Unit 1

The Multidisciplinary Nature of Environmental Studies

DEFINITION, SCOPE AND IMPORTANCE

Environmental studies deals with every issue that affects an organism. It is essentially a multidisciplinary approach that brings about an appreciation of our natural world and human impacts on its integrity. It is an applied science as its seeks practical answers to making human civilization sustainable on the earth’s finite resources.

Its components include biology, geology, chemistry, physics, engineering, sociology, health, anthropology, economics, statistics, computers and philosophy.

Scope:

1.Developing an awareness and sensitivity to the total environment and its related problems  
2. Motivating people for active participation in environmental protection and improvement  
3. Developing skills for active identification and development of solutions to environmental problems  
4. Imbibe and inculcate the necessity for conservation of natural resources  
5. Evaluation of environmental programs in terms of social, economic, ecological and aesthetic factors

IMPORTANCE

In the industrialized era that we live today, every component that we intake - be it, air, water or food are contaminated by industrial activities. THERE IS NO ZERO POLLUTION. To minimize this problem, knowledge of environmental studies is essential. An in-dept study of environmental studies will help us in the following ways:

1. We will begin to appreciate and adopt the idea of "DEVELOPMENT WITHOUT DESTRUCTION OF THEENVIRONMENT"

2. Knowledge about "VARIOUS TYPES OF ENVIRONMENTS & DIFFERENT ENVIRONMENTAL HAZARDS"  
3. Playing an effective role in protecting the environment by "DEMANDING CHANGES IN LAW AND ENFORCEMENTSYSTEMS".  
4. Having a "POSITIVE IMPACT" on "QUALITY OF LIFE".  
5. Creating a "CONCERN AND RESPECT FOR THE ENVIRONMENT".

NEEDFORPUBLICAWARENESS:

Increasing population, Urbanization and poverty have generated pressure on the natural resources and lead to a degradation of the environment. TO PREVENT THE ENVIRONMENT FROM FURTHER DEGRADATION, the Supreme Court has ordered and initiated environmental protection awareness through government and non-government agencies to take part in protecting our environment.  
Environmental pollution cannot prevented by laws alone. Public participation is equally important with regard to environmental protection.. Environmental Education (EE) is a process of learning by giving an overall perspective of knowledge and awareness of the environment. It sensitizes the society about environmental issues and challenges interested individuals to develop skills and expertise thereby providing appropriate solutions. Climate change, loss of biodiversity, declining fisheries, ozone layer depletion, illegal trade of endangered species, destruction of habitats, land degradation, depleting ground water supplies, introduction of alien species, environmental pollution, solid waste disposal, storm water and sewage disposal pose a serious threat to ecosystems in forest, rural, urban and marine ecosystems.  
Both formal and informal education on the environment will give the interested individual the knowledge, values, skills and tools needed to face the environmental challenges on a local and global level.

Elements of Environment

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

(1) Physical elements

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

(2) Biological elements

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

(3) Cultural elements

Cultural elements such as economic, social and political elements are essentially man- made features, which make the cultural background.

Natural Resources

Our environment provides us with a variety of goods and services necessary for our day to day lives. These natural resources include, air, water, soil, minerals, along with the climate and solar energy, which form the non-living or ‘abiotic’ part of nature.

Earth’s Resources and Man: The resources on which mankind is dependent are provided by various sources or ‘spheres’.

1) Atmosphere

Oxygen for human respiration (metabolic requirements).

Oxygen for wild fauna in natural ecosystems and domestic animals used by man as food.

Oxygen as a part of carbon dioxide, used for the growth of plants (in turn are used by man).

Living creatures cannot survive without air even for a span of a few minutes. To continue to support life, air must be kept clean. Major pollutants of air are created by industrial units that release various gases such as carbon dioxide, carbon monoxide and toxic fumes into the air. Air is also polluted by burning fossil fuels. The buildup of carbon dioxide which is known as ‘greenhouse effect’ in the atmosphere is leading to current global warming. The growing number of scooters, motorcycles, cars, buses and trucks which run on fossil fuel (petrol and diesel) is a major cause of air pollution in cities and along highways. Air pollution leads to acute and chronic respiratory diseases such as various lung infections, asthma and even cancer.

2) Hydrosphere

Clean water for drinking (a metabolic requirement for living processes).

Water for washing and cooking.

Water used in agriculture and industry.

Food resources from the sea, including fish, crustacean, sea weed, etc.

Food from fresh water sources, including fish, crustaceans and aquatic plants.

Water flowing down from mountain ranges harnessed to generate electricity in hydroelectric projects.

Human activities such as deforestation create serious changes in the hydrosphere. Once land is denuded of vegetation, the rain erodes the soil which is washed into the sea.Chemicals from industry and sewage find their way into rivers and into the sea. Water pollution thus threatens the health of communities as all our lives depend on the availability of clean water. This once plentiful resource is now becoming rare and expensive due to pollution.

3) Lithosphere

Soil, the basis for agriculture to provide us with food.

Stone, sand and gravel, used for construction.

Micronutrients in soil, essential for plant growth.

Microscopic flora, small soil fauna and fungi in soil, important living organisms of the lithosphere, which break down plant litter as well as animal wastes to provide nutrients for plants.

A large number of minerals on which our industries are based.

Oil, coal and gas, extracted from underground sources. It provides power for vehicles, agricultural machinery, industry, and for our homes.

Rocks, when broken down, form soil on which man is dependent for his agriculture. Their minerals are also the raw material used in various industries.

4) Biosphere

Food, from crops and domestic animals, providing human metabolic requirements.

Food, for all forms of life which live as interdependent species in a community and form food chains in nature on which man is dependent.

Energy needs: Biomass fuel wood collected from forests and plantations, along with other forms of organic matter, used as a source of energy.

Timber and other construction materials.

Natural cycles between the spheres: All four spheres are closely inter-linked systems and are dependent on the integrity of each other. Disturbing one of these spheres in our environment affects all the others.

The linkages between them are mainly in the form of cycles. For instance, the atmosphere, hydrosphere and lithosphere are all connected through the hydrological cycle. Water evaporated from the hydrosphere (the seas and freshwater ecosystems), forms clouds in the atmosphere. This becomes rain, which provides moisture for the lithosphere, on which life depends. The rain also acts on rocks as an agent of erosion and over millions of years has created soil, on which plant life grows. Atmospheric movements in the form of wind, break down rocks into soil. The most sensitive and complex linkages are those between the atmosphere, the hydrosphere and the lithosphere on the one hand, with the millions of living organisms in the biosphere on the other. All living organisms which exist on earth live only in the relatively thin layer of the lithosphere and hydrosphere that is present on the surface of land and in the water. The biosphere which they form has countless associations with different parts of the three other ‘spheres’.

RENEWABLE AND NON-RENEWABLE RESOURCES

Renewable resources: Natural resources which can be used but can be regenerated by natural processes provided if there is no intervention in natural regeneration cycle.Ex: water, wood

Non Renewable Resources: Those which will be exhausted in the future if we continue to extract these without a thought for subsequent generations. Example: minerals, fossil fuels.

Different types of resources viz., forest, water, food, energy and land resources are detailed below.

Forest Resources

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

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

Forest Functions :

I. Protective and ameliorative functions.

II. Productive functions

III. Recreational and educational functions

IV. Development functions

I. Protective and ameliorative functions

A. Watershed protection

Reducing the rate of surface run-off of water by increasing infighter from rate.

Preventing flash floods and soil erosion

Producing prolonged gradual run-off and thus safeguarding against drought.

B. Erosion control

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

C. Land bank

Maintaining soil nutrients and structure.

D. Atmospheric regulation

Absorption of solar heat during evapotranspiration

Maintaining carbon dioxide levels for plant growth

Maintaining the local climatic conditions

II. Productive Functions

Local use – Consumption of forest produce by local people who collect it for

sustenance

Food: (consumptive use) gathering plants, fishing, hunting from the forest.

Fodder for cattle

Fuel wood and charcoal for cooking and heating

Poles for building homes in rural and wilderness areas

Timber for house hold articles and construction

Fiber for weaving baskets, ropes, nets, strings, etc.,

Sericulture for silk

Apiculture for rearing bees for honey (bees as pollinators)

Medicinal plants for traditional medicines, investigating them as potential source for new modern drugs Market use (productive use) Most of the products used for consumptive purposes and good source of income for supporting their livelihood of forest dwelling people.

Minor forest products (NTFPs): Fuel wood, fruits, gum, fiber, etc which are collected and solid in local markets as a source of income for forest dwellers

Major timber extraction for construction, industrial uses, paper pulp etc. Timber

extraction is done in India by the forest department, but illegal logging continues in many of the forests of India and the world.

III. Recreational And Educational Functions: Eco tourism

IV. Developmental Functions

Employment functions

Revenue

Ecological significance of forests:

1. Balances CO2 and O2 levels in atmosphere.

2. Regulates earth temperature and hydrological cycle

3. Encourage seepage and reduces runoff losses, prevents drought

4. Reduces soil erosion (roots binding), prevents siltation of reservoirs and landslides thereby floods

5. Litter helps in maintaining soil fertility

6. Safe habitat for birds, wild animals and organisms against wind, solar radiation and rain

Deforestation:

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

.Causes for Deforestation:

1. Agriculture: Conversion of forests to agricultural land to feed growing numbers of people

2. Commercial logging: (which supplies the world market with woods such as meranti, teak, mahogany and ebony) destroys trees as well as opening up forest for agriculture. Cutting of trees for fire wood and building material, the heavy lopping of foliage for fodder and heavy grazing of saplings by domestic animals like goats.

3. The cash crop economy: Raising cash crops for increased economy.

4. Mining

5. Increase in population: The needs also increase and utilize forest resources.

6. Urbanization & industrialization

7. Mineral exploration

8. Construction of dam and reservoirs

9. Infrastructure development

10. Forest fires

11. Human encroachment & exploitation

12. Pollution due to acid rain

Environmental effects /Consequences of deforestation

1. Food problems

2. Ecological imbalance

3. Increasing CO2

4. Floods leading to soil erosion

5. Destruction of resources

6. Heavy siltation of dams

7. Changes in the microclimate

8. Loss of biodiversity

9. Dessication of previously moist forest soil

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

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

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

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

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

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

16. Most humid regions changes to desert

17. Environmental pollution

18. Global warming

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

Concepts in conservation

1. Restraining cutting of trees and submerging the forests

2. Reforestation

3. Afforestation

4. Control forest diseases and forest fire

5. Recycling forest products

6. Replacing forest products

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

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

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

Deforestation Afforestration –Planting of saplings

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Joint Forest Management (JFM)

The need to include local communities in forest managenet has become a growing concern. Local people will only support greening an area if they can see some economic benefits from conservation. An informal arranagement between local communities and the forest department began in 1972, in the Midnapore district of West Bengal. JFM has now evolved into a formal agreement which identifies and respects the local community’s right and benefits that they need from forest resources. Under JFM schemes, forest protection communities (FPCs) from local community members are formed. They participate in restoring the green cover and protect the area from being over – exploited.

