PREFACE

In the curricular structure introduced by this University for students of Post-Graduate degree programme, the opportunity to pursue Post-Graduate course in any subject introduced by this University is equally available to all learners. Instead of being guided by any presumption about ability level, it would perhaps stand to reason if receptivity of a learner is judged in the course of the learning process. That would be entirely in keeping with the objectives of open education which does not believe in artificial differentiation.

Keeping this in view, the study materials of the Post-Graduate level in different subjects are being prepared on the basis of a well laid-out syllabus. The course structure combines the best elements in the approved syllabi of Central and State Universities in respective subjects. It has been so designed as to be upgradable with the addition of new information as well as results of fresh thinking and analysis.

The accepted methodology of distance education has been followed in the preparation of these study materials. Co-operation in every form of experienced scholars is indispensable for a work of this kind. We, therefore, owe an enormous debt of gratitude to everyone whose tireless efforts went into the writing, editing, and devising of a proper lay-out of the materials. Practically speaking, their role amounts to an involvement in 'invisible teaching'. For, whoever makes use of these study materials would virtually derive the benefit of learning under their collective care without each being seen by the other.

The more a learner would seriously pursue these study materials, the easier it will be for him or her to reach out to larger horizons of a subject. Care has also been taken to make the language lucid and presentation attractive so that they may be rated as quality self-learning materials. If anything remains still obscure or difficult to follow, arrangements are there to come to terms with them through the counselling sessions regularly available at the network of study centres set up by the University.

Needless to add, a great deal of these efforts is still experimental—in fact, pioneering in certain areas. Naturally, there is every possibility of some lapse or deficiency here and there. However, these do admit of rectification and further improvement in due course. On the whole, therefore, these study materials are expected to evoke wider appreciation the more they receive serious attention of all concerned.

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POST GRADUATE GEOGRAPHY

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PGGR-07

Group A

Unit 1.1.1 ❑ Geographer's Approach to Environmental Studies; Physical components of Environment

Structure

1.1.1.1 Definition of the term 'Environment'

Environment in broad sense means everything that surrounds us. It also means the conditions under which any individual or thing sustains to live and develop. The surrounding conditions (Gilpin, 1990) are :

i) the sum total of physical conditions which affect and influence the growth and development of individual or community.

ii) the social and cultural conditions which affect the nature of an individual or community, and

iii) the surrounding of an inanimate object of intrinsic value.

1.1.1.2 Classification of Environment

Human environment is classified as a) biotic and b) abiotic. Biotic environment encompasses human beings, flora, fauna, bacteria, viruses, ecology and all the social factors that constitute the quality of life, while abiotic environment includes land, water, atmosphere, climate, sound, odour and tastes. The concept of environment emerged from an assembly of living and inanimate objects.

1.1.13 Definition of Environment given by European Commission

The European Commission defined 'Environment' as "the combination elements whose complex inter-relationships make up the settings, surroundings and the condition of life of the individual and society as they are felt". If we consider all approaches of defining environment it would appear that humanity has been put at the centre stage of all things. If practical orientation has to be given in defining 'Environment' one must.take into account the following ingredients of the word 'Environment' as laid down in the national legislations of most of the countries :

i) each and every aspect of surroundings of human beings which affects human beings as an individual groupings,

ii) air, water and land representing the gamut of natural resources,

iii) ecosystem and biological diversity,

iv) economic, social and cultural circumstances,

v) anthropogenic activities directly or indirectly producing any solid, liquid, gaseous, odour, heat, noise, vibration and radiation.

vi) natural assets, such as natural beauty, outlook and scenic routes,

vii) historical, cultural, religious and heritage assets,

viii) public health characteristics,

ix) environmental planning, protection and management of pollution control, nature conservation and other mitigation measures.

Tire word 'Environment' used in other situations are built environment, geo-environment, business environment, economic environment, political environment etc.

1.1.1.4 Ecology versus Environment

The concept of environment is based upon the themes of ecology. In 1859 St. Hilarie, the French Zoologist proposed the term *Ethology.* Later in 1868 Charles Ritter, the German Scientist, proposed the term *Oikology* derived from the Greek words *oikos* (meaning house) and logos (meaning a study); the literal meaning of which is 'organisms at home'. But it was not until 1869 that Earnest Haeckel, the English Biologist elaborated the meaning of the term Ecology by saying "Ecology is the study of totality of pattern or relations between organisms and their environment.

There is a certain relationship between ecology and environment. Basically Ecology is the study of structure and function of nature, mankind being a part of the nature; and Ecosystem is a self-sustaining community organisms, plants and animals taken together with its inorganic environment. In this unit there exists an interrelationship between biotic and abiotic factors through a system of exchange of energy and matter. The living and non-living in an ecosystem exist in a symbiotic relationship where a state of equilibrium is always maintained. Environmental science on the other hand is the aspect of science, which deals with environment, both biotic and abiotic, their impact on other and their interaction and cohesion which result in various ecosystems both terrestrial and marine.

1.1.1.5 Scope of the study

Scope of the study of environmental issues and awareness about it gradually developed since the termination of the Second World War in the mid-forties of the 20th century when, through practical experiences, man realized that some serious threats already started emerging from his physical and socio-economic surroundings owing to uncontrolled and excessive interference in the biosphere. This concern grew largely as a result of :

i) Calamities and catastrophes occurred under the direct impact of the war, *viz.*, explosion of atom bombs in Japan and other environmental degradation occurred in the aftermath of the war.

ii) Rapid growth of population as well as expansion of urbanization. The Southeast Asian, African and Latin American countries experienced rapid growth of population and faced food shortage.

iii) Interference and mass exploitation of natural resources in the so far untouched virgin lands (the Biomes of Tropical and Temperate forests, Arctic and Alpine environments), and

iv) Increasing use of chemical products in agriculture as fertilizer and in industry as dyers and petroleum products (for vehicles) discharging lethal wastes that become detrimental to the so far maintained quality of the nature (land, water, vegetation and atmosphere).

1.1.1.6 Contents of the environmental issues

Contents of the environmental issues in geography are multidimensional. They can be summarized as follows :

First, the concepts relate to the understanding of the classified form of environment, viz., natural and human environments are very important. This covers man-environment interrelationships with respect to population growth, human occupation, economy and technology.

Second, is the study of natural resources—their exploitation and management.

Third, the study of environmental hazards and disasters affecting the human beings is very important

Fourth, comes the study of the varied nature in physical, economic and human environments covering primary activities, social and demographic disparities and economic inequalities—their causes and consequences.

Fifth, is the study of emerging environmental issues like population explosion, deforestation, global wanning and the need and suggested pattern of biodiversity conservation.

Sixth, comes the important aspect of environmental management for sustainable development This covers planning for local regional and national development with special reference to our country India.

1.1.2 PHYSICAL COMPONENTS OF ENVIRONMENT

Physical system of the environment has four basic components, *viz.* atmosphere, hydrosphere, lithosphere and biosphere. Continuous interactions are going on among these components. These interactions involve the transport or transformation of elements, compounds and also various energy forms.

1.1.2.1 Atmosphere

The atmosphere, as we observe today, is the gaseous envelope around the earth.

Although the fluid system forms gaseous envelope around the earth, its boundaries are not easily defined. They can be arbitrarily defined as the earth's atmosphere interface and the space interface.

