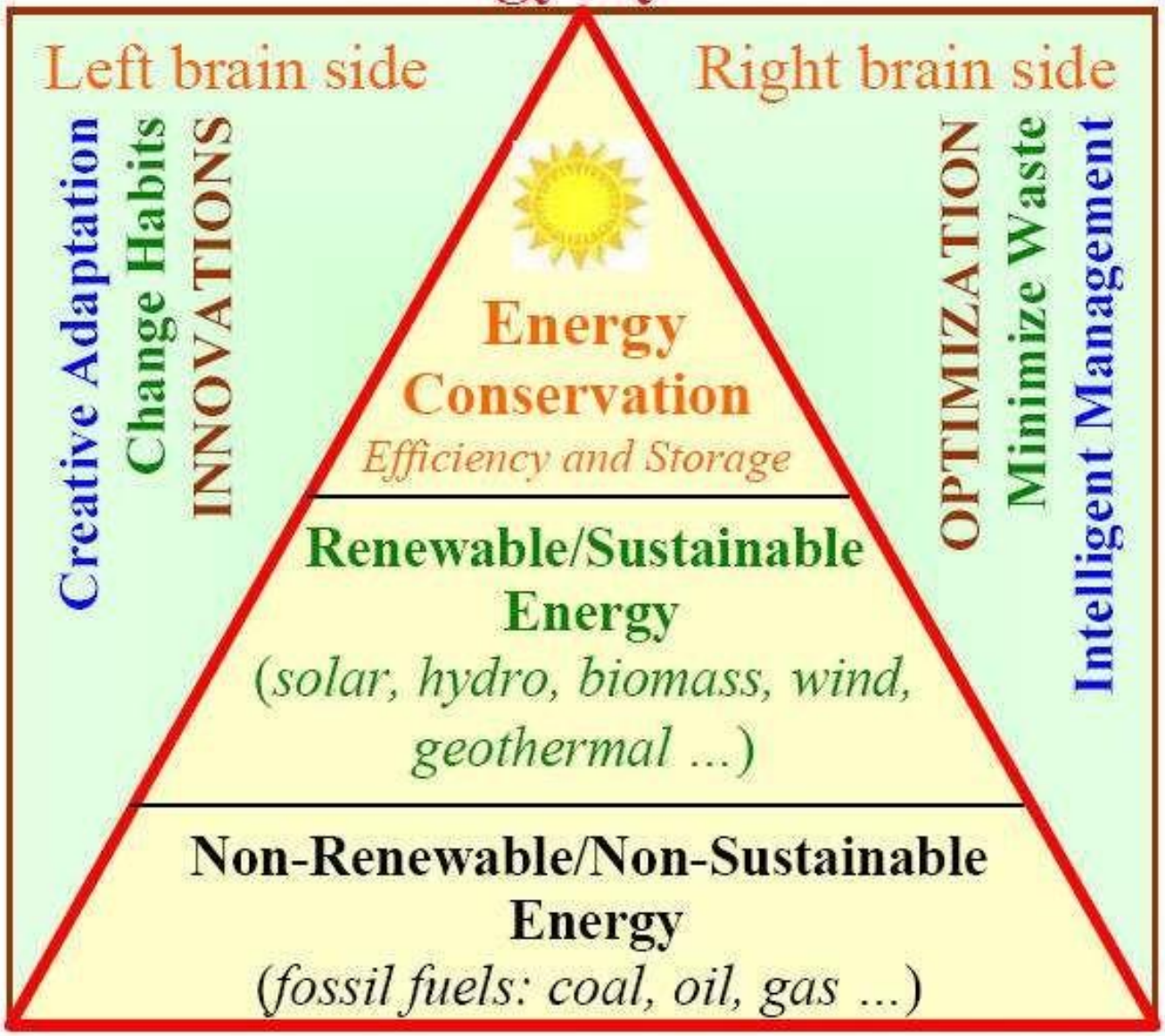
# Pyramid of Numbers

A pyramid of numbers can be used to show the number of organisms at each stage of a food chain.



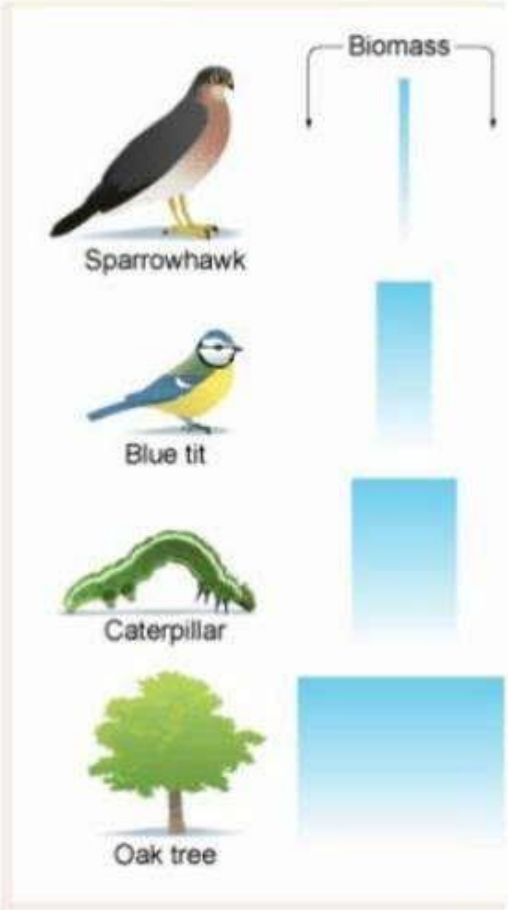
*Life May Be Happier After the Fossil-Fuel Era*

# Energy Pyramid




www.kostic.niu.edu © by M. Kostic

# Pyramids of biomass
## (mass of tissue of living organism)




- Energy moves from one trophic level to the next.
- So energy moves from oak tree to caterpillars.
- Energy is lost at each stage due to it being lost to the environment by

  - respiration (heat energy)
  - faeces (poo)

# FOREST, GRASSLAND & DESERT ECOSYSTEM

## FOREST ECOSYSTEM

A forest ecosystem is the one in which a tall and trees grow that support many animals and birds. The forest are found in undisturbed areas receiving moderate to hi rainfall.

The forest occupies nearly 40% of the world's land area. In India it occupies only 19% of its total land area.

**Types of forest ecosystem:**

Depending upon the climate conditions, forests can be classified into the following types:

1. Tropical Rain forests.
2. Tropical deciduous forests.
3. Tropical scrub forests.
4. Temperate rain forests.
5. Temperate deciduous forests.

## Features of different types of Forests

### 1.Tropical Rain forests

They are found near the equator. They are characterized by high temperature. They have broad leaf trees like teak and the animals like lion, tiger and monkey.

### 2.Tropical deciduous forests

They are found little away from the equator. They are characterized by a warm climate and rain is only during monsoon. They have different types of deciduous trees like maple, oak and hickary and animals like deer, fox, rabbit and rat.

**3.Tropical Scrub forests**

These are characterized by a dry climate for longer time. They small deciduous trees and shrubs and animals like maple, oak and hickory and animals like deer, fox, etc.,

**4.Temperate Rain Forests**

They are found in temperate areas with adequate rainfall. They are characterized by coniferous trees like pines, firs, red wood etc., and animals like, squirrels, fox, cats, bear etc.,

5. **Temperate deciduous forests**

They are found in areas with moderate temperatures. have major trees including broad leaf deciduous trees like oak, hickory and animals like deer, fox, bear, etc.,

**Characteristics of forest ecosystems**

1. Forests are characterized by warm temperature and adequate rainfall, which make the
2. generation of number of ponds, lakes etc.,
3. The forest maintains climate and rainfall.
4. The forest support many wild animals and protect biodiversity.
5. The soil is rich in organic matter and nutrients which support the growth of trees.
6. Since penetration of light is so poor, the conversion of organic matter into nutrients is very fast.

## Structure and Function of forest ecosystem

### I. Abiotic components

Climatic factors (temperature, light, rainfall) and minerals The abiotic components are inorganic and inorganic and organic substances found in the soil and atmosphere. In addition minerals, the occurrence of litter is characteristic features, majority of forests.

### II. Biotic components

1. **Producers:** The plants absorb sunlight and produce photosynthesis Trees, shrubs and ground vegetation..

## 2. Consumers

**a. Primary consumers (herbivores) :**They directly depend on the plants for their food.

Example : Ants, flies, insects, mice, deer, squirrels.

**b. Secondary consumers (primary carnivores):**They directly depend on the herbivores for their food

Examples: Snakes, birds, fox.

**c. Tertiary consumers :**They depend on the primary carnivores for their food

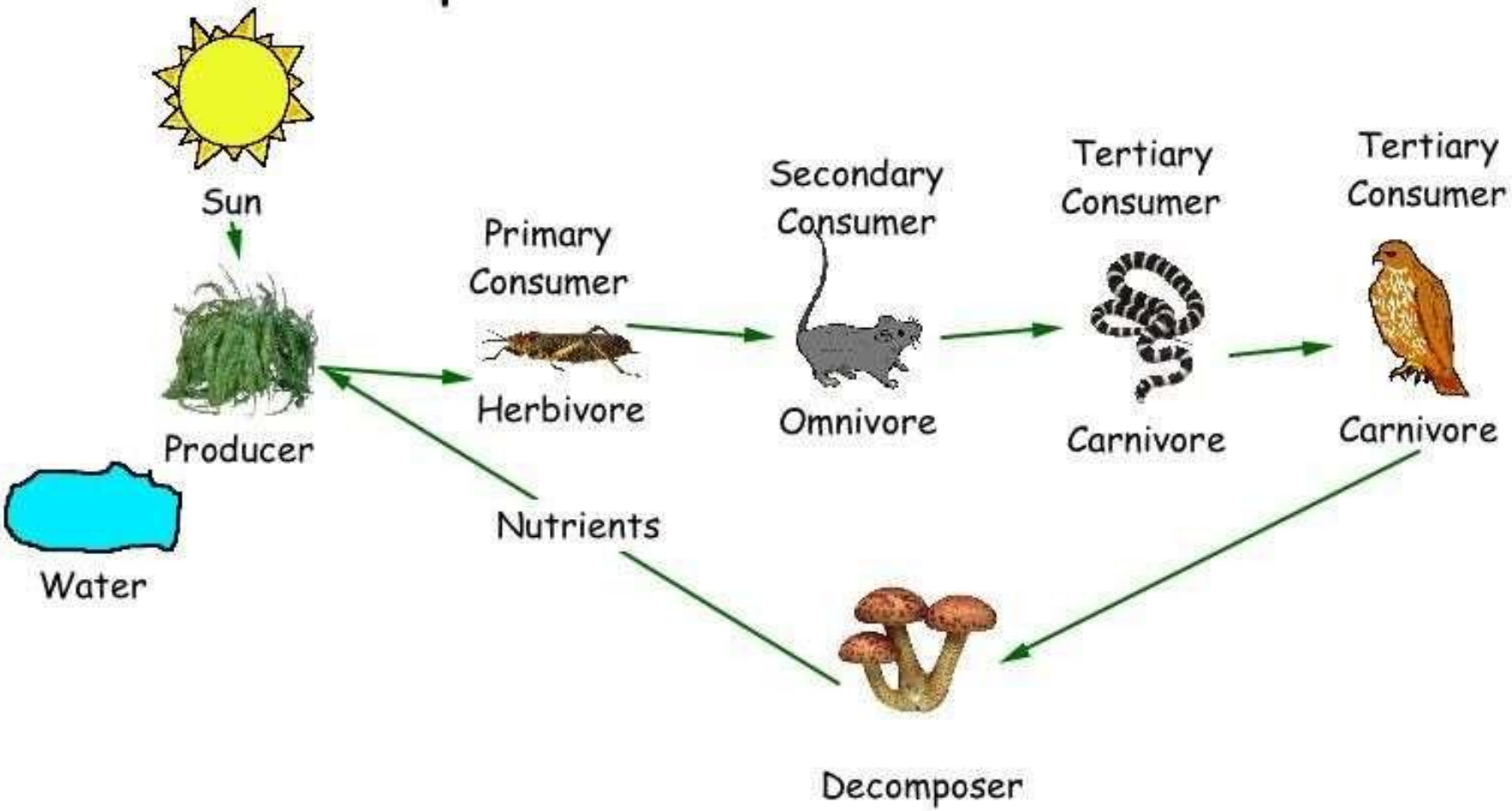
Examples : Animals, like tiger, lion, etc.,

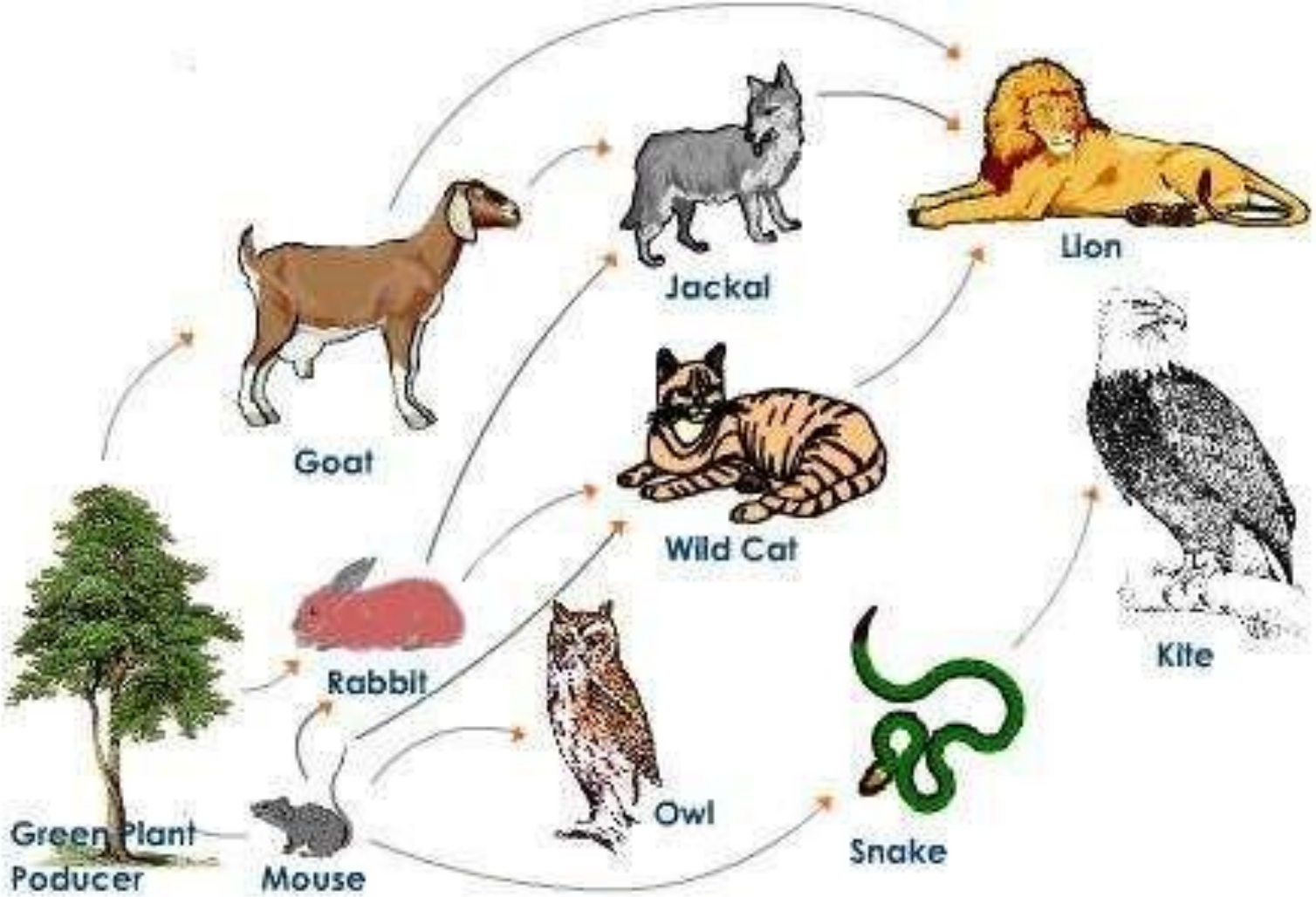
**3. Decomposers**

Bacteria and fungi.

They decompose the dead plant and animal matter of decomposition in tropical and subtropical forest is in rapid than the temperate forests.

# Temperate Deciduous Forest Food Chain






Food Web in a Forest

# GRASSLAND ECOSYSTEM.

## Introduction

Grassland occupies about 20% of earth's surface addition to grass species, some trees and shrubs are also present in grasslands.

Limited grazing helps to improve the net primary production of the grasslands.

## Types of grassland ecosystem

Depending upon the climate conditions grassland cal classified into three types

1. Tropical grasslands.
2. Temperate grasslands.
3. Polar grasslands.

**Features of different types of grassland**

**1. Tropical grasslands**

They are found near the borders of tropical rain . forests. are characterized by high temperature and moderate rainfall (40 to 100 cm). It is also known as Savanna type. They ye tall grasses with scattered shrubs and stunted trees and animals like zebras, giraffes, antelopes, etc.,

**2. Temperate grasslands**

They are usually found in the centers of continents, oil sloped hills.. They are characterized by very cold winters and hot summers: Intense grazing and summer fires, do not W shrubs or trees to grow.

**3. Polar grasslands**

They are found in arctic polar regions. They are characterized by severe cold and strong winds along with ice and snow. In summers several small annual plants grow. They ‘e animals like arctic wolf, weasel, arctic fox, etc.,

**Characteristics of Grassland Ecosystems**

Grassland ecosystem is a plain land occupied by grasses. Soil is very rich in nutrients and organic matter. Since it has tall grass, it is ideal place for grazing animals. It is characterized by low or uneven rainfall.

**Structure and function of the grassland Ecosystems**

**I. Abiotic components**

Nutrients, , H, 0, A, P, S, etc.,

These abiotic components are supplied by $C0_2$, $H_2$, C, Nitrate, phosphates and sulphates.

**II. Biotic Components**

**1. Producers:** They produce food.

Example :Grasses, forbs and shrubs.

**2. Consumers:**.

**Primary consumers** (herbivores) :They depend on grasses for their food

Examples: Cows, buffaloes, deer, sheep, etc.,

**Secondary consumers (carnivores)** :They feed on herbivores.

Examples: Snakes, lizards, birds, Jackals, fox, etc.,

**Tertiary consumers:** They feed on secondary consumers

Examples :Hawks, eagle, etc.,

**3. Decomposers :**They decompose the dead organic matter

Examples **:**Fungi and bacteria.

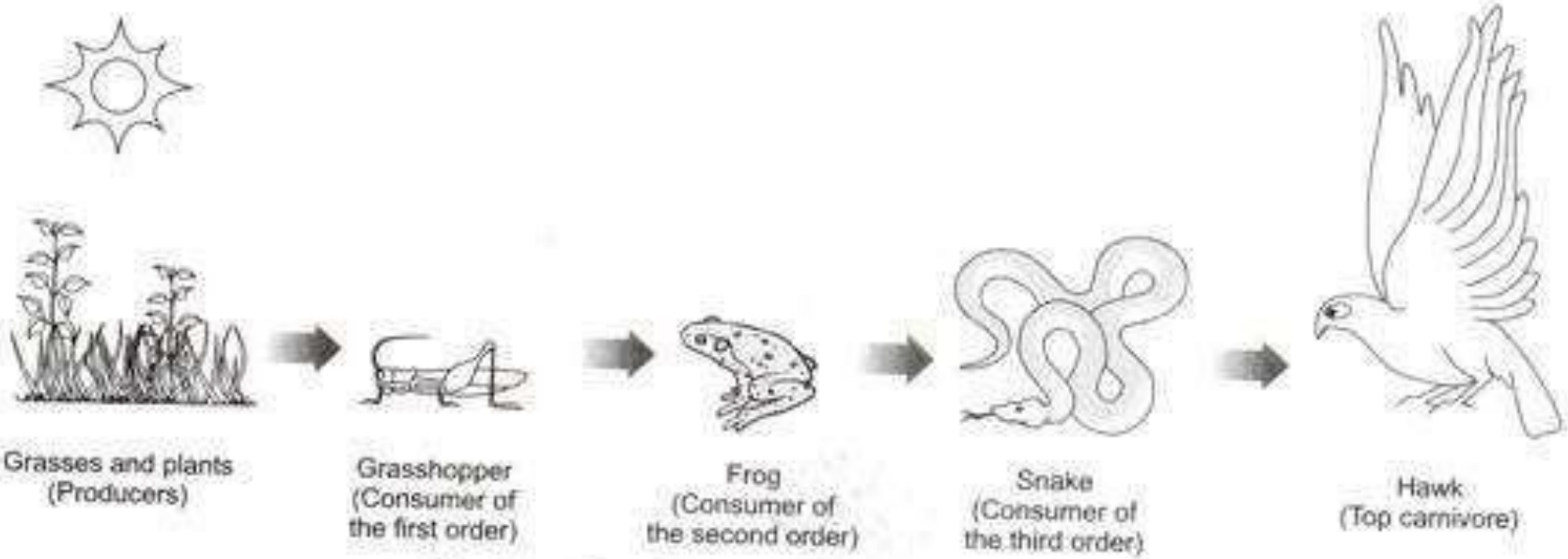
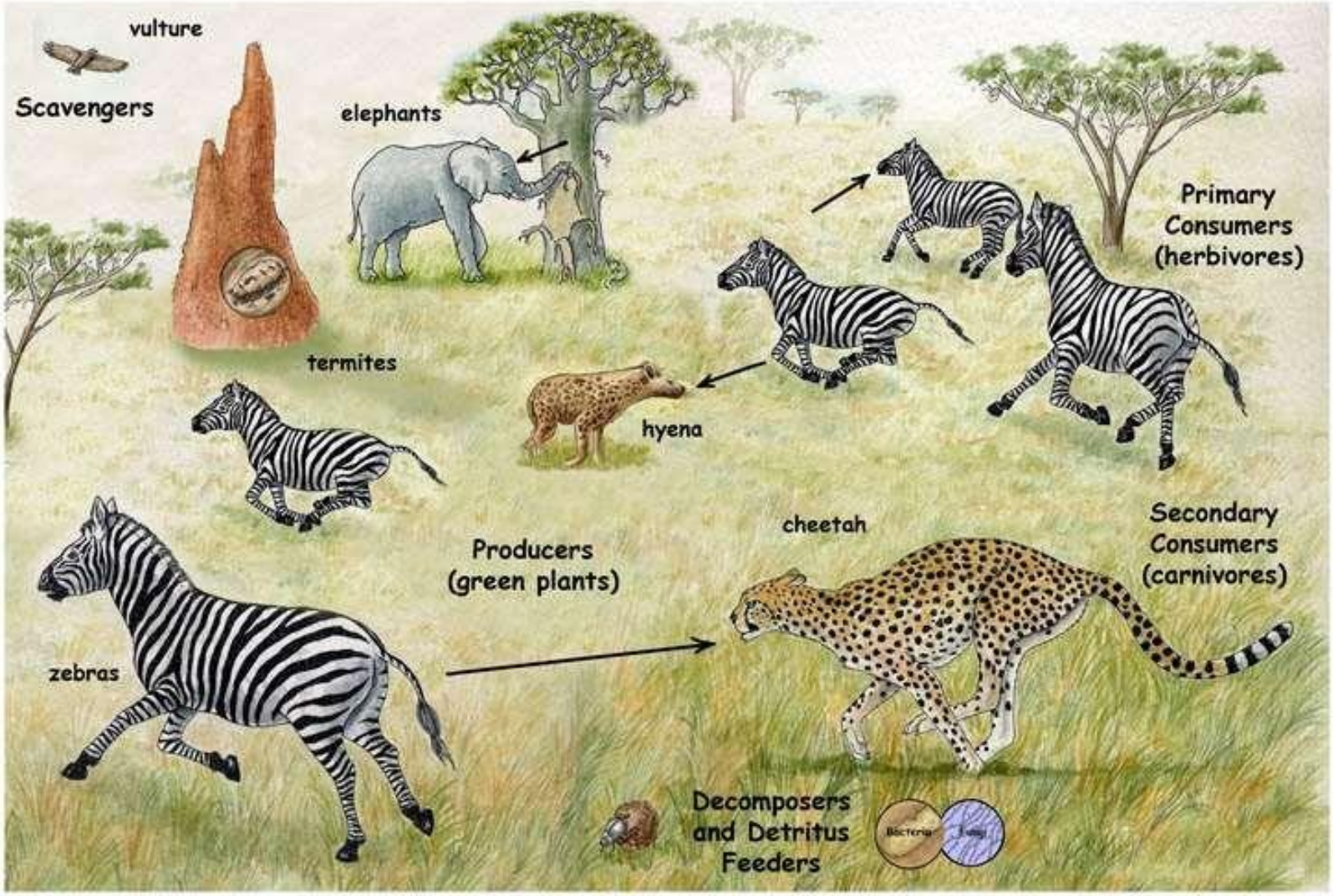



**Fig. 8.3** A food chain in a grassland ecosystem

In a freshwater aquatic ecosystem like a pond, the organisms in the food chain include algae, small animals, insects and their larvae, small fish, big fish and a fish-eating bird or animal (Figure 8.4).

# Grassland Food Web

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# DESERT ECOSYSTEMS

## Introduction

Desert occupies about 35% of our world's land area. It is characterized by less than 25 cm rainfall. The atmosphere is dry and hence it is a poor insulator .

## Types of desert ecosystems

Based on the climatic conditions, deserts are classified three types.

1. Tropical deserts.
2. Temperate deserts.
3. Cold deserts.

**Features of different types of deserts**

1. **Tropical deserts:** Tropical deserts are found in

- Africa: Sahara desert.
- Rajasthan: Thar desert.

They are characterized by only few species. Wind blow sand dunes are very common.

2. **Temperate deserts**

They are found in

South California: Majave.

They are characterized by very hot summer and very Winter time.

3. **Cold deserts**

They are found in

China: Gobi desert.

They are characterized by cold winters and summers.

**Characteristics of Desert ecosystem**

The desert air is dry and the climate is hot. Annual rainfall is less than 25 cm. The soil is very poor in nutrients and organic matter, Vegetation is poor.

**Structure and functions of the desert systems ecosystems**

**1. Abiotic Components**

**Examples :** Temperature, rainfall, sunlight, water, etc.,

The temperature is very high and the rainfall is very low. The nutrient cycling is also very low.

## II. Biotic Components

### Procedures

**Examples :**Shrubs, bushes, some grasses and few trees .In deserts mostly Succulent (e.g., cacti) plants are found available. They have water inside them to stay alive. They have. r on the outside to protect them from the sun.