Realising this, the MoEF formulated the National Forest Policy of 1988 to give

added importance to joint forest management (JFM), which co-opts the local village communities and the forest department to work together to sustainable management of ourforests. Another resolution in 1990 provided a formal structure for communityparticipation through the formation of village forest communities (VFS). Based on this experience, new JFM guidelines were issued in 2000 which stipulated that at least 25%of the income from the area must go to the  community. From the initiation of the program until 2002, there were 63,618 JFM communities managing over 140,953 sq km of forest under JFM in 27 states in India.The various states have tried a variety of approaches to JSM. The share of profits for the VFCs ranges from 25% in Kerala to at 100% in Andhra Pradesh, 50% in Gujrat,Maharastra, Odisha and Tripura. In many states, 25% of the revenue is used for village development. In many states, non-timber forest products (NTFPS) are available to the people free of cost. Some states have stopped grazing completely. While others have rotational grazing schemes that have helped in forest regeneration.(from Barucha)

Case Study: Chipko Movement From Barucha

About 300 years ago, a ruler in Rajasthan decided to fell the ‘khejri’ trees in his state to create lime. Local women led by a Bishnoi woman, Amrita Devi, clung to the trees to prevent the felling of the trees that formed the basis of the scarce resources on which they were dependent. The women were ruthlessly massacred. It is said that the ruler later realised his mistake. The story, however, has been remembered and was revived in the 1970s when severe tree-felling for timber in the Himalayas prompted local women, supported by people such as Sundertat Bahuguna and Chandi Prasad Bhat, led a people’s movement to prevent deforestation by timber contractors. They named their movement the ‘Chipko’ movement in memory of the event during which women had clung to their trees and given up their lives. The movement followed the path the 300 Bishnoi women had taken three centuries ago in Rajasthan. Chipko is a movement primarily begun and supported by local women in the hills of Uttarakhand and Garhwal, where the women (the traditional fuel collectors) have had to bear the brunt of deforestation. They have not only realized that their fuelwood and fodder resources have receded away from their ‘resource use areas’ around their settlements due to commercial timber extraction, but that this has led to serious floods and the loss of precious soil. Chipko activists have made long padayatras across the Himalayas protesting against deforestation. The movement has been highly successful and has been primarily supported by empowering local women’s groups, who are the most seriously affected segment. The movement has proved to the world that the forests of the hills are the life-support systems of local communities and of immense value in terms of local produce, and that the forest has less quantifiable but even more important ecological services such as soil conservation and the maintenance of the natural water regime of the whole region. The ability of local women to band together in the foothills of the Himalayas goes back to the preindependence days when women such as Miraben, a disciple of Gandhiji, moved to this region and understood that it was the deforestation that led to floods and devastation of villages in the valleys and in the Gangetic plains below. They also appreciated that substitution of oak and other broad-Leaved forests of the Himalayas with the planting of fast-growing pine for timber and resin was an ecological and social disaster which reduced the forest resources used by traditional hill communities.

MANGROVES

The word "Mangrove" is considered to be a combination of the Portuguese word "Mangue" and the English word "grove". Mangroves are salt-tolerant plants of tropical and subtropical intertidal regions of the world. The specific regions where these plants occur are termed as 'mangrove ecosystem'. These are classified as salt-tolerant evergreen forests, found along coastlines, lagoons, rivers or deltas in 124 tropical and subtropical countries and areas, protecting coastal areas against erosion, cyclones and wind. These are highly productive (wood, food, fodder, medicine and honey) but extremely sensitive and fragile. Besides mangroves, the ecosystem also harbours other plant and animal species. They are habitats for many animals like crocodiles and snakes, tigers, deer, otters, dolphins and birds. A wide range of fish and shellfish also depends on these coastal forests and mangroves help to protect coral reefs against siltation from upland erosion. Indonesia,Australia,Brazil, Nigeria and Mexico together account for around 50 percent of the total global mangrove area. The total mangrove area has declined from 18.8 million ha in 1980 to 15.2 million ha in 2005. The world has lost around 3.6 million hectares (from 18.8) of mangroves since 1980, equivalent to an alarming 20 percent loss of total mangrove area according to FAO’s recent mangrove assessment study, entitled ‘The world’s mangroves 1980-2005’. The rate of mangrove loss is significantly higher than the loss of any other types of forests. If deforestation of mangroves continues, it can lead to severe losses of biodiversity and livelihoods, in addition to salt intrusion in coastal areas and siltation of coral reefs, ports and shipping lanes. Tourism would also suffer. Asiasuffered the largest net loss of mangroves since 1980, with more than 1.9 million ha destroyed, mainly due to changes in land use. FAO cited high population pressure, the large-scale conversion of mangrove areas for shrimp and fish farming, agriculture, infrastructure and tourism, as well as pollution and natural disasters as the major causes for the destruction of mangroves. As the experiences have proved that the presence of mangrove ecosystems on coastline save lives and property during natural hazards such as cyclones, tsunami storm surges and erosion, the conservation efforts are given importance.

The distribution of mangrove ecosystem on Indian coastlines indicates that the

Sundarban mangroves occupy very large area followed by Andaman-Nicobar Islands and Gulf of Kachch in Gujarat. Rest of the mangrove ecosystems are comparatively smaller. Over 1600 plant and 3700 animal species have been identified from these areas. A Senior Forestry Officer reported that part of the largest mangrove area in the world, the Sundarbans Reserved Forest in Bangladesh, is well protected and no major changes in the extent of the area have occurred during the last few decades, although some damage to the mangroves was reported after the cyclone in 2007. In Ecuador, the abandoning of ponds and structures for shrimp and salt production led to a rebuilding of various mangrove sites.

Water Resources

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

Main sources of water for our use are:

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

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

Groundwater: India's groundwater resources are almost ten times its annual rainfall. According to the Central Groundwater Board of the Government of India, the country has an annual exploitable groundwater potential of 26.5 million hectare-meters. Nearly 85% of currently exploited groundwater is used only for irrigation. Groundwater accounts for as much as 70-80% of the value of farm produce attributable to irrigation. Besides, groundwater is now the source of four- fifths of the domestic water supply in rural areas, and around half that of urban and industrial areas. However, according to the International Irrigation Management Institute (IIMI), the water table almost everywhere in India is falling at between one to three meters every year. Furthermore, the IIMI estimates that India is using its underground water resources atleast twice as fast they are being replenished. Already, excessive ground water mining has caused land subsidence in several regions of Central Uttar Pradesh.

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

Consumption Patterns

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

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

REASONS FOR DECLINE OF GROUND WATER

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

i) Population explosion: World population is > 6 billion and will continue to

increase significantly during the next few decades - Enormous demands on the world’s limited freshwater supply. The total annual freshwater withdrawals today are estimated at 3800 cubic kilometers, twice as much as just 50 years ago (World Commission on Dams, 2000).

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

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

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

v) Dams - for Agriculture and Power Generation

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

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

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

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

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

and forest and land submergence

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

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

¬ Socio economic problems for example, displacement, rehabilitation and

resettlement of tribal people

¬ Fragmentation and physical transformation of rivers

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

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

¬ Dislodging animal populations

¬ Disruption of fish movement and navigational activities

¬ Emission of green house gases due to rotting of vegetation

¬ Large landholders on the canals get the lion’s share of water, while poor and

small farmers get less and are seriously affected leading to conflicts. Irrigation to support cash crops like sugarcane produces an unequal distribution of water.

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

Case Study : Narmada River Dams - For over a decade, villagers have waged an intense battle to stop dams on India’s Narmada River. TheNarmada Valley

Development Project include 30 major dams and 3,000 smaller dams. The Sardar Sarovar Project (SSP) has gained international notoriety due to intense opposition by villagers. Led by the Narmada Bachao Andolan (Save the Narmada movement), activists and villagers forced the World Bank to withdraw from the project in the early ‘90s. A case filed with the Indian Supreme Court stopped construction for nearly six years. However, on October 18, 2000, the Indian Supreme Court issued a controversial final ruling allowing construction to proceed. About 200 000 people would be displaced for the reservoir; hundreds of thousands more will lose land or livelihood due to related developments. Thousands of people who have been resettled are struggling to survive on cramped plots with no arabIe land or source of livelihood.Faced with these future prospects, villagers have vowed to remain on their lands and face submergence behind the partly-built dam rather than face a life of certain destitution. People affected by the extensive canal system are not considered as project affected people and are not entitled to the same resettlement and compensation packages as those living in the reservoir area. There are no credible environmental studies or rehabilitation plans. Although the legal framework requires that affected people be given land-for-land compensation, there is no land available for resettlement.

The project is expected to generate only 50MW (of 1450 MW planned) after seasonal water flow and power consumption for pumping water is accounted for. The project is supposed to irrigate 1.9 million hectares and provide drinking water to over 20 million people. However, these benefits are based on overestimates of annual flow in the river and assume extremely high irrigation efficiency. The arid Kutch region will not receive any water supply benefits until 2025.

SUSTAINABLE WATER MANAGEMENT

1. Building several small reservoirs instead of few mega projects

2. Developing small catchment dams and protecting wetlands

3. Soil management, micro-catchment development and afforestation permits recharging of underground aquifer, thus reducing the need for large dams

4. Treating and recycling municipal waste water for agricultural use.

5. Preventing leakages from dams and canals and loss in municipal pipes

6. Effective rainwater harvesting in urban environments

7. Water conservation measures in agriculture, such as using drip irrigation, control of growing water intensive cash crops ; control of waterlogging.

8. Pricing water at its real value makes people to use it more responsibility and efficiently and reducing wastage

9. In deforested areas where land has been degraded, appropriate soil management practices, making bunds along the hill-slopes and making nalla plugs can help retain moisture and make it possible to revegetate degraded areas

10. Domestically use water by VED principle- use for Vital activities, control for Essential activities, cut down for Desirable activities.

11. Use waste water for activities that does not need fresh water – Recycling

12. Adopt mini water harvesting models for domestic usage.

13. Protect existing tanks

14. Develop systematic water management and adopt strict water auditing

15. “Save water Campaigns” for public awareness on water scarcity

16. Through rainwater harvesting, community based participatory initiatives and holistic watershed management.

17. Responsible water usage can only be achieved by empowering local communities and creating local accountability.

18. The government should develop policies that protect water resources, promote sustainable watershed management and invest in technologies that will increase efficiency in irrigation, industrial usage and improve water harvesting techniques.

 Food Resources

Our food comes almost entirely from agriculture, animal husbandry and fishing

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

Global food production would not meet the food requirements of the world’s estimated 7.8 billion people by 2020.

Food prices are expected to jump by 20% in the next ten years as prolonged droughts and floods take their toll on food production.

The report, which looked at the impact of climate change on four cereals - wheat,`rice, maize and soybean - pointed out that

 global wheat production will experience a 14 percent deficit between production and demand

 Rice production will experience 11 percent deficit, and

 percent deficit in maize production.

 Soybean is the only crop showing an increase in global production, with an estimated five percent surplus.

Current wheat production is estimated to decline to 663 million tons by 2020 yet772.3 million tons is the estimated need at that time, creating a gap of 109 million tons.

Rice is estimated to grow to 692.1 million tons by 2020 yet demand at that time is estimated at 775.1 million –creating a shortage of 82.9 million tons.

Maize production stands at 826.2 million tons and is estimated to grow to 849.1 million tons by 2020 yet demand at that time is estimated at 933.7 million ton, creating a shortage of 85 million tons.

 WORLD FOOD PROBLEMS AND ENVIRONMENTAL CONCERNS:

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

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

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

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

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

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

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

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

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

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

The following 3 conditions must be fulfilled to ensure food security

- Food must be available

- Each person must have access to it.

- The food utilized must fulfill nutritional requirements

Options To Achieve Food Security

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

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

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

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

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

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

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

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

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

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

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

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

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

This includes

- Working on new avenues to produce food, such as using forests for their

multiple non-wood forest products such as fruit, mushrooms, sap, etc. which can be used for food if harvested sustainably. Of course, this takes time, as people must develop a taste for these new foods.

- Using unfamiliar crops such as Nagli, which are grown on poor soil on hill

slopes is another option. This crop grown in the Western Ghats now has no market and is thus rarely grown. Only local people use this nutritious crop themselves. It is thus not as extensively cultivated as in the past. Popularising this crop could add to food availability from marginal lands. (snake gourd in Italy)

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

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

World Food Day – October 16th

Case study - The Aral Sea Tragedy

The Aral sea, covering an area the size of Lithuania, started receding in the 1960s

after Soviet state planners diverted its water sources, the Amu Dar ya and the Syr Dar’

ya rivers, to irrigate cotton on other crop. From 1960 to 1990, the area of irrigated land

in central Asia increased from 3.5 million hectares to 7.5 millino ha. Cotton production

soared, making the region the world’s fourth largest producer. But by 1980s the annual

flow of fresh water into the Aral was barely one-tenth of the 1950 supply. The salinity

level increased, destroying the sea’s flora and fauna. The change in water chemistry

wiped out huge populations of fish. The decline of the fish populations in turn, wiped out

the commercial fishing industry on the lake. Today, fishing boats sit in the desert many

kilometers from the water’s edge. The lakebed sediments that are now exposed on the

desert floor become airborne quite easily, contributing to large dust storms in the region.