The gases like Nitrogen, Oxygen, Carbon dioxide; Argon, Neon, water vapour etc together make up the total volume of atmosphere. Together with suspended particles, viz., dust and soot, constitute the gaseous turbidity particularly in Troposphere. In terms of temperature condition, depth and vertical extension atmosphere has two major successions : **1) *Homosphere,*** and **2) *Heterosphere***. From the surface of the earth upto about 100 km the chemical composition, i.e., the proportion of different gases remains unchanged; this part is called *Homosphere.* Beyond this the proportion various widely and this part is called *Heterosphere*. The lower zone of the Homosphere is referred to as *Troposphere* and the upper is the *Mesosphere.* These are separated by a little mixing in which the atmosphere tends towards a layered structure referred to as the *Stratosphere.* Between the Troposphere and the Stratosphere is the *Tropopause* which marks the approximate upper limit of mixing in the lower atmosphere. The average height of Troposphere is about 11 km, but this varies over the earth. In tropical latitude its average height is 16 km and in polar latitude it is only 10 km there is one further zone of heating, above the *Mesosphere,* and more than 90 km above the earth's surface, where short wave ultra-violet radiation is absorbed by any oxygen molecules present at this height. This is referred to as *hermosphere.* Beyond the Thermosphere at a height of approximately 700 km, lies the exposure where the atmosphere has an extremely low density. About 99% of the total mass of the atmosphere lies within the Troposphere and Stratosphere. Concentration of O_3 forms a layer extending from the upper part of the Troposphere (at about 15 km above the earth's surface) throught the lower half of the Stratosphere (up to about 28 km above the earth's surface). This is known as ***Ozone Layer*** and it protects the entire Biosphere by absorbing the incoming Ultraviolet Ray from the sun.

1.1.2.2 Hydrosphere

It includes the surface water and its surrounding interface. It is vital for life molecule to survive. Water possesses a number of physical and chemical properties that help the molecule to act as best suited medium for life activities. The movement of water from earth surface to atmosphere through hydrological cycle appears to be a close system. Water is the most abundant substance on the earth's surface. The oceans cover approximately 71% of the planet, glaciers and ice caps cover additional areas; and water is also found in lakes and streams, in soils and underground reservoirs, in the atmosphere, and in the bodies of all living organisms.

Humans use water in the home, in industry, in agriculture and for recreation. These applications differ widely in the quantities and quality of the water that they require. ID one way or another, we use all available sources—inland waters, ground water, and even ocean water. The demand for global water resources increased day by day through pure fresh water availability decreased severely.

1.1.2.3 Lithosphere

It is the outer boundary layer of solid earth and the discontinuity within the mantle. The outer boundary forms a complex interface with the atmosphere and hydrosphere and is also the environment in which life has evolved. The inner boundary is adjacent to rock, which is near its melting point and is capable of motion relative to the Hthosphere above. Basically Hthosphere is nothing but a crucial system composed of various layers; core mantle and outer crust. Various elements constitute such crustal layer in mixture of different proportion. In general the earth's crust is composed of three major classes of rocks : igneous rocks, sedimentary rocks and metamorphic rocks. There are two types of crusts—continental crust which is composed of granitic rocks in silicon aluminium and with a mean density of 2.8, the other, oceanic crust with is basaltic in composition, consisting of more basic minerals and has a mean density of 3.0. Overall, the average density of the earth is 5.5 gm/cc.

Interaction between the crustal system of the Hthosphere and the atmosphere and biosphere takes place where continental crust is exposed above sea level. At the land-air interface crustal material becomes exposed to inputs of solar radiant energy, precipitation and atmospheric gases. Under the influence of these inputs, crustal rocks are broken down by weathering processes and are transformed to fine porous layer called soil.

1.1.2.4 Biosphere

The Biosphere encompasses all the zones on the earth in which life is present, i.e., entire bio-resources of the earth. It developed on the earth since 4.5 billion years through evolutionary processes. At the top of the Hthosphere, throughout the hydrosphere and into the lower atmosphere life of diverse type exists. These bio-resources and their surrounding constitute the ***Biosphere,*** where mankind is acting as the most evolved creature.

The steps involved in the origin of life on earth are very complex and requires several centuries. Considerable uncertainty surrounds the details of atmospheric composition, the processes involved and even the sequence of some events leading to

formation of living cells. The conventional view has been that the earliest organism on the plant was a heterotrophic prokaryotic bacterium. Subsequently autotrophic prokaryotes and eukaryotes start appearing as stepwise evolutionary changes.

Life on earth requires water, a source of energy (sun light) and variour nutrients found in the soil, water and air. Suitable comination of these essentials can not be found high in the upper atmosphere or deep underground. They exist only in a narrow layer near the surface of the earth. This biosphere layer extends over most of the surface of the earth. It includes the upper layers of the earth's crust and the thin layer of the soil that supports plants life. The zone of life also extends about 8 km up into the atmosphere (air biome biota) and as much as 8 km down into the depths of the sea. Living organisms are not distributed uniformly on globe; only a few organisms survive on polar ice caps and glaciers, where as a wide range of them live in tropical rainforests.

Within the biosphere there are several major regions containing specific types of ecosystems. These major regions are called *biomes.* Biomes are then recognized by the types of dominant ecosystems—tropical rainforests, temperate forests, prairies, deserts, and arctic tundra. The ecosystem is again composed of population and population is composed of individuals. The following table gives details of the number of species exist in the biosphere :

Class	**Identified species**	**Estimated species**
Mammals	4,170	43,000
Birds	8,715	9,000
Reptiles	5,115	6,000
Amphibians	3,125	3,500
Fishes	21,000	23,000
Investebrates	13,00,000	4,40,000
Vascular plants	2,50,000	2,80,000
Non-vascular plants	1,50,000	2,00,000
Rounded Total	***17,42,000***	***49,26,000***

Source : World Resource Institute, 1986

1.1.3 Model Questions

1) Give definition of the term ‘Environment and discuss the ingredients of it as proposed by the European Commission.

2) Make a discussion on Ecology vs. Environment.

3) Describe the physical components of the environment.

1.1.4 Select Readings

- Golly Frank B : A Primer for Environmental Literacy, University Press, Hyderabad
- Mukhopadhyay, A. D. (2003): Perspectives and Issues in Environmental Studies, Vidyasagar University, Medinipur
- Santra, S. C. (2001) : Environmental Science, New Central Book Agency, Kolkata
- Sharma, P. D. (2000) : Ecology and Environment, Rastogi Publications, Meerut
- Singh Savindra (2000) : Environmental Geography, Prayag Pustak Bhawan, Allahabad

Unit 1.2 ❑ Socio-cultural Components of Environment

Structure

1.2.1 Introduction

Knowledge of the physical environment can illuminate only one-half of any environmental issue. Hence after assuming the conditions and aspects of physical environment it is essential to have a clear about the human environment. As because it is always important to know the extent to and pattern of which the human beings respond to the physical environmental conditions in which they live.

Relationships between human activity and the natural world have changed greatly in the relatively short time that people have been present on the earth. A very large increase in human population, along v'ith widespread urbanization associated with advances in technology and related developments of economic, political and social structures have all combined to make the interaction between humankind and nature very different from the situation just a few thousand years ago.

Pre-historic human inhabitants responded to the physical environmental conditions, to large extent, morbidly and instinctively and to a limited extent cautiously. With the passage of time the development of ability of humans to conceive environment allowed them to formalize their view of the interactions with the physical environment

1.2.2 Human forces behind environmental issues

The interactions between humankind and the physical environment result from our attempts to satisfy real and perceived needs and wants. The specific actions include such

things as modifying natural distributions of vegetation and animal, overusing soils, polluting water and air and living in hazardous areas.

1.2.2.1 Housing and Sanitation

Housing is the prime need of the human beings. In the primary stage of civilization when he lived on hunting and food gathering, he did not have any permanent shelter. Afterwards he learn the art of farming and started living permanently in favourable places. He learnt how to build proper shelters in the form of huts and cottages. Later with development of civil engineering technology he improved housing conditions with proper sanitation systems. The remains of ancient civilizations, tike those of Indus valley *(Mahendjo daro* and *Harppa*), Nile valley (Egypt) bear the evidences of highly improved housing as well as sanitation systems of the urban areas with which they substantially improved their life style in the ancient days thus dominated over the natural environmental conditions. In the present day development of proper housing and sanitation system is the prime need of the mankind living in both rural and urban areas of the society. The housing and sanitation are also conditions for human health and hygiene, these reflect the income and education levels of the people. Higher the education and income level (as in the developed countries) better is the housing conditions of the people. Thus developed countries are ahead of the rest of the world in exercising controls over the physical environmental conditions of the earth.

1.2.2.2 Health and Nutrition

Man’s victory over his physical environment has become possible largely due to the improvement in health during the past century. Health is directly associated with nutrition and again nutrition depends upon the status and condition of food supply. Physical factors of environment, like air, water, climate, light, noise etc. influence the health status in any community. Human resource in any country is largely dependent upon nutrition and health.