### Consumers

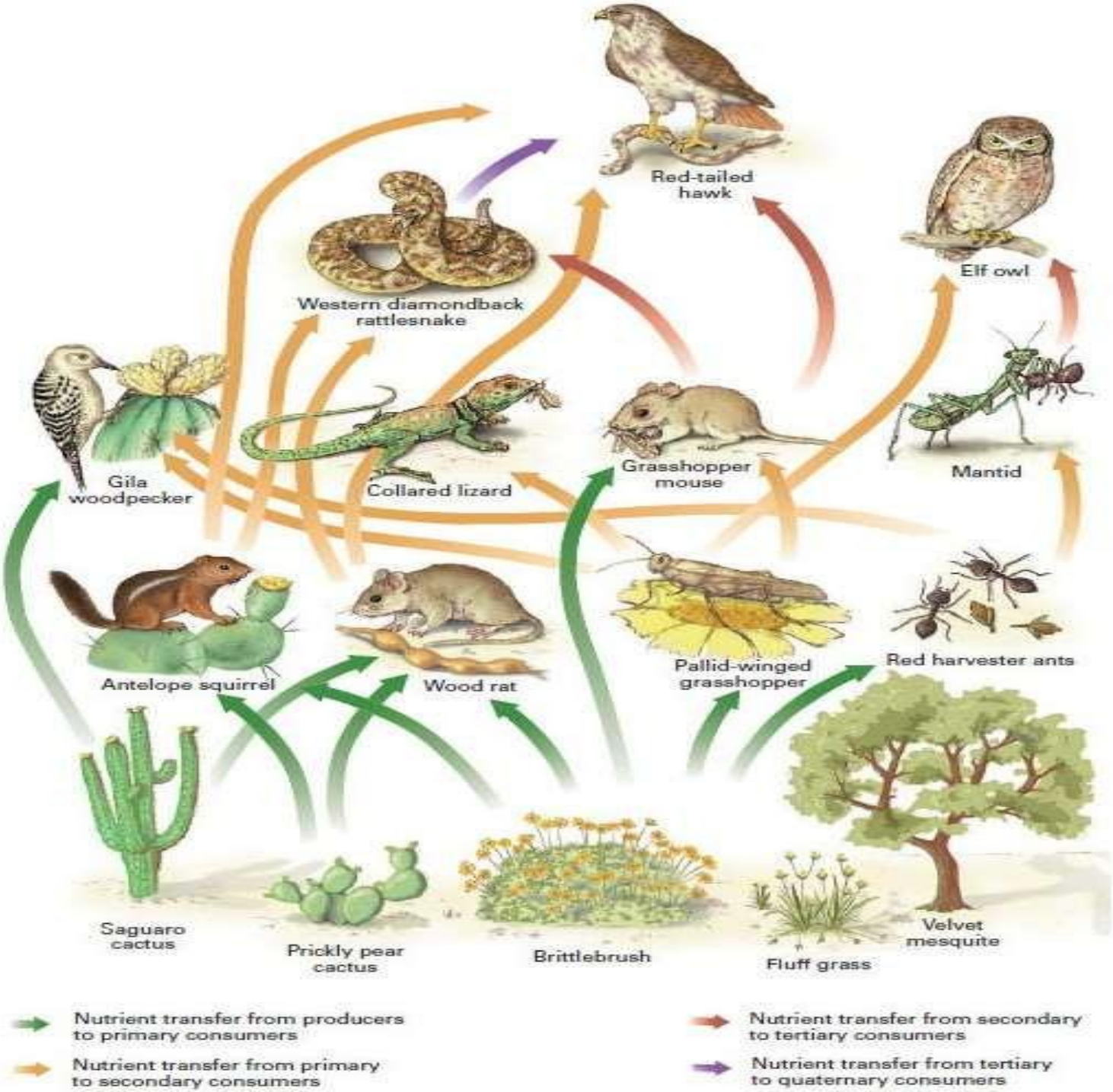
**Examples :**Squirrels, nice foxes, rabbits, deer and reptiles.

These animals dig holes in the ground to live in. They come out at night to find food. Most of the animals can extract water from the seeds they eat.

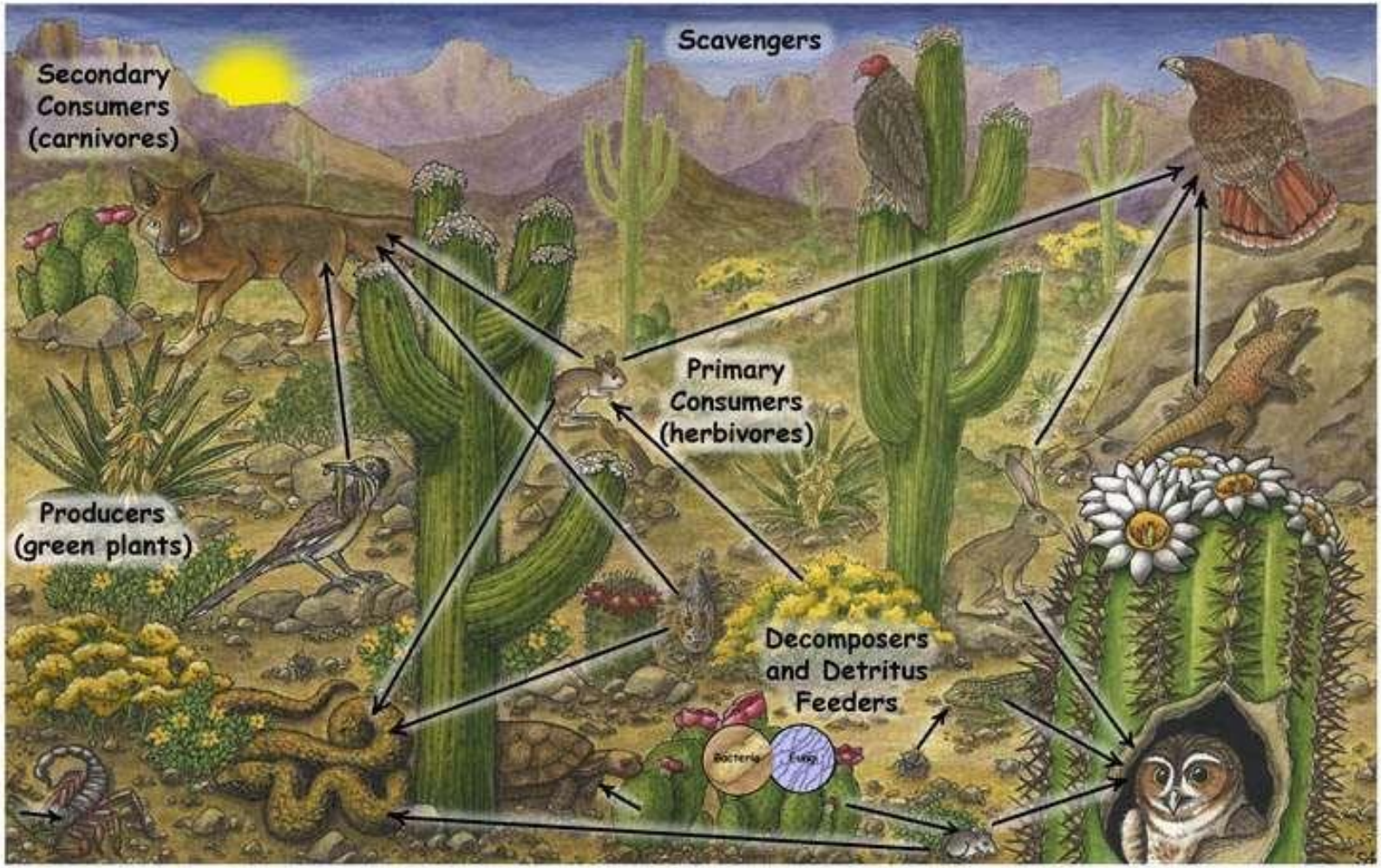
### Decomposers

**Examples :**Fungi and bacteria

Desert has poor vegetation with a very low amount of dead organic mater. They are decomposed by few fungi and bacteria.


Red-tailed hawk
Western diamondback rattlesnake
Elf owl
Gila woodpecker
Collared lizard
Grasshopper mouse
Mantid
Antelope squirrel
Wood rat
Pallid-winged grasshopper
Red harvester ants
Saguaro cactus
Prickly pear cactus
Brittlebrush
Fluff grass
Velvet mesquite
Nutrient transfer from producers to primary consumers
Nutrient transfer from primary to secondary consumers
Nutrient transfer from secondary to tertiary consumers
Nutrient transfer from tertiary to quaternary consumers

# Desert Food Web

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# Introduction, types, characteristic features, structure and function of Aquatic ecosystems: ponds, streams, lakes - Rivers, oceans, estuaries

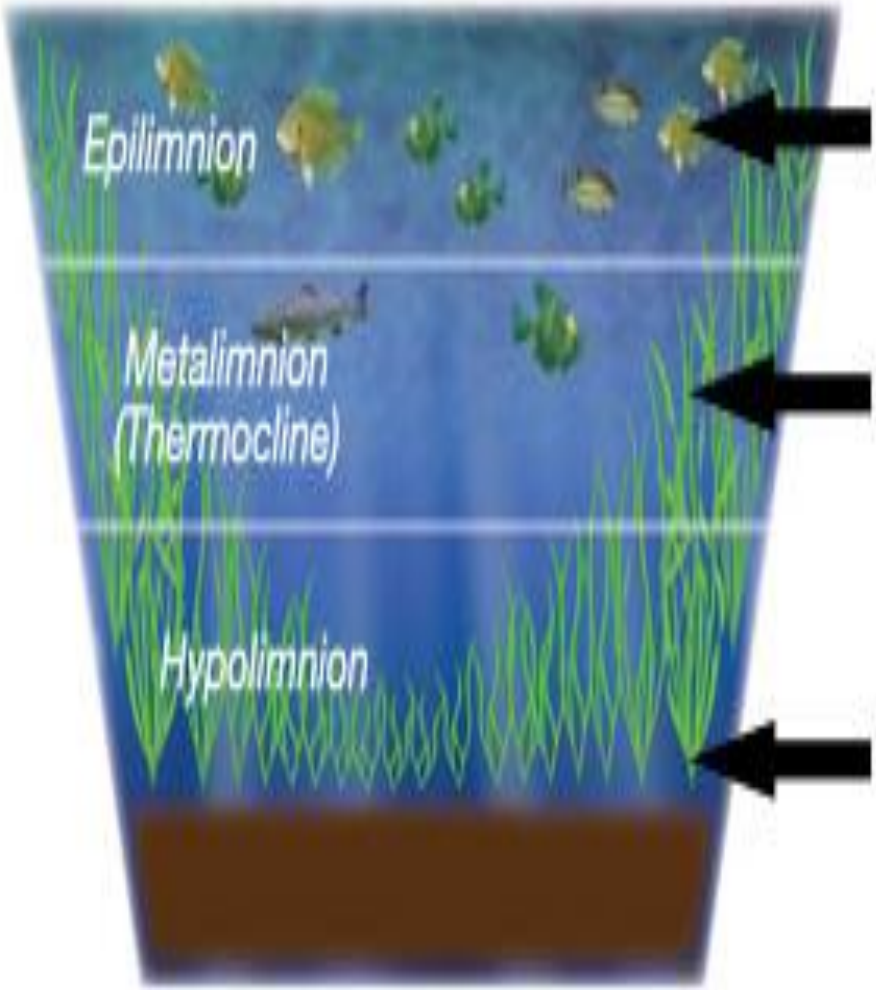
**Global aquatic ecosystems fall into two broad categories– the freshwater biomes and marine biomes.**

# FRESHWATER BIOMES

***lentic*** or standing-water ecosystems such as lakes and ponds

***lotic*** or running-water ecosystems such as springs, streams and rivers.

Associated with lentic and lotic ecosystems are the ***wetlands***



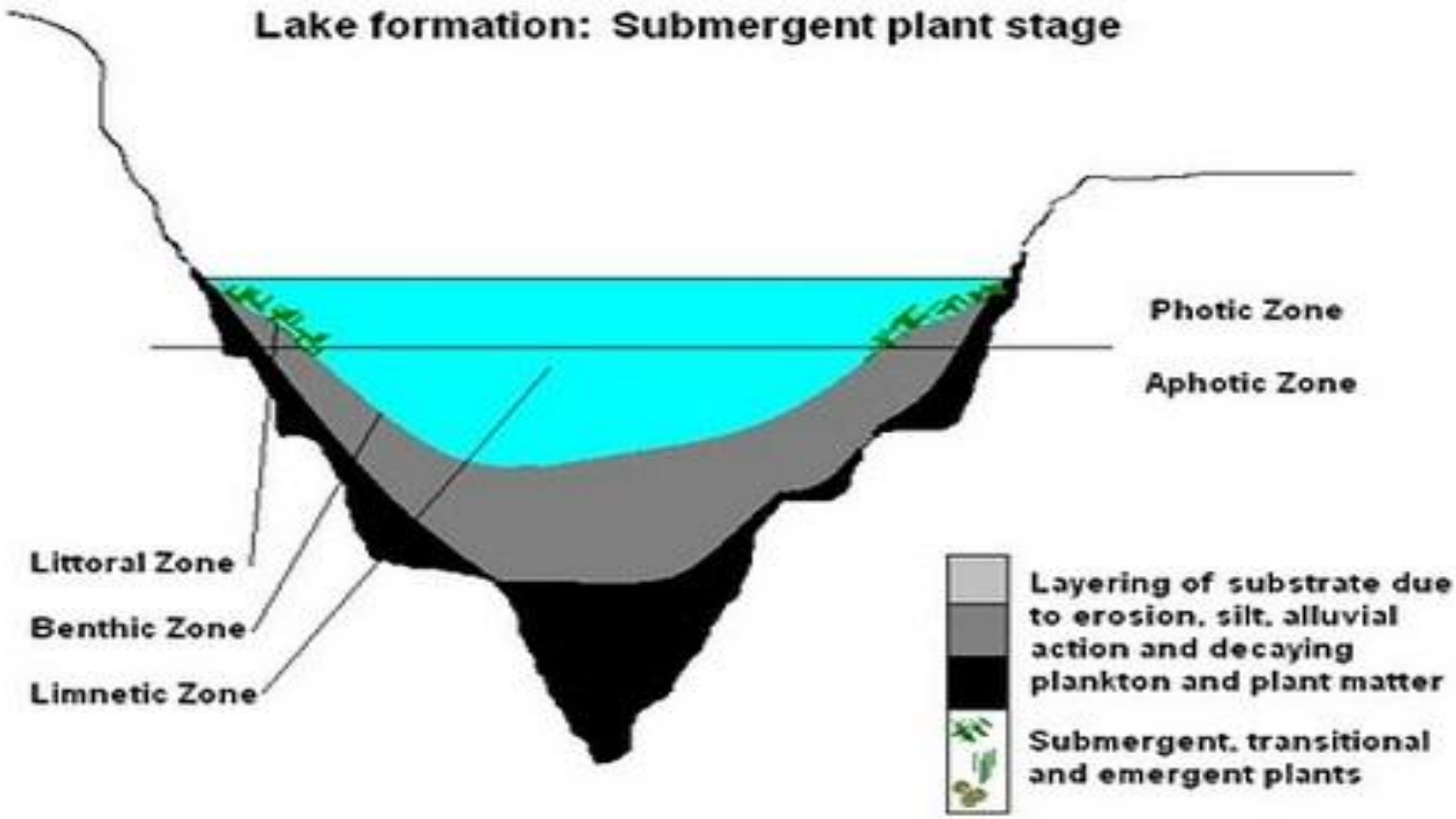

- Warm, typically oxygen-rich
- Recurrent surface scum
- Floating weed masses

- Zone of decreasing water temperature
- Zone of decreasing dissolved oxygen

- Zone completely void of oxygen
- Cold water temperatures
- Accumulating organic muck
- Weeds prevalent
- Unusable by fish and all aerobic organisms

Stratified without Aeration

# Typically lakes and ponds can be subdivided into following zones based on the depth and distance from the shoreline

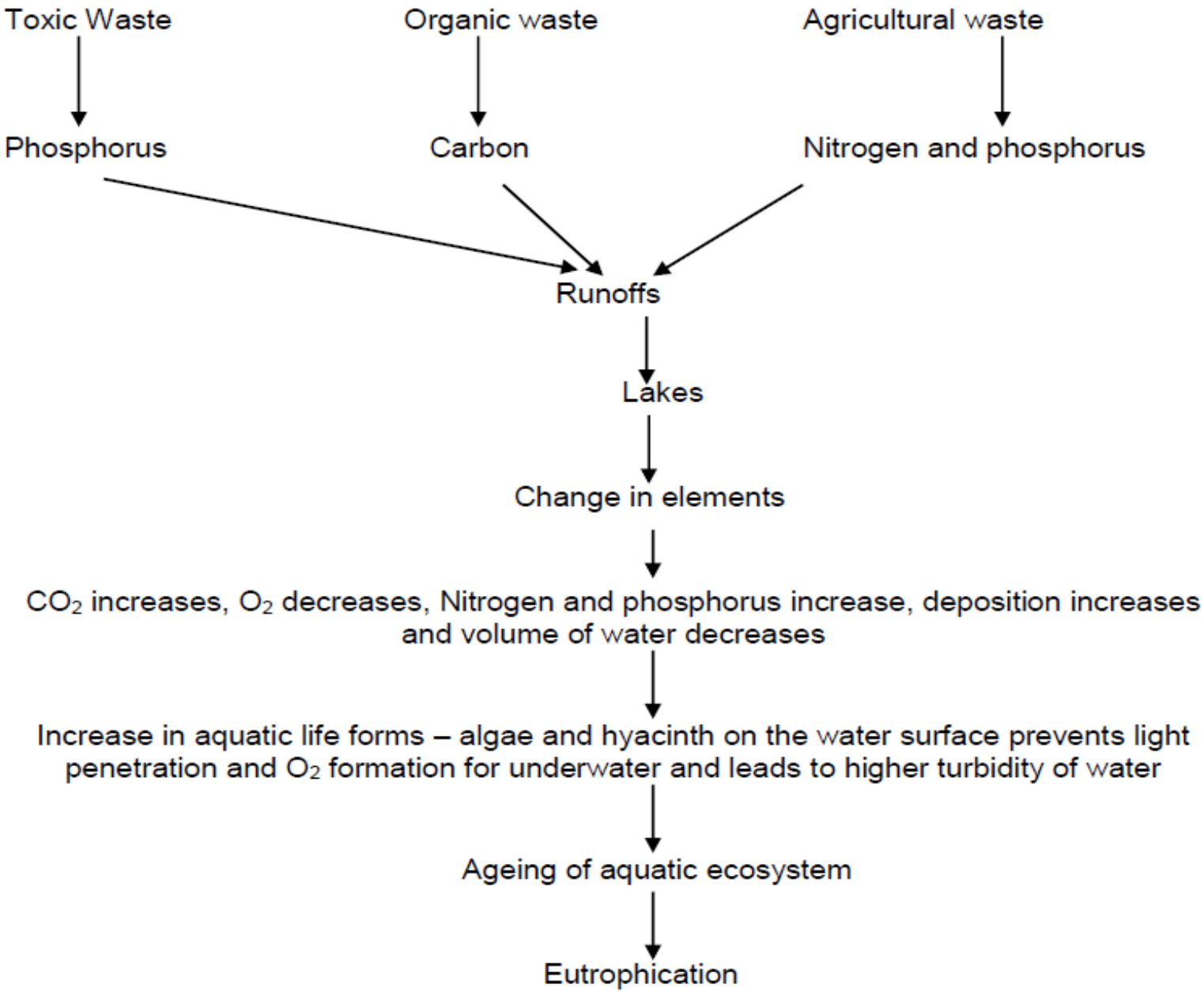


## Based on primary productivity lakes may be classified into two broad categories

### Oligotrophic lakes

- These are deep lakes having low surface to volume ratio with the hypolimnion larger than the epilimnion.
- Water is clear and appear blue to blue-green in sunlight.
- Bottom sediments are largely inorganic.
- The nutrient content of the water is low - causes low primary productivity.
- Littoral plants are scarce and plankton density is low.

# Eutrophic lakes



# Lotic ecosystems (Rivers)

The lotic ecosystem is essentially a continuum of physical and biological conditions from the headwaters to the river's mouth. These changing conditions in the gradient from small to large streams has been termed the **river continuum concept.**

# Wetlands

- Swamps
- Marshes
- Peat lands

# MARINE/OCEAN ECOSYSTEMS

**Physical factors that influence life in marine environments**

**Salinity**

**Light**

**Temperature**

**Pressure**

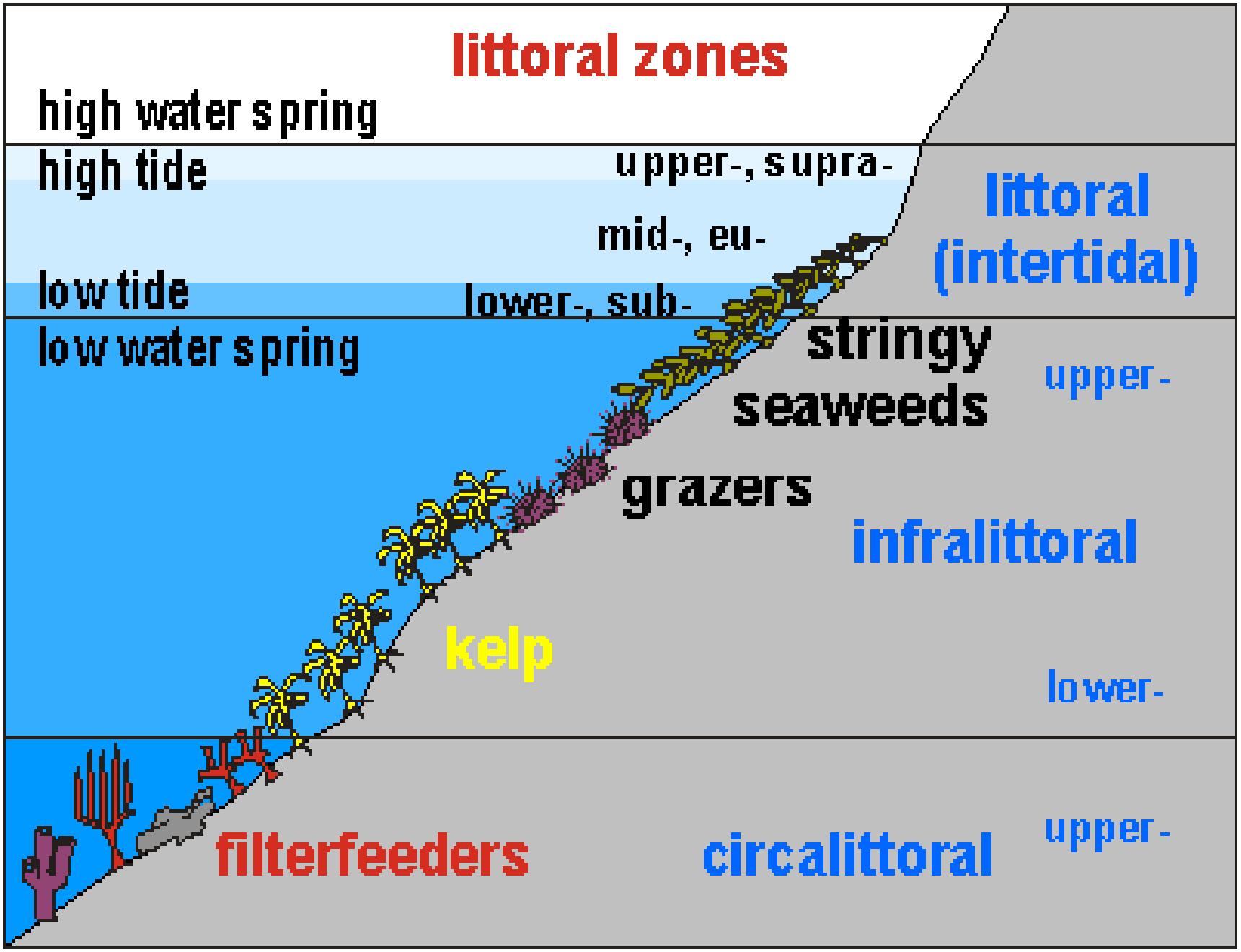
**Current**

**Sea shores**

# Sea shores

## Rocky shores

- **Supralittoral fringe** – At the uppermost end is a zone of bare rock marking the transition between land and sea.
- **Littoral zone** – It is the region covered and uncovered daily by tides and tends to be divided into subzones.
- **Infralittoral fringe** – It is the zone uncovered only at the spring tides for short periods of time. This zone consists of forests of large brown alga, *Laminaria* (one of the kelps) with a rich undergrowth of other brown (*Fucus)* and red algae.


littoral zones
high water spring
high tide
upper-, supra-
mid-, eu-
low tide
lower-, sub-
low water spring
littoral
(intertidal)
stringy
seaweeds
upper-
grazers
infralittoral
kelp
lower-
filterfeeders
circalittoral
upper-

# Sandy shores and Mudflats

- Both sandy shores and mudflats appear barren of life

- Supralittoral zone (dominant organisms are ghost crabs and beach hoppers), littoral or intertidal zone (abundance burrowing animals of varied groups) and infralittoral zone (predominant organisms are starfishes, sand dollars, predatory crabs and fishes).

# Open Sea

Two major regions of sea are **pelagic** or whole body of water lying above the ocean floor, and **benthic** or the entire sea bottom.

**Neritic zone** which is the shallow water zone on continental shelf and **oceanic zone** which is the region of open ocean beyond the continental shelf

# Coral reefs

- Coral reefs are one of the most beautiful and specialized ecosystems, widely distributed in warm shallow waters of tropical and subtropical seas.
- Built by carbonate-secreting organisms (coelentrata, Anthozoa)
- Coral reefs are built only under water at shallow depths and need a stable foundation upon which to grow.
- Reef building corals grow best at waters having average annual temperature of $24^0$ C, a depth of 40-50 metres and average salinity of 35‰.

## Various types of coral reefs.

Coral reefs can be categorized into several types according to their shape.

### Fringing reefs

Coral reefs occur adjacent to the coast. Most of the reefs in Japan are fringing reefs.

### Barrier reefs

These reefs are similar to the fringing reefs, but much larger at distant offshore forming deepening (called a lagoon) between the land and reefs.

### Atolls

Reefs occur in circular shape where land is absent in the middle of the circle. This type of reefs can be commonly seen in the South Pacific islands.

### Outer reefs

Reefs are isolated from the land. Small ones can be seen in Japan.