In 1989, Aral sea was divided into a smaller northern sea and a large southern one.

Drinking water in the region contains four times more salt per liter than

recommended by the world health organization. This has caused increases in kidney

disease, diarrhea and other serious ailments. Tuberculosis has reached epidemic

proportions. Cancers, lung diseases and infant mortality are 30 times higher than they

used to be because the drinking water is heavily polluted with salt, cotton fertilizers and

pesticides.

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

The worsening health and environmental problems of people living the Aral Sea

basin, which consists of part of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, are the direct consequences of man-made environmental disaster in the region. The children of Muynak have made a playground out of the wrecks of ships, which might have provided food and a future for them.

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

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

The Aral Sea is not an example of a success in water resource management. In

fact, it is a classic example of what can happen if we don’t start to take action before a crisis begins. Still, the Aral Sea is very instructive sustainability case study, as it demonstrates how few environmental problems

Energy Resources

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

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

From 1900 to 2000, population increased by 3 times while energy consumption by 14 times!

Energy Resources

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

Sources of Energy

Solar energy drives the following:

The global climate system which give as wind power.

Wave power

Hydroelectric power

Solar heating and Solar lighting

The global ecosystems which give as biomass power such as wood or muscle.

The ancient ecosystem whose energy is now stored as fossil fuels.

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

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

Gravitational energy for hydroelectric power

Chemical energy for nuclear power, electro- chemical reaction and hydrogen fuel cells.

Geothermal power from the heat of lower crust.

Other exciting energy sources are currently untapped, such as energy in the

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

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

Wind power

Wave power

Ocean Thermal Exchange Capacity (OTEC) - based on temperature differences in ocean layers.

Solar Power

Hydro power

Fuel cells

Bio- fuels- also known as biomass fuels-such as alcohol form, sugar, methane

from organic waste or charcoal from trees and biodiesel. The key characteristics of renewable energies is that the energy sources are continually available, still some cases such as with hydro power and biomass, continuing availability requires good management – for example tree planting or river management. Other renewable like solar and wind power are available for the foreseeable future without any human intervention.

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

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

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

Advantages and Disadvantages of various Energy Types

Energy type Advantages Disadvantages

Renewable

Non renewable

Sustanible

(Nuclear Power)

Wide availability

Lower running cost

Decentralized power production

Low Pollution

Available for the foreseeable future

Available in highly concentrated form

Easy to store

Reliable supply

Lower cost per unit of energy

produced as the technology is matured.

Highly reliable

Produces large amounts of energy with very little CO2emissions

Uses small amount of raw material per unit energy production.

Unreasonable supply

Usually produced in small quantities

Often very difficult to store

Currently per unit cost of energy is more compared to other types.

Highly polluting

Available only in few places

High running cost

Limited supply and will one day get exhausted

Risk of radioactivity

High waste disposal costs

High capital investment and maintenance cost

Non Renewable Energy Sources:

Environmental Impacts of fossil fuels in general

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

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

Spoil and solid wastes from mining and extraction have both visual and environmental impacts.

Wastewater and leachates from mining, drilling and excavation, and gas leaks from pipelines can pollute surrounding waters, air and land.

Purification or modification of raw products for use as fuels requires energy, and may lead to secondary sources of pollution.

Transportation of fuels to energy production sites uses fuel (causes air pollution) and possibly a pollution risk, eg.oil tankers are at risk from accidents and may lead to oil spills at sea.

Combustion of fuels to produce energy leads to air pollution (carbon, nitrogen and sulphur oxides) and in some cases, the production of solid wastes (in the form of ash).

Oil and Its Environmental Impacts:

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

Coal and Its Environmental Impacts:

Coal is the world’s single largest contributor of green house gases and is one of the most important causes of global warming. At the current rates of use the world’s coal reserves lasts for another 200 years. Many coal-based power generation plants are not fitted with devices such as electrostatic precipitators to reduce emissions of suspended particulate matter (SPM) which is a major contributor to air pollution. Burning coal also produces oxides of sulphur and nitrogen which, combined with water vapour, lead to ‘acid rain’. This kills forest vegetation, and damages architectural heritage sites, pollutes water and affects human health. Thermal power stations that use coal produce waste in the form of ‘fly ash’. Large dumps are required to dispose off this waste material, while efforts have been made to use it for making bricks/cement ingredient. Among the fossil fuels coal is most harmful to the environment.

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

Sustainable energy

Nuclear Power and it’s Environmental Impacts:

Energy that is trapped inside each atom is nuclear energy. In 1938 two

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

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

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

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

Renewable Energy:

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

Hydroelectric Power:

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

Advantages:

o The long life of hydropower plants,

o the renewable nature of the energy source

o very low operating and maintenance costs, and

o absence of inflationary pressures as in fossil fuels

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

To produce hydroelectric power, large areas of forest and agricultural lands are submerged. These lands traditionally provided a livelihood for local tribal people and farmers. Conflicts over land use are inevitable.

Silting of the reservoirs (especially as a result of deforestation) reduces the life of the hydroelectric power installations.

The reservoir drown large areas of farm land, wild life habitats and places of historical & cultural importance

Water is required for many other purposes besides power generation. These include domestic requirements, growing agricultural crops and for industry. This gives rise to conflicts.

The use of rivers for navigation and fisheries becomes difficult once the water is dammed for generation of electricity.

Resettlement of displaced persons is a problem for which there is no ready solution. The opposition to many large hydroelectric schemes is growing as most dam projects have been unable to resettle people that were affected and displaced.

In certain regions large dams can induce seismic activity which will result in earthquakes. There is a great possibility of this occurring around the Tehri dam

in the Himalayan foothills. With large dams causing social problems, there has been a trend to develop small hydroelectric generation units. Multiple small dams have less impact on the environment. The development of small hydroelectric power units could become a very important resource in India, which has steeply falling rivers and the economic capability and technical resources to exploit them.

Solar Energy:

Sun is the primary source of energy. Sun’s energy each day is 600 times greater

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

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

Biomass Energy:

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

Biogas is produced from plant material and animal waste, garbage, waste from

households and some types of industrial wastes, such as fish processing, dairies, and sewage treatment plants. It is a mixture of gases which includes methane, carbon dioxide, hydrogen sulphide and water vapour. In this mixture, methane burns easily. With a ton of food waste, one can produce 85 Cu. M of biogas. Once used, the residue is used as an agricultural fertilizer. Denmark produces a large quantity of biogas from waste and produces 15,000 megawatts of electricity from 15 farmers’ cooperatives. London has a plant which makes 30 megawatts of electricity a year from 420,000 tons of municipal waste which gives power to 50,000 families. In Germany, 25% of landfills for garbage produce power from biogas. Japan uses 85% of its waste and France about 50%.

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

Wind Power:

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

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

Tidal and Wave Power:

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

power is generated from both the incoming as well as the outgoing tide.

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

Thermal Energy:

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

Geothermal Energy: It is the energy stored within the earth (“geo” for earth and

“thermal” for heat). Core of the earth is very hot – as high as 60000C, temperature rises with depth @ 300C per Km. Geothermal energy starts with hot, molten rock (called magma) deep inside the earth which surfaces at some parts of the earth’s crust (volcanoes). With modern technology, wells are drilled deep below the surface of the earth to tap into geothermal reservoirs. This is called direct use of geothermal energy, and it provides a steady stream of hot water that is pumped to the earth’s surface. Geothermal energy is nearly as cheap as hydropower and will thus be increasingly utilised in future.

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

Methods to solve energy crisis

Avoid fossil fuels

Smokeless stoves

Use solar energy extensively

Biogas – (500kg litter gives 50m3/day)

Trees should be planted.

Land Resources

Land on earth is as finite as any of our other natural resources. Scientists today believe that at least 10 percent of land and water bodies of each ecosystem must be kept as wilderness for the long term needs of protecting nature and natural resources. Soil types are red soil, black cotton soil, laterite soil, alluvial soil, desert soil etc.

In nature India is moving North East @5cm/yr (fastest continent) so the Eurasian plate deforms and India compresses by 4mm/year

Land degradation: It is the decline in land quality or reduction in its productivity or production potential caused by human activities. World wide 5 -7 m ha farm land is being degraded annually.

Mechanisms that initiate land degradation include

Physical processes: decline in soil structure leading to crusting, compaction, erosion, decertification, Ana vision, environmental pollution and unsustainable use of natural resources.

Chemical processes: Acidification, leaching, decrease in cautions retention capacity and loss of nutrients.

Biological processes: Reduction in total and biomass carbon and decline in land

biodiversity.

Causes for land degradation:

i. Intensive irrigation leads to water logging and salinization, on which crops cannot grow.

ii. The use of more and more chemical fertilizers poisons the soil so that eventually the land becomes unproductive.

iii. The roots of trees and grasses bind the soil. If forests are depleted, or grasslands overgrazed, the land becomes unproductive and wasteland is formed.

iv.Land is also converted into a non-renewable resource when highly toxic industrial and nuclear wastes are dumped on it.

v. As urban centers grow and industrial expansion occurs, the agricultural land and forests shrink. This is a serious loss and has long term ill effects on human civilization.

vi.Land degradation/soil erosion due to deforestation is more evident on steep hill slopes in the Himalayas and in the Western Ghats. These areas are called ‘ecologically sensitive areas’ or ESAs. To prevent the loss of millions of tons of valuable soil every year, it is essential to preserve what remains of our natural forest cover. It is equally important to reforest denuded areas. The linkage between the existence of forests and the presence of soil is greater than the forest’s physical soil binding function alone. The soil is enriched by the leaf litter of the forest. It is broken down by soil micro-organisms, fungi, worms and insects, which help to recycle nutrients in the system. Further losses of our soil wealth will impoverish our country and reduce its capacity to grow enough food in future.

vii. The rate of mangrove loss is significantly higher than the loss of any other types of forests. If deforestation of mangroves continues, it can lead to severe losses of biodiversity and livelihoods, in addition to salt intrusion in coastal areas and siltation of coral reefs, ports and shipping lanes.

Land use planning:

Land use planning creates the prerequisite required to achieve a type of land use, which is sustainable, socially and environmentally compatible, socially desirable and economically sound. Planning approaches often fail because global models and implementation strategies are applied and taken over automatically and uncritically. Land use planning is not a standardized procedure which is uniform in its application world wide. Its content is based on an initial regional or local situation analysis. Land use planning should consider following principles.

1. It should take into account traditional strategies and local environmental knowledge.

2. Differentiation of state holders and the gender approach are core principles in land use planning.

3. The ecological, economical technical financial, social and cultural dimension of land use makes it necessary to work with inter disciplinary approach.

4. It should aim at finding solutions for present problems (soil erosion, low yield, and low income in rural house holds) with the planning towards long term conservations and sustainable use of land resources.

Desertification: It is land degradation occurring in arid, semiarid and dry subhumid areas of the world. It is a process where in fertile lands become arid through land mismanagement or climate changes. Many deserts in the world are man-made.

Desertification is taking place much faster worldwide than historically and usually arises from the demands of increased populations that settle on the land in order to grow crops and graze animals. These susceptible dry lands cover 40 percent of the earth’s surface and puts at risk more than 1 billion people who are dependent on these lands for survival.

Around 80 % of the productive land in the arid and semi-arid regions of the world is estimated to be converted into deserts and around 600 million people are threatened by desertification (according to UN EP). Globally around 2 billion acres of land have become deserts in the past 50 years. The current rate of desertification is around 15 million acres per year, the worst being in sub-Saharan Africa. Thar Desert in Rajasthan covers about 12,000 hectares of land.

Causes of desertification:

1) Overgrazing: By pounding the soil with their hooves, livestock compact the substrate, increase the proportion of fine material, and reduce the percolation rate of the soil, thus encouraging erosion by wind and water. Grazing and the collection of firewood reduce or eliminate plants that help to bind the soil.

2) Increased population: Livestock pressure on marginal lands accelerates desertification.

3) Deforestation practices: Loss of vegetation results in surface run off as there are no plants to bind the soil and resulting in soil erosion and depletion of nutrients.