In most developing countries, defective environment continues to be the main reason of health problem. Man has partially altered almost everything in his physical environment including hydrosphere, lithosphere, biosphere and atmosphere for his temporary benefits. In doing so, he has created for himself a host of new health problems such as pollutions on soils, water, air and others.

In 1072 WHO (World Health Organisation) has compiled a wide ranging survey on

environmental hazards to human health. On this survey, a new branch of social medicine has developed which is known as *Environmental Sanitation.* The term 'Environmental Sanitation' has been defined by WHO as "the control of all those factors in man's physical environment which exercise or may exercise a deleterious effect on his physical environment, health and survival".

The demographic growth and fast urbanization all over the world have been making profound changes on the socio-economic and socio-cultural environments. Therefore the attainment of a healthy environment becomes increasingly complex.

1.2.2.3 Health Hazards

Throughout the developing world, the greatest environmental health threats tend to be those closer to home. Many of these countries live in situations that imperil their health through steady exposure to biological pathogens in the immediate environment. More than one billion people in the developing countries live without adequate shelter or in unacceptable housing, more than 1.4 billion lack accesse to safe water, and more than 2.9 billion people have no access to adequate sanitation—all of which are essential for good hygiene. Unable to afford clean fuel, the poor rely instead on biomass fuel for cooking and heating. Inside the smoky dwellings of developing countries air pollution is often higher than it is outdoors in the world's most congested cities.

Such problems, historically considered rural, have now become urban as well, as sprawling slum settlements surround the world's major cities. Risks are compounded in these peri-urban settlements where garbage collection is often non-existent and drainage tends to be poor, creating ideal conditions for insects and other disease vectors. Overcrowding increases the risk of disease transmission.

In developing countries, the poorest strata are often excluded from the benefits of emerging prosperity and may also face a disproportionate share of health risks related to economic growth. Urban slums may be located near major roads and factories where waste disposal and polluted air cause serious health hazards.

1.2.2.4 Levels of Income and Education

The levels of income and education finally determine the status of socio-cultural environment. Education makes decisive improvements of the cultural level of the society. This helps man to perceive the natural ecosystem gives him expertise to keep up with

the system in the best possible way. Thus better the education level of man, higher is man's ability to adjust with the environmental condition and utilize environmental elements to improve his living condition. Education also teaches man how to handle the hazard situation, manage the disasters in the human environment. Teducation and income are to a great extent complementary to each other. While education makes up gradation of the society, the status of the society income supports man make his living condition better. The level of income is much higher in the educated society. Hence capacity of handling the environmental adversities and expertise in making best use of the natural environment for the betterment of the living condition increase.

In terms of economic development, today's world is quite sharply divided between economically backward (poor) and economically developed (wealthy) countries. As the disproportionate burden of ill health in the poorest country shows, a clear correlation between health and wealth. By and large wealthier a country, or the higher its average per capita income, the healthier would be its population.

Why is the link between health and wealth so strong? At the most fundamental level many of the world* s poorest of the poor, the 1.3 billion who live on less than Rs. 15/ - a day, are unable to secure even the bare necessities for a healthy life—adequate food, water, clothing, shelter and health care. One of the major causes of ill health globally is malnutrition, which are an issue of poverty and rarely an indicator of actual food shortages. Most recent estimates indicate that globally there are 158 million children under age 5 who are malnourished. By one estimate, malnutrition accounted for roughly 12 percent of all dathsin'1990.

1.2.3 Model Questions

1) Discuss the importance of human forces behind the environmental issues.
2) Discuss the role of conditions of housing, sanitation health and nutrition in reforming the structure of the socio-cultural components of the environment.
3) Discuss the impacts of health, hygiene, levels of Income and Education on the human society.

1.2.4 Select Readings

- Mukhopadhyay, A. D. (2003): Perspectives and Issues in Environmental Stadies, Vidyasagar University, Medinipur.
- Population and Development Goals, Oxford University Press, Kolkata.
- Santra, S: C. (2001) : Environmental Science, New Central Book Agency, Kolkata.
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- United Nations Population Fund (1997) : India : Towards.

Unit 1.3 ❑ Concept of Holistic Environment, Degradation, Hazards and Disaster

Structure

1.3.1 What is a Holistic Environment

A Holistic Environment is a building or location that does not need extra ordinary adaptation for any “Special” Group of people. It is a place that has been modified or predestined for everyone’s use and enjoyment throughout their life times.

An environment for ones lifetime includes way finding, multi-model transportation, building, auditing and environmental impact analysis and understanding, and comprehensive integral design concepts.

1.3.2 Comprehensive Integral Design

Working with the engineers and architects to assist in using the above elements in an environment in order to create a holistic environment that can support the conceptual design of the architect and engineer without compromising the importance and inclusion of the holistic elements of a design.

The inclusion of holistic environmental design concepts leads to a more universal configuration by :

1. Comprehensive thinking by engineers, designers and architects.
2. Fostering development for a continuing culture of understanding that values the holistic vision of human communities by municipal, state and federal entities.
3. Stringent enforcement of public that address holistic design.

New aspects that are missing from most programs include

1. Tactile Way finding
2. Full Sensory Signage
3. Sound, vibration and the impact of sound distribution within environments
4. Textural surfacing for natural environments
5. Studies of how people have navigated natural environments by reading the lay of the land
6. The physiology of motion in a designed environment

1.3.3 Environmental Degradation, Hazard and Disaster

Any kind of quality deterioration of the environment is called **Environmental degradation.** Environmental degradation occurs in most cases due to undue interference in the environmental system by the human being. Thus it is more of anthropogenic than a natural process.

As general people assumes ***Disaster*** is a state of total devastation in the existing environment, which extensively affects human beings as well as all living beings on the

earth. These events, whether caused by natural processes or through human interferences, are virtually the extreme events, which occur very rarely and aggravate natural environmental processes to cause disaster for human society such as sudden tectonic movements causing earthquake and volcanic eruption, continued dry conditions or heavy rains leading to droughts or devastating floods etc. In real sense disasters are brought by some environmental hazards.

It is also understood that *Environmental Hazard* is that extreme event, either natural or man-made which exceeds the tolerance limit within or beyond certain time limits, make adjust difficult, and in total, result in catastrophic loses of property and lives. Therefore two alternative terms, viz., ***Environmental hazards*** and ***Environmental disasters*** are used today to deal with the extreme events whether natural or man-made. *Hazards* are generally taken to be the processes, both natural and anthropogenic, which cause an accident or danger, whereas *Disasters are* sudden extreme events which cause greater and large-scale damages to. the human beings as well as the entire natural environmental system. Hence it can be stated that ***the environmental hazards are the process where as the environmental disasters are the result or responses of the environmental hazards.***

1.3.4 Types and nature of various Natural and Man-made Hazards causing Disasters in Human Environment

The type and nature of various natural ad made hazards, which eventually cause disasters in the human environment, are discussed below :

1.3.4.1 Earthquake

Earthquake is a natural phenomenon; which is unparallel in the suddenness of its occurrence as well as its fury. It is actually a tremor through the earth's crust, which rocks the surface. Huge destruction can be caused in a matter of a few seconds without any prior warning. Earthquakes can neither be prevented nor reliably predicted at the present state of knowledge. They occur repeatedly at regular interval of and with varying intensities in certain areas on the earth, called as seismic belts, which according to present hypothesis, lie on peripheral contacts of large tectonic plate of earth's lithosphere. These plates are constantly subjected to huge tectonic forces tending to move towards or away from the adjoining ones, releasing large amounts of stain energy in the process in the form of earthquake waves. Though not very common as the plate marginal ones,

intra-plate earthquakes also occur due to tectonic adjustment within the plate and sometimes they also become catastrophic.

In India, earthquake activity largely affects the areas of the Himalayan mountain region and in the northeastern India (the North-Eastem Hill States. However, intra-plate earthquakes are also common in peninsular shield area of India, especially the area of Gujarat, Maharashtra and Madhya Pradesh.