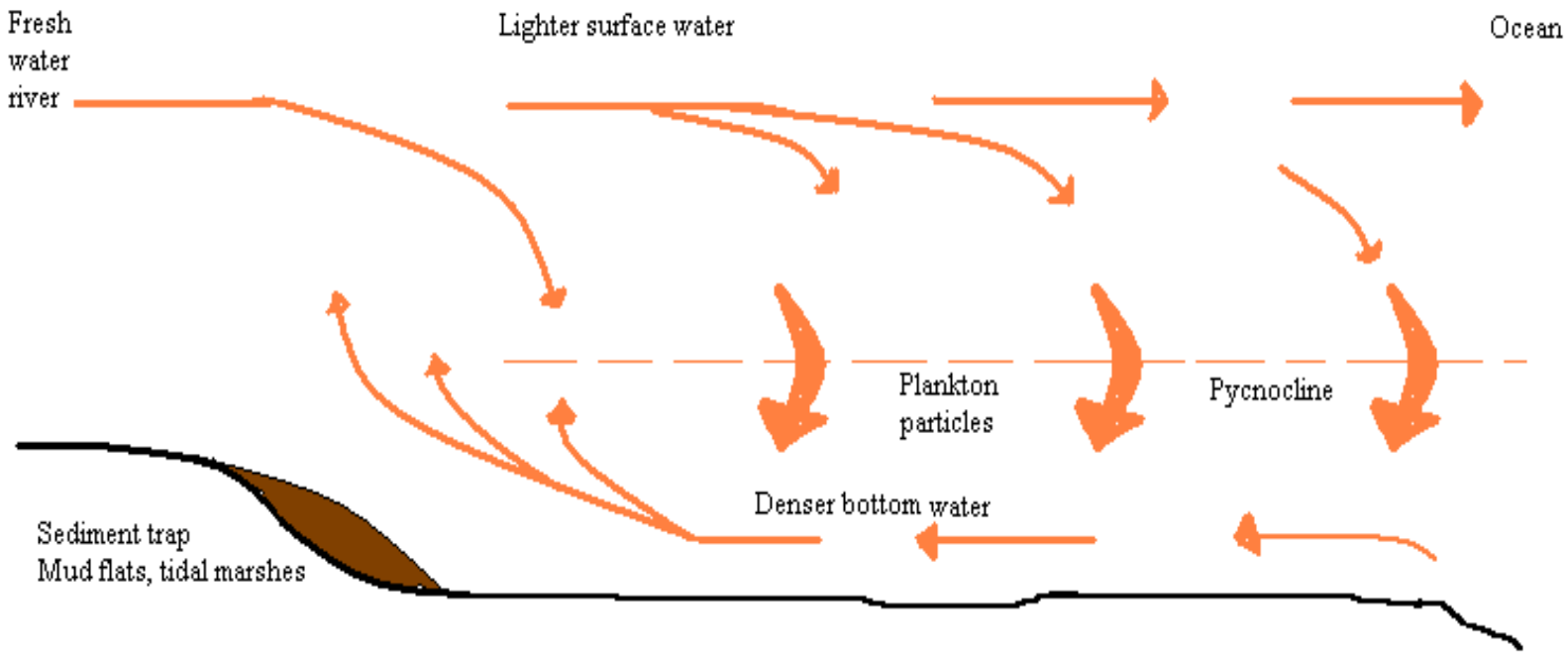
# Estuaries

- The salinity of estuary is intermediate between that of seawater **(salinity is about 35%).** and freshwater (salinity ranges from 0.065% to 0.3% )
- Estuary is, thus, a **transition zone or ecotone** between freshwater and marine ecosystems.
- They normally have a high silt content
- Current and salinity are two important factors that influence life in the estuary
- Salinity of estuaries varies vertically and horizontally and fluctuates between **0.5% to 35%**

# Biota and adaptation to estuarine environment

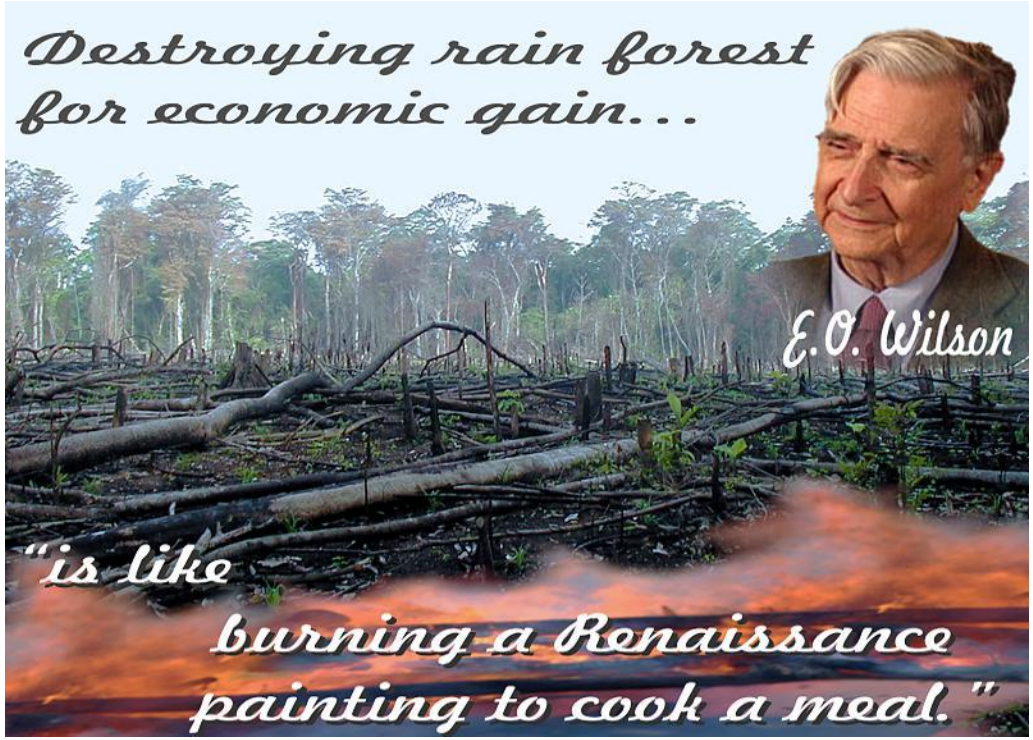
- Very few species are derived from freshwater and only those that are capable of **osmoregulation** in saltier water
- Maintenance of position and adjustment to **changing salinity**
- Majority of estuarine organisms are benthic and are securely attached to the bottom, are buried in the mud or occupy crevices and crannies about sessile organisms

# Estuary Productivity -Nutrient Trap



# Biodiversity and its conservation

# E.O. Wilson in 1985



# Types / Levels of Biodiversity

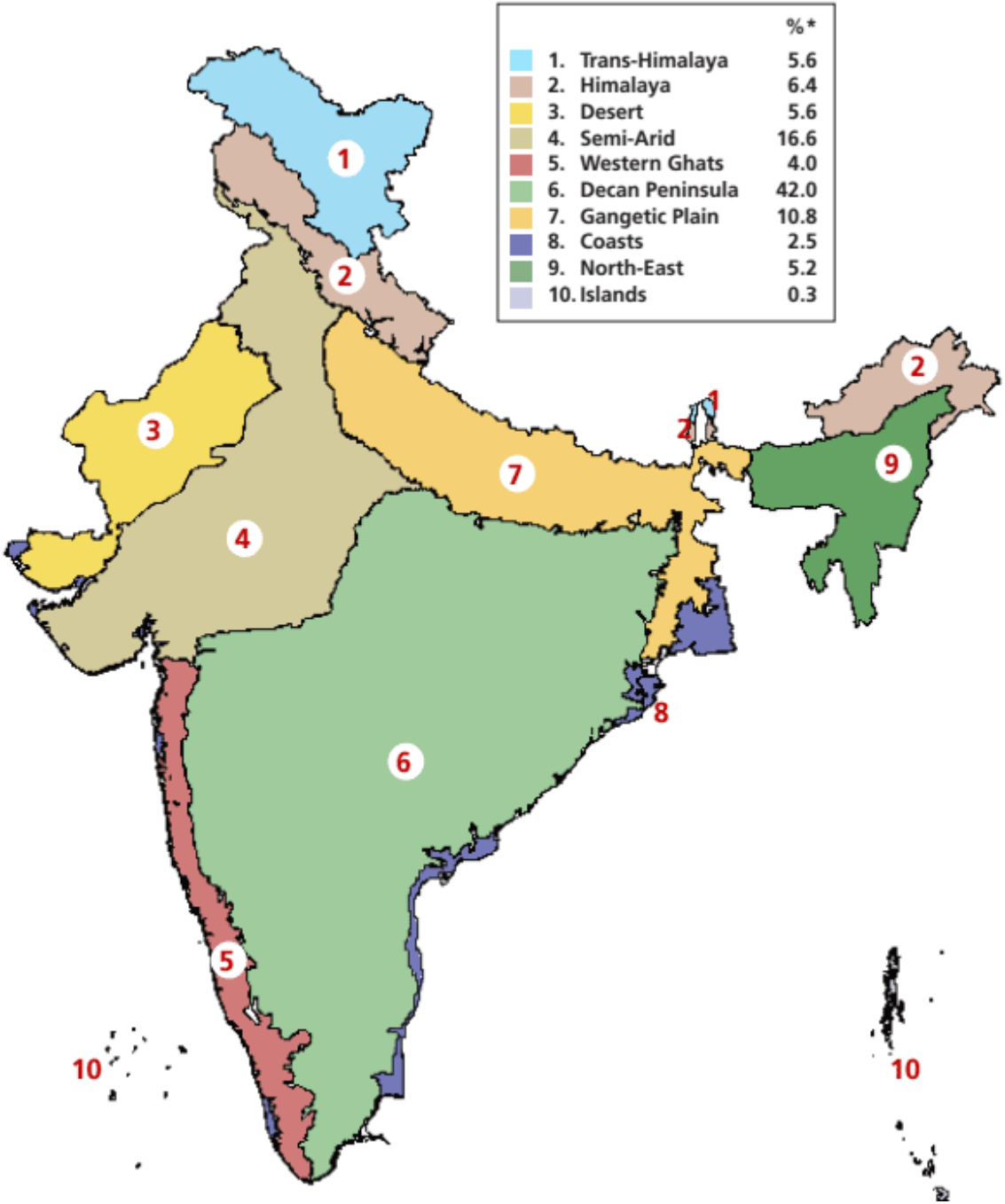
- Genetic diversity
- Species diversity
- Ecosystem diversity

**In General**

- α-Diversity
- β-Diversity
- γ -Diversity

**Whittaker (1965)**

# Biogeo-graphical regions in India



**India is one of the seventeen mega diversity nations of the world - Can you justify?**

# Importance of Biodiversity

1. Productive value
2. Consumptive value
3. Social value
4. Aesthetic value
5. Legal value
6. Ethical value
7. Ecological value
8. Economic value

1. Why we need to maintain biodiversity?

2. Is there any relationship between forest cover and biodiversity?

3. Biodiversity Vs Human – Debate?

# Global Species Diversity – A glance

| Group | Number of described species |
|---|---|
| Bacteria and blue-green algae | 4,760 |
| Fungi | 46,983 |
| Algae | 26,900 |
| Bryophytes(Mosses and Liverworts) | 17,000 |
| Gymnosperms(Conifers) | 750 |
| Angiosperms(Flowering plants) | 250,000 |
| Protozoans | 30,800 |
| Sponges | 5,000 |
| Corals and Jellyfish | 9,000 |
| Roundworms and earthworms | 24,000 |
| Crustaceans | 38,000 |
| Insects | 751,000 |
| Other arthropods and minor invertibrates | 132,461 |
| Molluscs | 50,000 |
| Starfish | 6,100 |
| Fishes(Teleosts) | 19,056 |
| Amphibians | 4,184 |
| Reptiles | 6,300 |
| Birds | 9,198 |
| Mammals | 4,170 |

**Total : 1,435,662 species**

**Biodiversity at global, National and local levels - India as a mega-diversity nation - Hotspots of biodiversity - Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts**

## Current Protected Area Status

National Parks = 94 Area Covered = 37,591.75 $km^2$

Wildlife Sanctuaries = 502 Area Covered = 118,952.11 $km^2$

Conservation Reserves = 2 Area Covered = 42.44 $km^2$

Protected Areas = 598 Area Covered = 156,586.3 $km^2$

National Parks % of G.A. = 1.14 %

Wildlife Sanctuaries % of G.A. = 3.62 %

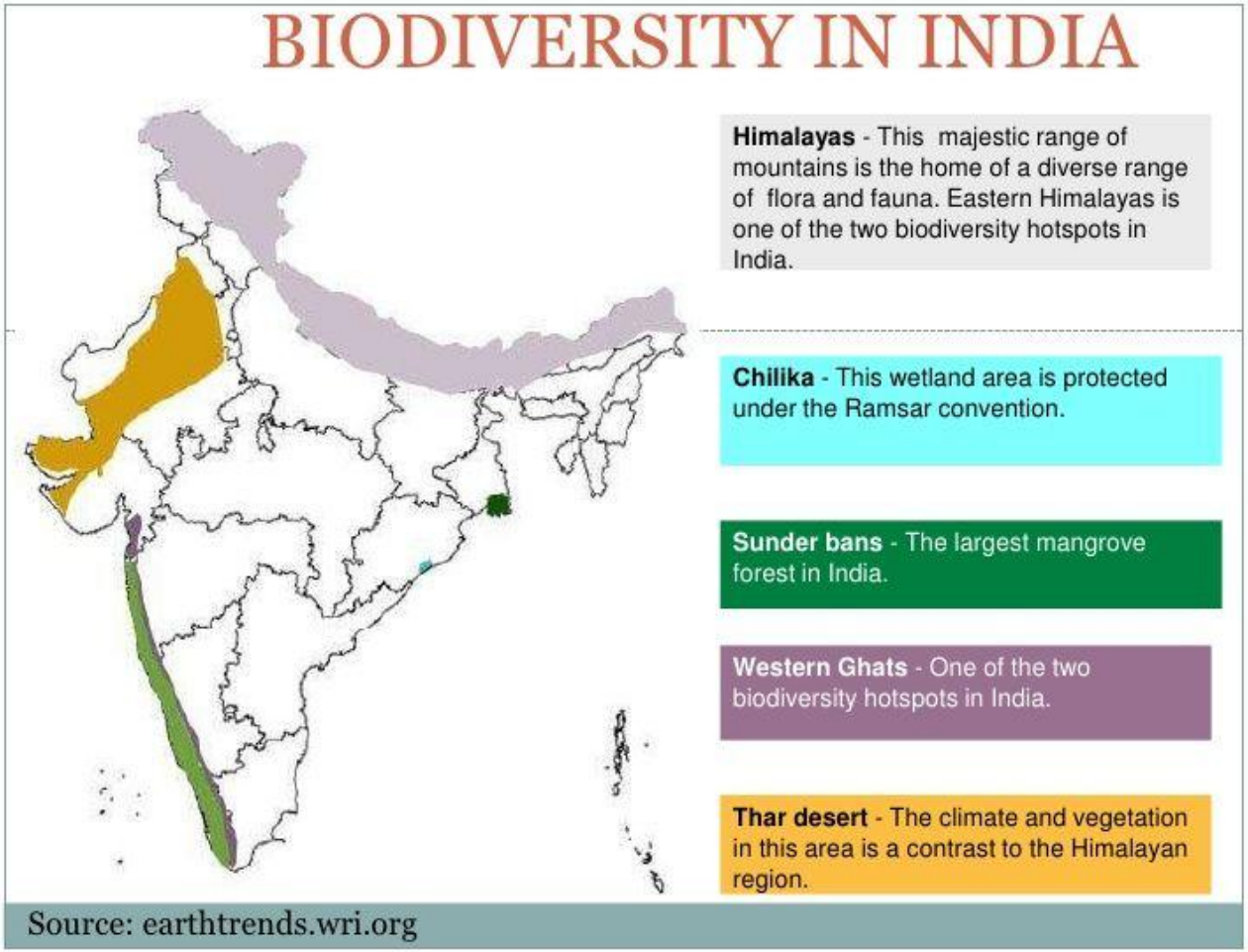
Conservation Reserves % of G.A. = 0.0012 %

Protected Areas % of G.A. = 4.76 %

- It has 7.3% of the global fauna and 10.88% of global flora as per the data collected by Ministry of Environment and forest.
- It has 350 different mammals, 1200 species of birds- 453 different reptiles, 182 amphibians and 45,000 plants spices.
- It has 50,000 known species of insects which include 13,000 butterflies and moths.
- It has 10 different biogeographical regions and 25 biotic provinces having varieties of lands and species.
- In addition to geographical distribution, geological events in the land mass provide high level of biological diversity.
- Several crops arose in the country and spread throughout the world.
- There is wide variety of domestic animals like cows, buffaloes, goats, sheep, pigs, horses etc.
- The marine biota includes sea weeds, fishes, crustaceans, molluses, corals, reptiles etc.
- There are a number of hot spots (namely Eastern Ghats, Western Ghats, North Eastern hills etc.).

# Hot Spots

- **Species endemism:** the region must contain at least 1,500 species of vascular plants (> 0.5% of the world's total) as endemics
- **Degree of threat:** the region has to have lost at least 70% of its original habitat.



# Indian Biodiversity Hot Spots

There are 3 biodiversity hot spots present in India.

**The Eastern Himalayas (Arunachal Pradesh, Bhutan, Eastern Nepal)**

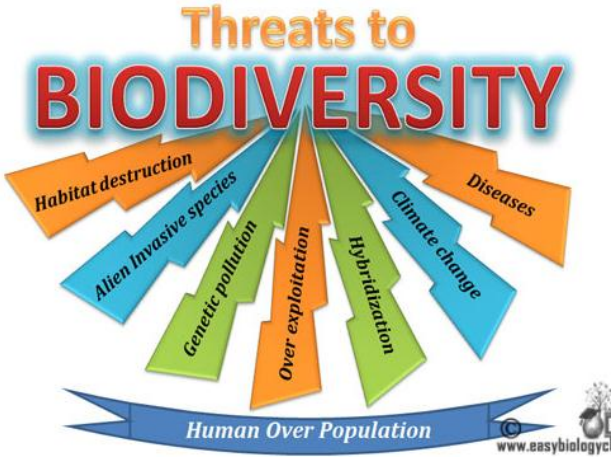
**Indo-Burma and (Purvanchal Hills, Arakan Yoma, Eastern Bangladesh)**

**The Western Ghats and Sri Lanka**

These hot spots covering less than 2% of the world's land area are found to have about 50% of the terrestrial biodiversity.

# Threats to Biodiversity

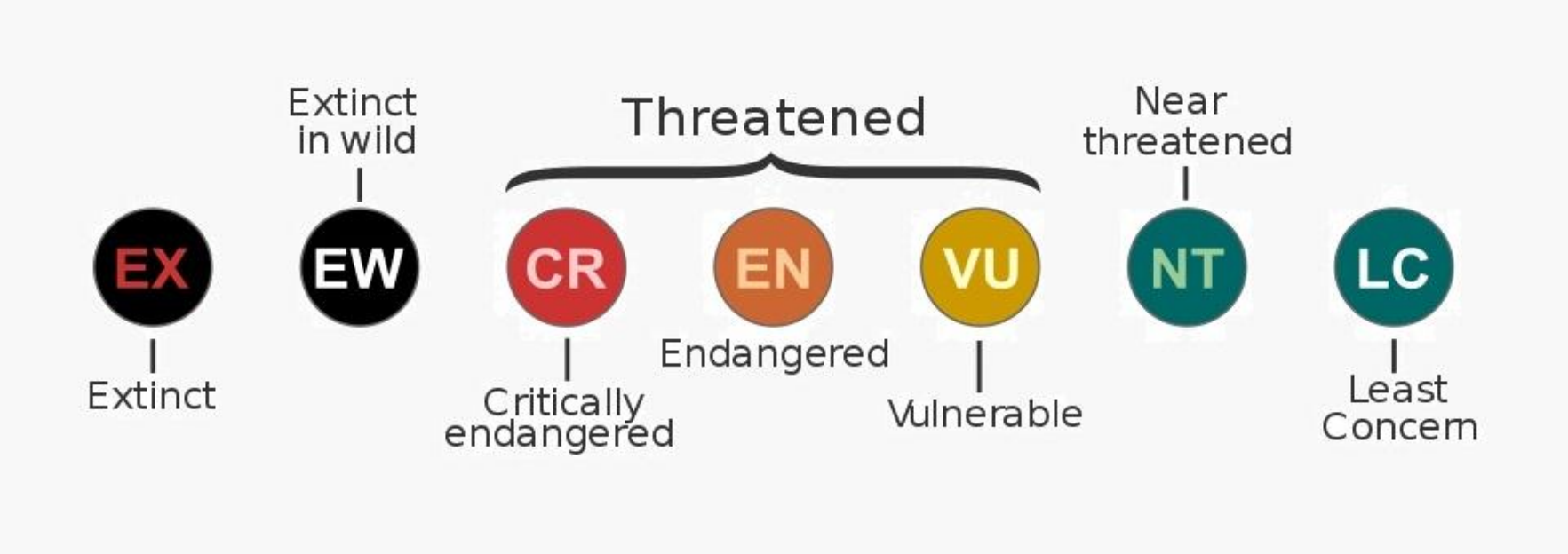
- Habitat destruction
- Habitat fragmentation
- Pollution
- Over exploitation
- Introduction of exotic species
- Shifting or Jhum cultivation
- Poaching of wild life
- Human induced disasters
- Political and policy issues
- Diseases



# Categories of threat

- **Endangered**
- **Vulnerable**
- **Rare**
- **Threatened**

| Endangered and Endemic Species of India Category | Enlisted species | Highly endangered Species |
|---|---|---|
| 1. Higher plants | 15,000 | 135 |
| 2. Mammals | 372 | 69 |
| 3. Reptiles and amphibians | 580 | 22 |
| 4. Birds | 1175 | 40 |
| 5. Fishes | 1693 | — |



# Man and wildlife conflicts

# ENDANGERED AND ENDEMIC SPECIES OF INDIA - CONSERVATION OF BIODIVERSITY

# Keystone species

- **Keystone species is a species whose addition to or loss from an ecosystem leads to major changes in occurrence of at least one other species.**

- **Playing a critical role in maintaining the structure of an ecological community, affecting many other organisms in an ecosystem and helping to determine the types and numbers of various other species in the community.**

- All top predators (Tiger, Lion, Crocodile, Elephant) are considered as keystone species because it regulates all other animal population indirectly. Hence top predators are given much consideration in conservation.

- If keystone species is lost, it will result in the degradation of whole ecosystem. For example certain plant species (ebony tree, Indian-laurel) exclusively depends upon bats for its pollination. If the bat population is reduced then regeneration of particular plants becomes more difficult

- ***Rhododendron arboreum Sm***. – A Keystone Species in Central Himalayan Region
- Responsible Mechanism - Allelopathy, N mineralization and anthropogenic disturbance (grazing sheep) have been mentioned as key processes in ecosystems

- **Ficus – key species in the conservation of many birds, bees, insects and mammals**.
- Over 500 Indian flying foxes roost in huge banyan trees in puliangulam in Madurai district, Keelarajakularaman in Virudhunagar district and Sri vaikundam in Tirunelveli district.

# Red data book

- **The Red Data Book is the state document established for documenting rare and endangered species of animals, plants and fungi as well as some local sub-species that exist within the territory of the state or country. This book provides central information for studies and monitoring programmes on rare and endangered species and their habits.**

- The International Union for Conservation of Nature (IUCN) is the world's main authority on the conservation status of species.

- The **IUCN Red List of Threatened Species** (also known as the **IUCN Red List** or **Red Data List**), founded in 1964, is the world's most comprehensive inventory of the global conservation status of biological species.

# IUCN Red list Categories

Species are classified by the IUCN Red List into nine groups, set through criteria such as rate of decline, population size, area of geographic distribution, degree of population and distribution fragmentation.

- Extinct (EX) – No known individuals remaining.
- Extinct in the wild (EW) – Known only to survive in captivity, or as a naturalized population outside its historic range.
- Critically endangered (CR) – Extremely high risk of extinction in the wild.
- Endangered (EN) – High risk of extinction in the wild.
- Vulnerable (VU) – High risk of endangerment in the wild.
- Near threatened (NT) – Likely to become endangered in the near future.

Least concern (LC) – Lowest risk. Does not qualify for a more at-risk category. Widespread and abundant taxa are included in this category.

Data deficient (DD) – Not enough data to make an assessment of its risk of extinction.

Not evaluated (NE) – Has not yet been evaluated against the criteria.

When discussing the IUCN Red List, the official term "threatened" is a grouping of three categories: Critically Endangered, Endangered, and Vulnerable.

# Endemic species

- A species or taxonomic group that is restricted to a particular geographic region because of such factors as isolation or response to soil or climatic conditions; this species is said to be endemic to the region (Allaby 1998).
- In India this is highly significant
- Of the 4,900 species flowering plants 33% of flora sp. are endemic distributed over 141 genera belonging to 47 families.
- Concentrated in areas of N.E. India, western Ghats, N.W. Himalayas and Andaman and Nicobar islands
- Western Ghats and Eastern Himalayas-1600 and 3,500 endemic species of flowering plants.
- Forest owlet  endemic to Madhya Pradesh, Chattisgarh
- Jerdon courser endemic to Andhra Pradesh
- Marsh Babbler endemic to Brahmaputra floodplain
- Sikkim Wedge-billed Babbler endemic to North eastern himalaya

# Categories - Endangered

**Endangered**

- Species in danger of extinction whose survival is unlikely
- 427 – endangered plant species (BSI) in **Red Data Book**
- Contributes to about 20% of India's floristic wealth of higher plants

**Birds**

- Narcondam hornbill (*Rhyticero*)
- Steppe Eagle (*Aquila nipalensis*)
- Great Knot (*Calidris tenuirostris*)
- Masked Finfoot (*Heliopais personatus*)
- Greater Adjutant (*Leptoptilos dubius*)
- White-bellied Blue Robin (*Myiomela albiventris*)
- Nilgiri Blue Robin (*Myiomela major*)
- White-headed Duck (*Oxyura leucocephala*)
- Green Peafowl (*Pavo muticus*)
- Spotted Greenshank (*Tringa guttifer*)
- Banasura Laughingthrush (*Trochalopteron jerdoni*)

# Mammals

- Asiatic lion (*Panthera leo persica*)
- Bengal tiger (*Panthera tigris tigris*)
- Blue whale (*Balaenoptera musculus*)
- Banteng (*Bos javanicus*)
- Dhole (*Cuon alpinus*)
- Fin whale (*Balaenoptera physalus*)
- Ganges river dolphin (*Platanista gangetica gangetica*)
- Gee's golden langur (*Trachypithecus geei*)
- Kolar leaf-nosed bat (*Hipposideros hypophyllus*)
- Hispid hare (*Caprolagus hispidus*)
- Indian elephant (*Elephas maximus indicus*)
- Lion-tailed macaque (*Macaca silenus*)
- Mandelli's mouse-eared bat (*Myotis sicarius*)
- Nilgiri tahr (*Nilgiritragus hylocrius*)
- Nicobar treeshrew (*Tupaia nicobarica*)
- Red panda (*Ailurus fulgens*)
- Snow leopard (*Uncia uncia*)

## Vulnerable

- Taxa likely to move into endangered category in near future if casual factors continue operating due over exploitation, extensive destruction of habitats

## Mammals

- Clouded leopard (*Neofelis nebulosa*)
- Dugong (*Dugong dugon*)
- Gaur (*Bos gaurus*)
- Indian rhinoceros (*Rhinoceros unicornis*)
- Marbled cat (*Pardofelis marmorata*)
- Rusty-spotted cat (*Prionailurus rubiginosus*)
- Stump-tailed macaque (*Macaca arctoides*)
- Sun bear (*Helarctos malayanus*)
- Takin (*Budorcas taxicolor*)
- Yak (*Bos grunhniens*)

**Rare**

- Taxa with small world population that are not at present endangered or vulnerable but are at risk.

- These are localized within restricted geographical areas.

  Eg. *Raufolia serpentina*, Red Headed Vulture

- Austen's Brown Hornbill *Anorrhinus austeni* – Brahmaputra valley, Andhra Pradesh (Namdapha National Park)

# Noise Pollution

- Sound is a form of energy giving the sensation of hearing and is produced by vibrations as longitudinal mechanical waves in materials including solids, liquid and gas and is transmitted by oscillation of atoms and molecules of matter.
- **1. The frequency (cycles/second)** of the waves determines the pitch of the sound.
- **2. The amplitude or magnitude** (measured in decibel (dB) units) is a measure of loudness.

- **Noise Pollution**
- Production of unwanted sounds that are annoying, distracting or damaging to one's hearing.

## Noise level of various house hold equipment and appliances

| Category | Noise level (dB) |
|---|---|
| Television | 66 |
| Refrigerator | 46 |
| Exhaust fan | 51 |
| Electric grinder | 81 |
| Vacuum cleaner | 83 |
| Stove | 74 |
| Water tap | 67 |
| Radio/tape recorder | 81 |
| Ceiling fan | 51 |
| Air conditioner | 64 |
| Pressure cooker | 68 |
| Lawn mover | 79 |
| Flush toilet | 70 |

## Noise levels of Agricultural machineries

| Agricultural Implements | Noise level (dB) |
|---|---|
| Tractors | 90-98 |
| Thresher | 90-95 |
| Combine harvesters | 92-99 |
| Power sprayers | 93 |

# Effects of noise

1. **Repeated interference with sleep**
2. **Effects on communication**
3. **Effects on Human Health**
4. **Hearing loss**
5. **Physiological responses**

- A vascular response characterized by peripheral vaso-constriction, changes in heart rate and blood pressure.
- Various glandular changes such as increased output of adrenaline evidenced by chemical changes in blood.
- Slow, deep breathing.
- A change in the electrical resistance of skin with changes in activity of the sweat glands.
- Brief changes in skeleton muscle tension.