4) Increased food production from marginal lands in arid or semi- arid areas.

5) Irrigation projects in areas with no drainage facility.

6) Shifting of sand dunes by wind storms

Effects: A major impact of desertification is biodiversity loss, and loss of productive capacity, such as the transition from grassland dominated by perennial grasses to one dominated by perennial shrubs. In extreme cases, it leads to the destruction of lands’ ability to support life.

Control of desertification

1. Afforestation and planting of soil binding grasses can check soil erosion, floods and water logging.

2. Crop rotation and mixed cropping improve the fertility of the soil. It would increase production which can sustain large population.

3. Desertification can be checked by artificial bunds or mechanical measures covering the area with proper type of vegetation.

4. shifting of sand can be controlled by mulching (use of artificial protective covering.)

5. Salinity of the soil can be checked by improved drainage. Saline soil can be recovered by leaching with more water, particularly where water table of the ground is not very high.

4.7 ROLE OF AN INDIVIDUAL IN CONSERVATION OF NATURAL RESOURCES

Until fairly recently mankind acted as if he could go on for ever exploiting the ecosystems and natural resources such as soil, water, forests and grasslands on the earth’s surface and extracting minerals and fossil fuels from underground. But, in the last few decades, it has become increasingly evident that the global ecosystem has the capacity to sustain only a limited level of utilization. Biological systems cannot go on replenishing resources if they are overused or misused. At a critical point, increasing pressure destabilizes their natural balance. Even biological resources traditionally classified as ‘renewable’ - such as those from our oceans, forests, grasslands and wetlands, are being degraded by overuse and may be permanently destroyed. And no natural resource is limitless. ‘Non-renewable’ resources will be rapidly exhausted if we continue to use them as intensively as at present.

The two most damaging factors leading to the current rapid depletion of all forms of natural resources are increasing ‘consumerism’ on the part of the affluent sections of society, and ‘rapid population growth’. Both factors are the results of choices we make as individuals.

Energy conservation

Turn off lights and fans as soon as you leave the room.

Use tube lights and energy efficient bulbs that save energy rather than bulbs. A 40- watt tube light gives as much light as a 100 watt bulb.

Keep the bulbs and tubes clean. Dust on tubes and bulbs decreases lighting levels by 20 to 30 percent.

Switch off the television or radio as soon as the program of interest is over.

A pressure cooker can save up to 75 percent of energy required for cooking. It is also faster.

Keeping the vessel covered with a lid during cooking, helps to cook faster, thus saving energy.

Water conservation:

Keep taps closed when brushing teeth and taking a bath

Use drip and sprinkler type of irrigation in agricultural fields

Practice rain water harvesting techniques

Reuse the waste water from kitchens and bath for garden use

Soil conservation:

Do not cut trees and induce soil erosion

Practice contour farming, agro forestry and strip cropping

Practice no till farming for less soil disturbance

Avoid over use of fertilizers, pesticides and water logged conditions

Use organic fertilizers and vermicomposting

Practice integrated pest management practices

Mineral Resources: Definition, Types, Use and Exploitation!

Definition:

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.

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.

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.

A mineral deposit is a concentration of naturally occurring solid, liquid, or gaseous material, in or on the Earth’s crust in such form and amount that its extraction and its conversion into useful materials or items are profitable now or may be so in the future. Mineral resources are non-renewable and include metals (e.g. iron, copper, and aluminum), and non-metals (e.g. salt, gypsum, clay, sand, phosphates).

Minerals are valuable natural resources being finite and non-renewable. They constitute the vital raw materials for many basic industries and are a major resource for development. Management of mineral resources has, therefore, to be closely integrated with the overall strategy of development; and exploitation of minerals is to be guided by long-term national goals and perspectives.

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%.

(A) Fuel Minerals:

Coal, oil and natural gas are the basic fossil fuel. We have good reserves for coal but are very poor in more essential fuel — oils and natural gas.

(i) Coal:

Proven coal reserves of the country as on January 1994 (estimated by GSI) is about 68 billion tonnes. We are mining about 250 tonnes annually and this rate is expected to go by 400 – 450 tonnes by 2010 A.D. If we could maintain our mining rate of 400 tonnes per year then the coal reserves might last for about 200 years taking proven reserves as 80 billion tonnes.

The calorific value of coal varies with percentage of carbon present in it. Coal depending upon variation in percentage carbon, can be divided into three cat­egories .

(ii) Crude Oil (Petroleum):

It is believed that petroleum has been formed over a period of millions of years, through conversion of remains of micro organisms living in sea, into hydrocar­bon by heat, pressure and catalytic action. The petroleum on fractional distillation and further processing provides us nu­merous products and by-products.

Some of the common products obtained on fractional distillation are given in Table 2.4, along with the temperature (just below the boiling point) at which they tend to liquefy after crude oil feed at the base is heated to about 400°C. One million tonne of crude oil on fractional distil­lation provides about 0.8 million tonnes of petroleum products.

The percentage composition varies with the quality of crude oil or it could be varied up to a certain limit depending upon the requirement or demand. On an average the percentage composition of the common product with their number of carbon atoms

(iii) Natural Gas:

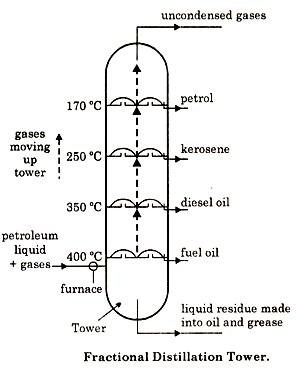
The proven reserve for natural gas on April 1993 works out to be approx. 700 billion cubic meter (BCM). As regard to production vis a vis utilization aspect in earlier years, more than half of gas coming out of the wells remained unutilized. However, in recent years, we have achieved a utilization rate of 80 – 90%. Keeping in view the future demands and proven gas reserves, it is unlikely that our gas reserves might last for more than 20 years.

(B) Metallic and Non-metallic Minerals:

India is poorly endowed with mineral wealth. Except for iron ore and bauxite our share of world reserves of every other mineral is one percent or less. How­ever, there has been a phenomenal growth in production since independence. As per estimates if the present trend of production continues, we will exhaust our reserves of all the important minerals and fuels, except coal, iron ore, lime­stone and bauxite, in 25 to 30 years.

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.

[](http://cdn.yourarticlelibrary.com/wp-content/uploads/2014/02/image172.png)

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.

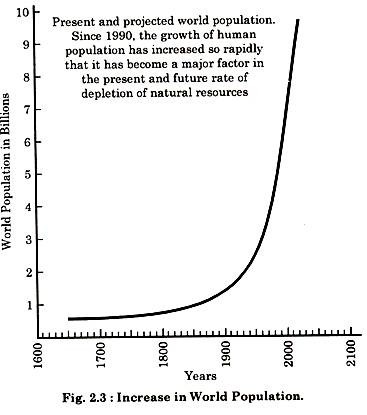
Human wealth basically comes from agriculture, manufacturing, and mineral resources. Our complex modern society is built around the exploitation and use of mineral resources. Since the future of humanity depends on mineral resources, we must understand that these resources have limits; our known supply 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.

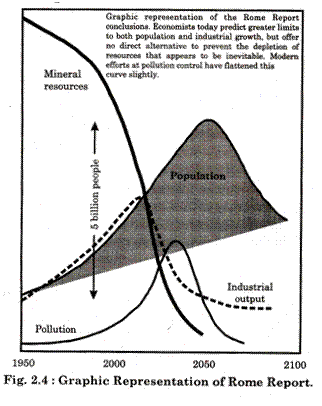
The consumption of natural resources proceeded at a phe­nomenal rate during the past hundred years and population and production increases cannot continue without increasing pollution and depletion of min­eral resources.

The geometric rise of population as shown in Fig. 2.3 has been joined by a period of rapid industrialization, which has placed incredible pres­sure on the natural resources. Limits of growth in the world are imposed not as much by pollution as by the depletion of natural resources.

[](http://cdn.yourarticlelibrary.com/wp-content/uploads/2014/02/clip_image004108.jpg)

As the industrial­ized nations of the world continue the rapid depletion of energy and mineral resources, and resource-rich less-developed nations become increasingly aware of the value of their raw materials, resource driven conflicts will increase.

In Fig. 2.4., we see that by about the middle of the next century the critical factors come together to impose a drastic population reduction by catastrophe. We can avert this only if we embark on a planet-wide program of transition to a new physical, economic, and social world that recognizes limits of growth of both population and resource use.

[](http://cdn.yourarticlelibrary.com/wp-content/uploads/2014/02/clip_image0064.gif)

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.

Exploration for Mineral Resources:

Mineral exploration is shaped by geologic factors but cultural factors and other variables define the favorable areas. The factors include:

·       Accessibility to major highways and railways

·       Archeological evidence of ancient metal works

·       Historical evidence of previous mining activity

·       Accidental discoveries.

·       Availability of geological information about rocks.

·       The demand for the minerals.

Factors to consider in the search and exploration of minerals:

·       Probability of successful search

·       Initial capital expenditure and running cost for extracting, processing and marketing the mineral

·       Levels of future demand and current price

·       Political risks

·       Risks stemming from changing market conditions and the development of substitutes.

Reducing risks in mineral Exploration

 Search for minerals in areas where:

·       there has been historical evidence of mineral presence

·       base maps and geological survey data are available

·       successful discoveries have already been made

·       in sectors where there is proven expertise

·       Avoid countries with record of past political instability and government restrictions on foreign investment.

·       Spreading investment sites

·       Develop known minerals through developments in technology

·       Pool resources to explore potential minerals.

Strategic Minerals:

·       Determined by economic importance, military necessity and accessibility to the mineral.

·       Defined from a particular national perspective so that a mineral that is strategic for one country (which must rely on imports to meet its needs) is not strategic for another country with a domestic source of supply.

FORMS OF GOVERNMENT INTERVENTION

1. Developing Countries:

Trade in minerals is controlled by multinational companies from the developing world. To increase their share of profits from the mining of their minerals, several developing countries have taken measures including:

·       Formation of producer organizations to control supply and price.

· Nationalization of assets of multi-national mining companies by state governments

2. Advanced Capitalist Economies:

Several mechanisms have been developed to Intervene in the exploration & production of minerals

1. Trade Regulation: Devised to decrease the flow of imports into a state.

·       import tariffs (tax on imported minerals)

·       setting premiums on volume of imported minerals through import quotas

·       total import bans and export embargos

·       import licenses.

2. Investment promotion Measures:

·       Promotion drives,

·       favorable loan conditions,

·       direct trade subsidies,

·       government underwriting of private sector risks.

3. Taxation:

·       Royalty tax - a levy per unit of output or a percentage of the value of production

·       Profit tax - a tax on net income or profit.

·       Capital value tax - taxing the value of the property owned by a company

4. Tax Concessions: Granting free tax status to a company

5. Price Fixing

6. Subsidies: Direct grants and low interest loans to encourage companies take specific actions

 7. Granting environmental regulation exemptions to encourage mineral exploration.

Why governments may Intervene in Mining?

·       To ensure and support industrial growth.

·       To ensure continued economic growth

·       To make a country secure militarily by exploiting minerals for the production of arms

·       Spread economic development across the country

·       To make a country self sufficient in strategic minerals

IMPACTS OF MINING

1. Environmental Conflicts:

·       Clash between commercial interests (Supported by people seeking employment) and groups anxious to preserve the aesthetic qualities of local lands.

·       Development of ghost towns left behind after the closure of the mining operations.

·       Clash between native people claiming land rights and international mining companies using the land for mining.

2. Economic Impacts:

·       Promotion of economic growth in the country - employment, consumer goods etc.

·       Industrial development of peripheral regions - markets, transportation, energy, schools etc

·       Creation of enclaves where mining communities remain isolated from the larger society

Environmental Impacts:

·       Transporting, refining and processing of minerals creates air and water pollution.

·       Acid drainage (from abandoned mine sites) pollute ground and surface water.

·       Mining has caused ground subsidence in such places as Long Beach, CA and Houston, Texas.

·       Surface mining creates an eyesore for mine waste (overburden or spoil).