Earth quake hazards : The primary hazards caused by earthquakes in a few seconds ground shaking, ground settlement, land and mud slides, soil liquefaction, avalanches etc. These are responsible for collapse and destruction of house, road bridges, railway lines etc.; damage to property and public utility services and finally death and injury to man and animal.

The secondary effects of earthquake results in a few days time, in Tsunamis and seiches for submarine earthquakes, floods due to failure of both artificial and natural dams and levees, across and along the rivers, respectively. It has been observed that during severe earthquakes in the higher reaches of river regime natural darns, are created across the river due to landslides and mass movements, to the downstream of which water level is lowered very rapidly after the earthquake. When the pressure of the impounded water overcomes the strength of such natural damming the dam bursts and the downstream area received flash flood of very high intensity creating havoc. This had happened in the upstream of Brahmaputra River during 1950 in great Assam earthquake. After a violent submarine earthquake the seismic energy, traveling along the interface of sea bottom and water column towards the coast, generates catastrophic Tsunamis in the coastal area. Another ***important secondary adverse effect of disastrous earthquake is the psychological changes and*** traumatic among the survivors requiring counseling and speedy settlement.

Mitigative measures **:** A number of mitigative measures are to be taken to combat the earthquake disaster. They are as follows

i) Collection of all past historical earthquake data; ii) identification of all seismogenic and neo-tectonic faults, their rupture length, periodicity of their episodic movements; iii) preparation of seismogenic and seismic zoning maps; iv) establishment of close network of seismic monitoring stations in vulnerable areas and the data thus generated to be analyzed regularly; v) related studies towards earthquake prediction; vi) study of physical effects of past earthquakes—their spatial and temporal variations, including the study of paleoseismicity; vii) in situ stress measurements; viii). estimation of risk and vulnerability to disaster; ix) adopting proper landuse method and regulation, proper

design parameters, enforcing strict building code based on probabilistic analysis of maximum credible earthquake of the area and x) finally, creating awareness among people and preparedness for timely relief and rehabilitation.

Though pioneering scientific studies of earthquake have been carried out in India after the 1897 Assam earthquake, a lot has remained to,be done based on the state of art of knowledge towards the study for understanding the cause of earthquake, determination of source, predictive research and for mitigative measures even today.

1.3.4.2 Flood

The flood is a condition of partial or complete inundation of normal dry land in a river valley of coastal plain. There are various types of floods, such as, flash or reverie flood, coastal and shoreline flood induced by wave action and tidal effects and backwater flooding induced by variety of conditions that led to damming of rivers. Flash or riverine flood, the most common type of flood, develops from concentrated rainfall or melting of snow into the headwater tributaries, which merge the tributary floods into a single flood-wave along the main channel. Coastal flooding occurs as a result of a) inundation of stream flooding, b) coastal wave action including high tides and c) storm surges. Backwater flood is abrupt waveforms as dammed waters are suddenly released from a dam break or generated as splash wave by a landslide in to the reservoir.

In majority of cases, flooding is caused by a river over spilling its banks/levee due excessive precipitation in a short period in the catchment area combined with inadequate channel capacity associated with aggradation of river bed and inadequate waterways at rail and road crossings. Most important cause of flood hazard is unplanned encroachment of flood plains and lack of control of proper lands. Deforestation and lack of soil conservation and watershed management are causes contributory to flash flood and soil erosion. Structural measures adopted for flood hazard mitigation or for flood control frequently enhance the risk of more severe flood damage.

Out of 329 hectares of land areas of our country, about 44 million hectares is estimated to be liable to flood hazard, thus constituting 13% of the country’s geographical area. Though so far reasonable protection measures have been provided to about 10 million hectares, the intensity of damage due to floods in terms of human lives and area affected has been increasing alarming. The National Flood Commission had estimated in 1978, that the flood-prone area has increased from 25 million hectares at the end of 1960s’ to about 40 million hectares by the mid- 1970s’. Using the same methodology, Centre for science and Environment has found that flood-prone area in

the country by 1984 was 59 million hectares—an extraordinary increase in just six years since 1978.

Mitigation of Flood Hazard **:** So far in India flood control and protection measures include two major aspects, viz. construction of retention structures and storage reservoirs, drainage channel improvement, flood diversion, protective embankments, and b) flood warning and evacuation. These efforts carried out so far have not borne much fruit probably due to the fact that these measures are not planned on the basis of validated data on surface hydrology, climatic conditions, geo-factors of terrain and natural resources of the project area, so that protective structures and their locations can be harmonious with nature.

Though we have no control on the vagaries of nature connected with heavy rains in a very short period. Upliftment of catchment area and subsidence of river basins etc. through understanding of these processes should be attempted and actions be taken. Best way of flood mitigation is to avoid the flood prone area for settlement and for any development activities. Strictly prohibit deforestation in catchment area with simultaneous whole hearted effort to afforestation. It may be mentioned here a good forest canopy removes 40% of precipitation through transportation and canopy interception, and increases the infiltration of water into the soil and decreases soil erosion and mass movement substantially thus reducing silt load of the river channel.

1.3.43 Drought

According to the National Commission on Agriculture (1976) drought is of three types :

i) ***Meteorological drought*** **:** It is a situation when there is a significant (>25%) decrease of rainfall from normal value over an area.

ii) ***Hydrological drought*** **:** Meteorological drought when prolonged, results in hydrological drought with a marked depletion of surface water and consequent drying up of reservoirs, lakes, streams and rivers, cessation of spring flows and also fall in ground water level.

iii) ***Agricultural drought*** **:** It occurs when soil moisture and rainfall are inadequate during the growing season to support healthy crop growth to maturity and causes crop stress and wilting. Almost all the area in the country, which received a normal rainfall of less than 700 mm, can be classified as drought prone. This is about 35% of the country's area. Another 18.5% of the country, which receives a normal rainfall of 750-1,000 mm, can be described as

transitional zone. Thus over a half of the country, without irrigation would be drought prone.

Causes of drought : As is evident from the definition, drought is a natural phenomenon which results from reduction in the usual rainfall in an area; sometime reduction of rainfall in proper season or time. However, there is indirect correction between certain human activities and occurrence of drought viz., deforestation, over exploitation of grazing land* over exploitation of groundwater, neglect of tanks/water reservoirs, inequitable distribution of canal irrigation water. Therefore it is believed that drought is the combined effect of neglect and over exploitation of common environmental resources, essentially the system that provide a cushion against the problems caused by dry periods.

Drought mitigative **measures** : The following measures are recommended for mitigation of drought :

i) It is estimated that about 28.75% of rain and snow melt water received in the country, flows to ocean as surface runoff. Therefore utmost effort will be to retain as much as possible the surface runoff by way of water harvesting especially in the drought prone areas.

ii) To increase the measure of afforestation and development of grassland which help in retaining the soil moisture and water percolation during the rains.

in) Measures leading to regeneration of ground water and controlled exploitation of ground water in problem areas.

iv) Increase the storage capacity of all water retention structures by way of enlargement and desalinization.

v) In some places ground reservoirs must be maintained as ground water sanctuaries and to be used only for drinking water during the period of acute drought.

vi) Effort towards regeneration of all wasteland produced by over exploitation and prevents all types of land degradation in drought prone area.

vii) Mixed cropping to be encouraged in dry land agriculture to reduce risk of crop failure.

Thus it is seen that as the tree cover declines and ecological imbalance grows, this inevitably affects the marginal crop lands, by adversely exposing them to increased floods and droughts.

1.3.4.4 Landslides

A landslide is an event in which surface materials of earth move outward and

downward from their underlying and stable floors in response to the force of gravity. Such movement includes falls, creeps, flows and slides which may be triggered by various factors. Down slope movement of large volumes of surface materials under gravitational influences-poses a serious threat of environmental hazard, especially in mountainous terrain. Rapid movements cause loss of life and damage; slow movements on the other hand have less potential to kill but can be costly for the economic life of the country.