6. **Psychological responses**

- Annoyance
- Anxiety
- Aggression
- Depression

# Effects of high intensity noise on human beings

| Noise (dB) | Effects observed |
|---|---|
| 0 | Threshold of audibility |
| 150 | Significance change in pulse rate |
| 110 | Stimulation of reception in skin |
| 120 | Pain threshold |
| 130-135 | Nausea, vomiting, dizziness, with touch and muscle sense |
| 140 | Pain in ear, prolonged exposure causing insanity |
| 140 | Extreme limit of human noise tolerance |
| 150 | Prolonged exposure causing burning of skin |
| 160 | Minor permanent damage if prolonged |
| 190 | Major permanent damage in a short time |

# Effects on Wildlife

- Damage to Hearing
  - Can reduce chances of survival
  - Kangaroo rat
- Physiological Response
  - Hormone imbalance
  - Chronic stress
- Behavioral Response
  - Panic and escape behavior
- Responses Result in:
  - Decrease in food intake
  - Loss of energy
  - Abandonment of offspring
  - Injury

# Effects on Marine Life

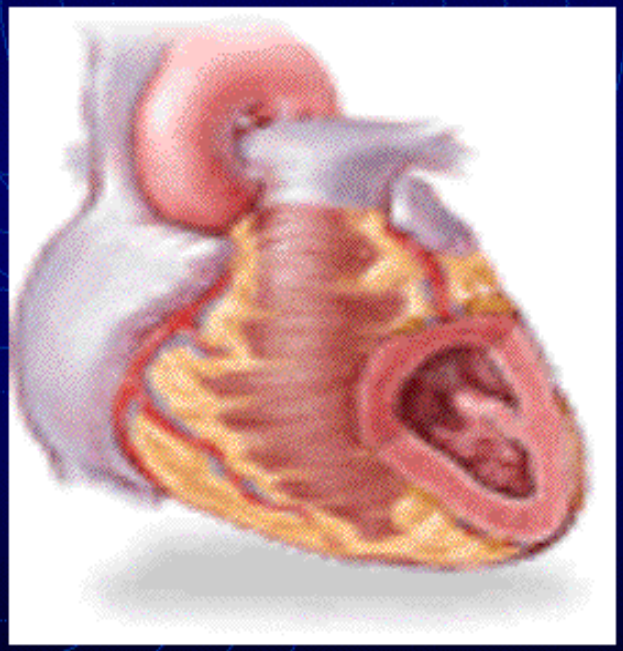
- Marine Mammals use echolocation
  - Sonar
  - Explosive testing
- Whales and dolphins
  - Deaths occurring
  - “Bends”
  - Beaching themselves

# Damaging Levels of Sound

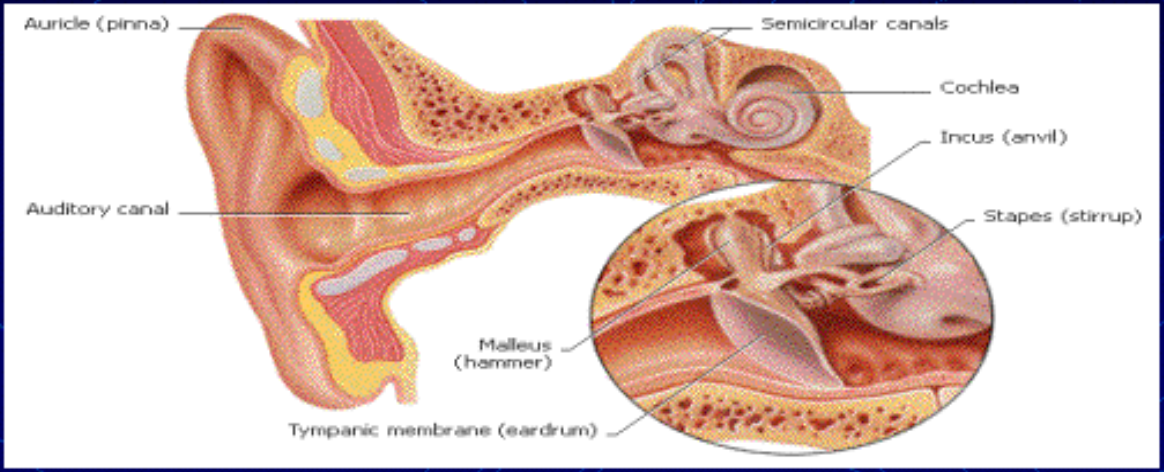
| Source | Sound in DB | Effects |
|---|---|---|
| Rocket launching | 180 | Danger level |
| Gunshot | 140 | Danger level (threshold of pain) |
| Jet | 130 | Cause Damage: 3.5min/day |
| Car horn | 120 | Cause Damage: 7.5min/day |
| Night club | 110 | Cause Damage: 30min/day |
| lawnmower | 105 | Cause Damage: 1hr/day |
| Truck/scream | 90 | Cause Damage: 8hr/day |
| Alarm clock | 80 | annoying |

# Effects on Humans: Health

- Be a Disturbance
  - Sleep-effect performance
  - Workplace-lack of productivity
- Cause Stress
  - Blood pressure / heart rate rise
  - May cause cardiovascular diseases
  - Due to both high and low levels of noise
  - Has been linked to excessive use of alcohol, drugs, food
- Have also been linked to immune depression and problems with fetus development



# Effects on Humans: Hearing




- Actually hear with our brains, not our ears
  - Hair cells send impulses to brain
  - Hair cells are extremely delicate
- Damage to hair cells can result in hearing loss
  - Threshold shift-several hours
  - Trauma-permanent
  - Noise induced-gradually become permanent

# Noise sources

1. Traffic noise
2. Highway vehicle noise
3. Sources of noise from industry and controlling measures

# Noise control

1. Enclosures
2. Screen the receiver
3. Ear protection
4. Absorbing materials
5. Barriers and panels

# Control of industrial noise source by design changes in equipment

- The design may be modified by reducing the weight, size, or height of fall of the impacting mass, changing the metal, or inserting noise absorbers if possible at the places of noise production.
- Anchoring the machine to the floor with noise absorbing supports.
- Whenever practical, one of the impact heads or surfaces can be made of non-metallic material to reduce resonance.
- Substitute the application of a small impact force over a long period for a large force over a short period to achieve the same result.
- Smooth out acceleration of moving parts by applying accelerating forces gradually. Avoid high, jerky acceleration or jerky motion.
- Minimize overshoot, backlash and loose play in cams, followers, gears, linkages and other parts.

**Based on Noise Regulation Rules under the Environment (Protection) Act of 1986.**

| **Areas** | **Noise level (dB)** | |
|---|---|---|
| | **Day time (6am -9pm)** | **Night time (9pm – 6 am)** |
| Industrial area | 75 | 65 |
| Commercial area | 65 | 55 |
| Residential area | 55 | 45 |
| Silence zones | 50 | 45 |

## Acceptable level of noise for human health

| **Activities** | **dB** |
|---|---|
| Talking | 50 |
| House holds | 40 |
| Motor cycle | 65-105 |
| Heavy vehicles | 85-100 |
| Hammer(2m distance) | 120 |
| Aero plane (50-100m height) | 90-100 |

***Presbycusis***

***Sociocusis***

# Soil Pollution

**The build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health.**

# Types of Soil Pollution

## Agricultural Soil Pollution

**i) pollution of surface soil**
**ii) pollution of underground soil**

## Soil pollution by industrial effluents and solid wastes

**i) pollution of surface soil**
**ii) disturbances in soil profile**

## Pollution due to urban activities

**i) pollution of surface soil**
**ii) pollution of underground soil**

**Indiscriminate use of fertilizers**

**Indiscriminate use of pesticides, insecticides and herbicides**

**Dumping of solid wastes**

**Deforestation**

Oil Spill

# Soil Erosion

## Pollution Due to Urbanisation

# Heavy metal pollution

## Causes in brief:

- Polluted water discharged from factories
- Runoff from pollutants (paint, chemicals, rotting organic material) leaching out of landfill
- Oil and petroleum leaks from vehicles washed off the road by the rain into the surrounding
habitat
- Chemical fertilizer runoff from farms and crops
- Acid rain (fumes from factories mixing with rain)
- Sewage discharged into rivers instead of being treated properly
- Over application of pesticides and fertilizers
- Purposeful injection into groundwater as a disposal method
- Interconnections between aquifers during drilling (poor technique)
- Septic tank seepage
- Lagoon seepage
- Sanitary/hazardous landfill seepage
- Cemeteries
- Scrap yards (waste oil and chemical drainage)
- Leaks from sanitary sewers

# Effects of Soil Pollution

# Agricultural

- Reduced soil fertility
- Reduced nitrogen fixation
- Increased erodibility
- Larger loss of soil and nutrients
- Deposition of silt in tanks and reservoirs
- Reduced crop yield
- Imbalance in soil fauna and flora

# Industrial

- Dangerous chemicals entering underground water
- Ecological imbalance
- Release of pollutant gases
- Release of radioactive rays causing health problems
- Increased salinity
- Reduced vegetation

# Urban

- Clogging of drains
- Inundation of areas
- Public health problems
- Pollution of drinking water sources
- Foul smell and release of gases
- Waste management problems

# Environmental Long Term Effects of Soil Pollution

- pollution runs off into rivers and kills the fish, plants and other aquatic life
- crops and fodder grown on polluted soil may pass the pollutants on to the consumers
- polluted soil may no longer grow crops and fodder
- Soil structure is damaged (clay ionic structure impaired)
- corrosion of foundations and pipelines
- impairs soil stability
- may release vapours and hydrocarbon into buildings and cellars
- may create toxic dusts
- may poison children playing in the area

# Control of soil pollution

# 1. Physical methods

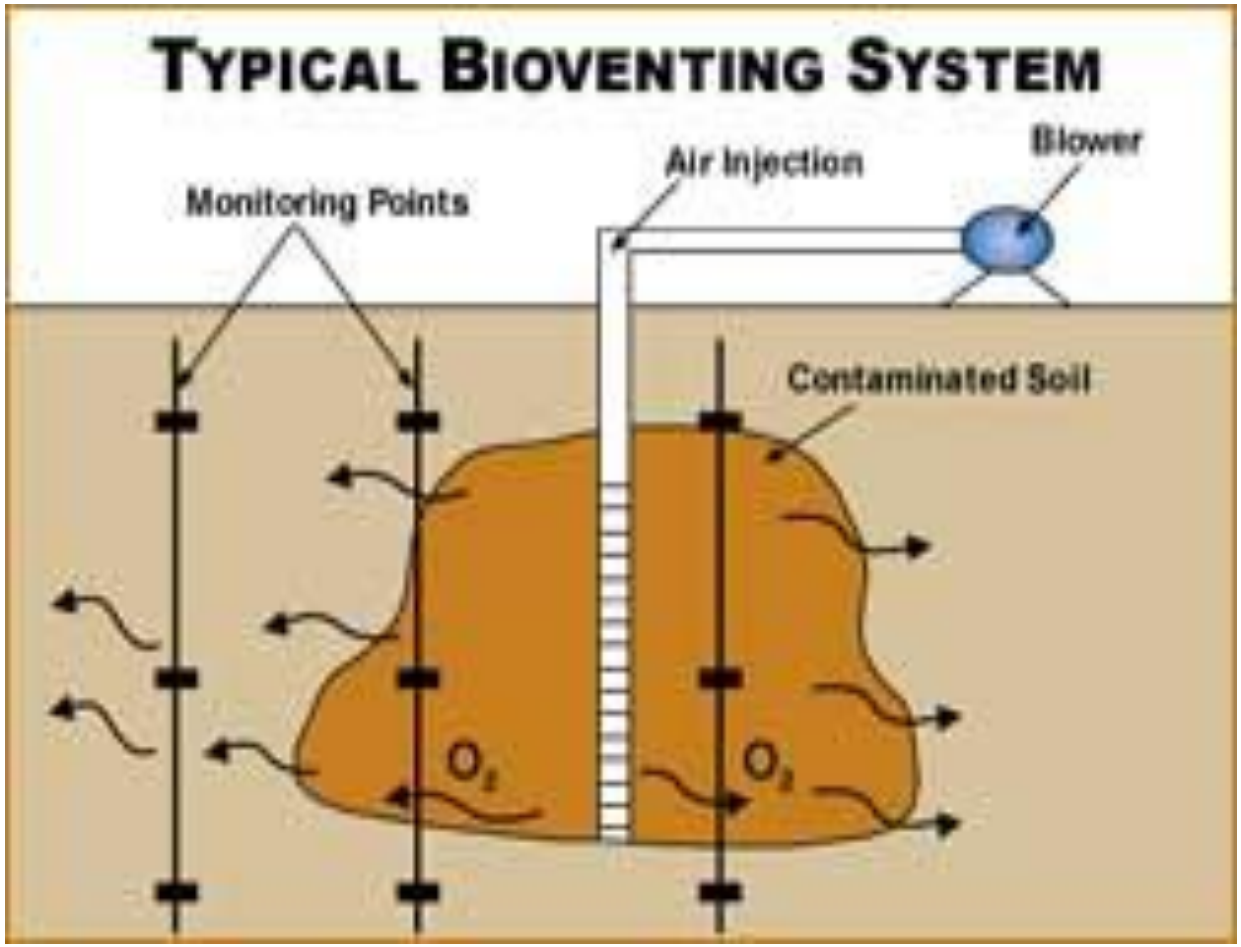
**Land filling**
**Incineration**

# 2. Biological method

**Phytoremediation**
**Bioremediation**

# In-situ-Bioremediation

- *Biostimulation* (stimulates biological activity)
  - Bioventing (Inject air/nutrients into unsaturated zone – good for midweight petroleum, jet fuel)
  - Biosparging (Inject air/nutrients into unsaturated *and* saturated zones)
- *Bioaugmentation* (inoculates soil with microbes)


TYPICAL BIOVENTING SYSTEM
Blower
Air Injection
Monitoring Points
Contaminated Soil
$O_2$
$O_2$

# Ex-situ -Bioremediation

- *Slurry-phase*
  - Soil combined with water/additives in tank, microorganisms, nutrients, oxygen added
- *Solid-phase*
  - Land-farming: soil put on pad, leachate collected
  - Soil biopiles: soil heaped, air added
  - Composting: biodegradable waste mixed with bulking agent
  - Land Applied – waste added directly to soil which is later planted to a crop.

## Reducing chemical fertilizer and pesticide use

- Biological control of pests and diseases is a method of controlling pests and diseases in agriculture that relies on natural predation rather than chemicals.
- Choose a cover crop as a bio-control for a specific pest
- Time tillage to give crops the best advantage from the resulting biological activity
- Manage habitats at the edge of fields to support predators of pests

**Reusing of materials**

**Recycling and recovery of materials**

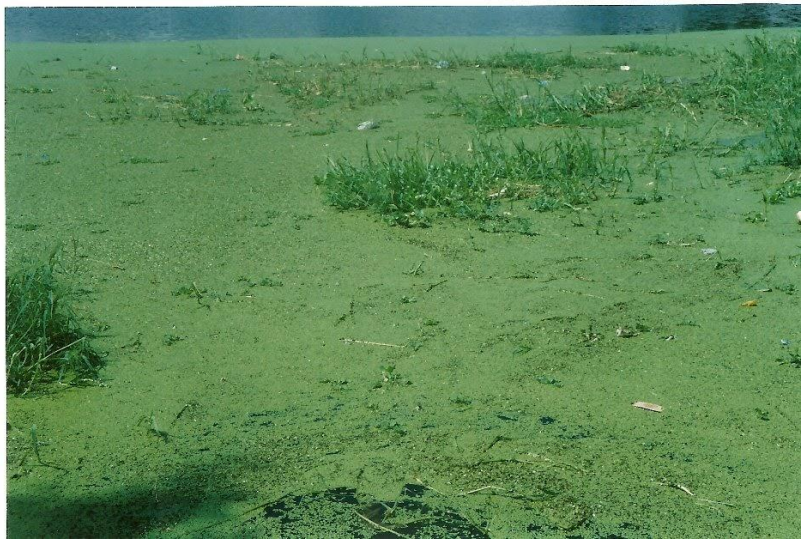
**Reforesting**

# Water Pollution

- **Types**
  - **Surface water pollution**
  - **Sub surface water pollution**

## Sources & Effects

**1. Domestic wastes/sewage wastes**
**Eutrophication**
**Strychnine**

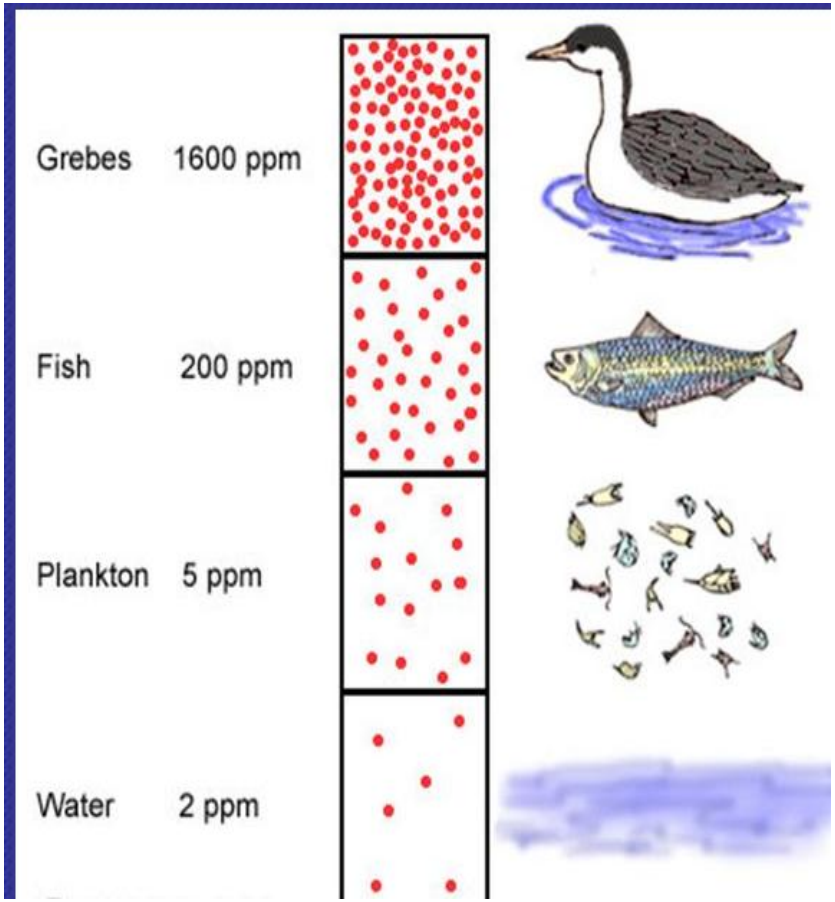


# 2. Industrial wastes

| Various organic and inorganic pollutants of water and their sources | | |
|---|---|---|
| **Industry** | **Inorganic pollutants** | **Organic pollutants** |
| Iron and steel | Suspended solids, iron, cyanide, thiocyanate, sulphides, oxides of Cu, Cd, Hg etc. | Oil, phenols, naphtha etc. |
| Soap and detergents | Tertiary ammonium compounds, alkali | Fats and fatty acids, glycerol, polyphosphates, sulphonated hydrocarbons |
| Paper and pulp | Sulphides, sulphites, beaching liquors | Cellulose fibres, wood, bark, sugars, organic acids etc. |
| Mining | Chlorides, various metals, ferrous sulphate, sulphuric acid, ferric hydroxide, $H_2S$, surface wash offs, suspended solids, heavy metals etc | ____ |
| Food processing | ____ | Highly putrescible organic matter, pathogens etc. |
| Pharmaceuticals | ____ | Proteins, carbohydrates, organic solvents, drugs, antibiotics, intermediate products etc. |

# 3. Agricultural wastes

- **Nitrate pollution**
  - **Methaemoglobinaemia or bluebaby syndrome**
  - **Biological magnification**



# HEAVY METAL POLLUTION

## Xenobiotics

## Heavy metals

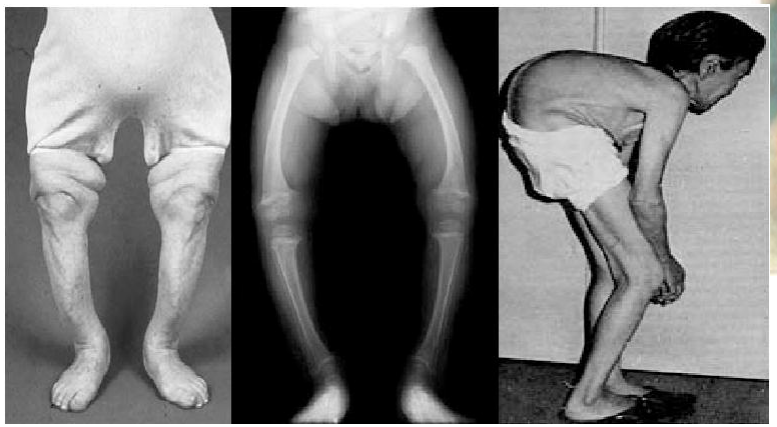
### Minamoto disease

### blackening in fish

### Keratosis & melanosis

### Chromium

### Itai itai



# Waste water disease transmission

| **Bacterial agent** | **Major disease** | **Major reservoir** | **Principal site affected** |
|---|---|---|---|
| *Salmonella typhi* | Typhoid fever | Human feces | Gastrointestinal tract |
| *Salmonella paratyphi* | Paratyphoid fever | Human feces | Gastrointestinal tract |
| *Shigella* | Bacillary dysentery | Human feces Human feces | Lower intestine |
| *Vibrio cholerae* | Cholera | Human feces | Gastrointestinal tract |
| Enteropathogenie *E. coli* | Gastroenteritis | Human feces | Gastrointestinal tract |
| *Yersinia enterocolitica* | Gastroenteritis | Human / animal feces | Gastrointestinal tract |
| *Campylobacter jejuni* | Gastroenteritis | Human / animal feces | Gastrointestinal tract |
| *Legionella pneumophila* | Acute respiratory illness (legionnaire's disease) | Thermally enriched waters | Lungs |
| *Mycobacterium tuberculosis* | Tuberculosis | Human respiratory exudates | Lungs |
| *Leptospria* | Leptospirosis (Weil's disease) | Animal feces and urine | Generalized |
| Opportunistic bacteria | Variable | Natural waters | Mainly gastrointestinal tract |

# Water pollution prevention and control

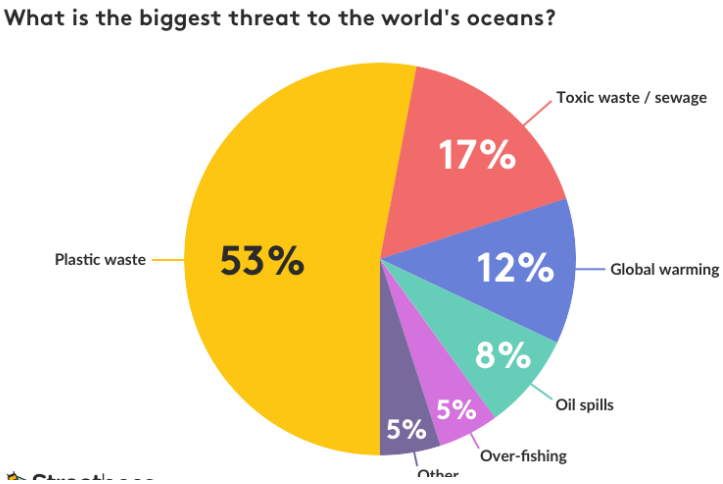
- Self purification of water
- Reutilisation and recycling of waste
- Removal of pollutants
- Enforcement of standards
- Installation of waste water treatment plants

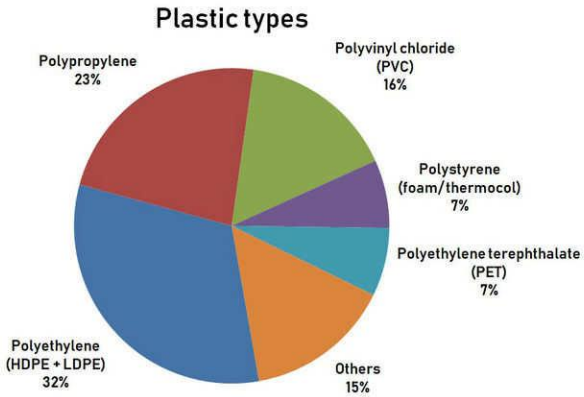
| Characteristics | Sewage | Industrial effluents for discharge into | |
|---|---|---|---|
| | | Inland surface water | Public sewers |
| BOD (5 day 20$^{o}$C) (mg $l^{-1}$) | 20 | 30.0 | 500.0 |
| COD (mg $l^{-1}$) | - | 250.0 | - |
| pH | - | 5.5.9.0 | 5.5.9.0. |
| Total suspended solids (mg $l^{-1}$) | 30 | 100.0 | 600.0 |
| Temperature ($^{o}$C) | - | 40.0 | 45.0 |
| Oil & grease (mg $l^{-1}$) | - | 10.0 | 100.0 |
| Phenolic compounds (mg $l^{-1}$) | - | 1.0 | 5.0 |
| Cyanides (mg $l^{-1}$) | - | 0.2 | 2.0 |
| Sulphides (mg $l^{-1}$) | - | 2.0 | - |
| Fluorides (mg $l^{-1}$) | - | 2.0 | - |
| Total residual chlorine (mg $l^{-1}$) | - | 1.0 | - |
| Insecticide (mg $l^{-1}$) | - | 0.0 | - |
| Arsenic (mg $l^{-1}$) | - | 0.2 | - |
| Zinc (mg $l^{-1}$) | - | 5.0 | 15.0 |
| Chlorides (mg $l^{-1}$) | - | - | 600.0 |
| Sulphates (mg $l^{-1}$) | - | - | - |

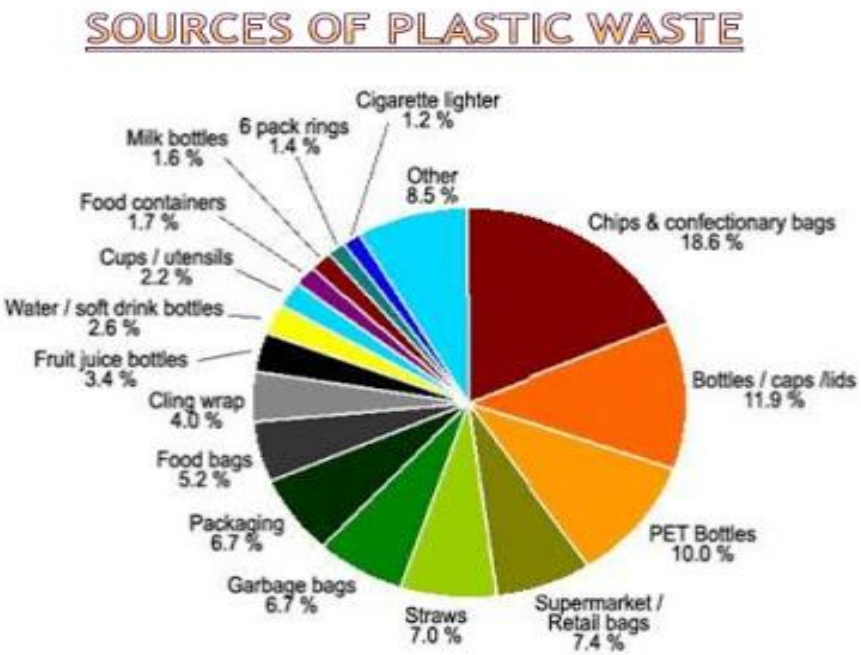
| **Parameters** | **WHO Standards (mg/l)** |
|---|---|
| pH | 6.5-7.2 |
| Total Dissolved Solids | 500 |
| BOD | 3-6 |
| COD | 10 |
| Coliform count | In any sample of 100ml should be zero |
| PCB's (µg/l) | 0.2 |
| Mercury | 0.001 |
| Cadmium | 0.05 |
| Lead | 0.05 |
| Chromium | 0.05 |
| Arsenic | 0.05 |

# Marine pollution

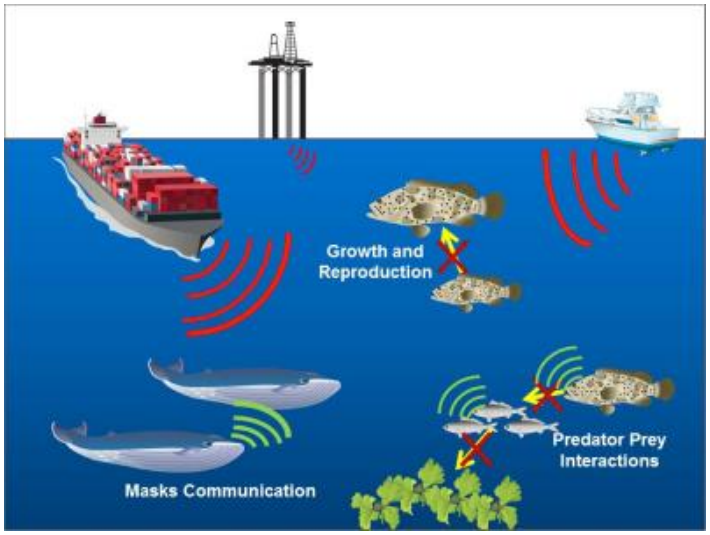
# Sources of Marine Pollution



# Effects of Marine Pollution



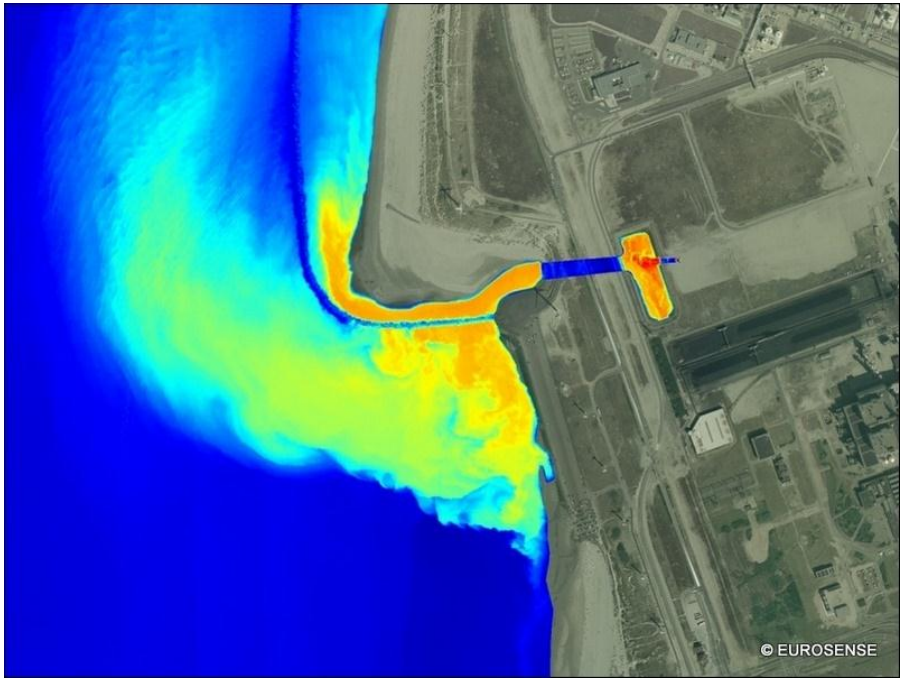

- **Reduction in photosynthesis rate in marine pollution**: High pollutant concentration makes the water turbid, decreasing the penetration of light
- **Decline in volume of dissolved oxygen** effecting the survival of marine organisms: decrease in photosynthesis rate decreases DO.
- **Toxicity of water by heavy metals** such as mercury, arsenic, cadmium etc
- Consumption of marine food collected from **polluted water caused various diseases** such as viral hepatitis, cholera,t yphoid and digestive problems

# Control Measures of Marine Pollution

- Introduction of sewage treatment plants to **reduce BOD** of final product before discharging into sea.
- Cleaning oil from surface waters and contaminated beaches can be accelerated through the use of **chemical dispersants** which can be sprayed on the oil.
- Load on top system reduce oil pollution cleaned with high pressures jets of water.
- Crude oil washing: The cling age is removed by jets of crude oil while the cargo is being unloaded.
- Skimming off the oil surface with a section device.
- Spreading a high density powder over the oil spill, so that oil can l be sunk to the bottom.