·       Erosion of mine waste chokes streams and fills dams and reservoirs

·       Oxidation of sulfur rich rocks form sulfuric acid which flow into streams and lakes to destroy fish and habitat.

·       Water runoff from piles of spoil materials results in increased sediment load in streams and causes floods

·       Surface mining creates noise and dust and destroys wildlife habitat, at least temporarily.

·       Surface mining causes groundwater levels to fall thereby drying up municipal and agricultural wells in adjacent lands.

In 1977, the US Congress passed the Surface mining Reclamation and Control Act which requires reclamation on surface mined lands.

UNIT 2

Concept Of Ecosystem

The German biologist Ernst Haeckel in 1869 coined the word “Ecology” combining two Greek words – oikos, meaning “household” or “home” and logos, meaning “study of” – to coin ecology, the science that deals with the study of organisms in their natural home interacting with their surroundings ie., other living organisms and physical components. Ecology examines the life histories, distribution and behaviour of individual species as well as the structural and functions of a natural system in terms of population, communities, ecosystems and landscape.  In 1935 essay the English biologist Arthur Tansley proposed the concept of an energy model involving “ecosystems” and “energy”. Tansley (1935) described an ecosystem as a group of biotic communities of species interacting with one another and with their non-living environment exchanging energy and matter.  On the energy model, the ecological whole is to be understood as an energy system or circuit. Just as the physicist studies the flow of energy through a physical system, the ecologist studies the flow of energy through an ecosystem. The language of food chain is replaced with the mathematically more precise language of chemistry nd physics. The ecosystem appears as just another physical, mechanical system. Ecosystem is necessary for the maintenance of life on Earth. For an ecosystem to function, both input and output environments are important. The flow of energy, the cycling of materials and community are the components for making an ecosystem functional. The living community of plants and animals in any area together with the non-living components of the environment such as soil, air and water, constitute the ecosystem. Ecosystems are divided into terrestrial or land based ecosystem and aquatic ecosystem in water. These form the two major habitat conditions for the Earth’s living organisms. At global level thin mantle of the earth on the land , the sea and the air, forms the biosphere. At a sub-global level, this is divided into bio-geographical realms.eg. Eurasia called the palaeartic realm; South and South-east Asia of which India form a major part is the Oriental realm; North America is the Nearctic realm; South America forms the Neotrophical realm; Africa the Ethiopian realm; and Australia the Australian realm.

At the national level or state level, this forms biogeographic regions. There are several distinctive geographical regions in India-the Himalayas, the Gangetic Plains, the Highlands of Central India, the Western and Eastern Ghats, the semi-arid desert in the West, the Deccan Plateau, the Coastal Belts, and the Andaman and Nicobar Islands. These geographically distinctive areas have plants and animals that have been adapted to live in each of these regions.

2.1.1 Structure and functions of an ecosystem:

The structure of an ecosystem consists of  both biological communities and abiotic components. The two basic components of an ecosystem are i. The autotrophic component and ii) the heterotrophic component.  
The autotrophic components include the autotrophs which convert the radiant energy of the sun into chemical energy and stored as complex organic molecules. The heterotrophs feed on the food manufactured by the autotrophs. The heterotrophs recover the energy by breaking down the complexorganicmolecules.

An ecosystem comprises of:

1. Abiotic, 2. Producers, 3.Consumers and 4. Decomposers. The nonliving substances called abiotic include factors like light, temperature,   pressure, soil, water, carbondioxide, pH, mineral and chemical compounds. The physical and chemical components of an ecosystem constitute its abiotic structure which includes soil, geographical, climatic factors, energy, nutrtients and toxic substances. The producers are to autotrophs mainly green plants, algae, etc., and they are further sub-divided into i)micro vegetation and ii)macrovegetation. Producers can make their own food by using the carbon dioxide in the atmosphere, water and sunlight and chlorophyll in the leaves through the process of photosynthesis. They are also called as photo autotrophs. Some microorganisms can produce organic matter through oxidation of certain chemicals in the absence of sunlight. They are called as chemosynthetic organisms or chemo-autotrophs. At ocean depths, chemoautotrophic bacteria using the heat available at earth core to convert dissolved hydrogen sulphide and carbon dioxide into organic compounds.  
The consumers are mainly heterotrophs like animals that feed on other organisms. They are further sub-divided into micro-consumers and macro-consumers. Herbivores or primary consumers feed directly on producers. Carnivores or secondary consumers feed on herbivores and if they feed on other carnivores known as tertiary carnivores. Omnivores feed on both plants and animals. Detritivores feed on the parts of dead organisms and wastes of living organisms.  The Decomposers are heterotrophs which include mainly bacteria and fungi which derive their nutrition by decomposing and breaking down the complex organic molecules to simple organic compounds and ultimately into inorganic nutrients. The biotic structure prevails in most of the ecosystems. In forests and agroecosystems primary producers predominate whereas in deep ocean decomposers predominate.  
Both the biotic and abiotic components influence each other and are linked through energy flow and matter recycling. The flow of energy and matter take place through the food chains.

2.2 FOOD CHAIN AND ENERGY FLOW:

The plants convert the radiant energy of sun into chemical energy and store them as complex molecules; this is the food energy stored in plants.  This food energy is transferred to the primary consumers while the plant is consumed. When the large consumers feed on the primary consumers, the food energy is transferred to them. The transfer of food energy through a chain of organisms is called the “food chain”.  Each organism in the ecosystem is assigned a feeding level depending on its nutritional status. The level of energy flow in each link of the food chain is called ‘trophic level’.  
There are three types of food chain viz i) prey predator, ii)detritus and iii) parasitic food chains. Prey predator food chain is also called grazing food chain: grass land ecosystem, pond ecosystem, marine ecosystem and forest ecosystem. Detritus food chain is also called as saprophytic food chain like mangrove habitat. Parasitic chain goes from larger to smaller organisms. These food chains are not isolated units but are hooked together on food webs.  
Flow of energy through an ecosystem in a way parallels the flow of food through the food chain. Photosynthesis is the process through which solar energy breaks the chemical bonds of carbon dioxide and water molecules forming new molecules of carbohydrates and oxygen. Respiration transforms carbohydrates and oxygen back into carbon dioxide, water and energy. The energy released in this process powers the chemical and physical processes of life, growth, reproduction and so on. Photosynthesis and respiration are the processes of the carbon and oxygen cycles in ecosystems.

2.2.1 FOOD WEB:

Neither do most primary consumers feed upon just one kind of plant, nor are they fed upon to only one kind of secondary consumer. Food web denotes the more complex pattern of feeding relationships among organisms. Food web is a network of food chains where different types of organisms are connected at different trophic levels, so that there are a number of options of eating and being eaten at each trophic level. Food webs give greater stability to the ecosystem.  In a linear food chain, if one species becomes extinct or one species suffers then the species in the subsequent trophic levels are also affected. In a food web, there are a number of options available at each trophic level and hence if one species is affected it does not affect other trophic levels so seriously. Food chain and food web play an important role in the ecosystem, because the energy flow and nutrient cycling take place through them. Food chains regulate and maintain the population size  of different animals, thereby maintaining the ecological balance. However, many heavy metals, pesticides and other chemicals are not bio-degradable and also not decomposed by micro organisms. These chemicals pass on from one trophic level to another and at each level they keep on increasing in concentration known as ‘biomagnifications’.

FUNCTIONS OF ECOSYSTEM

Ecosystem invariably performs in a systematic way under natural conditions. It converts the radiant energy of sun and pass it to biotic components.The biotic components exchange themselves and abiotic components the energy, nutrition and water for life processes. The main functions of an ecosystem are i) Energy flow, ii) food chain, iii) biochemical cycling of nutrients, iv) primary and secondary production and v) Ecosystem development and regulation.

Energy Flow In The Ecosystem

All the ecosystems are interrelated by different mechanisms that affect the lives of plant, animal and human beings. The commonly known mechanisms are the water cycle, the carbon cycle, the oxygen cycle, the nitrogen cycle and the energy cycle. All the ecosystems are controlled by these cycles and their abiotic and biotic features are distinct. All the functions of the ecosystem are in some way related to the growth and regeneration of its plant and animal species. These linked processes depend on energy from sunlight.  Most organisms depend on the sun for the energy needed to create structures and carry out the process required to sustain life. During photosynthesis carbon dioxide is taken up by plants and oxygen is released. Animals depend on this oxygen for their respiration. The water cycle depends on the rainfall, which is necessary for plants and animals to live. The energy cycle recycles nutrients into the soil on which plant life grows. The human and animal lives are closely linked to the proper functioning of these cycles and if human activities go on altering them then humanity cannot survive on our planet.

The Water Cycle

Water is the essence of life on the earth, without which living organisms cannot survive. The hydrologic cycle is a continuous natural process of transportation of water from the reservoirs and oceans to the atmosphere, then to the land surface, and finally back to the reservoirs and oceans. During this process of transportation, water takes the form of liquid, solid and gas at different stages of the cycle. Water, in the form of liquid in reservoirs and oceans, evaporates and converts itself into gaseous state to form clouds; water then precipitates in the form of liquid as rain, and as solid in the form of snow and hail. When it rains, the water runs along the ground and flows into rivers or falls directly into the sea. A part of the rainfall is intercepted by the plant leaves, buildings and other objects on the land surface. A part of the rainwater that falls on land percolates into the ground. This is stored underground throughout the rest of the year. Water is drawn up from the ground by plants along with the nutrients from the soil. The water is transpired from the leaves as water vapour and returned back to the atmosphere which will fall back as rainfall. This process of movement of water in a hydrologic cycle involves the dynamic aspects of water.

 The Carbon cycle

Carbon is a building block of both plant and animal tissues. The carbon, which occurs in organic compounds, is included in both the abiotic and biotic parts of the ecosystem.  In the atmosphere, carbon occurs as carbon dioxide (CO2). The atmosphere is a minor reservoir of carbon dioxide, while the oceans are major reservoirs of CO2 with 50 times the concentration as compared to air. About  2700 billion tons of carbon dioxide is available in the atmosphere and about 6600 billion tons in the biosphere, vegetation, and soil and about 1,36,000 billion tons in the oceans. In the presence of sunlight, plants take up carbon dioxide from the atmosphere through their leaves. The plants combine  carbon dioxide with water, which is absorbed by their roots from the soil. In the presence of sunlight they are able to form carbohydrates that contain carbon. This process is known as photosynthesis. Plants use this complex mechanism for their growth and development. In this process, plants release oxygen into the atmosphere on which animals depend for their respiration. Plants therefore help in regulating and monitoring the percentage of Oxygen and Carbon dioxide in the earth's atmosphere. All of mankind thus depends on the oxygen generated through this cycle. It also keeps the CO2 at acceptable levels. Plants, human beings and animals release carbon dioxide during  respiration and also as excreted waste. The dead bodies of plants and animals also return carbon to the soil thereby completing the  processes of the carbon cycle.

The Oxygen Cycle

Oxygen is an important element for life in the biosphere. It is taken up from the air by plants, human beings and animals for respiration. However it is returned back to the atmosphere by the plants during photosynthesis. There exists a link between Oxygen Cycle and Carbon Cycle. Afforestation generally increases the oxygen levels in our atmosphere thereby plays an important role in our lives.

The Nitrogen Cycle

The air in troposphere, the air which we breathe, consists, by volume, of about 78 % nitrogen, 21 % oxygen, 1 percent argon and 0.03 % carbon dioxide. Also, present are traces of other gases, most of which are inert. Nitrogen is fixed either by the physical process of lightening or biologically by some bacteria and / or blue green algae. When animals defecate, this waste material is broken down by worms and insects mostly beetles and ants. This material is thus broken down further into nutrients that plants can absorb and use for their growth. Thus nutrients are recycled back from their growth. Thus nutrients are recycled back from animals to plants. Similarly the bodies of dead animals are also broken down into nutrients that are used by the plants for their growth. Thus the nitrogen cycle on which life is dependent is completed.