In recent years, landslide risk is increasingworldwide as land hunger forces new developments onto unstable slopes. According to Jones (1992) it is under-recognised threat because the impacts tend to be frequent and small scale, whilst the process itself is often attributed to other hazards, such as earthquakes and rainstorms. During the early 1970s an average of nearly 600 people per year were killed by slope failures worldwide, with som 90% of these deaths occurring around the Pacific Ocean Rim. This zone is particularly susceptible to mass movements because of the combinations of rock type, steep terrain, heavy typhoon rainfall, rapid landuse change and high population density. However, it is likely that most of these deaths would be associated with slope failures caused by seismic events. As with many other environmental hazards, it is urban areas which are most vulnerable because of the large populations at risk (Alexander, 1989). Economic losses due to landslides have been estimated at more than US $ 1 billion per year in several countries. In India, numerous urban centres and transport networks over the Himalayan region stretching from Kashmir in the west to the Arunachal Pradesh in the east are threatened by landslide activity. In addition to direct damage, mass movement hazards cause a variety of indirect losses such as road blockages, flooding due to landslide dams across rivers, reduced agricultural and industrial production.

Sensitive zones for landslide hazards : Jones (1995) claimed that landslides would become an increasingly important hazard, especially in the developing countries and drew attention for several types of terrain where the greatest physical threat exists. These are as follows :

1) Areas subject to seismic shaking : An earthquake can trigger widespread mass movements in thousands of individual slides, as in 1950 Assam (in eastern India) earthquake when over 50 × 109 m^3 of material was dislodged over a total area of 15,000 km^2. Major landsides were also a feature of the 1988 Armenian and the 1990 Iranian earthquakes.

2) Mountain environments with high relative relief : Environmentalists all over the world have estimated that the high-energy mountains such as the Himalaya or the Andes mountain chains produce extensive catastrophic rock fall. These

slope failures comprise huge masses of material (up to 100 × 106 m^3) which at least at the initial stages of movement travel near-vertically at very high velocities and cover long run out distances.

3) Areas of moderate relief suffering severe land degradation : Readily erodable soils on slopes subject to land degradation resulting from deforestation, overgrazing and other poor management practices create the potential for gully expansion and land slipping.

4) Areas covered with thick sheets of loess : Any mantling of an existing surface with finely grained material such as windblown loess is likely to lead to a shear zone with the old surface. Slope failure occurs in the loose cohesion less deposit, often in the form of flow or slides.

5) Areas subject to high rainfall inputs : In tropical areas subject to monsoon or cyclonic rainfall weathering can penetrate tens of metres below the ground surface. Throughout the humid tropics intensively weathered soils produce a relatively deep and porous mantle, which is prone to landslides.

Causes of landslides : Causes of landslide include a variety of events that combine .either to increase the driving force or to reduce the shear resistance on a slope. Factors that increase the driving forces may be either physical or human aid include:

1. An increase in slope angle, which may occur if a stream erodes the bottom of a slope or if the slope is steepended by building work.
2. Removal of any lateral support at the foot of the slope again caused either by natural mass wasting processes or by building activity.
3. Any additional weight placed on the slope, as through the dumping of waste or . house construction. Residential development not only adds weight to the slope through the buildings themselves but also through excess water supplied from landscape irrigation and sewage effluent systems.
4. Removal of vegetation, which can occur naturally from forest fire or through human activities such as logging, overgrazing or construction.
5. Local shocks and vibrations, which can occur naturally *from* seismic activity or from the operation nearby of heavy construction machinery.

Factors that leas to a reduction in the shear resistance on a slope :

a) An increase in pore-water pressure in slope materials, especially along a slip surface. This is the most important single factor and explains the close relationship, which exists between shallowseated landslides, debris flows and rainstorms.

b) An increase in slope angle. Many developed slopes are over-steepended by - cutting into the base, a process, which increases the driving force.

c) A combination of weathering and other natural processes. These include the physical and chemical breakdown of slope materials.

In most urban areas landslides may be attributed to a combination of the above factors. The progressive human invasion of landslide hazard zones is not confined to the wealthy developed world. The need for improved transportation is leading to new road construction in terrain with a high probability of slope movement throughout the developing world. In mis world limited resources may lead to inadequate hazard protection.

Event Modification Adjustments : The ability to assess the probability of landslide risk at specific sites is of considerable assistance in implementing mitigation strategies. General indicators include the structure and lithology of slopes, including the presence of weak rock types, clay-rich soils and slopes generally in excess of 25°. Property damage from landslides usually leads to demands for engineering works to stabilise the slope. However, the human response to slope failure is often complicated by statutory and funding distinctions, which are made between emergency and permanent works. If the problems can be overcome, the stability of the slope may be improved by a variety of engineering techniques :

- Excavation and filling method can be used to produce a more stable average slope. This type of reshaping is usually successful but becomes more difficult and expansive as the slide area increases. Specific techniques include unloading the head of the slide and loading the toe, with the replacement of failed material with lighter loads.
- Drainage, especially sub-surface drainage, can be equally effective where changes in pore-water pressure have been cause by the rise in the water table. Properly designed and constructed drainage systems work well but others soon become clogged by fine particles.
- Vegetation of slopes performs several functions. Plant roots help to bind soil particles together, the vegetation canopy protects the soil surface from rain-splash impact and transpiration processes aid in drying out the slope.
- Restraining structures—such as piles, buttresses and retaining walls—can be helpful for slides covering limited areas. But they are generally too expensive for large, unstable slopes and the location of property boundaries may also restrict the approach.

- Other methods include the chemical stabilisation of slopes and the use of grouting to reduce soil permeability and increase its strength.

Slope stabilisation, along with hazard-resistant construction techniques, appears to be the most effective preventive strategy for controlling new development

1.3.4.5 Severe Storms (Tropical Cyclones)

Tropical cyclones are among the most destructive hazards around the globe. Strong winds, heavy rains, give rise to development of storm surge, flood and landslide. As a result considerable amount of loss of life and property takes place. Such natural hazards set back social and economic advancement of country like India; e.g., devastating storms around the Paradwip coastal tract of Orissa in 1999. The hazards become even worse due to lack of appropriate warning and preparedness system. To reduce loss of lives, suffering and property damage, the nation shall have to strengthen her capability to provide timely warning of occurrence and impact of cyclone and associated phenomena such as floods and storm surges, as well as to organise and execute the related disaster prevention and preparedness measures.

Tropical Cyclones in India: Tropical cyclones over the Bay of Bengal and Arabian Sea are of major concern to coastal people in and around west and east coast of India. Each year considerable number of cyclonic storms hit these coasts. Seven percent of the global tropical cyclones form over the Bay of Bengal and Arabian Sea. Formation of cyclones in these regions is related to seasonal migration of ITCZ. Ratio of cyclones in Bay of Bengal and Arabian Sea is 4 : 1. Tropical cyclones over Bay of Bengal form during pre-monsoon and post-monsoon seasons. During premonsoon phase, they form in The North Bay and travel northwards. Few of them attain the structure of tropical cyclone as the time available for their formation is small. During monsoon phase prevalent high wind shear inhibits their formation. During post-monsoon phase, the available time being sufficient, the depressions turned out to be a cyclonic storm often imparts severe disastrous effect. In post-monsoon phase, the average life of these storms is 4-5 days. Storms of hurricane intensity has average life of 2-4 days (<6 days for global average).

Factors responsible for generation of storm surge and cyclone **:** The following factors are responsible for generation of storm surge and cyclone :

1. In the location of tropical storm, the low-level velocity is twice that in non-developing disturbances. This increases upward motion, cumulus convection and as a result, release of more latent heat. Increased heating due to latent heat release increases horizontal convergence, which again increases relative velocity.

2. Near-equator Carioles parameter is very small. For this reason they **do** not form between 00 and 6° N latitude.

3. Above and around the zone of formation of vertical wind shear should be low. Otherwise latent heat released through convection will be advected away. If during formation upper level divergence is above the lower level convergence, intensification takes place rapidly.

4. Sea-surface temperature should normally be above 27° around the zone of formation.

5. For the formation mature tropical cyclone, the vertical gradient of equivalent potential temperature should be very high. The equivalent potential temperature at sea surface level should higher than that

6. Relative humidity should be high in lower and middle troposphere.

Disaster management on cyclone-affected areas **:** Disaster management on cyclones can be done in two separate and systematic ways : a) by Hazard and Risk Mapping and b) by making Disaster ***Management and Preparedness Programme.***

Through risk mapping potential losses in hazardous areas can be identified. A hazard index is devised to indicate intensity of a hazard. Usually it is numerical grading on the basis of the area's history of past disasters. Real time risk assessment is related to estimation of risk due to impending cyclone and storm surge. On the basis of this assessment, evacuation programmes, arrangement for relief and rehabilitation measures can be undertaken. In such cases, it is needed to forecast the magnitude of wind speed, storm surge height and amount of associated flood accuracy. Better the forecasting capability; the less is the loss of life and property.