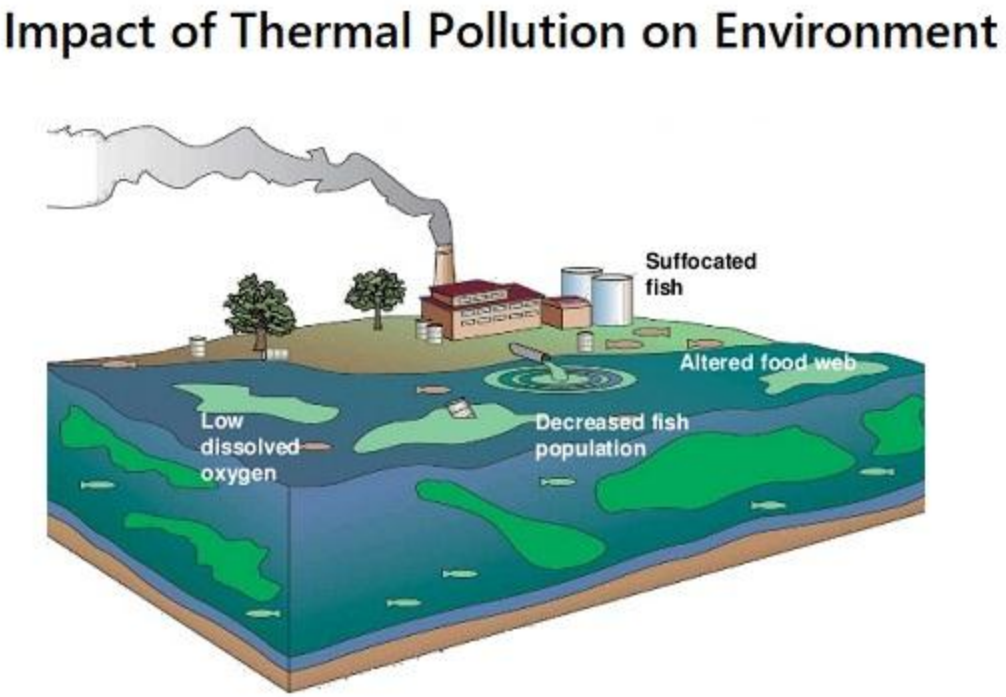
# Thermal pollution

- Definition
- **<u>Sources of Thermal Pollution</u>**
    - Nuclear power plants
    - Coal fired plants
    - Industrial effluents
    - Domestic sewage
    - Hydro-electric power



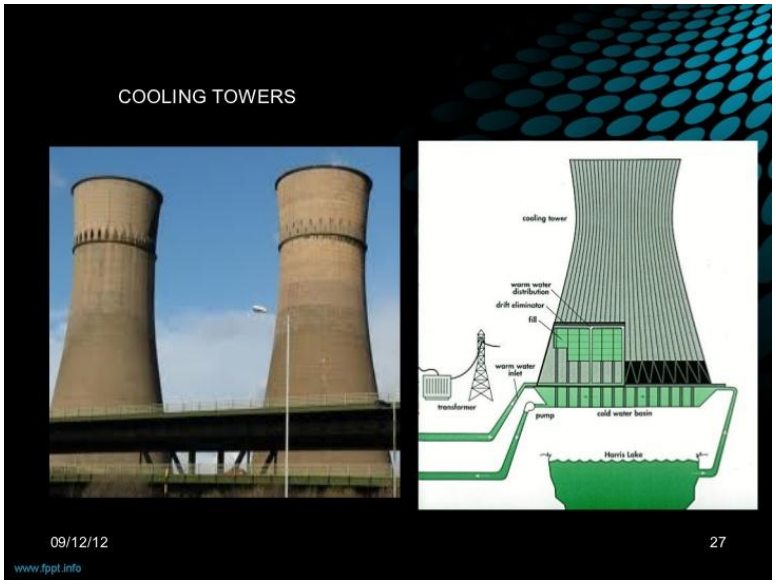
# Effects of Thermal pollution

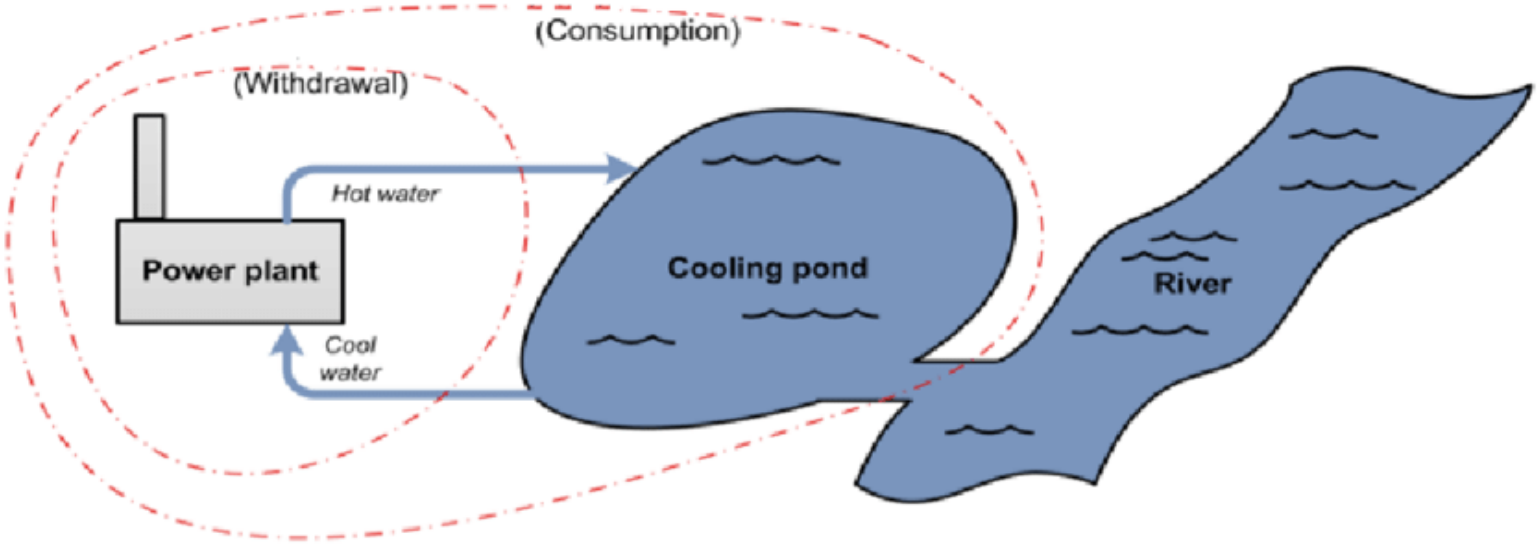
- Reduction in dissolved oxygen
- Increase in toxicity
- Interference in biolog
- Interference in reproc
- Direct mortality
- Food storage for fish



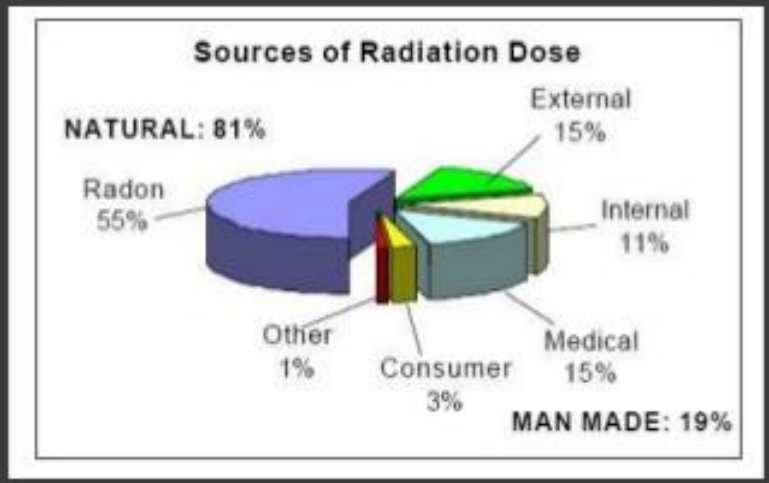
# Control measures for thermal pollution

- Cooling towers
- Cooling ponds
- Spray ponds
- Artificial lakes



# Nuclear hazard



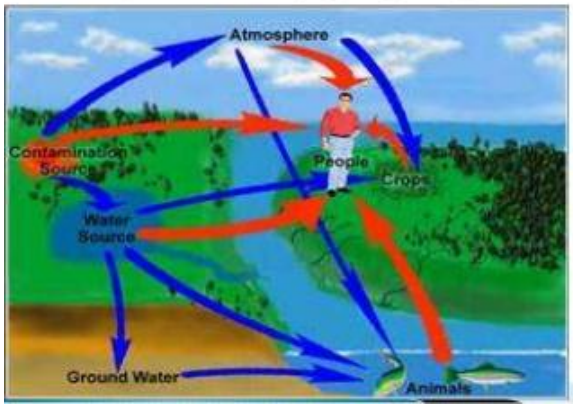

- **Natural sources (81%)** include radon (55%), external (cosmic, terrestrial), and internal (K-40, C-14, etc.)
- **Man-made sources (19%)** include medical (diagnostic x-rays- 11%, nuclear medicine- 4%), consumer products, and other (fallout, power plants, air travel, occupational, etc.)

# Impact of Nuclear Hazard

- **Genetic damage**
- **Somatic damage**
- **Physiological effects**

## Effects on Humans:

- 1)Skin Diseases
  2)Damage of Reproductive Organs
  3)Causes of Abnormality in Bone Marrow
  4)Destroys Retina of Eyes
  5)Shortening of Life Span



# Control measures

- **Distance from the source**
- **Time of exposure**
- **Shielding**

# ENVIRONMENTAL ACTS

**Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act**

**Main objectives**

- Control of pollution
- The conservation and management of land

**Key functions of environmental law**

- Establish regulatory structures for environmental management
- Enable regulators to manage environmental impacts using plans, policies, standards, licenses and incentives.
- Enable members of the public to take part in environmental planning and environmental assessment, such as through making submissions.
- Require activities of environmental significance to be assessed before permission can be granted, such as through an environmental impact statement.
- Provide administrative, civil and criminal penalties for breaches of the law.
- Allow the legality of the decisions of regulators to be challenged by members of the public in appropriate courts.
- Allow the merits of certain decisions of regulators to be challenged by members of the public.
- Allow for third parties to enforce breaches of the law through court action.

## Environment Protection Act

The Environment (Protection) act, (EPA) 1986 is a landmark legislation which provides for a single focus in the country for the protection of environment and aims at plugging the loopholes in the existing legislation.

It is a comprehensive legislation to deal with water, air and land pollution and hazardous wastes and handling, storage and transportation of hazardous chemicals and wastes.

# <u>Environment Protection Act</u>

## Objectives:

The general objectives of this Act shall include

(a) To coordinate the role of government in relation to environmental protection and sustainable development;

(b) Provide a mechanism for the development of environmental policy and law;

(c) To promote a clean and healthy environment for all

(d) To prevent, control, monitor and respond to pollution;

(e) To promote public awareness and involvement in environmental issues and the preservation

# Air (Prevention and Control of Pollution) Act

## The Air Act, 1981

This act is passed to clean up the air by controlling pollution

The main objective of this act is

- To provide for the prevention , control and abatement of air pollution
- To provide for the establishment of central and state boards with a view to implement the act.
- To confer on the Boards the powers to implement the provisions of the Act and assign to the Boards functions relating to pollution.

## Powers and Functions of the Boards

### Central Pollution Board

The main function of the Central Board is to implement legislation created to improve the quality of air and to prevent and control air pollution in the country.

### State Pollution Control Boards

The State Boards have the power to advise the State Government on any matter concerning the prevention and control of air pollution.

### Penalities

The person managing the industry are to be penalized if they produce emissions of air pollutants in excess of standards laid down by the state board.

Imprisonment extended upto a three months or fine of Rs.10, 000 or both

Continuing the offence means, then Rs. 5000 for every day

## Water (Prevention and control of Pollution) Act

## The water (prevention and control of pollution) act, 1974

The act was passed in 1974 to prevent the pollution of water by industrial, agricultural and household wastewater that contaminate the water resources

**Objectives**

To provide for prevention, control and abatement of water pollution and the maintenance or restoration of the wholesomeness of water. It is designed to assess pollution levels and punish polluters.

**Powers and Functions of the Boards:**

The Act provides for constitution of central and State Boards for preventing water pollution, power to take water samples and their analysis, discharge of sewage or trade effluents, appeals, revision, minimum and maximum penalties, publication of names of offenders, offences by companies and Government departments, cognizance of offences, water laboratories, analysis etc.

**Penalities**

The person managing the industry are to be penalized if they discharge exceeds of standards laid down by the state board.

Imprisonment extended upto a three months or fine of Rs.10,000 or both Continuing the offence , then Rs. 5000 for every day

## Wild life Protection Act

## The Wildlife Protection Act, 1972

This act deals with the declaration of National parks and Wildlife Sanctuaries
It provides for setting up Wildlife Advisory Boards

### Major activities

1. It defines the wildlife related terminology.
2. Enactment of an All India Wildlife Protection Act (1972).
3. It provides for the appointment of wildlife advisory Board, Wildlife warden, their powers, duties etc.
4. Protection to some endangered plants.
5. The Act provides for setting up of National Parks, Wildlife Sanctuaries etc.
6. The Act provides for the constitution of Central Zoo Authority.
7. There is provision for trade and commerce in some wildlife species with license for sale, possession, transfer etc.
8. The act imposes a ban on the trade or commerce in scheduled animals.
9. It provides for legal powers to officers and punishment to offenders.

# Forest Conservation Act

## Forest Conservation Act, 1980

**Main objective**

- To preserve the biological diversity and genetic resources
- To control deforestation
- Protection and conservation of flora, fauna, forests and wildlife.
- Afforestation and regeneration of degraded areas
- Protection of environment in order to promote sustainable development.

**Penalties for offences in Reserved Forest**

No person is allowed to make clearings or set fire to a reserved forest Imprisonment for a term of six months, or with fine of Rs.500 or both

**Penalties for offences in Protected Forest**

A person who commits any of the offences like felling of trees, stripping the bark or leaves trees Imprisonment for a term of six months, or with fine of Rs.500 or both.

# Disaster Management - Natural Disasters - Meaning and nature of natural disasters, their types and effects - Floods, drought

# Introduction

- Disasters are as old as Mankind.
- The first description of Disaster and its management comes from mythological “Noah” and his ark.
- Similar Flood tales are widespread in- Greek Mythology, Puranas, Mesopotamian stories, and many cultures.

## *Etymology*

- ***Originated from Greek***
- ***dus = bad aster = star***
- ***Calamity due to position of a planet or a star.***
- ***Then evolved in Italian as disastro,***
- ***To become French désastre (de.zastʁ).***
- ***& then disaster .***

- Disaster means a "**situation in which there is a sudden disruption of normalcy within society causing widespread damage to life and property**".

- A disaster can be defined as an occurrence either nature or man made that causes human suffering and creates human needs that victim cannot alleviate without assistance.

(American Red Cross)

- A specific disaster may spawn a secondary disaster that increases the impact.
- A classic example is an

  "**earthquake**" that causes a

  **tsunami**, resulting in

  **coastal flooding**;

  **changing the land in to**

  **saline problem soils** and

  **poor quality of water** sources

  ultimately **affecting crop production**

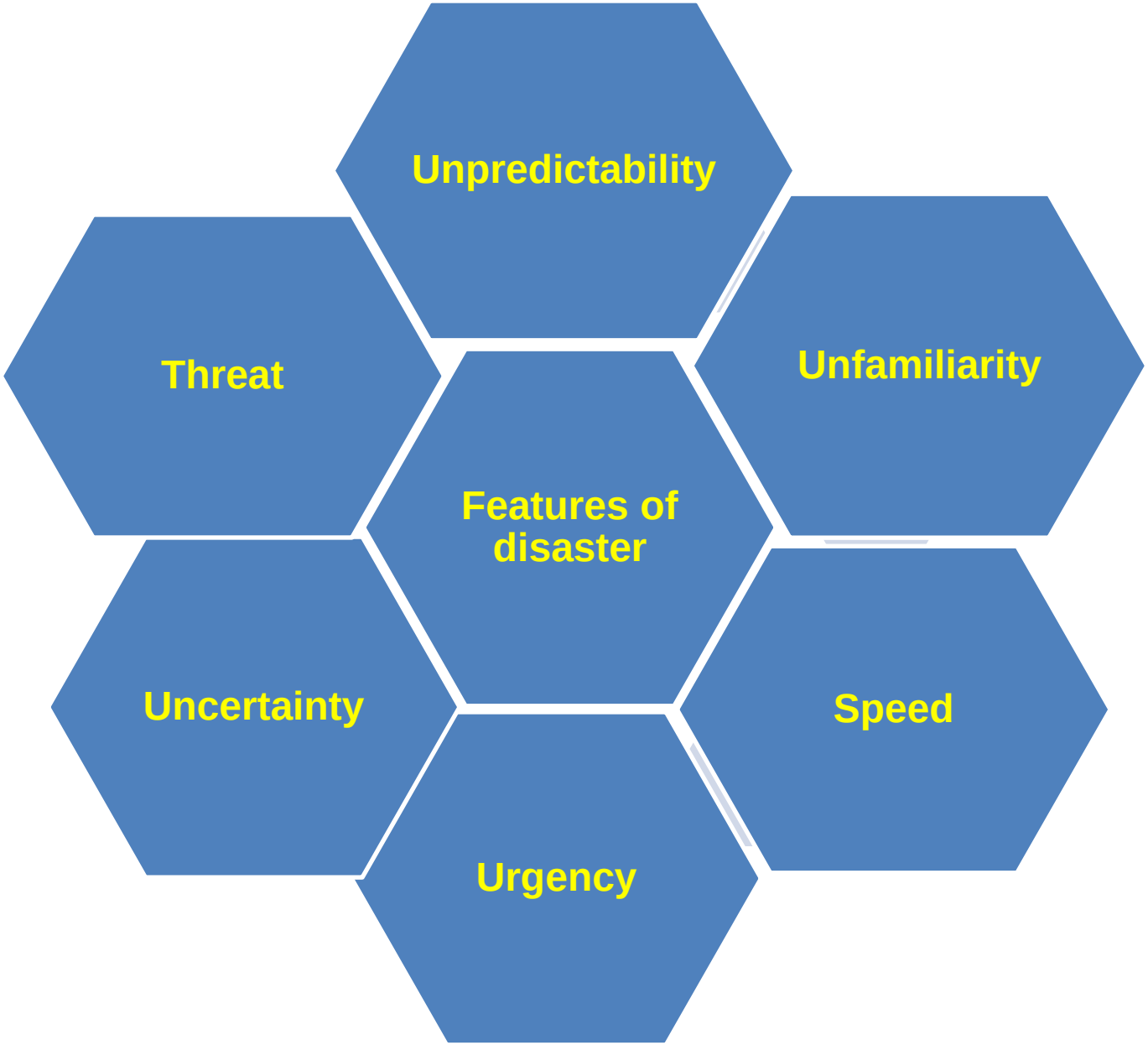
# Effects of Disaster

- A disaster is a natural or manmade event which results in widespread human loss, loss of livelihood, property and life often resulting in permanent changes to human societies, ecosystems and environment.

- The damage caused by disasters is immeasurable and varies with the geographical location, climate and the type of the earth surface/degree of vulnerability which influences the mental, socio-economic, political and cultural state of the affected area.

- A Disaster is an event that occurs in most cases suddenly and unexpectedly, causing severe disturbances to people, objects and environment, resulting in loss of life, property and health of the population.

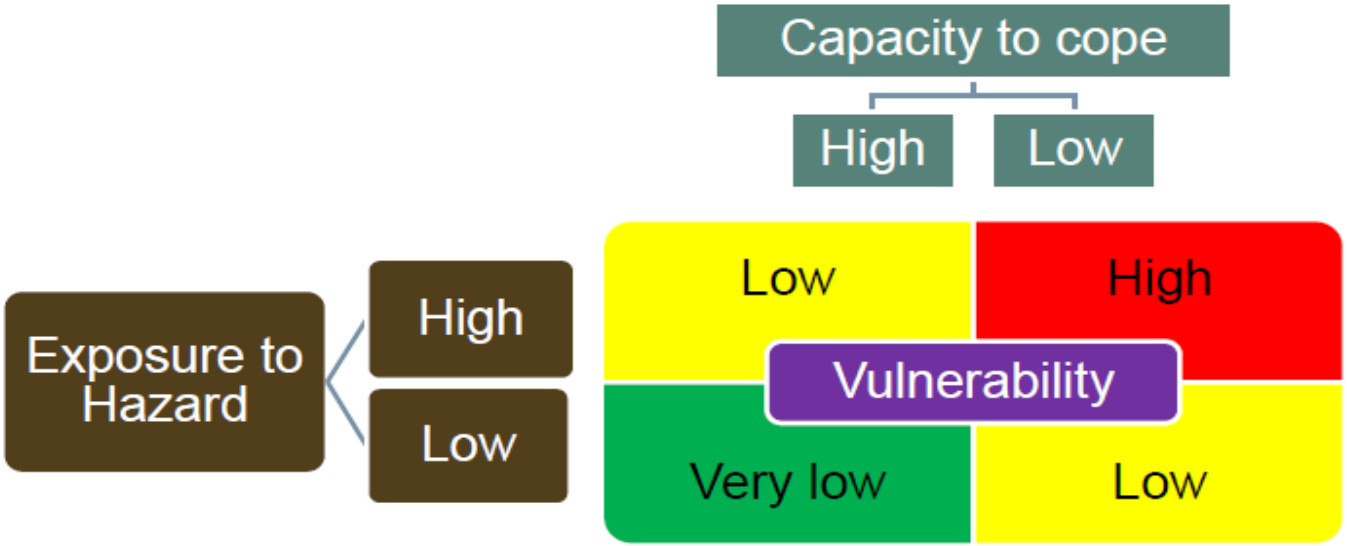
- Disaster causes disruption in normal pattern of life, generating misfortune, helplessness and suffering affecting the socio-economic structure of a region/country to such an extent that there is a need for assistance or immediate outside intervention


Unpredictability
Threat
Unfamiliarity
Features of disaster
Uncertainty
Speed
Urgency

- **Risk:** Risk is a measure of the expected losses due to a hazardous event of a particular magnitude occurring in a given area over a specific time period. Risk is a function of the probability of particular occurrences and the losses each would cause.

- The level of risk depends on
  - Nature of the Hazard
  - Vulnerability of the elements which are affected
  - Economic value of those elements

- **Vulnerability:** It is defined as "the extent to which a community, structure, service, and geographic area is likely to be damaged or disrupted by the impact of particular hazard, on account of their nature, construction and proximity to hazardous terrain or a disaster prone area"




**The propensity of things to be damaged by a hazard**

- **Hazards:** Any phenomenon that has the potential to cause disruption or damage to people and their environment

**"A hazard is natural event while the disaster is its consequence. A hazard is perceived natural event which threatens both life and property……**

**A disaster is a realization of this hazard."**

**-John Whittow**

- **When hazard involves elements of risks, vulnerabilities and capacities, they can turn into disasters.**

# TYPES OF DISASTER

- **Natural Disasters**
  - Meteorological
  - Topographical
  - Environmental
- **Man-made Disasters**
  - Technological
  - Industrial accidents
  - Security related

# Natural Disasters

## Meteorological Disasters

- Floods
- Tsunami
- Cyclone
- Hurricane
- Typhoon
- Snow storm
- Blizzard
- Hail storm

## Topographical Disasters

- Earthquake
- Volcanic Eruptions
- Landslides and Avalanches
- Asteroids
- Limnic eruptions

## Environmental Disasters

- Global warming
- El Niño-Southern Oscillation
- Ozone depletion-UVB Radiation
- Solar flare

# Man made Disasters

## Technological

- Transport failure
- Public place failure
- Fire

## Industrial

- Chemical spills
- Radioactive spills

## Warfare

- War
- Terrorism
- Internal conflicts
- Civil unrest
- CBRNE

- **Land movement disasters**
  - Avalanches
  - Earthquakes
  - Lahars
  - Volcanic eruptions
- **Water disasters**
  - Floods
  - Limnic eruptions
  - Tsunami
- **Weather disasters**
  - Blizzards
  - Cyclonic storms
  - Droughts
  - Hailstorms
  - Heat waves
  - Tornadoes
- **Fire**
- **Health and diseases**
  - Epidemic
  - Famine
- **Space**
  - Gamma ray bursts
  - Impact events
  - Solar flares
  - Supernovae and hypernovae

## Disasters affecting India

- Earthquake
- Volcanic eruption
- Tsunami
- Cyclone
- Flood
- Landslide
- Bushfire
- Drought
- Major accident (fire, explosion, hazmat)

## General Effects of Disaster

- ✓ Loss of life
- ✓ Injury
- ✓ Damage to and destruction of property.
- ✓ Damage to and destruction of production.
- ✓ Disruption of lifestyle
- ✓ Loss of livelihood.
- ✓ Disruption to essential services
- ✓ Damage to national infrastructure
- ✓ Disruption to governmental systems
- ✓ National economic loss
- ✓ Sociological and psychological after effect.

## Flood

- ✓ The term "flood" is a general or temporary condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waters or from the unusual and rapid accumulation or runoff of surface waters from any source.

- ✓ Flood is usually an overflow of excessive water that submerges land and the inflow of tide onto land.

- ✓ Flooding and flash flooding are the deadliest of natural disasters.

- Floodwaters claim thousands of lives every year and render millions homeless.

- One of the more frightening things about flooding is that it can occur nearly anywhere, at any time.

- It can result from excess water jams on rivers, even moderate rain, or a single very heavy downpour as it occurred in Himachal Pradesh recently.

- Floods usually cause large-scale loss of human life and wide spread damage to properties. This damage is known as flood damage.

- Unimaginable damage will be caused to agriculture; thereby affects government planning and this will upset the financial budgeting, thereby slowing down the economy as a whole.

## Factors that help determine whether a flood is minor or major

- ✓ Deep snow cover
- ✓ Frozen ground
- ✓ Wet or saturated soil
- ✓ Full reservoirs
- ✓ High river and stream levels
- ✓ Ice-covered rivers
- ✓ Widespread, heavy rain

# Effects of Flood

- **Primary:** Physical damages like damage to bridges, cars, buildings, sewer systems, roadways, and even casualties like people and livestock death due to drowning.