Nitrogen fixing bacteria and fungi in soil  gives this important element to plants, which absorb it as nitrates. The nitrates are a part of the plant's metabolism, which help in forming new plant proteins. This is used by animals that feed on the plants. The nitrogen is then transferred to carnivorous animals when they feed on the herbivores.  When we think of food webs, we usually think of the large mammals and other large forms of life. But we need to understand that it is the unseen small animals, plants and microscopic forms of life that are of great value for the functioning of the ecosystem. Circulation of nitrogen between living components and soil/ atmosphere is mediated by a group of micro-organisms which convert one form of nitrogen into another.

The Energy Cycle

The energy cycle is based on the flow of energy through the ecosystem. Flow of energy in an ecosystem takes place through the food chain and it is the energy flow which keeps the ecosystem going. The flow of energy is unidirectional or one way flow. According to the first law of thermodynamics, energy can neither be created nor be destroyed but it can only be transformed from one for to another. Energy from sunlight is converted by plants themselves into growing new plant material which includes leaves, flowers, fruit, branches, trunks and roots of plants. Since plants can grow by converting the sun's energy directly into their tissues, they are known as producers in the ecosystem. The solar energy captured by the green plants (producers) gets converted into biochemical energy of plants and later into that of consumers. The plants are used byherbivorous animals as food, which gives them energy. A large part of this energy is used up for day to day function of these animals such as breathing, digesting food, supporting growth of tissues, maintaining blood flow and body temperature. Energy is also used for activities such as looking for food, finding shelter, breeding and bringing up young ones. The carnivores in turn depend on herbivorous animals on which they feed. Thus the different plant and animal species are linked to one another through food chains. Each food chain has three or four links. However as each plant or animal can be linked to several other plants or animals, these inter-linked chains can be depicted as a complex food web. This is thus called the 'web of life' that shows that there are thousands of interrelationships in nature.

The energy in the ecosystem can be depicted in the form of a food pyramid or energy pyramid. The amount of energy present at each trophic level is considered for this type of pyramid. The food pyramid has a large base of plants called 'producers'. The pyramid has a narrower middle section that depicts the number and biomass of herbivorous animals, which are called 'first order consumers'. The apex depicts the small biomass of carnivorous animals called 'second order consumers'. Main is one of the animals at the apex of the pyramid. Thus to support mankind, there must be a large base of herbivorous animals and an even greater quantity of plant material. At every successive trophic level, there is a huge loss of energy in the form of heat, respiration etc. Thus, at each next higher level only 10 % of the energy passes on. Hence, there is a sharp decline in energy level of each successive trophic level as we move from producers to top carnivores. Therefore, the energy pyramid is always upright.

Integration of cycles in Nature

The various cycles described above are a part of global life processes. These biogeochemical cycles have specific features in each of the ecosystems. All theses cycles are closely interlinked in some form or other. These cycles are however linked to those of adjacent ecosystems. All ecosystems regulate themselves and maintain themselves under a set of environmental conditions. Their characteristics are specific to the plant  and animal communities in the region. This is related to the geographical features of the area, the climate and the chemical composition of the soil. Together the cycles are responsible for maintaining life on earth. If mankind disturbs these cycles beyond the limits that nature can sustain, they will eventually break down and lead to a degraded earth on which man will not be able to survive.

Major Ecosystem Types

The ecosystem can be mainly classified into two types namely Terrestrial ecosystem and Aquatic ecosystem.  Terrestrial ecosystem can be of forest, grassland, deserts, mountains etc., whereas aquatic ecosystem types can be of water bodies like pond, lake, wetland, river, delta etc.  For these ecosystems we have to understand the nature, structure and functions. What for the ecosystem is used, and how it is degraded and what has to be done to protect it from deterioration i.e., its conservation.

FOREST ECOSYSTEM

Forest ecosystems are formed predominantly by trees that are interspersed with a large number of species of herbs, shrubs, climbers, lichens, algae and a wide variety of wild animals and birds. As discussed above forests are found in undisturbed areas receiving moderate to high rainfall and usually occur as stable climax communities. In India forest occupies an area of 69.63 million ha in 2007-08 with 22.80 % of the geographical area whereas it was only 14.20 % with 40.48 million ha during independence. However, it remains same during the last one decade at 22.80 % but the scientists estimate that India should ideally have 33 % of its land under forests. Most of the ‘natural’ undisturbed forests are located mainly in the National Parks and Wildlife Sanctuaries in India.  The forests perform the following functions : i) Protective and ameliorative functions : protecting the watersheds, creating conducive conditions for rainfall, soil erosion control, nutrient conservation, atmospheric regulation, ii) productive functions : producing food, fodder, firewood, fibre, timber and also medicinal plants and apiculture, iii) Recreational and educational functions like eco-tourism and iv) development functions involving revenue and employment generation.

The forest ecosystem consists of two parts namely i) non-living or abiotic aspects and ii) living or biotic aspects. Vegetation in the forest areas differ according to climatic conditions like  amount of rainfall received, local temperature as well as its latitude, altitude and soil type. For each forest area there are specific plants and animals accordingly they can be of the following types:

(a) Tropical Rain Forests: This type of evergreen broad leaf forests are located near the equator region characterized by high temperature, high humidity and high rainfall, all of which favour the growth of trees. Here, the temperature is warm throughout the year and precipitation occurs almost daily. The annual precipitation of a tropical rainforest is typically from 2000 to 4500 mm. Throughout the year the climate remains uniform and the forests have rich biodiversity. An evergreen forest thus looks green throughout the year. Different forms of life occupy specialized areas (niches) within different layers and spaces of the ecosystem depending upon their needs for food, sunlight, water , nutrient etc. The trees overlap with each other to form a continuous canopy.

Different types and layers of plants and animals can be seen in the tropical rain forests. A fully developed rainforest has atleast three layers of vegetation. The topmost layer of the tallest broad-leaf evergreen trees of height 50 m or more are exposed to direct sunlight. Below which lies the canopy where top branches of shorter trees of height 30 to 40m form an umbrella like cover. Below this is present the understory of still smaller trees. A large variety of birds, insects and animals like monkeys have made their natural homes (habitats) in these forests.

The area beneath the thick trees usually receive very dim sunlight. They usually develop dark green leaves with high chlorophyll content so that they can use the diffused sunlight for photosynthesis . The shrub layer receives even less sunlight and the ground layer. Normally, the floor or ground of the forest area receives almost no sunlight and is a dark layer. The forest is rich in orchids, mosses, bromeliads and ferns. The barks of the trees are covered in moss. Interestingly, the flowers of forest trees are very large, colourful, fragrant and attractive which helps in pollination by insects, birds, bats etc. Most of the animals like bats, birds, insects etc. occupy the bright canopy layer while monkeys, toads, snakes, chameleons etc. keep on moving up and down in sunny and darker layers. Termites, fungi, mushrooms etc. grow on the ground layer. Warm temperature and high availability of moisture facilitate rapid breakdown (decomposition) of the dropped leaves, twigs etc thereby accumulating the organic wealth. These forests are found in Central and South America, Africa and South east Asis. The Silent Valley in Kerala is the only tropical rain forest lying in India which is the natural habitat for a wide variety of species.

(b) Tropical deciduous forests: They are found a little away from the equator in regions with a moderate amount of seasonal rainfall that lasts for only a few months in a year during monsoon and are warmer year round. A large part of the year remains dry and therefore different types of deciduous trees are found here, which lose their leaves during dry season. The deciduous trees shed their leaves during winter and hot summer months, thus having periods of leaf fall and canopy regrowth. A thick undergrowth of vegetation can be witnessed on the forest floor as light can penetrate easily onto the floor of the forest.

(c) Tropical scrub forests: They are found in areas where the dry season is even longer. Here there are small deciduous trees and shrubs.

(d) Temperate rain forests: They are found in temperate areas with adequate rainfall. The coniferous trees like pines, firs, redwoods etc are grown predominantly in these forests. They also consist of some evergreen broad leaf trees. Temperate rain forests have relatively nutrient poor soil, although its organic content may be high. Cool climate slows down the bacterial and fungal activities and hence the decomposition of fallen leaves, branches, trunks and twigs into nutrients takes longer time.

(e) Temperate deciduous forests: Hot summers and cold winters are characteristics of these forests. They are found in areas with moderate temperatures. The precipitation ranges from 750 to 1250 mm. There is a marked seasonality with long summers, cold winter and abundant rainfall  throughout the year. The major trees include broad leaf deciduous trees like oak, hickory, beech, poplar etc and they lose their foliage annually. Trees form a dense canopy that overlies samplings and shrubs.

(f) Evergreen coniferous forests (Boreal Forests): In these forests winters are long, cold and dry. Sunlight is available for a few hours only. In summer the temperature is mild, sun-shines for long hours but the season is quite short. These forests have tall stately trees with needle like leaves and downward sloping branches so that the snow can slip off the branches. The major trees include pines, spruce, fir, cedar etc. which have tiny, needle-shaped leaves having a waxy coating so that they can withstand severe cold and drought. The leaves of coniferous trees are looking like needles, fall on the forest floor and cover the nutrient poor soil. The soil is found to get frozen during winter when only few species can survive and soil is acidic and prevent other plants from/growing. Species diversity is rather low in these forests because the soil is thin and often not fertile.

GRASSLAND ECOSYSTEMS

A wide range of landscapes with grasslands are dominated by grass species but sometimes also has few trees and shrubs. Rainfall is average but erratic. Limited grazing helps to improve the net primary production of the grasslands but overgrazing leads to degradation of these grasslands resulting in desertification. Three types of grasslands are found to occur in different climatic regions:

(a) Tropical grasslands: They occur near the borders of tropical rain forests in regions of high average temperature and low to moderate rainfall. In Africa, these are typically known as Savannas, which have tall grasses with scattered shrubs and stunted trees. The Savannas have   
a wide diversity of animals including zebras, giraffes, gazelle; antelopes etc. During dry season, fires are quite common. Termite mounds are very common here. The termites gather the detritus (dead organic matter) containing a lot of cellulose and build up a mound. On the top of the mound fungi are found to grow which feed upon this dead matter including cellulose and in turn release methane, a greenhouse gas.

Tropical savannas have a highly efficient system of photosynthesis. Most of the carbon assimilated by them in the form of carbohydrates is in the perennating bulbs, rhizomes, runners etc. which are present underground. Deliberate burning of these grasslands can release huge quantities of carbon dioxide, another green house gas, responsible for global warming.

(b) Temperate grasslands: They are usually found on flat, gentle sloped hills, winters are very cold but summers are hot and dry. Intense grazing and summer fires do not allow shrubs or trees to grow.

In United States and Canada these grasslands are known as prairies, in South America as Pampas, in Africa as Velds in central Europe and Asia they are known as Steppes.

Winds keep blowing and evaporation rate is very high. It also favours rapid fires in summer. The soils are quite fertile and therefore, very often these grasslands are cleared for agriculture.

(c) Polar grasslands (Arctic Tundra): They are found in arctic polar region where severe cold and strong, frigid winds along with ice and snow create too harsh a climate for trees to grow. In summers the sun-shines almost round the clock and hence several small annual plants   
grow in the summer. The animals include arctic wolf, weasel, arctic fox, reindeer etc. A thick layer of ice remains frozen under the soil surface throughout the year and is known as permafrost. In summer, the tundra shows the appearance of shallow lakes, bogs etc. where   
mosquitoes, different type of insects and migratory birds appear.

DESERT ECOSYSTEMS

Deserts have infrequent and unpredictable precipitation and are dry in nature. These ecosystems occur in regions where evaporation exceeds precipitation (rainfall, snow etc.). The precipitation is less than 25 cm per year. About 1I3rd of our world's land area is covered by deserts. Deserts are located in South west of America, north and south of Africa and also in China, India, France and Australia. The coastal deserts of South America and Africa are among the driest regions in the world. Deserts have little species diversity and consist of. drought resistant or drought avoiding plants. The deserts are very hot during day time and very cool during nights. Deserts are of three major types, based on climatic conditions:

(a) Tropical deserts like Sahara and Namib in Africa and Thar desert, Rajasthan, India are the driest of all with only a few species. Large sand dunes due to high wind erosion are very common.

(b) Temperate deserts like Mojave in Southern California where day time temperatures are very hot in summer but cool in winters.

(c) Cold deserts like the Gobi desert in China has cold winters and warm summers.