Disaster management and preparedness programme covers all the activities of collecting information related to disaster comprising : i) collection and analysis of data on past disasters, ii) risk assessment, iii) prevention and preparedness programme, iv) relief, v) reconstruction, vi) rehabilitation, vii) policy planning and viii) action plan.

Our objective of tropical cyclone and storm surge disaster mitigation programme should be to strengthen the capability of providing:

a) Reliable forecast of tropical cyclone track and intensity and related forecasts of strong winds, quantitative timely assessment of heavy rainfall, quantitative forecast and simulation of storm surge and timely warning to all hazard-prone areas.

b) Promote response to warning and carry out activities at the interface between warning system and users of warning.

c) The required meteorological and hydrological data and assessment of risk and disaster.

d) National disaster preparedness and prevention measures. Natural Disaster Reduction and Management

The reduction of natural hazards and disasters and their management involves : 1) provision of immediate relief measures to disaster affected people, 2) prediction of hazards and disasters and 3) measures of adjustment to natural hazards.

The provision of relief measures to the disaster victims involves several steps to be followed such as i) there should be correct picture of the nature and magnitude of disasters. Very often the news media report their own misconception instead of reporting the real events. This is not done deliberately. The misconceptions about a particular natural event arise because of the personal opinion of the observer or analyzer. It is, therefore desirable for the international communities to respond to the official requests of the concerned government only; ii) priorities must be decided before undertaking the remedial and relief measures. For example, relief measures must be concentrated in the high-density areas of the affected locality. Special resource tools, communication equipment, heavy machines to remove debris, water pumps, cement and technicians are more important than drugs and doctors because the health dangers after disasters are predominantly environmental in character and not medical.

Management of natural hazards involves disaster research and disaster predictions. The predictions of natural hazards may be made on the basis of the study of the past history of the area prone to a particular natural hazard in terms of frequency, recurrence intervals, magnitude and dimension of events, precursor events, nature of causative factors *(e.g.,* possible floods may be forecast on the basis of amount and intensity of rainfall in the catchment area; spotting of the tropical cyclones and local storms near their sources).

Mapping and Monitoring of Natural Hazards and Disasters and global changes in the environmental conditions are very important aspects of disaster management Tliis requires in-depth study of hazard-prone areas at global, regional and local levels. The *INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS (ICSU)* and other organizations have launched several research programmes to study the environmental changes caused by human activities and natural disasters in terms of the mechanisms involved in the genesis of such disasters, their monitoring and mitigation.

1.3.5 Man-induced (Anthropogenic) Hazards and Disasters

Environmental degradation may also occur as a result of undue interference of man on the nature. Any environmental degradation induced by man becomes hazard and disaster when it assumes alarming proportion and causes irreparable loss to human society. Man-induced environmental hazards and disasters may be caused through a variety of human activities both of intentional and unintentional character.

The man-induced environmental hazards and disasters may be classified in three broad categories

i) Man-induced Physical Hazards such as earthquakes, landslides and accelerated rate of soil erosion;

ii) Man-induced Chemical Hazards such as release of toxic chemicals and dumping and exposure at later date of toxic chemicals, nuclear explosion, leakage of crude oil from oil tankers into the oceanic water etc. and

iii) Man-induced Biological Hazards such as population explosion, eutrophication etc.

Earthquakes are certainly natural phenomena and are caused by the endogenetic forces coming from within the earth but certain human activities, such as pumping of water and oil, deep underground mining, blasting of rocks by dynamites for constructional purposes, nuclear, explosion, storage of huge volume of water hi big reservoirs etc. also cause earth tremors of serious consequences. The introduction of additional artificial superintendent load through the construction of large dams and impounding of enormous volume of water in big reservoirs behind the dam causes disequilibria of already isostatically adjusted rocks below the reservoirs or further augment the already fragile structures due to faults and fractures underneath.

The process causes earthquakes of varying intensity, which inflict damage to human life and property. Many major seismic events have been correlated with dams and reservoirs all over the world, such as i) earthquake of 1931 hi Greece due to Marathon Darn constructed in 1929; ii) start of earth trarnours since 1936 around Hoover Darn USA due to creation of Mead Lake in 1935; iii) Koyna earthquake of 1967 (Koyna, Maharashtra in India) due to Koyna reseryoir constructed in 1962; other examples of significant earthquakes caused by dams and reservoirs are of Monteynard and Grandvale in France, Mangla in Pakistan, Kariba in Zambia etc. Underground disturbance due to hydrostatic pressure of water in the reservoirs also causes landslides and earth-flow

along the natural and artificial walls of the reservoirs. It may be pointed out that the intensity of earthquakes has been positively correlated with the levels of the water in the reservoirs.

Dumping of toxic chemical substances in the ground may become hazardous to subsequent colonization of the area concerned by human beings. For example, the ditch dug out in 1892 for the construction of Love Canal in USA was later abandoned, and was thereafter continued to be used as dumping ditch for the industrial wastes. The process of 'dumping of chemical substances went on till 1952 when this dumpsite was colonized by 200 houses as the suburb of Niagara Falls city. The 'TIME BOMB' in the form of toxic chemicals hidden in the dumped canal suddenly burst during the winter of 1976-77 due to heavy rainfall and heavy snow fall which resulted into severe health bazard of alarming proportion as the residents of newly built suburb suffered from higher rate of abortions (among women), blood an liver abnormalities, birth defects, and several kinds of physiological disorders.

Spilling of immense quantity of crude oil from oil tankers into sea water causes rapid rate of spreading of oil slicks which creates disastrous hazard for marine organisms and the human population faces the shortage of food supply. For example the great marine disaster was created because of leakage of 100,000 tons of crude oil from the huge oil tanker, which stnicke the Spanish coast near the Port of La Corunna and exploded on May 12,1976. The oil slicks killed most of the sea organisms meant for human food such as mussels, oysters and clams. Another incident of leakage of crude oil occurred on June 24, 1989 when 5,000,000 tons of crude oil leaked from an oil tanker into Atlantic Ocean.

Unintentional disaster of nuclear establishment becomes most lethal hazards because its adverse effects not only affect plants and animals including man at the time of disaster but they are perpetuated for several years to come and many generations of human beings may continue to suffer from radioactive substances. The disaster of nuclear installation of Ghernobyl (USSR) in 1986 is burning example of such man-induced environmental disaster. The Bhopal (M.P.) Gas Tragedy of Union Carbide Factory in 1984 is another example of lethal environmental hazard caused due to improper maintenance of the gas containers. The dropping of atom bombs on the cities of Nagasaki and Hiroshima (Japan) by the USA in 1945 and resultant nuclear disaster affecting millions of Japanese population is the example of environmental hazard caused by man's intentional actions.

1.3.6 Distinct types of Man-made Environmental Degradation

1. **Degradation of Wildlife** : India presently has more than 15,000 species of higher plants and 80,000 species of animals, constituting respectively 5.2% and 4.3% of all the knowi plants and animals of the world. About 134 species of plants (99 species in the Himalayan region alone), 29 species of mammals, 29 species of birds and three species of reptiles are threatened. Deforestation has destroyed the habitats of birds and other vertebrates and also threatened the survival of many secies of birds and mammals in particular. Significantly the extinction of birds and animals is directly related to the increase in human population in earth planet It is a certain fact that in India the extermination of rich wild life is due to the demands of the first multiplying hungry human population.