- **Secondary:** Disruption of many essential services like gas and electricity

- **Tertiary:** Generally long-term effects like the location of river channels that may change because of flooding; fewer new channels will develop, leaving the old channels dry

# Preventive measures for flood

- ✓ **Risk Identification**
- ✓ **Risk Reduction/Mitigation, Risk Transfer**
- ✓ **Emergency Reponses**

# Drought

**What Causes Drought**

**Types of Drought**

**The consequences of drought**

# Cyclone, earthquakes, Landslides, avalanches

# Cyclone

- The name cyclone was first coined by Captain Henry Piddington, Chairman of Marine Court, Calcutta in 1848.

- It is derived from Greek word means coil of a snake.

- Cyclone is an meteorological phenomena in which an area of low pressure characterized by inward spiraling winds that rotate counter clockwise in the northern hemisphere and clockwise in the southern hemisphere of the earth.

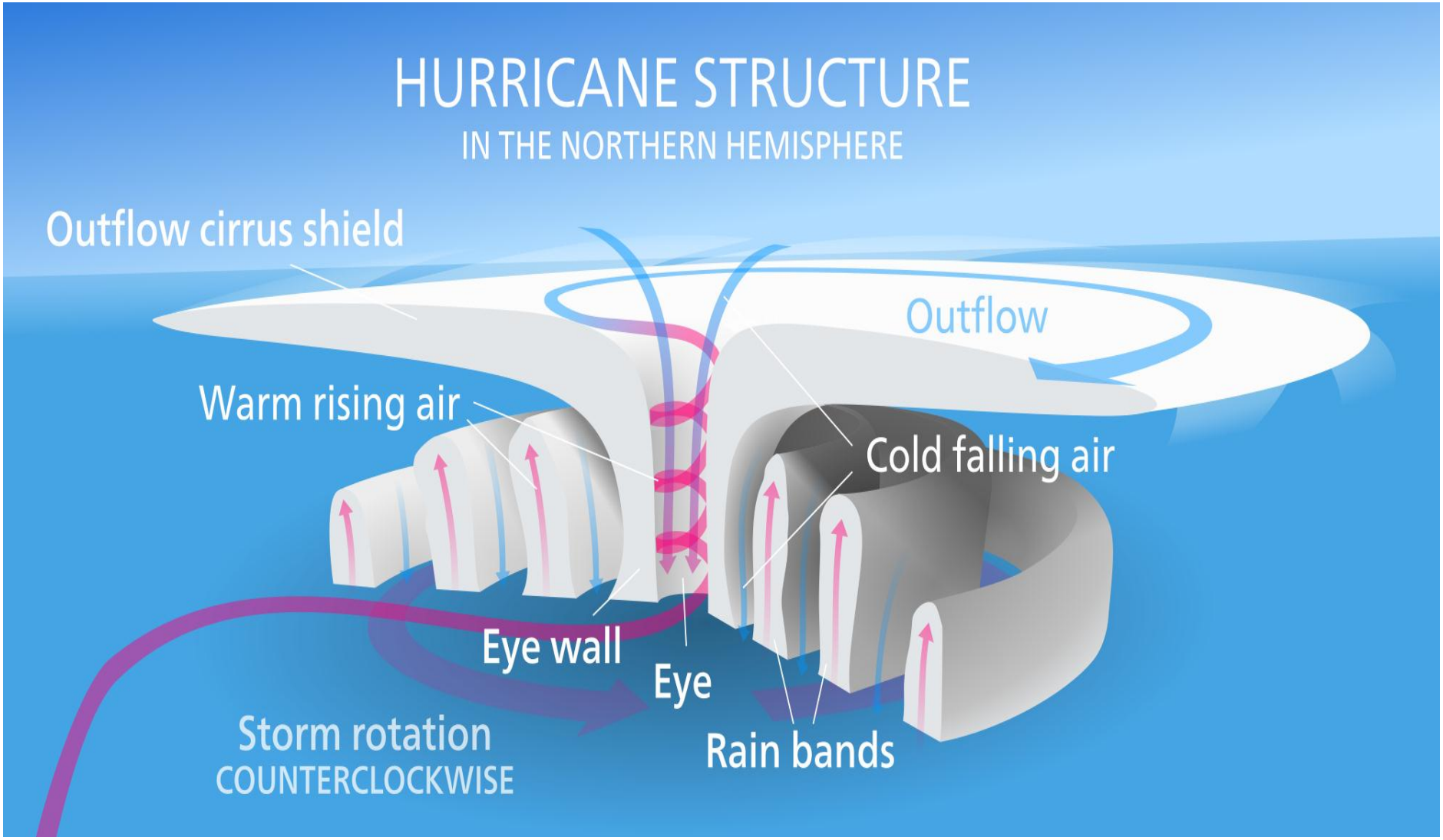
- Near the places of their origin they are only 80 Km in diameter, but well developed cyclones have their diameter ranging from 300 to 1500 km.
- They move at faster rate over the oceans than over the land because the irregularities of the land surface retard their speed.

- **The six main types of cyclones are polar cyclone, polar low, extra tropical, subtropical, tropical and mesoscale.**

# Types of Cyclones

- Cyclone - Tropical cyclones
- Cyclone - Extra tropical cyclones
- Cyclone - Subtropical cyclones
- Cyclone – Mid latitude cyclones
- Cyclone - Polar low
- Cyclone - Arctic cyclone
- Cyclone – Meso cyclones
- Cyclone - Tornadoes
- Cyclone - Martian cyclones

# Tropical cyclone - Structure and classification



# *Tropical cyclone - Structure*

- **Surface low -** Rotate around an area of low atmospheric pressure near the Earth's surface
- **Warm core -** release of large amounts of latent heat of condensation as moist air is carried upwards and its water vapor condenses. This heat is distributed vertically, around the center of the storm
- **Central Dense Overcast (CDO) -** dense shield of very intense thunderstorm activity that make up the inner portion of the hurricane. This contains the eye wall, and the eye itself.

- **Eye -** eye is normally calm and free of clouds. Eyes are home to the coldest temperatures of the storm at the surface, and the warmest temperatures at the upper levels. The eye is normally circular in shape, and may range in size from 8 km to 200 km (5 miles to 125 miles) in diameter
- **Eyewall -** A band around the eye of greatest wind speed, where clouds reach highest and precipitation is heaviest. The heaviest wind damage occurs where a hurricane's eyewall passes over land.
- **Outflow -** The upper levels of a tropical cyclone feature winds headed away from the center of the storm with an anticyclonic rotation.

Tropical cyclones owe this unique characteristic to the warm core at the center of the storm.

# Tropical cyclone - Categories and ranking

## How do they measure hurricanes?

| Saffir-Simpson Hurricane Scale | | |
|---|---|---|
| Category | Wind speed (mph) | Storm surge (feet) |
| 5 | 156 | More than18 |
| 4 | 131–155 | 13–18 |
| 3 | 111–130 | 9–12 |
| 2 | 96–110 | 6–8 |
| 1 | 74–95 | 4–5 |
| Additional classifications | | |
| Tropical storm | 39–73 | 0–3 |
| Tropical depression | 0–38 | 0 |

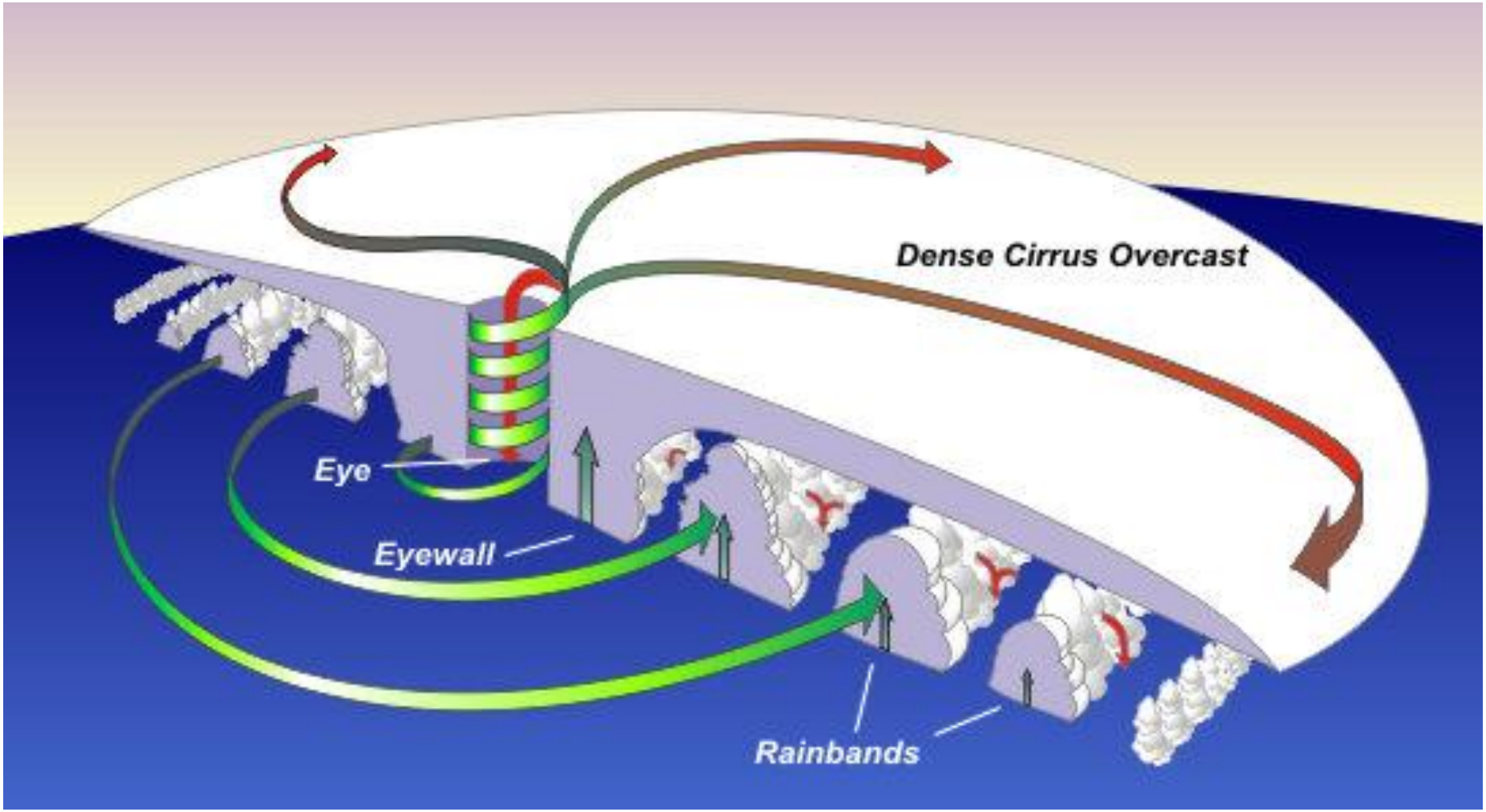
**Hurricanes are ranked according to their maximum winds using the Saffir-Simpson Hurricane Scale**

# *Tropical cyclone - Classification*

- Tropical cyclones are classified into three main groups
  - Tropical depressions
  - Tropical storms and
  - Third group whose name depends on the region.

- **Tropical depressions**: is an organized system of clouds and thunderstorms with a defined surface circulation and maximum sustained winds of less than 17 metres per second (33 knots, 38 mph, or 62 km/h). It has no eye, and does not typically have the spiral shape of more powerful storms. It is already becoming a low-pressure system, however, hence the name "depression".

- ***Tropical storm :*** is an organized system of strong thunderstorms with a defined surface circulation and maximum sustained winds between 17 and 33 meters per second (34â€“63 knots, 39â€“73 mph, or 62â€“117 km/h). At this point, the distinctive cyclonic shape starts to develop, though an eye is usually not present. Government weather services assign first names to systems that reach this intensity



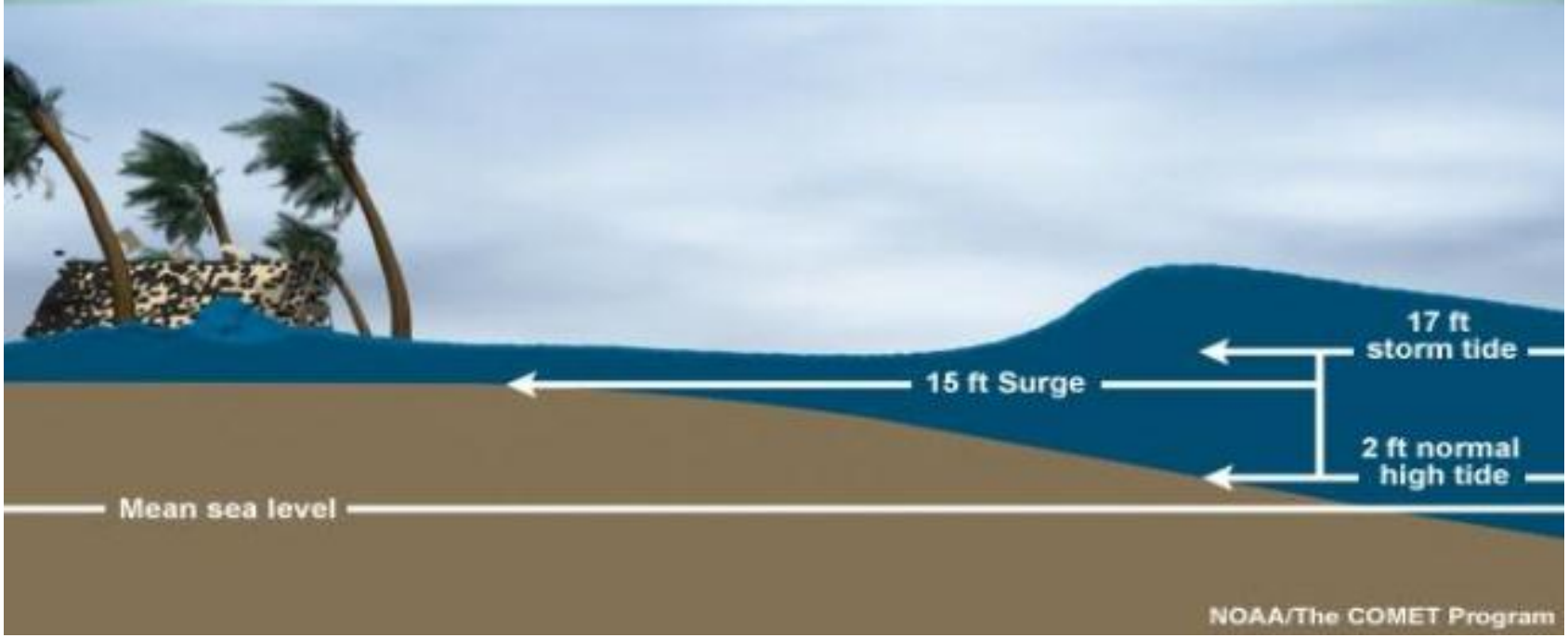

- **8 km to 200 km (5 miles to 125 miles) in diameter**

# **Tropical cyclones** can result in extensive flooding and storm surge

- Bhola Cyclone, striking East Pakistan (now Bangladesh) in 1970,
- Typhoon Nina, striking China in 1975,
- Tropical Storm Allison, which struck Houston, Texas in 2001 and
- Hurricane Katrina, which left most of New Orleans under water in 2005. Much of the flooding was due to the failure of the city's levee system.

# So what is storm surge?

**Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides.** Storm surge should not be confused with **storm tide**, which is defined as the water level rise due to the combination of storm surge and the astronomical tide (National Hurricane Center)



- A cyclone is known as a **typhoon** if it forms in the north west Pacific. Cyclones can also be known as hurricanes, tropical storms, depressions and cyclonic storms, depending on which ocean they form over and how severe they become. A **super typhoon** is a storm that reaches sustained windspeeds of at least 150mph

The only **difference between** a **hurricane**, a cyclone, and a **typhoon** is the location where the storm occurs. ... **Hurricanes**, cyclones, and **typhoons** are all the same weather phenomenon; we just use different names for these storms in different places. In the Atlantic and Northeast Pacific, the term "**hurricane**" is used.

Cyclone Laila

Cyclone Thane

Cyclonic Storm Nilam

Cyclone Phailin

Cyclone Hudhud

Cyclone Vardah

Cyclone Ockhi

Cyclone Gaja

# Earthquakes

An **earthquake** is a sudden movement of the Earth caused by the abrupt release of energy that has accumulated over a long time.

The underground point of origin of the earthquake is called the **"focus".** The point directly above the focus on the surface is called the **"epicenter".**

# Earthquake Prediction

Types of plate boundaries

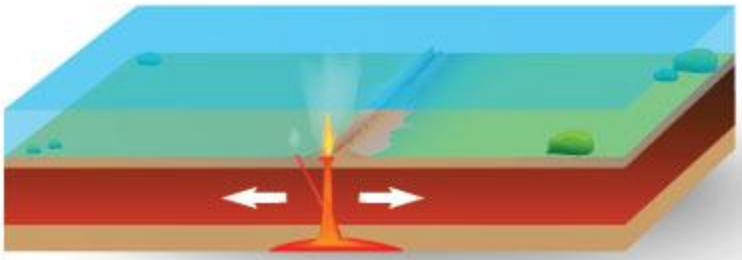
- ***Spreading zones***: At *spreading zones,* molten rock rises pushing two plates apart and adding new material at their edges. Most spreading zones are found in oceans.

- ***Transform faults*** are found where plates slide past one another. Earthquakes at transform faults tend to occur at shallow depths and form fairly straight linear patterns.

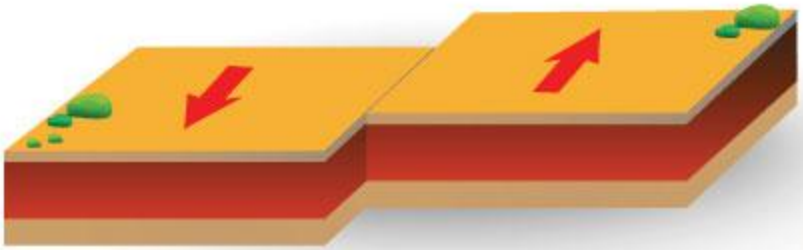
- ***Subduction zones*** are found where one plate overrides, or subducts, another, pushing it downward into the mantle where it melts.

# THREE TYPES OF PLATE BOUNDARY

Divergent plate boundary

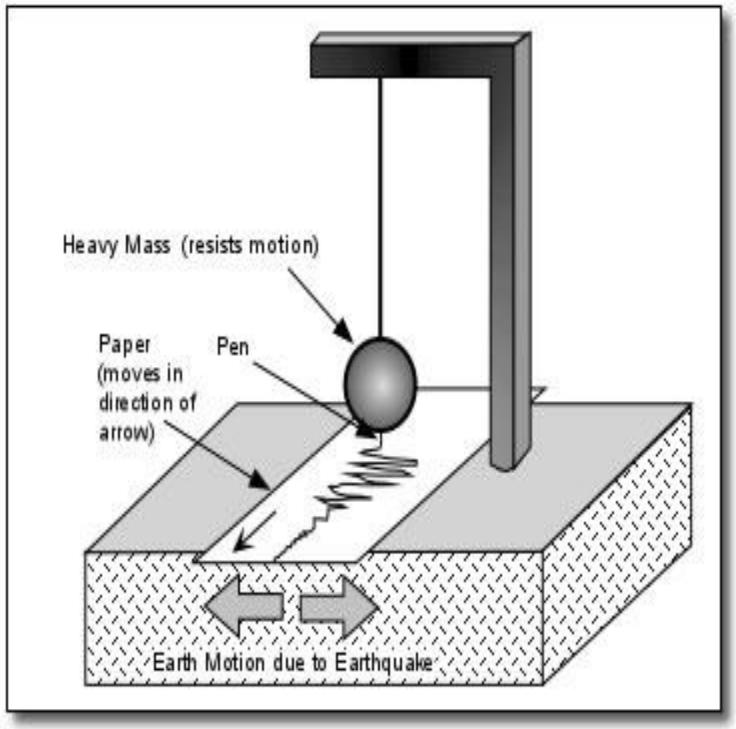


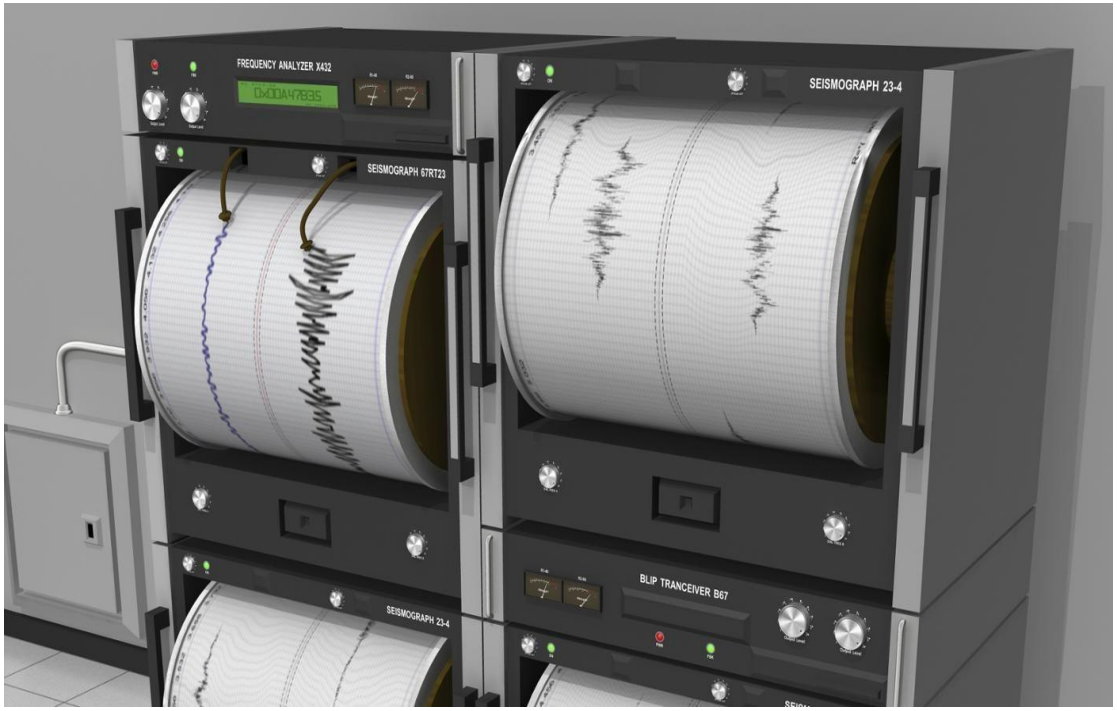
Transform plate boundary



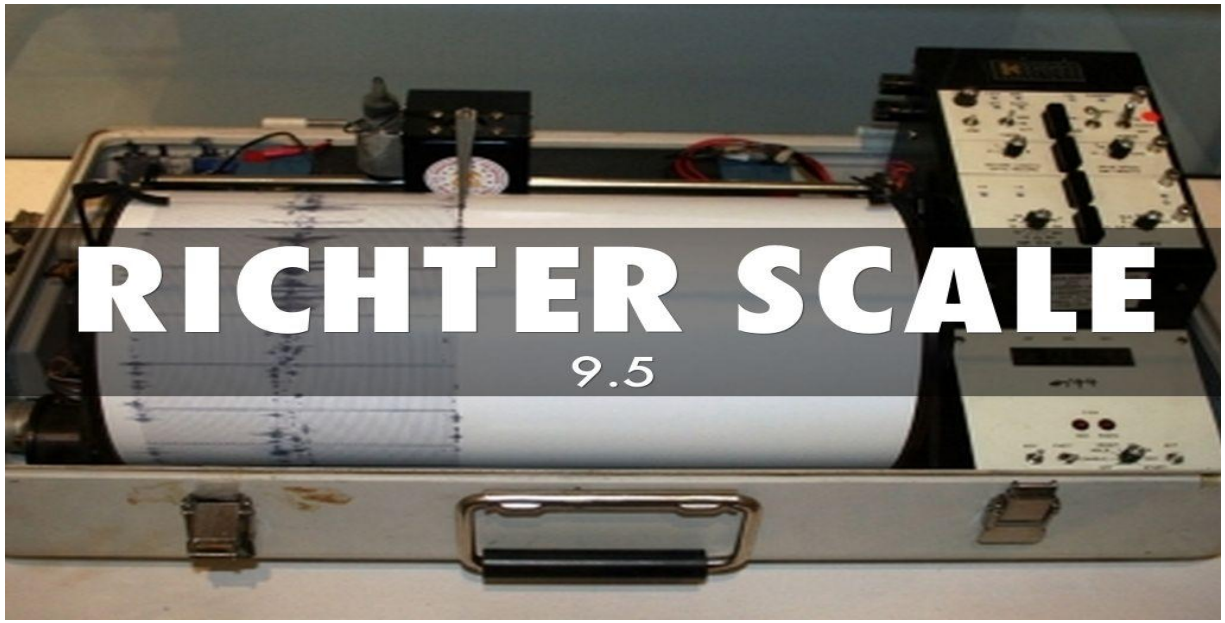
Convergent plate boundary

- The vibrations produced by earthquakes are detected, recorded, and measured by instruments called seismographs. The jagged line made by a seismograph—called a seismogram—reflects the changing intensity of the vibrations by responding to the motion of the ground surface beneath the instrument.



- Richter scale is the best-known scale for measuring the magnitude of earthquakes.
- The scale is logarithmic, so a recording of 7, for example, indicates a disturbance with ground motion 10 times as large as a recording of 6.
- A quake of magnitude 2 is the smallest quake normally felt by people.
- Earthquakes with a magnitude of 6 or more are considered major; great earthquakes have magnitudes of 8 or more.



# Tsunamis

**Tsunamis are waves generated by earthquakes or any large, sudden offset of the ocean floor (caused by submarine landslides etc.). They are sometimes incorrectly called tidal waves, they have nothing to do with the tides.**

**A tsunami is a series of gigantic waves that occur in the ocean or in other large bodies of water.**

- The 2004 Indian Ocean earthquake, the third largest earthquake in recorded history, registering a moment magnitude of 9.1-9.3. The huge tsunamis triggered by this earthquake cost the lives of at least 229,000 people.

- The 7.6-7.7 2005 Kashmir earthquake, which cost 79,000 lives in Pakistan.

- The 7.7 magnitude July 2006 Java earthquake, which also triggered tsunamis.

- The 7.9 magnitude May 12, 2008 Sichuan earthquake in Sichuan Province, China. Death toll at over 61,150 as of May 27, 2008.

# Landslides

- Landslides are one of the natural hazards that affect at least 5% of land area in India exceeding 0.49 million $km^2$.
  - Surface subsidence
  - Subsurface subsidence

# Avalanches

## Snow slide

A change in temperature, a loud noise, or vibrations are all that are necessary to trigger one of these snowfalls that begin at a "starting zone." The avalanche continues downslope along the "track" and ultimately the avalanche fans out and settles in the "runout zone."

- **An avalanche is any amount of snow sliding down a mountainside. It can be compared to a landslide, only with snow instead of earth.**

- Avalanches occur when the gravity pushing the collection of snow at the top of the slope is greater.

- The types and scale of avalanches can differ depending on the combination of weather conditions and the weight of the snow cover

# Volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion

# Volcanic Eruptions

Volcanoes occur because the Earth's crust is broken into 17 major tectonic plates that are rigid but float on a hotter, softer layer in the Earth's **mantle**.

Within the Earth's mantle, temperatures are hot enough to melt rock and form a thick, flowing substance called **magma**.

Most occur near the edge of plates or along the edges of continents where one plate overlaps a second plate; this is called **a seduction zone**

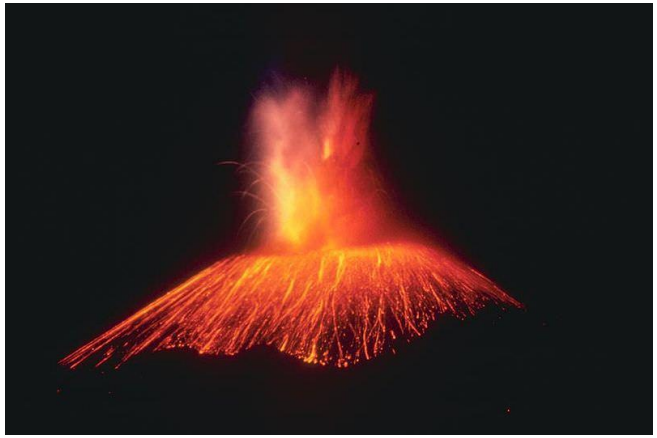
- A volcano is an opening in the Earth's surface where molten rock can escape from underneath.
- The Earth's surface is made up of tectonic plates, which are spreading apart, crunching into each other, or sliding beside one another.
- Volcanoes are typically found at the fault lines between these plates.
- There can be active volcanos, which are currently, or have recently erupted. There are also dormant volcanoes, which haven't erupted recently, and extinct volcanoes, which will never erupt again.