Desert plants and animals are having most typical adaptations for conservation of water. Many desert plants are found to have reduced, scaly leaves so as to cut down loss of water due to transpiration or have succulent leaves to store water. Many a times their stems get flattened and develop chlorophyll so that they can take up the function of photosynthesis. Some plants show very deep roots to tap the groundwater. Many plants have a waxy thick cuticle over the leaf to reduce loss of water through transpiration. Desert animals like insects and reptiles have thick outer coverings to minimize loss of water. They usually live inside burrows where humidity is better and heat is less. Desert soil is rich in nutrients but deficient in water. Due to low species diversity, shortage of water and slow growth rate, the desert-plant communities, if faced with a severe stress take a long time to recover.

 Aquatic Ecosystems

Water is an essential medium for all living processes of biota. Approximately, 71 % of the earth’s surface is covered by ocean. The aquatic ecosystem constitutes the marine environments of the seas called ‘marine ecosystem’ and the fresh water systems in lakes, rivers, streams, ponds and wetlands called ‘fresh water ecosystem’. These ecosystems provide human beings with a wealth of natural resources. Freshwater ecosystems are further of standing type (lentic) like ponds and lakes or free-flowing type (lotic), like rivers and streams. Freshwater ecosystems are influenced by local climate, soil, resident communicates and also on surrounding terrestrial ecosystems.

(a) Pond ecosystem: It is a small freshwater aquatic ecosystem where water is stagnant. Ponds may be seasonal in nature i.e. receiving enough water during rainy season. Ponds are usually shallow water bodies which playa very important role in the villages where most of the activities center around ponds. They contain several types of algae, aquatic plants, insects, fishes and birds. The ponds are, however, very often exposed to tremendous anthropogenic (human-generated) pressures. They are used for washing clothes, bathing, swimming, cattle bathing and drinking etc. and therefore get polluted.

(b) Lake ecosystems: Lakes are usually big freshwater bodies with standing water. They have a shallow water zone called Littoral zone, an open-water zone where effective penetration of solar light takes place, called Limnetic zone and a deep bottom area where light penetration is negligible, known as profundal zone.

Some famous lakes in India are the Dal Lake in Srinagar (J & K) and Naini Lake in Nainital (Uttarakand).

Several types of organisms live in lake environment:

 (a) Planktons:  phytoplanktons like algae and zooplanktons like rotifers float on the surface of the lakes.

(b) Nektons  are the fish species that live in water.

(c) Neustons that rest or swim on the surface.

(d) Benthos are living in the bottom of the lakes in sediments e.g. snails.

 (e)Periphytons that are attached or clinging to other plants or any other surface e.g. crustaceans.

Stratification : The lakes contain different strata or zones based on temperature differences. During summer, the water in the top layers get warmer than the water in the bottom layers. The warm water in the top layer circulates without mixing with the colder layer at the bottom, thus forming a distinct zonation.

The lighter warm circulating surface layer is called as Epilimnion and the cold non-circulating bottom layer of viscous nature is called Hypolimnion.

The layer in between the two layers is known as thermocline.

Types of Lakes: Some important types of lakes are:

(a)Oligotrophic lakes are having low nutrient concentrations.   
(b) Eutrophic lakes are with agricultural runoff or municipal sewage discharge in the water body. They are over nourished by nutrients like nitrogen and phosphorus. They are covered with "algal blooms" and many lakes in India are having this problem as most of the lakes are serving as drainage water bodies.

(c) Dystrophic lakes that have low pH, high humid acid content and brown waters.

(d) Endemic lakes are invariably ancient and very deep. They have endemic fauna.

The Lake Baika ,in Russia is a deep lake, which is now suffering due to industrial pollution.

(e) Desert salt lakes  occur in arid regions. They are with high salt concentrations as a result of high evaporation.  e.g. Sambhar lake in Rajasthan.

(f) Volcanic lakes receive water from magma after volcanic eruptions

  (g) Meromictic lakes are rich in salts and are permanent stratified.

  (h) Artificial lakes or impoundments are created by the construction of dams.

Streams

These are freshwater aquatic ecosystems where water current is a major controlling factor, oxygen and nutrient in the water is more uniform and land-water exchange is more extensive. Although stream organism have to face more extremes of temperature and action of currents as compared to pond or lake organisms, but they do not have to face oxygen deficiency under natural conditions. This is because the stream are shallow, have a large surface exposed to air and constant motion which churns the water and provides abundant oxygen. Their dissolve   
oxygen level is higher than that of ponds even though the green plants are much less in number. The stream animals usually have a narrow range of tolerance to oxygen. That is the reason why they are very susceptible to any organic pollution which depletes dissolved oxygen in the water. Thus, streams are the worst victims of industrial   
development.

River Ecosystem: Rivers are large streams that flow downward from mountain highlands and flowing through the plains fall into the sea. So the river ecosystems show a series of different conditions.

The mountain highland part has cold, clear waters rushing down as water falls with large amounts of dissolved oxygen. The plants are attached to rocks (periphytons) and fishes are cold-water, high oxygen requiring fish like trouts.

In the second phase on the gentle slopes, the waters are warmer and support a luxuriant growth of plants and less oxygen requiring fishes.

In the third phase, the river waters are very rich in biotic diversity. Moving down the hills, rivers shape the land. They bring with them lots of silt rich in nutrients which is deposited in the plains and in the delta before reaching the ocean.

Wetlands:

Wetlands are ecosystems in which the land surface is saturated or covered with standing water at least part of the year. The wetland vegetation is adapted for growth under saturated water conditions. Wetlands can be classified into Swamps, Marshes and Bogs and fens. In swamps trees are there whereas marshes are without trees. Bog and fens are waterlogged areas saturated by groundwater or rainwater. As the water depth in swamps and marshes is shallow, enough sunlight will penetrate inducing higher photosynthetic activity. Because of this, more biomass production and greater species diversity can be observed. Vast stretch of wetlands are available in Canada and Russia. Migratory birds use wetlands for breeding.

Oceans

These are gigantic reservoirs of water covering more than 70% of our earth's surface and play a key role in the survival of about 2,50,000 marine species, serving as food for humans and other organisms, give a huge variety of sea-products and drugs. Oceans provide us iron, phosphorus, magnesium, oil, natural gas, sand and gravel.

Oceans are the major sinks of carbon dioxide and play an important role in regulating many biogeochemical cycles and hydrological cycle, thereby regulating the earth's climate.

The oceans have two major life zones:

Coastal zone with relatively warm, nutrient rich shallow water. Due to high nutrients and ample sunlight this is the zone of high primary productivity.

Open sea: It is the deeper part of the ocean, away from the continental shelf (The submerged part of the continent). It is vertically divided into three regions:

(i) Euphotic zone which receives abundant light and shows high photosynthetic activity.

(ii) Bathyal zone receives dim light and is usually geologically active.

(iii) Abyssal zone is the dark zone, 2000 to 5000 metres deep. The abyssal zone has no primary source of energy i.e. solar energy. It is the world's largest ecological unit but it is an incomplete ecosystem.

Estuary

An estuary is a semi-enclosed coastal bay area at the mouth of a river where fresh water and salty seawater meet or the rivers enter the sea. The rich nutrient sediments taken by the rivers from the upper inland regions are carried down with the fresh water. Constant mixing of water stirs up the silt which makes the nutrients available for the primary producers. These are the transition zones which are strongly affected by tidal action. There are wide variations in the stream flow and tidal currents at any given location diurnally, monthly and seasonally. The combination of physical factors in estuaries makes them very productive and of high species diversity.

Biodiversity Value, Threats And Conservation

 INTRODUCTION

The word biodiversity refers to the variety of living organisms (flora and fauna). Biodiversity or Biological diversity is defined as the variability among all living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part. Wilson (1988) defined ‘Biological diversity’ or ‘biodiversity’ as that part of nature which includes the differences in genes among the individuals of a species, the variety and richness of all the plant and animal species at different scales in space i.e. local, regional, country wise and global, and various types of ecosystems- both terrestrial and aquatic-within a defined area.

TYPES OF BIODIVERSITY:

Biological diversity deals with the degree of nature’s variety in the biosphere. This variety can be observed at three levels i.e., genetic, species and ecosystem.

Genetic diversity: Genetic diversity refers to the variation at the level of individual genes. Tremendous amount of genetic diversity exists within individual species. This genetic variability is responsible for the different characters in species. Genetic diversity is the raw material from which new species arise through evolution. Today, the genetic diversity is made use to breed new crop varieties, disease resistant crops.

Species diversity The number of species of plants and animals that are present in a region constitutes its species diversity. This diversity is seen both in natural ecosystem and in agricultural ecosystem. Some areas are richer in species than others. For example, natural undisturbed tropical forests have much greater species richness than mono culture plantations developed by the forest department for timber products. A natural forest ecosystem provides large number of non-timber forest products that local people depend on such as fruits, fuel, wood, fodder, fiber, gum, resin and medicines. Timber plantations do not provide the large variety of goods that are essential for local consumption. Modern intensive agro ecosystem have a relatively lower density of crops than traditional agropastoral farming systems, where multiple crops were planted. Areas that are rich in species diversity are called ‘hotspots’ of diversity and the countries with the highest species richness or have a relatively large proportion of these hot spots of diversity are referred to as ‘megadiversity nations’. India is among the world’s 15 nations that are exceptionally rich in species diversity. The earth’s biodiversity is distributed in specific ecological regions. There are over a thousand major eco-regions in the world. Of these, 200 are said to be the richest, rarest and most distinctive natural areas. These areas are referred to as the Global 200. It has been estimated that 50,000 endemic plants which comprise 20% of global plant life, probably occur in only 25 ‘hot spots’ in the world. These hotspots harbour many rare and endangered species. Two criteria help in defining hotspots namely rich endemism and the degree of threat. To qualify as hotspots an area must contain at least 0.5 per cent or 1500 of the worlds 3,00,000 plants species as endemics (Myers et al., 2000).

 ECOSYSTEM DIVERSITY:

 There are a large variety of different ecosystem on earth, each having their own complement of distinctive inter linked species based on differences in the habitat. Ecosystem diversity can be described for a specific geographical region or a political entity such as a country, a state or a taluk. Distinctive ecosystems include landscapes like forests, grasslands, deserts, mountains etc as well as aquatic ecosystems like rivers, lakes and seas. Each region also has man- modified areas such as farmland or grazing pastures. It refers to the variation in the structure and functions of the ecosystem. It describes the number of niches, trophic levels and various ecological processes that sustain energy flow, flood webs and the recycling of nutrients. It has focus on various biotic interactions and the role and functions of keystone species (species determining the ability of large number of other species to persist in the community).

 METHODS OF MEASURING BIODIVERSITY:

There are three perspectives measuring of diversity at the level of community.

These are (i) Alpha diversity, (ii) beta diversity and (iii) gamma diversity. Community diversity refers to the variations in the biological communities in which species live.

(i) Alpha diversity indicates diversity within the community. It refers to the diversity of organisms sharing the same community or habitat. A combination of species richness and equitability / evenness is used to represent diversity within a community or habitat.

(ii) Beta diversity indicates diversity between communities. Species frequently change when habitat or community changes. There are differences in species composition of communities along environmental gradients, e.g, altitudinal gradient, moisture gradient, etc. the higher heterogeneity in the habitats ina region or greater dissimilarity between communities exhibit higher beta diversity.

(iii) Gamma diversity refers to the diversity of the habitats over the total land scope or geographical area. The sum of alpha and beta diversities of the ecosystems is an expression of the biodiversity of landscape, which is considered as Gamma Diversity. Higher diversity at community level provides stability and higher productivity. In temperate grasslands, it has been observed that diverse communities are functionally more productive and stable, even under environmental stresses such as prolonged dry conditions.

Endangered & Endemic Species In India

Several species of plants and animals have been endangered due to human activities. The Species whose existence is in danger by human activities are called Man-wild life conflict.