2. **Depletion of Ozone layer** : Depletion of Ozone layer in the •Stratosphere has become a serious concern in recent years. The phenomenon is the formation of Ozone hole, which has been occurring locally over the Antarctic continent in the Austral spring, between September and November each year since about 1979. Stratospheric Ozone is very important because it acts as a Ultra-violet Filter, cutting out short-wave ultraviolet radiation from the sun which otherwise would be damaging plants and animals as they have evolved on Earth. In addition, as a result of absorbing this short wave, highly energetic radiation ozone causes a wanning of the upper stratosphere, which influences global air motions. Increase in man-made pollution of atmosphere by nitrogen oxides and more seriously by CFG and CH_4 has given rise to fears that the delicate ozone balance might be shifted, with possibly serious consequences. The processes leading to the ozone hole formation particularly in the Antarctic region.

3. **The Greenhouse effect** : The greenhouse effect arises because the atmosphere is largely transparent to incoming solar radiation, while being quite heavily absorbing to outgoing thermal radiation from the planetary surface and the atmosphere. Of course, the greenhouse effect is a perfectly natural process, which exists whether or not mankind is thought to be modifying the climate. It is the enhancement to the greenhouse effect resulting from man's activities that is liable to destabilize the natural balance. Many different gases in the atmosphere contribute to the greenhouse effect. Among the greenhouse gases CO_2 has a major effect, in that a temperature rise of 0.53-0.79 k is predicted for just a 25% increase in concentration.

4. **El Nino :** The El Nino phenomenon, e.g. 'El Nino is a warm oceanic current affecting the Peruvian coast every 10 years or so*. It is not a process with a clear beginning and end, at least not on the basis of our present understanding. It is system of several coupled phenomena; each interacting with and driving the others and what is not clear is just how a particular cycle of events is triggered. This phenomena occurring as an anomaly of warming atmosphere.

5. **Acid rain and industrial pollution :** With rise of global industrialisation, increasing acidity in natural waters and soils has become a problem. The acidity is associated with the transport and subsequent deposition of sulfur dioxide, nitrogen oxides and their acid oxidation products. Thus much concern was raised in the international platform about the future strategies for combating industrial emission of pollutants, regionally and locally.

6. **Problems with toxic waste, chemicals and radioactive substance disposal:** with gradual rise of mining industries, nuclear power plants and production on of hazardous chemicals all over the world an arena of environmental hazards started during past couple of decades. Hazards related to toxic substances are already exposed after a number of disasters like the Bhopal gas tragedy, Chernobyl nuclear power plant accident etc. Chemical and biological weapons used in wars also significantly deteriorate the global environment Intensive agricultural practices over the past three-four decades also added newer chemicals like insecticides and pesticides in the cropping areas. Many of these chemicals are not only hazardous to biological system but also non-biodegradable, so that they accumulate in biological systems slowly and finally cause long-term damage to the systems.

1.3.7 Degradation and Hazards due to Social problems

13.7.1 Poverty

In terms of economic development, today's world is quite sharply divided between economically backward (poor) and economically developed (wealthy) countries. As the disproportionate burden of ill health in the poorest country shows, a clear correlation exists between health and wealth. By and large wealthier a country becomes, or the higher its average per capita income, the healthier its population becomes, by several measures.

Why is the link between health and wealth so strong? At the most fundamental level many of the world's poorest poor, the 1.3 billion who live on less than Rs. 15/- a day, are unable to secure even the bare necessities for a healthy life—adequate food, water,

clothing, shelter and health care. One of the major causes of ill heaUn globally is malnutrition, which is an issue of poverty and rarely an indicator of actual food shortages. Most recent estimates indicate that globally there are 158 million children undfr age 5 who are malnourished. By one estimate, malnutrition accounted for roughly 12 percent of all deaths in 1990.

1.3.7.2 Urban poverty

Traditionally poverty has been concentrated in rural areas. Yet as the bulk of the world's population shifts from rural to urban areas, poverty is becoming an increasingly urban phenomenon. The World Bank estimates that in 1988 approximately one quarter of the developing world's absolute poor was living in urban areas. By this year of 2000, half of the developing world's absolute poor will be in urban areas. Several factors, including structural adjustment programs, economic crisis, and massive rural-to-urban migration, have contributed to an increasing number of urban poor since the 1980.

Urban poverty is especially pronounced in Latin America. In this region, the absolute number of urban poor already surpasses the number of rural poor. Between 1970 and 1990, the number of urban poor increased from 44 million to 115 million, while the number of rural poor increased from 75 million to 80 million. In Asia, large decreased in the proportion of the population living in poverty were reported for the rapidly growing economies, such as Malaysia, the Republic of Korea and Indonesia. However South Asia is expected to continue to house a large share of the world's urban poor.

Poverty has also risen steeply in the countries of Central and Eastern Europe as they struggle with the transition toward a market economy. Cities that relied heavily on industrial production are experiencing record numbers of unemployed as factories shut down and production is curtailed.

In North America and industrial Europe most of the population, and thus most of the poverty, has been concentrated in urban areas since the beginning of the 20th century. The characteristics of urban poverty, however, are changing. As the manufacturing base of many cities has declined and the middle class has fled to the suburbs, urban poverty has become concentrated in the inner cities and among ethnic minorities, especially hi North America.

1.3.73 Poverty and crime

In the economically backward countries, poverty not only brings health hazards but also ensures series of social problems, particularly crimes. Crime may be fantasy for

groups of young stars in the rich urban sectors of the wealthy countries, but in the economically backward countries steadily growing population aggravates unemployment problem, more numbers of jobless persons generally get involved in crimes like burglary, mugging, robbery etc. In the periurban areas of the rich countries as well where mainly labour-class prople live (like the Ghetto areas around New York and Chicago metropolitan cities in U.S.A.) this problem is obvious, this problem is particularly acute in the slum areas where groups of young unemployed persons, in order to earn money, commit regular violence and crimes around their own areas and alsa spread their icy hands in the other sectors of the city.

13.7A Poverty and social risks

Health hazards : Poverty influences health because it largely determines an individual's environmental risks, as well as assess to resources to deal with those risks.

Throughout the developing worlck the greatest environmental health threats tend tobe those closest to home. Many of these countries live in situations that imperil their health through steady exposure tobiological pathogens in the immediate environment. More than one billion people in the developing countries live without adequate shelter or in unacceptable housing, more than 1.4 billion lack access to safe water, and more than 2.9 billion people have no access to adequate sanitation - all of which are essential for good hygiene. Unable to afford clean fuels, the poor rely instead on biomass fuels for cooking and heating. Inside the smoky dwellings of developing countries air pollution is often higher than it is outdoors in the world's most congested cities.

Such problems, historically considered rural, have now become urban as well, as sprawling slum settlements surround the world's major cities. Risks are compounded in these peri-urban settlements where garbage collection is often non-existent and drainage tends to be poor, creating ideal conditions for insects and other disease vectors. Overcrowding increases the risk of disease transmission.

In developing countries the poorest strata are often excluded from the benefits of emerging prosperity and may also face a disproportionate share of health risks related to economic growth. Urban slums may be located near major roads and factories where waste disposal and polluted air cause serious health hazards.

13.7.5 Urbanisation and Unemployment problems :

Unemployment is a significant problem in most cities in developing countries, because the formal economies of Africa, Asia and Latin America are unable to absorb the enormous influx or workers. Given the urbanisation rates, these cities are now experiencing the demand for new jobs which will be intense: Starting in 1990, it is

estimated that an additional 35 million jobs per year will be required to provide employment to all new labour force participants. As a result, substantial number of the developing world's urban poor makes their living through subsistence activities or informal jobs - namely, production and exchange outside of the formal market. These jobs run the gamut from providing services such as garbage collection and domestic help, to provide goods such as food and building materials in small stores, to small-scale clothing manufacturing. Informal jobs make up an estimated 75 percent of urban employment in many countries in sub-Saharan Africa and between 30 and 50 percent in Latin America.

1.3.8 Model Questions

1) What do you mean by Holistic Environment? Suggest for a Comprehensive Integral Design of holistic environment

2) Make brief discussion on the terms: Environmental Degradation, Hazard and Disaster.

3) Discuss upon causes, consequences and mitigative measures of earthquakes.

4) Make a concise discussion on the environmental hazards created by floods and droughts and suggest for their mitigative measures.

5) Make a concise discussion on the environmental hazards created by landslides and suggest for their mitigative measures.