- **There are several factors to classify a volcano that includes**
  - ❖ **Recent activity**
  - ❖ **Periodicity of eruptions**
  - ❖ **Size**
  - ❖ **Potential impact and others**

# 4 major types of volcanoes

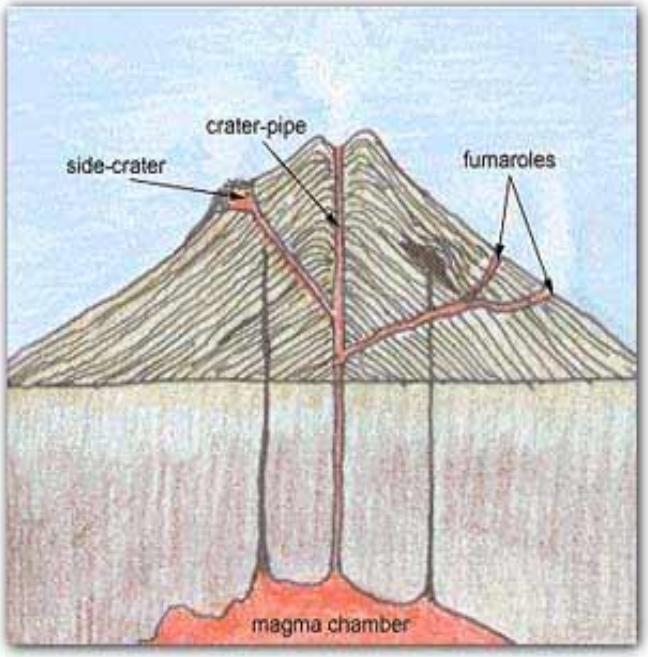
## Cinder Cone Volcanoes

- These are the simplest type of volcano. They occur when particles and blobs of lava are ejected from a volcanic vent.
- The lava is blown violently into the air, and the pieces rain down around the vent.
- Over time, this builds up a circular or oval-shaped cone, with a bowl-shaped crater at the top.
- Cinder cone volcanoes rarely grow larger than about 1,000 feet above their surroundings.



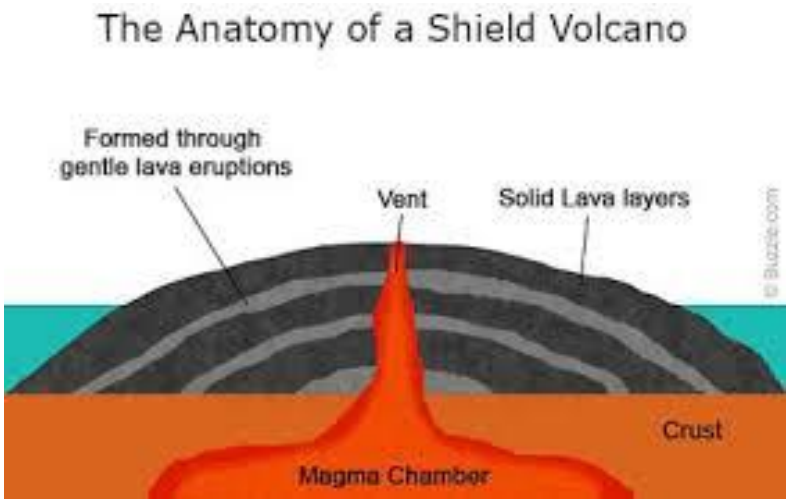
# Composite Volcanoes

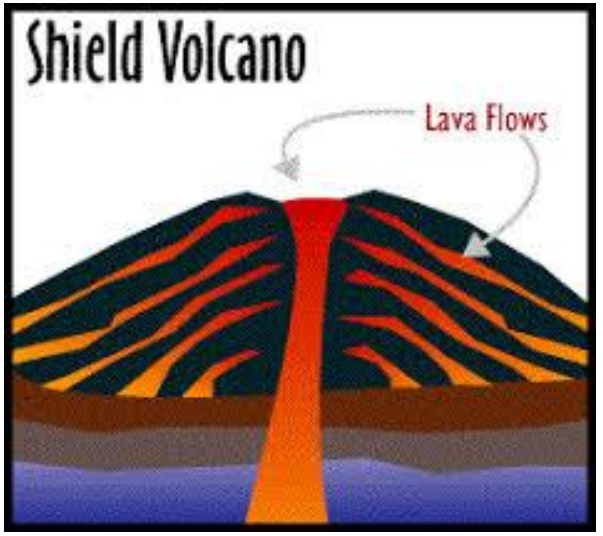
- Composite volcanoes, or stratovolcanoes make up some of the world's most memorable mountains: Mount Rainier, Mount Fuji, and Mount Cotopaxi, for example.
- These volcanoes have a conduit system inside them that channels magma from deep within the Earth to the surface.
- They can have clusters of vents, with lava breaking through walls, or issuing from fissures on the sides of the mountain.
- With all this material coming out, they can grow thousands of meters tall.
- The famous Mount Saint Helens, composite volcanoes can explode violently.



## Shield Volcanoes

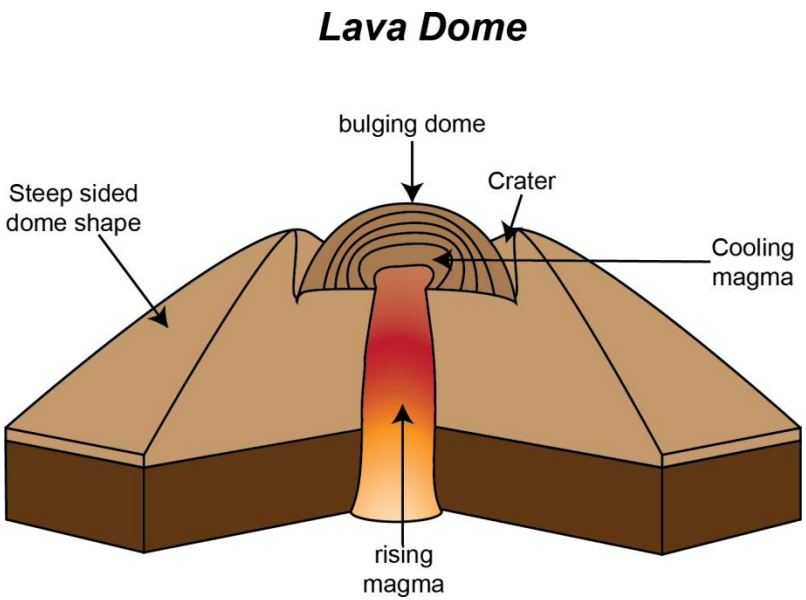
- These are large, broad volcanoes that look like shields from above – hence the name.
- The lava that pours out of shield volcanoes is thin, so it can travel for great distances down the shallow slopes of the volcano.
- These volcanos build up slowly over time, with hundreds of eruptions, creating many layers.
- They're not likely to explode catastrophically. Perhaps the best known shield volcanoes are the ones that make up the Hawaiian Islands, especially Mauna Loa and Mauna Kea.



## Lava Domes

- Volcanic or lava domes are created by small masses of lava which are too viscous (thick) to flow very far.
- Unlike shield volcanoes, with low-viscosity lava, the magma from volcanic domes just pile up over and around the vent.
- The dome grows by expansion of the lava within, and the mountain forms from material spilling off the sides of the growing dome.
- Lava domes can explode violently, releasing a huge amount of hot rock and ash.



# Eruption Types

Subglacial

Strombolian

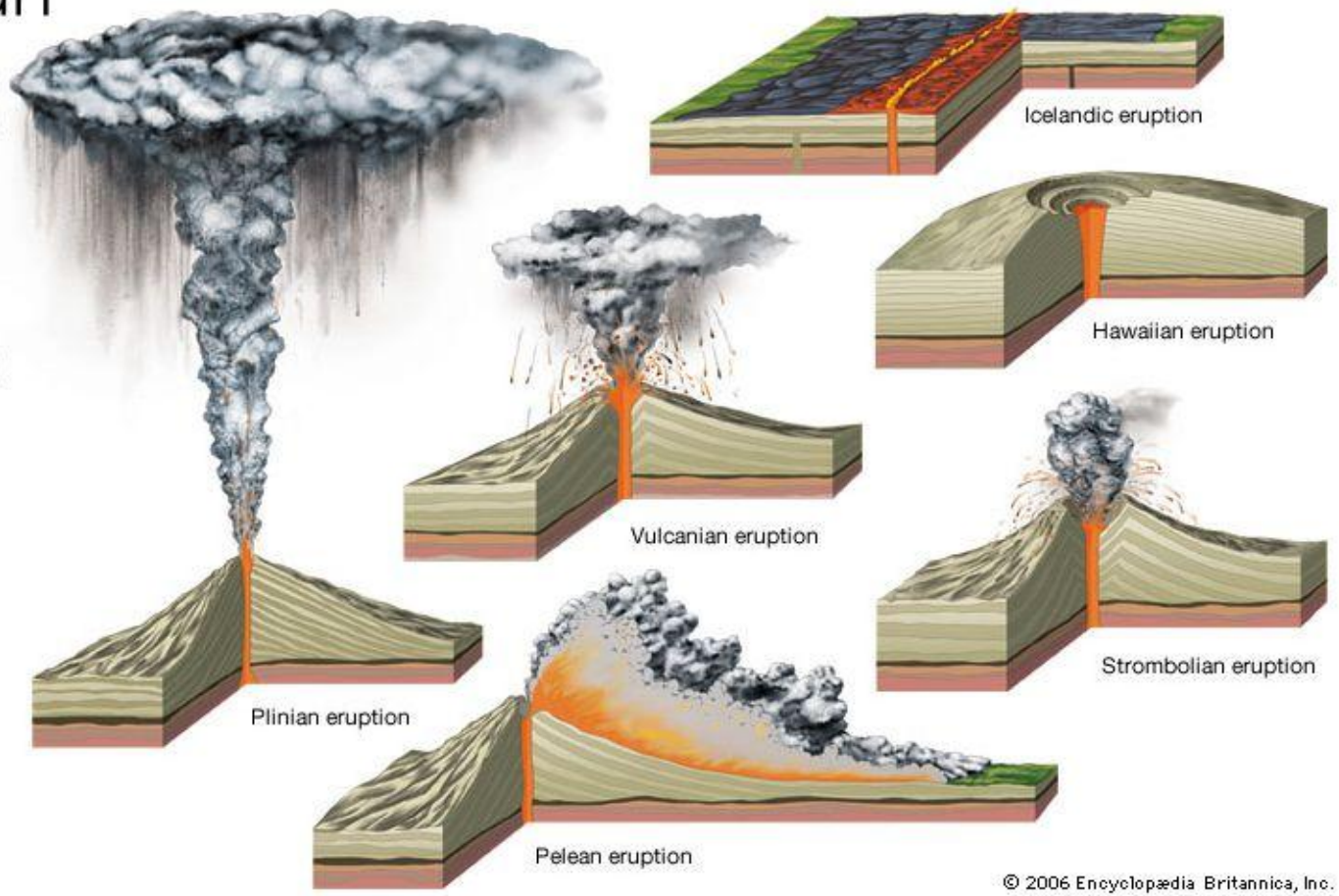
Vulcanian

Peléan

Hawai'ian

Phreatic

Plinian



# Primary Volcanic Hazards

- **Lava flows -** steady march of lava
- **Pyroclastic flows -** travel upwards of 150 km/hr they can seldom be outrun. They are a mixture of superheated ash, gas, and rock and level or bury pretty whatever is in their path.

# Secondary Volcanic Hazards

- **Lahars – mud flow**
- **Ash falls**
- **Landslides**
- **Climate changes**

# Heat and Cold waves

A Heat Wave is a period of abnormally high temperatures, more than the normal maximum temperature that occurs during the summer season in the **North-Western parts of India**.

Heat Waves typically occur between **March and June**, and in some rare cases even extend till July.

The Indian Meteorological Department (IMD) has given the following criteria for Heat Waves :

- Heat Wave need not be considered till maximum temperature of a station reaches atleast 40*C for Plains and atleast 30*C for Hilly regions
- When normal maximum temperature of a station is less than or equal to 40*C Heat Wave Departure from normal is 5*C to 6*C Severe Heat Wave Departure from normal is 7*C or more
- When normal maximum temperature of a station is more than 40*C Heat Wave Departure from normal is 4*C to 5*C Severe Heat Wave Departure from normal is 6*C or more
- When actual maximum temperature remains 45*C or more irrespective of normal maximum temperature, heat waves should be declared.

# Health Impacts of Heat Waves

- **Heat Cramps: Edema (swelling) and Syncope (Fainting) generally accompanied by fever below 39*C i.e.102*F.**
- **Heat Exhaustion: Fatigue, weakness, dizziness, headache, nausea, vomiting, muscle cramps and sweating.**
- **Heat Stoke: Body temperatures of 40*C i.e. 104*F or more along with delirium, seizures or coma. This is a potential fatal condition**

# Heat Wave, India.

In India Jun 6, 2012: Heat wave caused over 100 deaths in Bengal. In Bengal majority of deaths were reported from Asansol -Durgapur belt.

# Cold Wave

A cold wave is a weather phenomenon and refers to a rapid fall in temperature within a 24 hour period requiring substantially increased protection to agriculture, industry, commerce, and social activities.

A cold wave can cause death and injury to livestock and wildlife. Exposure to cold mandates greater caloric intake for all animals, including humans, and if a cold wave is accompanied by heavy and persistent snow, grazing animals may be unable to reach needed food and die of hypothermia or starvation.

- Freezing in water pipelines.
- Indoor plumbing ruptures as water expands within them.
- Demand for electrical power and fuels rises dramatically during such times
- Some metals may become brittle at low temperatures.
- Motor vehicles may fail as antifreeze fails and motor oil gels, resulting even in the failure of the transportation system.
- Fires become even more of a hazard during extreme cold.
- more intense fire because the content of dissolved oxygen is more in the cold water

**Indian cold wave** during the winter months of 2012 killed at least 92 people across the northern and eastern India.

- **Eruption Of Mt Vesuvius 1944**
- **5 Most Deadly Volcanic Eruptions In Human History - Great Animation**
- **Volcano types: Cinder cone, composite, shield and lava domes explained - TomoNews**
- **Volcanoes 101 | National Geographic**

# Manmade Disaster - Building fire, coal fire, oil fire, forest fire and deforestation

# Manmade Disaster

- **Rise in population, rapid urbanization and industrialization, development within high-risk zones, environmental degradation, and climate change** aggravates the vulnerabilities to various kinds of disasters

- Due to inadequate disaster preparedness, communities, and animals are at increased risk from many kinds of human-induced hazards arising from accidents (industrial, road, air, rail, on river or sea, building collapse, fires, mine flooding, oil spills, etc.).

- Chemical, Biological, Radiological, and Nuclear (CBRN) hazards rank very high in among the human-induced risks.

- Terrorist activities and secondary incidents add to these risks and call for adequate preparedness and planning

# Manmade Disaster-Fire

## Fire Risk

- Building Fires
- Coal Fires
- Oil Fires
- Gas Fires
- Forest Fires

# Causes of Forest Fire

- **Natural causes-** Lightning - set trees on fire.
- The rain extinguishes such fires without causing much damage.
- High atmospheric temperatures and dryness (low humidity) offer favorable circumstance for a fire to start.

- **Manmade causes**- Fire is caused by naked flame, cigarette or bidi, electric spark or any source of ignition comes into contact with inflammable material

# Classification of Forest Fire

**Forest fire can broadly be classified into three categories**

- Natural or controlled forest fire.
- Forest fires caused by heat generated in the litter and other biomes in summer through carelessness of people (human neglect) and
- Forest fires purposely caused by local inhabitants

# Types of Forest Fire

## i) Surface Fire and ii) Crown Fire

- **Surface Fire** - A forest fire may burn primarily as a surface fire, spreading along the ground as the surface litter (senescent leaves and twigs and dry grasses etc) on the forest floor and is engulfed by the spreading flames.
- **Crown Fire** - The other type of forest fire is a crown fire in which the crown of trees and shrubs burn, often sustained by a surface fire.
- A crown fire is particularly very dangerous in a coniferous forest because resinous material given off burning logs burn furiously.
- On hill slopes, if the fire starts downhill, it spreads up fast as heated air adjacent to a slope tends to flow up the slope spreading flames along with it.
- If the fire starts uphill, there is less likelihood of it spreading downwards.

# Vulnerability

- The youngest mountain ranges of Himalayas are the most vulnerable stretches of the world susceptible to forest fires.
- The forests of Western are more frequently vulnerable to forest fires as compared to those in Eastern Himalayas.
- This is because forests of Eastern Himalayas grow in high rain density.
- With large scale expansion of chirr (Pine) forests in many areas of the Himalayas the frequency and intensity of forest fires has increased.

# Preparedness and Mitigation Measures

- Forest fires are usually seasonal. They usually start in the dry season and can be prevented by adequate precautions.
- During the British period, fire was prevented in the summer through removal of forest litter all along the forest boundary. This was called "Forest Fire Line" This line used to prevent fire breaking into the forest from one compartment to another.
- The collected litter was burnt in isolation. Generally, the fire spreads only if there is continuous supply of fuel (Dry vegetation) along its path. The best way to control a forest fire is therefore, to prevent it from spreading, which can be done by creating firebreaks in the shape of small clearings of ditches in the forests.

# Precautions

**The followings are the important precautions against fire:**

- **To keep the source of fire or source of ignition separated from combustible and inflammable material.**
- **To keep the source of fire under watch and control.**
- **Not allow combustible or inflammable material to pile up unnecessarily and to stock the same as per procedure recommended for safe storage of such combustible or inflammable material.**
- **To adopt safe practices in areas near forests viz. factories, coalmines, oil stores, chemical plants and even in household kitchens.**
- **To incorporate fire reducing and firefighting techniques and equipment while planning a building or coal mining operation.**
- **In case of forest fires, the volunteer teams are essential not only for firefighting but also to keep watch on the start of forest and sound an alert**
- **To arrange firefighting drills frequently.**

# Impacts of Forest Fires on Biological Environment

- Forest fires also pose serious health hazards by producing smoke and noxious gases, as the events in
- Indonesia - forest fires on the islands of Sumatra and Borneo in 1977.
- The burning of vegetation gives off not only carbon dioxide but also a host of other, noxious gases (Green house gases) such as carbon monoxide, methane, hydrocarbons, nitric oxide and nitrous oxide, that lead to global warming and ozone layer depletion.
- Consequently, thousands of people suffered from serious respiratory problems due to these toxic gases.

# Deforestation

- Deforestation is the permanent destruction of indigenous forests and woodlands.
- The term does not include the removal of industrial forests such as plantations of gums or pines.
- Currently, 12 million hectares of forests are cleared annually.
- Almost all of this deforestation occurs in the moist forests and open woodlands of the tropics. At this rate all moist tropical forest could be lost by the year 2050

# General causes of deforestation

## Deforestation is brought about by the following:

- **Population Growth**
- **Conversion of forests and woodlands to agricultural land**
- **Development of cash crops and cattle ranching**
- **Commercial logging**
- **Felling of trees for firewood and building material; the heavy lopping of foliage for fodder**
- **To compound the problem, the poor soils of the humid tropics do not support agriculture for long. Thus people are often forced to move on and clear more forests in order to maintain production.**

# Consequences of Deforestation

- ***Alteration of local and global climates through disruption of***:

a) **The carbon cycle -** Forests act as a major carbon store because carbon dioxide ($CO_2$) is taken up from the atmosphere and used to produce the carbohydrates, fats, and proteins that make up the tree/plants.

When forests are cleared, and the trees are either burnt or rot, this carbon is released as $CO_2$. This leads to an increase in the atmospheric $CO_2$ concentration. $CO_2$ is the major contributor to the greenhouse effect. Because of this, forest is referred as sink of $CO_2$. It is estimated that deforestation contributes one-third of all $CO_2$ releases caused by people

b) **The water cycle** - Trees draw ground water up through their roots and release it into the atmosphere (transpiration). In Amazonia over half of all the water circulating through the region's ecosystem remains within the plants. With removal of part of the forest, the region cannot hold as much water. The effect of this could be a drier climate.

c) **Soil erosion** - With the loss of a protective cover of vegetation more soil is lost.

d) **Silting of water courses -** lakes and dams: This occurs as a result of soil erosion.

e)**Extinction of species -** which depend on the forest for survival. Forests contain more than half of all species on our planet - as the habitat of these species is destroyed, so the number of species declines.

f) **Desertification -** The causes of desertification are complex, but deforestation is one of the contributing factors.

# Wild fire

- A **wildfire** is any uncontrolled fire that occurs in the countryside or a wilderness area.
- Other names such as **brush fire**, **bushfire**, **forest fire**, **grass fire**, **hill fire**, **peat fire**, **vegetation fire**, and **wildland fire** may be used to describe the same phenomenon depending on the type of vegetation being burned.
- A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, and its ability to change direction unexpectedly and to jump gaps, such as roads, rivers and fire breaks.
- Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

# Types of Wild fires

- **Ground** fires are fed by subterranean roots, duff and other buried organic matter. This fuel type is especially susceptible to ignition due to spotting. Ground fires typically burn by smoldering, and can burn slowly for days to months, such as peat fires in Kalimantan and Eastern Sumatra, Indonesia, which resulted from a rice land creation project that unintentionally drained and dried the peat.

- **Crawling** or **surface** fires are fueled by low-lying vegetation such as leaf and timber litter, debris, grass, and low-lying shrubbery.

- **Ladder** fires consume material between low-level vegetation and tree canopies, such as small trees, downed logs, and vines.

- **Crown**, **canopy**, or **aerial** fires burn suspended material at the canopy level, such as tall trees, vines, and mosses. The ignition of a crown fire, termed *crowning*, is dependent on the density of the suspended material, canopy height, canopy continuity, and sufficient surface and ladder fires in order to reach the tree crowns.

# Road accidents, Rail accidents, Air accidents, Sea accidents

**Accident**

- An unfortunate incident that happens unexpectedly and unintentionally, typically resulting in damage or injury.

**Common Causes of all type of Accidents**

1. **Shortcuts**
2. **Overconfidence**
3. **Poor, or Lack Of Housekeeping**
4. **Starting a Task Before Getting All Necessary Information**
5. **Neglecting Safety Procedures**
6. **Mental Distractions**
7. **Lack of Preparation**

**Road accidents**

- India has overtaken China's killing fields. "Nearly 1.05 lakh people die in road accidents in India. It is the highest in the world," Brahm Dutt, secretary of the department of road transport and highways (India) said.
- **Most common causes of accident**
- Determining the causes of the accident is important for the victim, as it has a direct bearing on whether he or she is eligible to receive compensation. Here are some of the most common causes of accident for road crashes. Road accidents are common. While many of them are minor fender-benders, others are major mishaps, often even leading to fatalities. The most common cause of accident in road mishaps is human error.

## Some of the most common causes of accident for road crashes

- **Substance abuse:** Substance abuse such as consumption of alcohol, recreational and prescription drugs is a major offender when it comes to road accidents.
- **Speeding:** Speeding accounts for nearly a quarter of all automobile accidents.
- **Road layout and conditions:** The road itself could be one of the causes of accident. Many roads have well-known 'blind spots', where drivers coming from one side cannot see vehicles coming from the other direction until it are too late. Also, roads become slippery during rain, snow, hail, etc. As they wear, they develop cracks and patholes.

- **Vehicle failure:** Breakdown of the mechanical components in a vehicle is another reason behind road accidents. The most common mechanical failures involve damage to the tyres and their associated components. In addition, break, axle, and steering wheel failures are associated with accidents.
- **Driver's fault:** Some accidents are caused purely due to the driver's mistake. Distractions, such as talking on the phone or to co-passengers, calming children or pets in the backseat, or trying to retrieve fallen items are common causes of accident. Aggressive driving and disregarding traffic rules also fall in this category.

# 6 OUT OF 10 teen crashes involve driver distraction.

**The most common forms of distraction leading to a teen driver crash include:**

For teen driving tips, visit
**TeenDriving.AAA.com**

AA

**Preventive measure for road accident**

1. Pull into traffic slowly. Stop, Look, Listen.
2. Watch for red light runners.
3. Keep at least one hand on the steering wheel.
4. Watch for kids.
5. Perform engine maintenance regularly.
6. Scan 12 seconds ahead.
7. Look backwards when backing out.
8. Do not tailgate.

**Train/railroad accidents:**

- Trains offer one of the cheapest, safest and most convenient modes of transportation. However, just like any other form of transportation, the trains are also prone to getting accidents. These accidents are normally rare with most of them being very tragic. These cause severe injuries and multiple deaths.

# Common causes of train accidents

- **Mechanical failure:** Mechanical failures like broken lights and problems with the engine are the major causes of the accidents that are caused by trains. To avoid this, the train should be inspected thoroughly on a regular basis by professionals to ensure everything is in order.
- **Human error**: This can either be from the driver of the train or miscommunication by the person who handles the lines trains use. Other mistakes can include inappropriate cargo and overloading of cargo.Trains usually travel on different time schedules and this can be confused causing a greasily head on collision. Improperly managed tracks etc. Trains running in excessive speeds and Improper linking of train cars, Improper loading and storage of toxic and dangerous materials also some of the human errors.

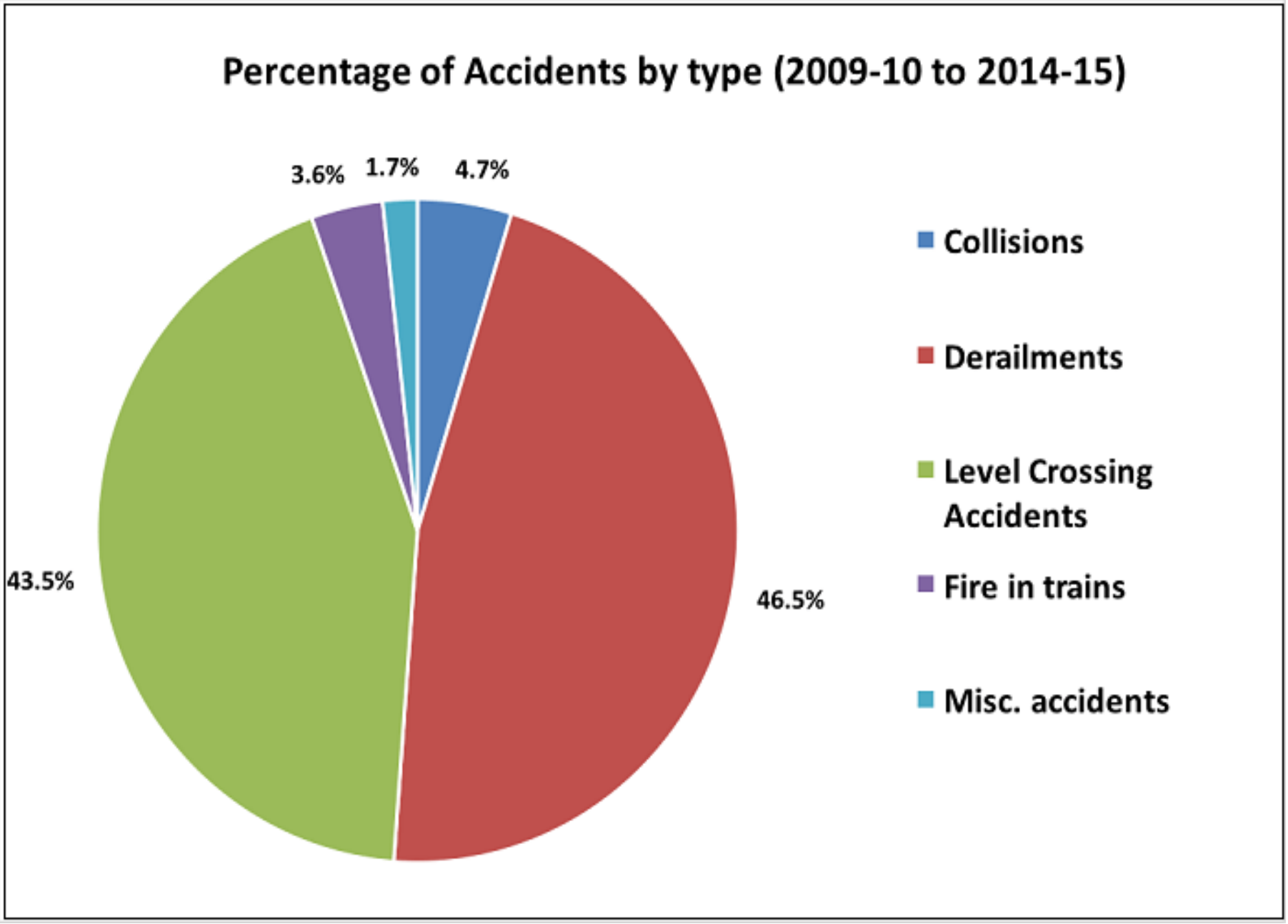
# Common causes of train accidents

- **Weather conditions:** Can also cause the accidents. For instance, if it is raining heavily, the engineers and the operators can be derailed from performing their duties because they cannot see the trains ahead.
- **Train Crashes:** This could be single crashes where the train is removed from the tracks by force; it could be a collision between two trains on the same track; or it could be a collision with another vehicle like a car or with pedestrians.