Man- wild life conflicts endangered species. These endangered species have been categorized into four viz,1)Vulnerable 2) Rare 3) Intermediate 4) Threatened. Endangered species which are on verge of extinction are called threatened species. Most of the endangered species, are found today only in protected areas (PAs). Some eg of the species being Tiger, rhino, elephant; bird species include Siberian crane, great Indian bustard, Florican, vultures; reptiles and amphibians. Habitat loss caused by human activity is causing threat to plants species like orchids. Over harvesting as ingredients in medical products or cosmetics is also threatening species. To protect endangered species India has created a wildlife protection act. Under this plants and animals are characterized according to thereat to their survival. The species which are unique to a locality/region are called endemic species. Some species are found only in India and are thus endemic (restricted to our country). Some have very localized distribution and are considered highly endemic. Some species of this category being Indian wild ass, angular kashmiri stag, golden langur, pigmyhog.

Conservation of biodiversity: is of two types i.e., In situ and Ex situ

In situ conservation: Conserving a species in its own environment by creating national parks and wildlife sanctuaries. Habit is protected with all the other spp that in it in nature Biodiversity at all levels can be best preserved in situ by setting aside wildness as protected areas (in national parks and wildlife sanctuaries) with distinctive ecosystem included in the network. Such net work preserve the total diversity of life of the region.

Biologists view point is to deal with areas which are 1) Species rich 2) Rare

/threatened/endangered species / endemic species are found should be given imp as there spp would easily become extinct due to human activity. For eg. Elephants utilize open grasslands after the rains (when it is nutritious) but move into forest to feed on foliage in dry season. Hence a PA for elephant must be large to include a diverse habitat that supports a complete complement of interlinked species.

India has 589 PAs of which 89 are national parks and 500 are wildlife sanctuaries. Over 100 PAs are created in Andaman and Nicobar to preserve the special island ecosystem. The great Himalayan national park is the largest sanctuaries in the ecosystem and is the home of snow leopard. Dachigam sanctuary for hangul or kashmiri stag; Kaziranga national park for animals like elephant, guar, wild boar and swamp deer, and birds like ducks geese, pelicans and storks; Manas sanctuary for golden langur, pigmy hog and wild boar are some of the examples worth mentioning under in situ conservation.

Ex situ conservation: Conserving the species outside the natural habitat in a carefully controlled situation, such as botanical garden for plants or zoological parks for animals, expertise exists to multiply species under artificially managed condition. Gemplasm is preserved in a gene bank for future need, this is taken up for expensive endangered /extinct species. Care is taken to avoid inbreeding such that weak offspring would not develop. Breeding programmes in zoos  provide animal needs including enclosures that simulate their wild habitat. Modern zoo’s function is to breed endangered species as a conservation. Successful examples are 1. Madras crocodile trust bank has successfully bred the 3 crocodiles. Here crocodiles lay two clutches of eggs in one year year instead of one in wild. 2. Guchali zoo has bred pigmy hog 3. Delhi zoo has bred the rare Manipur brow antlered deer. The successful breeding programme also  aims at reintroduction of the species into wild habitat, with simultaneous removal of problems like poaching disturbances and man made influences.

 2.8 CONSERVATION OF CULTIVARS AND LIVESTOCK BREEDS:

Fifty years ago nearly 30,000 rice var. were grown in India now only a few of  these are cultivated. The new varieties being developed use the germplasm of these original types. But if all these traditional types vanish, it would be difficult to develop new disease resistant varieties for future. Use of varieties from gene banks have been expensive and risky. Farmers need to be encouraged to grow traditional varieties. This is a concern for future of mankind. Gene banks have at present 34,000 creeds and 2200 pulses). Traditional breeds/ varieties have to be encouraged for genetic variability. In contrast men interested in cash returns in short time wouldn’t appreciate the benefits of growing indigenous varieties.

Biological Diversity Act 2002

Biological diversity is a national asset of a country, hence the conservation of biodiversity assumes greater significance. The first attempt to bring the biodiversity into the legal frame work was made by way of the biodiversity bill 2000 which was passed by the Lok sabha on 2nd December 2002 and by Rajya Sabha on the December 2002.

OBJECTIVES OF THE ACT:

 1. To conserve the Biological Diversity

2. Sustainable use of the components of biodiversity

3. Fair and equitable sharing of benefits arising out of the use of the B.D

A national biodiversity authority has been established by the Biodiversity Act 2002 to regulate act implementing rules 2004 has been operationalized since coming in to force.

Act: Regulating access as well as pushing the officially sponsored documentation of biological resources and traditional practices through people’s diversity registers at the local and data bases at the national levels, respectively. It further probes the extent to which the principles of conservation have realized.

Provisions of Act.

1. Prohibition on transfer of Indian genetic material outside the country without specific approval of the Indian Government

2. Prohibition of anyone claiming an (IPR) such as a patent over biodiversity or related knowledge without permission of Indian Government.

3. Regulation of collection and use of biodiversity by Indian national while exempting local communities from such restrictions

4. Measures from sharing of benefits from use of biodiversity including transfer of technology, monitory returns, joint research and development, joint IPR ownership etc.

5. Measuring to conserve sustainable use of biological resources including habitat and species protection (EIP) of projects, integration of biodiversity into the plans and policies of various Departments and Sectors.

6. Provisions for local communities to have a say in the use of their resources and knowledge and to charge fees for this

7. Protection of indigenous or tradition laws such as registration of such knowledge

8. Regulation of the use of the genetically modified organisms

9. Setting up of National, state and local Biodiversity funds to be used to support conservation and benefit sharing

10. Setting up of Biodiversity Management Committees (BMC) at local village levels, State Biodiversity Boards at state level and National Biodiversity Authority at national level.

 2.9.2 FUNCTIONS OF AUTHORITY:

 1. Advise the central Government on any matter concerning conservation of biodiversity, sustainable use of its components and fair and equitable sharing of benefits arising out of the use of biological resource and knowledge

2. Coordinate the activities of state biodiversity

3. Provide the technical assistance and guidance to the state biodiversity boards

4. Sponsor investigation and research

5. Engage consultants for a specific period not exceeding 3 years for providing technical assistance to the Authority in the effective discharges of its functions.

6. Collect, compile and publish technical and statistical data, manuals, codes or guides relating to conservation of biodiversity, sustainable use of its components and fair and equitable sharing of benefits arising out of the use of biological resource and knowledge’s

7. Organize through mass media a comprehensive programme regarding conservation of biodiversity, sustainable use of components and fair and equitable sharing of benefits arising out of the use of biological resources and knowledge.

8. Plan and organize training of personal engaged or likely to be engaged in programmes for the conservation of biodiversity and sustainable use of its components

9. Prepare the annual budget of the authority including its own receipts as also the devaluation from the central Government provided that the allocation by the central government shall be operated in accordance with budget provisions approved by the central govt.

10. Recommend creation of posts to the central Government for effective discharge of the functions by the authority.

11. Approve the method of recruitment to the officers and servants of the authority.

12.Take steps to build up data base and to create information and documentation system for biological resources and associated traditional knowledge through biodiversity register and electronic data bases to ensure effective management, promotion and sustainable uses.

13. Give directions to state Biodiversity Boards and the Biodiversity Management Committees in writing for effective implementation of the act.

14. Report to the central Government about the functioning of the Authority and implementation of the Act

15.Sanction grants to the State Biodiversity Board and Biodiversity Management committees for specific purposes.

16.Take necessary measures including appointment of legal experts to oppose grant of intellectual property right in any country outside india on any biological outside India on any biological resource and associated knowledge obtained from India and in an illegal manner.

17. Do such other functions as may be assigned to directed by the central government from time to time

18. Regulates the commercial utilization or biosurvey and bio-utilization of any biological resource by Indians.

Biodiversity Conservation

The reasons for conservation of biodiversity can be grouped into three categories: narrowly utilitarian, broadly utilitarian, and ethical.

The narrowly utilitarian arguments for conserving biodiversity are obvious; humans derive countless direct economic benefits from naturefood (cereals, pulses, fruits), firewood, fibre, construction material, industrial products (tannins, lubricants, dyes, resins, perfumes) and products of medicinal importance. More than 25 per cent of the drugs currently sold in the market worldwide are derived from plants and 25,000 species of plants contribute to the traditional medicines used by native peoples around the world. Nobody knows how many more medicinally useful plants there are in tropical rain forests waiting to be explored. With increasing resources put into 'bioprospecting' (exploring molecular, genetic and species-level diversity for products of economic importance), nations endowed with rich biodiversity can expect to reap enormous benefits.

The broadly utilitarian argument says that biodiversity plays a major role in many ecosystem services that nature provides. The fast dwindling Amazon forest is estimated to produce, through photosynthesis, 20 per cent of the total oxygen in the earth's atmosphere. Can we put an economic value on this service by nature?  You can get some idea by finding out how much your neighborhood hospital  spends on a cylinder of oxygen. Pollination (without which plants cannot give us fruits or seeds) is another service, ecosystems provide through pollinators layer- bees, bumblebees, birds and bats. What will be the costs of accomplishing pollination without help from natural pollinators? There are other intangible benefits - that we derive from nature - the aesthetic pleasures of waking up to a bulbul's  song in the morning. Can we put a price tag on such things?

The ethical argument for conserving biodiversity relates to what we owe to millions of plant, animal and microbe species with whom we share this planet, Philosophically or spiritually, we need to realise that every species has an intrinsic value, even if it may not be of current or any economic value to us. We have a moral duty to care for their well-being and pass on our biological legacy in good order to future generations.

Ways to conserve Biodiversity

We have to conserve and protect the whole ecosystem thereby biodiversity at all levels is protected. When we save the entire forest we save an animal in the forest say, the tiger. This approach is called in situ (on site) conservation. However, when there are situations where an animal or plant is endangered or threatened and needs urgent measures to save it from extinction, ex situ (off site) conservation is the desirable approach.

In situ conservation- Faced with the conflict between development and conservation, many nations find it unrealistic and economically not feasible to conserve all their biological wealth. Invariably, the number of species waiting to be saved from extinction far exceeds the conservation resources available. On a global basis, this problem has been addressed by eminent conservationists. They identified for maximum protection certain 'biodiversity hotspots' regions with very high levels of species richness and high degree of endemism (that is, species confined to that region and not found anywhere else). Initially 25 biodiversity hotspots were identified but subsequently nine more have been added to the list, bringing the total number of biodiversity hotspots in the world to 34. These hotspots are also regions of accelerated habitat loss. Three of these hotspots - Western Ghats and Sri Lanka, Indo-Burma and Himalaya - cover our country's exceptionally high biodiversity regions. Although all the biodiversity hotspots put together cover less than 2 percent of the earth's land area, the number of species they collectively harbour is extremely high and strict protection of these hotspots could reduce the ongoing mass extinctions by almost 30 per cent.

In India, ecologically unique and biodiversity-rich regions are legally protected as biosphere reserves, national parks and sanctuaries. India now has 14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries. India has also a history of religious and cultural traditions that emphasised protection of nature. In many cultures, tracts of forests were set aside, and all the trees and wildlife within were venerated and given total protection. Such sacred groves are found in Khasi and Jaintia Hills in Meghalaya, Aravalli Hills of Rajasthan, Western Ghat regions of Karnataka and Maharashtra and the Sarguja, Chanda and Bastar areas of Madhya Pradesh. In Meghalaya, the sacred groves are the last refuges for a large number of rare and threatened plants.

Ex situ Conservation- In this approach, threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care. Zoological parks, botanical gardens and wildlife safari parks serve this purpose. There are many animals that have become extinct in the wild but continue to be maintained in zoological parks. In recent years ex situ conservation has advanced beyond keeping threatened species in enclosures. Now gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques, eggs can be fertilised in vitro, and plants can be propagated using tissue culture methods. Seeds of different genetic strains of commercially important plants can be kept for long periods in seed banks.

Biodiversity knows no political boundaries and its conservation is therefore a collective responsibility of all nations. The historic Convention on Biological Diversity('The Earth Summit') held in Rio de Janeiro in 1992, called upon all nations to take appropriate measures for conservation of biodiversity and sustainable utilization of its benefits. In a follow-up, the World Summit Africa, 190 countries pledged their commitment to achieve by 2010, a significant reduction in the current rate of biodiversity loss at global, regional and local level.