## The most common causes of Railroad crashes are

- Poor design of railroad crossing leading to limited operator vision
- Failure to blow horns at required distances
- Trains running beyond speed limits
- Failure to trim plants and vegetations that obscure train paths
- Malfunctioning crossing arms, warning bells and warning lights
- Absence of crossing guards at dangerous intersections, especially at locations where there is a history of previous crashes

- **Toxic Exposure:** Collisions and crashes are not the only danger that people should look out for in trains. Dangerous chemicals and other toxic materials could be transported through trains and a crash could expose not only the passengers, but the nearby communities as well. It could lead to different types of illnesses that could affect the lungs, skin, heart and other internal organs. Most often, these diseases need lifetime treatment.


Percentage of Accidents by type (2009-10 to 2014-15)
3.6%
1.7%
4.7%
43.5%
46.5%
Collisions
Derailments
Level Crossing Accidents
Fire in trains
Misc. accidents

# Preventive measure for train accident

- **Never walk on or along railroad tracks - trespassing is illegal!**
- **Always look out for warning signs and signals.**
- **Always assume there is a train coming, as trains can run on any track at any time.**
- **Be aware that trains cannot stop quickly. The average freight train traveling 55 miles per hour takes a mile or more to stop.**
- **Only cross tracks at designated crossing areas, and always look both ways before crossing.**
- **Never try to beat a train across the tracks. There is no reason to risk your life for a few extra minutes.**

# Preventive measure for train accident

- **If you're in a vehicle, don't stop on the tracks. Before you cross, make sure there is enough room for your vehicle on the other side. There should be at least 15 feet between the end of your vehicle and the tracks.**

- **If your vehicle stalls on a crossing, get everyone out immediately. Stand far away from the tracks, even if you don't see a train. Then call the emergency notification number posted on or near the crossing, or call local law enforcement.**

- **Be aware that some vehicles, like school buses, commercial buses and trucks carrying hazardous materials, must always come to a full stop at railroad crossings. (State laws vary.)**

- **It might look easy and fun in the movies, but it is extremely dangerous to attempt to jump on board a moving train. A minor slip could lead to a lost limb or even death.**

# Air accidents

- An aviation accident is the worst nightmare of every pilot or passenger that has ever ridden in an aircraft. Although air travel is one of the safest forms of transportation, accidents do happen with dramatic and terrifying results. The causes of these aviation accidents vary greatly depending on specific circumstances and problems that may develop during the flight process. The chances of an aircraft crashing due to mechanical problems is statistically very low but given the wide publicity generated by the media, it appears that statistics can appear to be quite misleading. In reality, human error is the primary contributor to more than 70 percent of all commercial airplane accidents. Pilot error is a far more likely cause of an airplane crash than mechanical failure or bad weather conditions.

## Descent and landing accidents

- There are five stages of the descent and landing process. These include descent, approach, landing, go-around or aborted landing, and taxi. When a problem occurs during any of the five steps, an accident could result. Descent and landing accidents account for 36 percent of all general aviation mishaps and the most common type of accident. Takeoff mishaps, mechanical failures, pilot errors, fuel mismanagement, and poor weather are only some of the many plights that can lead to injuries or death in the sky. When flight crew and pilots do their jobs correctly, aviation accidents are much less likely to occur. Although not all accidents result in death, there is an increased likelihood of injury and fatalities may occur.

# Common causes for air accidents

**Pilot Error**

- Half of all plane crashes are caused by pilot error.

**Mechanical Error**

- The second most common cause of plane crashes is mechanical error, which accounts for about 22% of all aviation accidents.

**Weather**

- Around 12% of all plane crashes are caused by weather conditions.

**Sabotage**

- Plane crashes that are caused by sabotage draw the most media attention, but they only account for about 9% of total plane crashes. Some sabotaged flights crash because of hijackers, and of course the most notable examples are the three flights that were hijacked on September 11th.

**Other Human Error**

- The bulk of the remaining plane crashes, about 7%, are caused by other kinds of human errors. Some plane crashes are inadvertently caused by air traffic controllers.

**Preventive measure for air accident:**

- Proposed precautions against airliner sabotage
- Stress on airworthiness and plane maintenance
- Steps to curtail accidents due to bad weather
- Improvement of traffic control and landing aids
- Improving aviation safety systems and improving services
- **New Air Navigation System**
- **Enhancing air traffic services**

- Improving airspace
- Airspace on sea
- Airspace around airports

- Improving airports
- **Improving major airports in large cities**
- **Improving airport safety technology**

- Strengthening supervision system for air transport companies
- Improving the skills of aviation workers
- Improving guidance on accident prevention of small aircraft

## Sea accident

- According to insurers' statistics, 80% of oil tanker accidents which cause oil spills at sea are a result of human errors: badly handled manoeuvres, neglected maintenance, insufficient checking of systems, lack of communication between crew members, fatigue, or an inadequate response to a minor incident causing it to escalate into a major accident. From a more practical point of view, analysis of the circumstances surrounding accidents demonstrates the high proportion of spills due to groundings and collisions.

# Causes of sea accidents

- **Collisions** are generally due to manoeuvring errors, especially in poor visibility and/or busy shipping traffic areas, often made worse by high winds, challenging currents and bad weather.

- **Grounding :** Equipment failure is a more common cause of groundings than of collisions.

- **Oil spills :** Oil wastes that enter the ocean come from many sources, some being accidental spills or leaks, and some being the results of chronic and careless habits in the use of oil and oil products.

## The reasons for oil spills are

- Ship groundings
- Improper Transporting
- Pipeline breaks
- Overfilling of gas tanks
- Leaking underground storage tanks
- Parking lots during rain storms
- Bilge pumping from ships
- People making mistakes or being careless.
- Equipment breaking down.

# Effect of oil spills

## Effects of oil spills on habitats

- One of the areas that is most obviously affected after an oil spill is the shoreline. The oil washes up on the beaches coating the sand, rocks, and plants with oily residue. When the sand is covered with oil it can't support the vegetation that normally would grow there. Wildlife may eat the contaminated vegetation and become sick or die.

## Economic effects

- The local economy is affected by an oil spill. Recreational areas that are covered with oil are not appealing to tourists and towns that depend on tourism can find themselves in a difficult financial situation.

**Effects of spills on wildlife**

- Probably one of the areas of greatest concern is the effect of the oil spill on wildlife. From the smallest plankton to the largest whale, all marine life is impacted by an oil spill.
- Behavioral changes
- Blindness
- Damage to internal organs
- Spread to other habitats
- Sores
- Stress

**Effects of oil on the ocean**

- Although the big oil spills from offshore drilling get a lot of attention, there are millions of gallons of oil dumped into the world's oceans every year from other sources.

**Coral reef impact**

- Oil may impact coral reefs in a negative way. These reefs are not only beautiful, they provide a habitat for many sea creatures.

**Preventive measure for sea accident:**

- Working system and preparation
- Planning for cargo oil operations
- Pre-safety meeting
- Effective communication
- Promote techniques of hazard prediction training
- Preparation of Watch schedule & pic of oil transfer operations
- Have a complete meeting beforehand with terminal
- Cargo oil transfer check lists
- Ship / Shore safety checklist
- Pre arrival checks
- Transfer of duty in conscientious manner
- Check operational conditions and training of crew

## QUESTIONS

**Multiple choice questions**

1. The Word environment is derived from----------

A) Latin B) French

C) Greek D) Spain

2. Resources which are not reconstructed/regained are called

A) Renewable resources B) Non- Renewable Resources

C) Cyclic resources D) none of the above

3. Atmospheric volume of $CO_2$ is

A) 0.03 % B) 0.01%

C) 10% D) 3%

4. Soil and water is an example for ----------resource

A) Renewable B) Non- Renewable

C) Cyclic D) Reproducible

5. The layer which separates troposphere and Stratosphere is called as

A) Stratopause B) Mesopause

C) Tropopause D) None of the above

6. Honey is an example for ---------

A) Productive functions B) Protective functions

C) Regulative functions D) None of the above

7. Wildlife Protection Act came in the year ----------

A) 1990 B) 1982

C) 1972 D) 1981

8. Mention the Canopy cover of mangrove forest

A) Canopy < 30% of land B) Canopy < 40% of land

C) Canopy < 70% of land D) Canopy < 10% of land

9. Total number of hotspot in India

A) 2 B) 10

C) 4 D) 7

10. Which one of the following forest received annual rainfall ranges between 200 and 250 cm?

A) Moist tropical Forest B) Alpine forest

C) Tropical forest D) Desert forest

11. Temples of the Modern India called are called as

A) River B) Oceans

C) Dams D) Lakes

12. Natural Water Policy enacted on -------

A) April 2004 B) April 2001

C) April 2002 D) April 2000

13. Permissible concentration of nitrate in water----------

A) 15 mg/L B) 5 mg/L

C) 10 mg/L D) 45 mg/L

14. Which one of the following incorrect statement?

A) Water is the most abundant, inexhaustible renewable resource. B) About 40% of the world's population lives in arid or semi-arid regions

C) 10% of the water is utilized for agricultural purposes in India. D) only 3% is available as freshwater

15. The process that takes away mineral components from saline water, making it fit for drinking and other purposes is ----------

A) Desalination B) Desolation

C) Siltation D) De siltation

16. More than two-thousand minerals have been identified and most of these contain inorganic compounds formed by various combinations of the
    a. Eight elements O, Si, Al, Fe, Ca, Na, K, and Mg
    b. Seven elements Si, Al, Fe, Ca, Na, K, and Mg
    c. Six elements O, Si, Ca, Na, K, and Mg
    d. Five elements Fe, Ca, Na, K, and Mg
17. Mineral resources are non-renewable and include metals like _____
    a. Iron
    b. Copper
    c. Aluminum
    d. All

18. Mineral resources are non-renewable and include non-metals
    a. Salt
    b. Gypsum
    c. Clay
    d. All
19. Although about 80,000 species of plants are edible only about _____ crops feed the world
    a. 10
    b. 20
    c. 30
    d. 50
20. Which among the following is not a cause of water logging?
    1. Excessive water supply to the croplands
    2. Heavy rain
    3. Poor drainage
    4. Bio-drainage by trees like Eucalyptus
21. The application of excess fertilizers in fields leads to wash off of the nutrient loaded water into nearby lakes causing over-nourishment. This is called_____.

    A) Soil erosion B) Nutrification

    C) Eutrophication D) Nitrification

22. Most pesticides are non-bio degradable and accumulis at the food chain. This is called

A) Bio- accumulation B) Bio- magnification

C) Both A&B D) None of these

23. If water stands on land for most of the year, it is called as_____.

A) Water scarcity B) Water lagging

C) Water loggingD) Flood

24. The resource that can be generated continuously and are in exhaustible is called

A) Renewable energy B) Non-renewable energy

C) Fossil fuels D) None of the above

25. Examples of Non-renewable energy

A) Coal B) Petrol

C) Natural gas D) All the above

26. The process of deterioration of soil or loss of fertility of soil is called_____.

A) Land slide B) Soil erosion

C) Land degradation D) Denitrification

27. Degradation of the environment due to over utilisation of natural resources is called

A) Sustainable development B) Unsustainable development

C) Soil erosion D) Land degradation

28. Causes of land degradation

A) Population B) Urbanisation

C) Fertilizers and pesticides D) All the above

29. The downward movement of slope composed of earth materials such as rock soil or artificial fills is called _____

A) Land slide B) Soil erosion

C) Land degradation D) Denitrification

30. The process of removal of superficial layer of soil is called _____.

A) Land slide B) Soil erosion

C) Land degradation D) Denitrification

31. Example of primary consumer.

A) Deer B) Lion

C) Eagle D) Wolf

32. Example of secondary consumer.

A) Deer B) Lion

C) Eagle D) Wolf

33. Example of tertiary consumer.

A) Deer B) Lion

C) Rabbit D) Wolf

34. Example of decomposer.

A) Deer B) Lion

C) Eagle D) Bacteria and fungi

35. _____ includes saline water eco-system like ocean, seas etc.,

A) Terrestrial eco-system B) Industrial eco-system

C) Marine eco-system D) Limnic eco-system

36. The word forest is derived from a French word _____

a. Fores
b. Foris
c. Forys
d. Foriis

37. There are _____ major types of forests according to latitude

a. One
b. Two
c. Three
d. Seven

38. Taiga is also known as _____
    a. tropical forests
    b. temperate forests
    c. boreal forests
    d. None of these

39. Grassland with scattered individual trees are called
    a. Savannas
    b. Steppes
    c. Prairies
    d. Pampas

40. Areas with an annual rainfall of less than _____ are called deserts
    a. 25
    b. 50
    c. 100
    d. 150

41. Evaporation rates regularly exceed rainfall rates. Sometimes rain starts falling and evaporates before reaching the ground. The peculiar phenomena connected with _____
    a. Hot and Dry desert
    b. Semiarid desert
    c. Coastal desert
    d. Cold desert

42. Which of the following animals is now extinct?
    a. Tasmanian tiger
    b. Tasmanian devil
    c. Pademelon
    d. Quoll

43. _____ is defined as the number of species represented in a specific region, landscape or an ecological community.

a. Coevolution
b. Commensalism
c. Species richness
d. Population density

44. _____ is the forest cover to be maintained as per the National Forest Policy (1988)

a. 67% for hills & 33% for plains
b. 37% for hills & 11% for plains
c. 17% for hills & 23% for plains
d. None of the above

45. _____ occurs when the death of the last individual in a species occurs.

a. Adaptation
b. Phylogenic diversity
c. Speciation
d. Extinction

46. _____ is not generally seen in biodiversity hotspots.

a. Endemism
b. Species richness
c. Loss of diversity
d. Lesser interspecific competition

47. _____ is an example of an ex-situ conservation.

a. Sacred groves
b. Wildlife sanctuary
c. Seed bank
d. National park

48. _____ is one of the most prevalent hotspots of biodiversity in India

a. Himalayas
b. Western Ghats
c. Ganges
d. None of the above

49. When do we celebrate as International Day for Natural Disaster Reduction?

A) March 1 B) April 15
C) September 12 D) October 13

50. Which of the following techniques are not used for oil spill response?

A) Use of booms and skimming B) Bio- recovery
C) Use of dispersants D) Burning

51. Road safety cell was setup in the year ----------

A) 1977 B) 1986
C) 2000 D) 2004

52. What is the main cause of accidents in urban areas?

A) Improper planning B) Additional thickness of the pavement
C) Extra wide roads D) Traffic congestion

53. Land use, transportation and road network plans are _____

A) Depends on the network B) Intra linked
C) Inter linked D) Not linked

54. In disaster management, mitigation measures involves

A) Community action and administration B) Military action and administration
C) Governmental action and administration D) None of the above

55. Which of the following is not a component of disaster management cycle?

A) Preparedness B) Construction
C) Recovery D) Response

56. Which of the following organization is the apex authority of disaster management in India?

A) NDA B) CDMA

C) NDMA D) INDR

57. District disaster management authority is headed by

A) District magistrate B) BDO

C) Chief secretary D) None of the above

58. Who released the first Disaster Management Plan of India?

A) H. D. Deve gowda B) Atal Bihari Vajpayee

C) Manmohan Singh D) Narendra Modi

59. NDMP is

A) National Disaster Mitigation plan B) National Disaster Management Plan

C) National Disaster Moderation plan D) National Disaster Modification plan

60. Disaster Management Act

A) 2002 B) 2009

C) 2005 D) 2010

61. Nodal Ministry for matters concerning disaster management

A) Ministry of defence B) Ministry of Finance

C) Ministry of Home Affairs D) Ministry of human resource development

62. National disaster management authority is headed by

A) Prime Minister B) Home Minister

C) Finance Minister D) Defence Minister

63. NDRF is

A) National Disaster Relief Forum B) National Disaster Reduction Force

C) National Disaster Response Force D) National Disaster Resource Fund

64. Disaster Management Institute is located in

A) Hyderabad B) New Delhi

C) Bhopal D) Nagpur

65. Centre for Disaster Management (CDM) is in

A) Pune B) Kolkata

C) Mumbai D) Ahmedabad

66. Environment Protection Training and Research Institute is in

A) Hyderabad B) New Delhi

C) Chennai D) Kochi

67. Disaster Mitigation Institute is in

A) Kolkata B) Pune

C) Ahmedabad D) Jaipur

68. PRT Institute of Post Graduate Environmental Education & Research is in

A) Haryana B) New Delhi

C) Hyderabad D) Bangalore

69. Nodal Ministry for drought management is

A) Ministry of Finance B) Ministry of Agriculture and farmers welfare

C) Ministry of Commerce and trade D) Ministry of Environment, forest and climate change

70. Which constitutional amendments recognise Panchayat Raj Institutions as 'Institutions of self- government'

A) 73 and 74th B) 63 and 64th

C) 83 and 84th D) 53 and 54th

71. At district level who is the authority responsible for implementation of disaster relief duties

A) District Collector B) Block Development Officer

C) Thasildar D) District revenue officer

72. Nodal ministry responsible for chemical and industrial disasters

A) Ministry of Earth Sciences B) Ministry of health and family welfare

C) Ministry of defence D) Ministry of Environment, forest and climate change

73. Nodal ministry responsible for nuclear and radiological emergencies

A) Ministry of defence B) Department of Atomic Energy

C) Ministry of Mines D) Ministry of Earth Sciences

74. Where is National Institute of Disaster Management located?

A) Kanpur B) Mumbai

C) New Delhi D) Bengaluru

75. Which of the following groups of people is more vulnerable in the event of disaster?

A) Men, boys, old people B) Women, children, old people

C) Men, women, boys D) None of the above

76. Under which Ministry National Disaster Management Authority comes?

A) Ministry of Home Affairs B) Ministry of Pollution

C) Ministry of Foreign Affairs D) Ministry of Environment

77. The State Disaster Management Authority is headed by

A) Chief Secretary of the State B) Governor

C) Chief minister D) None of the above

78. What is called for the manuals that identify the role of each officer in State for managing the natural disasters?

A) State Relief Manuals B) State Disaster Manuals

C) State Environmental Protection Manuals D) State Protection Manuals

**Fill-up**

1. The average salinity of the sea water is ____%
2. The uppermost end of a rocky shore is a zone of bare rock being the transition between sea and land is known as _____
3. The two major regions of sea are _____ and the _____.
4. Based on the light penetration, the pelagic zone is vertically divided into _____ and _____
5. Global aquatic ecosystem fall into two broad categories namely _____ and _____.
6. The term biodiversity was coined by _____
7. _____ describes the assemblage and Interaction of spices living together and the physical environment a given area.
8. The three biodiversity indices is given by _____
9. α diversity depends on _____ and _____
10. _____ are mega diversity countries in the world

11. The total number of hotspots in the world ----------
12. Indian Giant squirrel is endemic to _____
13. United Nations declared _____ to be the International Year of Biodiversity
14. Expand IUCN _____
15. _____ is also known as "Sahyadri Hills"
16. The World Heritage Sites was adopted by the UNESCO in _____
17._____ is the major contributor of carbon monoxide
18._____ is the major naturally hydrocarbons emitted in the atmosphere
19._____ causes extensive damage to building like marbles, limestone
20. The permissible limit of Suspended Particulate Matter in Industrial and Mixed Area is _____.
21. The permissible noise level during day time in Industrial areas is _____
22._____ involves heating of solid waste at very high temperature in very sparse air or oxygen condition
23._____ is the toxins produced by algal blooms
24._____ is caused by the reaction of nitrate with haemoglobin
25. Heavy metals have an atomic mass greater than _____
26. Keratosis and melanosis are caused by ----------
27. The permissible limit of BOD of the treated wastewater to be discharged into the inland surface water is _____mg $L^{-1}$.
28. _____ are manmade water bodies that offer once through cooling in which the heated effluent may be discharged at one end and the water for cooling purpose can be withdrawn at the other end.
29. Radioactive emission is measured in _____.
30. Evaporation treatment is suitable for ----------
31. Very sever radiation sickness is due to _____ to _____Gy.

**Short notes**

1. What is Environment?
2. Define hydrosphere
3. What do mean by Biosphere?
4. Define Ecology
5. What is Rayon?
6. What do you mean by Agro-Forestry?

7. What is shifting (jhum) cultivation?
8. Define conservation forestry
9. Mention about the fresh Water resources
10. What are DAMS?
11. What is Consumptive water use ?
12. Define flood
13. What is a mineral? Give example
14. Name the four essential crops account for many of the caloric consumption of human beings
15. Differentiate : Marasmus and Kwashiorkor
16. Define energy.
17. What is superpest?
18. What are the two major types of agriculture?
19. What is wind breaks or shelter belts?
20. What is alley cropping or agro forestry?
21. Define terracing.
22. Define eco-system.
23. Define food chain.
24. Define food web.
25. What are the two main divisions of grasslands?
26. List out the four major types of deserts
27. List out the biotic and abiotic components of a desert ecosystem
28. Define thermocline and benthic zone
29. Define wetlands and the three categories of wetland
30. Define neritic and oceanic zone
31. List the biogeographical regions of India?
32. Differentiate species richness and species evenness?
33. Listout any 8 biodiversity hotspots across the world?
34. Describe endangered and threatened species with suitable examples?
35. List out the two types of biodiversity conservation
36. Name any two world heritage sites in India
37. Define pollution?
38. Classify pollutants based on degradation?

39. Listout the primary pollutants?

40. Define Suspended Particulate Matter?

41. Define Sociocusis?

42. Define indoor air pollutants and mention its sources?

43. Write the types of pollutants based on source with examples?

44. ention the types of soil pollution?

45. Define incineration and vitrification?

46. Draw a example flowchart of biological magnification?

47. Match the following

| | |
|---|---|
| a. Mercury | (i) Flurosis |
| b. Fluoride | (ii) Itai Itai |
| c. Cadmium | (iii) Keratosis |
| d. Arsenic | (iv) Minamata Disease |

48. Explain water borne diseases with examples?

49. Define roentgen?

50. Explain about the physiological effects of nuclear hazards?

51. Differentiate cooling tower, cooling pond and cooling spray?

52. What is Road Safety Act?

53. What are the causes of ship collision?

54. What are the team members at village level disaster management

55. What is Disaster Management Code?

56. Write any two ministries involved in disaster management

57. What is NCMC ?

58. Mention the categories of disaster related data

59. Context of Disaster Management Information Systems (DMIS) used in

60. Chairman of the National Crisis Management Committee is

61. State level committee for disaster management is head by

62. What is the role of National Emergency Response Team

63. Brief about 'The Salvation Army'

**Brief notes**

1. Write a brief note on Renewable resources
2. List the Segments of atmosphere
3. What are the Objectives of Environmental Science?
4. Mention the Ecological uses of forest
5. What is mining? Mention its effect on environment
6. Write the characteristics of Alpine forest
7. Mention the four national level conflicts over water
8. Mention the reasons for occurrence of Drought
9. Write about different Types of Drought
10. Draw a neat sketch about the fractional distillation tower.
11. What are the environmental effects of mineral extraction?
12. What are the major world food problems?
13. Define agriculture and mention types.
14. What are the problems in using pesticides?
15. What are the problems in salinity?
16. Define contour farming.
17. What is urbanisation?
18. Define conservational till farming or non-till farming.
19. Define ecological pyramids.
20. Define radio isotope method.
21. What are the subdivisions of tropical forests based on the seasonal distribution of rainfall?
22. List out the biotic and abiotic components of a Grass land ecosystem
23. What are the two major classifications of temperate grasslands?
24. Draw diagram depicting the Structure and function of a Biosphere
25. What are Sacred Forests?
26. What was the worst plane crash in history?
27. What are the causes of railway accident?
28. What is the main aim of disaster management?
29. Brief about National Calamity Contingency Fund
30. Role of WHO in disaster management
31. Write in short : UNICEF
32. What is State Relief Manuals

33. Components of a National Disaster Management Information System
34. Duties of the local bodies during disaster management
35. List out any four ministries involved in disaster management?
36. What is the role of police in Disaster Management
37. Mention any four International Conventions/ Agreement on Disaster management

**Paragraph Questions**

1. Write the characteristics of troposphere and Stratosphere
2. What are the Key Concepts in Environmental Science
3. What is Van Allen radiation belt ?
4. Mention the impact of DAMS on forest and wild life
5. What are the key functions of a Forest ?
6. Mention the forest and wildlife protection Law in India
7. Write shortly about the effects of Flood with management
8. Brief about drought management
9. Mention the problems related to water resources
10. What are the uses of mineral resources?
11. How mineral resources are extracted and exploited ?
12. What are the two types of food production?
13. What are the problems in using fertilizers?
14. Mention causes and measures to prevent water logging.
15. What are the harmful effects of land degradation?
16. What are the causes of land slide?
17. Mention the dynamics of the eco-system.
18. What are the four mega ecosystems.
19. Write a short note on Boreal forest
20. What are the three types of savannas?
21. What are the subdivisions of temperate forests based on the seasonal distribution of rainfall?
22. Write the IUCN classification of species extinction?
23. Write a short note about Biosphere Reserve ?
24. Differentiate national parks and wild life sanctuaries
25. How can we prevent road accidents?

26. What are the role of functional group at district level disaster management
27. Level of disasters
28. Disaster management cycle
29. Components of a National Disaster Management Information System
30. Functions of Control Room
31. What is Crisis Management Group ?
32. What is Contingency action plan?
33. Write about the International Relief Friendship Foundation (IRFF)

**Essay questions**

1. Elaborate the Scope and importance of Environmental Science
2. Bring out a detailed account on classification of natural recourses
3. Define deforestation. Bring out a detailed account of their causes, consequences and prevention activities
4. Write a detailed note on Indian Forest types
5. Write about DAMS and their benefits and drawbacks on environment.
6. Write a detailed note on over utilization and conservation approaches of water resources
7. Write a detailed note about the mineral resources, their use and exploitation, environmental effects of extraction and use?
8. Rite in detail about energy resources and its types with example.
9. Mention the role of individual in the conservation of natural resources.
10. Explain the measurement of primary production.
11. What are the types of Desert Ecosystem? Explain in detail
12. What are the classifications of Grassland Ecosystem? Explain in detail
13. Write a detailed note about the different classification of forest ecosystem
14. Explain in detail about marine ecosystem and the vital factors that influence the life in marine environment?
15. What you meant by coral reefs and explain its types with line diagram?
16. Explain the levels of biodiversity with suitable examples?
17. Describe the three biodiversity indices?
18. Explain in detail about the importance and uses of biodiversity?
19. Define hotspots and mention the criteria for a region to qualify as a hotspot?

20. Explain the biodiversity hotspots in India?
21. Narrate the different categories of biodiversity threat?
22. Write a detailed note about the Exsitu and Insitu conservation of Biodiversity with example
23. Explain the effect of air pollution on human health?
24. Describe a control measures adopted for of noise pollution?
25. Explain in detail about the preventive and control measures of air pollution?
26. Explain the major sources, causes and effects of eutrophication with process flow chart?
27. Describe the preventive and control measure of soil pollution?
28. Define thermal pollutions and explain its sources, effect and control measures?
29. Describe the impact of nuclear hazard?
30. List out the ten ways to prevent rail accidents
31. Write about National Policy on Disaster Management
32. Write in detail about role of National disaster management authority (NDMA)
33. Explain the basic concepts of Emergency Management in detail
34. Role of media in Disaster management ?
35. Role of NGOs on disasters management ?
36. Role of central government in disaster management ?
37. Role of the state government in disaster management
38. Discuss about role of the armed forces during disaster