6) Make a concise discussion on the environmental hazards created by severe storms and suggest for their mitigative measures.

7) Describe some typical hazards and disasters that may be of anthropogenic origin and show their extent of impacts upon the human beings.

1.3.9 Select Readings

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Unit 1.4 ❑ Global Resource Crisis and Sustainable Development

Structure

Part-I.

Part-II.

1.4.1 Introduction of Global Resource Crisis and the Need of Sustainable Development

Sustainable Development is **a** system of development with which a Nation or Society can be able to satisfy its requirements - social, economic and others without jeopardizing the interest of future generations. ***Sustainability*** is a concept on which social and natural scientists, and philosophers have expressed their views from time to time. It is long term as against short-term development, which is to be addressed. The concept of long term overlapping generations brings in certain difficulties in understanding development However, for all operational and practical purposes, policy options and empirical content can determine and justify the length of the time horizon.

Sustainable Development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and the institutional change are all in harmony and enhance both current and future potential to

meet human needs and aspirations (WCED-1987, Report).

The focus in this manner of characterising sustainable development is on a process which links exploitation of resources, investments, technology and institutions with human needs and aspirations. Operationalising sustainable development within this framework is the responsibility of policy makers and administrators. In order to translate policies expressed as employment programmes investments, price supports and transfer of technology, into sustainable development indicators, they need to have information on the current state of production, consumption, employment, prices, distribution of income, and so on. In addition, to conceptualise the links of economic variables with sustainable development, it is essential that the information is supplemented with measures of the services supplied and welfare augmented by non-market assets such as environmental goods and resources, as well as the utility provided by the level.and the quality of their stock, should be monitored carefully. Only then can it be ascertained whether the economic performance of a region or a area is becoming more or less sustainable overtime.

Thus Sustainable Development has been defined in terms of meeting the needs of present generation without compromising the ability of future generations to meet their own needs (WCED, 1987). According to this anthropocentric definition, sustainability becomes meaningless when human survival is under threat Development may be unsustainable due to various reasons such as socio-economic transformation, unequal access to resources and localisation of growth, etc. The basic rule of sustainable development is to harvest the renewable resources at an optimum rate which should not exceed its generation rates (Rennings and Wiggering, 1996).

Resource utilisation at a rate higher than its generation rate will be ecologically unsustainable. But, resource utilisation and a rate below its regeneration capacity may cause economic unsustainability on a regional scale.

Therefore, sustainable development could be defined as ***the management and the conservation of natural resources base and the orientation of technological and institutional change, in such a manner as to ensure the attainment and continued satisfaction of human needs for the present and future generations.*** Such development conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable.

1.4.2 Why the need of Sustainable Development has been felt

During the last centuries population of the world has been growing rapidly. Since

1900 the rate of growth of population declined in Europe, North America and Oceania. But in Africa, Asia and Central and Southe America the population growth has increased. The rapid growth of world population prompted the growth of global production and consumption. Thus a need for immediate and rapid development has been felt aiming at controlling world population growth. Countries with higher population growth rates experienced faster conservation of land to agricultural uses putting additional pressure on land and natural habitats.

It is in fact that in comparison to the demands of world population there is shortage of natural resources. The carrying capacity of the earth is already over-sought and as a consequence citizens of the world must find ways to reduce material consumption. In other words, citizens should try to reduce total resource use taking into account sustainable life style. Sustainable development stresses the need for the people to live within the capacity of nature.

The pursuit for development in such a scenario of population growth vis-a-vis high consumption is only oriented towards a short-term economic goal and is not a sustainable one. Economic Boom and its result on the environment can be understood from the following :

1) Protest against a dam to be built on prime farmland led to killing of four villagers in Madura off Eastern Java.

2) More than one million farmers in Thailand were faced with massive displacement to make way for large-scale tree plantation to supply pulp for the global industry.

3) More than 400 villagers were arrested since 1987 for defending ancestral lands against logging of Sarawark, Malaysia.

4) HOECHST threatened a lawsuit against indigenous workers who decry toxic pesticide poisoning in Philippines.

5) Such instances for instance tussle over land rights and access to natural resources, livelihood and health are erupting more and more in the cauldron of rapidly industrialising south-east Asia in its transformation from traditionally agricultural societies to intensive export oriented economics.

6) Structural shifts in resource use and perceptions of nature, and escalating materialism among a growing urban middle class are driving to the surface fundamental clashes between those who benefit from the economic success and those who are victimised.

7) When primary resources were first exploited population who traditionally lived in forests and coastal areas were direct victims.

8) The countries like Thailand and Philippines have logged so much forests that they have not only a valuable heritage of biodiversity but face severe water shortages and regular floods. They deprive the forests to play their ecological functions

9) The FAO and International Rice Research Institute have in the past year, officially acknowledged that the Green Revolution has failed and rice production has dropped by 1-3% per year.

10) Industrialisation itself has spread pollution in the unprecedented scale in the regions like Bangkok, Djakarta and Manila.

1.4.3 Key elements of Sustainable Development

In the context of the discussion upon Sustainable Development it is worth mentioning that the word "development" so frequently been used in the context of the term "Economic Development". The word ***Sustainable Development*** (SD) carries the meaning of the word' "Development" quite different from' 'Economic Development:'' Development (D) encompasses three sources of development: 1) Social (W) 2) Economic (I) and Environmental (N). This is indicated as D = WIN. This is indicative of the fact that development takes place when social, economic and environmental objectives or any grouping is present in dominant form. Wide recognition of the concept of SD came with the publication of Brutland Commission Report on "Our Common Future" in 1980.

Brutland Commission reaffirmed the basic promises of the UN Declaration on the right to development that "right to development is inalienable human right and human personis the central subject of development". Club of Rome highlighted a further dimension to SD "a sustainable society implicitly connects one that is based on a long-term vision. In that it must foresee the consequence of its diverse activities to ensure that they do not breach the cycles of renewal.

a) Key elements of the concept of Sustainable Development

ILA's (1993) NIEO Committee in its Cairo Conference (UN) noted the following key elements of the concept of sustainable Development :

i) The concept of SD dows not imply limits - not absolute limits but limitations imposed by the present state of technology and social organizations and environmental resources and by the ability of the biosphere to absorve the effect of human activities;

ii) SD requires the needs of all and extending to all the opportunity to fulfill their aspirations for a better life i,e., world in which poverty is endemic and will always be prone to ecological and other catastrophe;

iii) SD requires meeting essential needs that requires not only a new era of economic growth for nations in which the majority are poor, but an assurance that those poor get their full shoe of the resources required to attain their growth.

iv) SD requires that equity would be aided by political systems that secure effective citizens participation in decision making and by greater democracy in international decision making; and

v) SD requires that those who are more affluent adopt life style within the planet's ecological means - their use of energy. For example, rapidly growing populations can increase the pressure on resources

A significant achievement for the Rio conference is the setting up of institutional machinery "Sustainable Development Commission (SDC)" and the adoption of Agenda 21 by different countries into national policies.

b) Principal features of Sustainable Development

SD implies integrated human development It means meeting the basic needs of all and extending opportunity to all to fulfill their aspirations for better life. SD seeks to provide poor with an assurance for full share of resources required to attain the growth. SD symbolizes effective citizen's participation to decision-making and greater democratic process for formulation of international norms and conventions. Thus SD means allround development without causing environmental disaster.

SD is not a static concept or static state of harmony but rather a process of change in which the use of resources, the diversions of investments, the orientation of technological developments an institutional changes are made consistent with future as well as present needs. SD is a relational notion, related to pattern of investment, state of technological development and trend in international change. In fact SD rests on political will/system in international decision-making.

SD is viewed as the mutually beneficial interaction between the legitimate interests of business and the economy, government and the policy, civil society and culture. From this perspective, five dimensions of sustainable development are clearly visible - these are i) Human being, ii) Culture, iii) Polity and iv) Economy and v) Nature.

SD emanates from basic principles of a) equity, b) solidarity and c) duty to cooperate for global development. The principle of Equity aims to achieve a balance between

converging and diverging interests of developed and developing countries.

1.4.4 Sustainable Development – Major transformation in society

To act in a sustainable fashion involves a major transformation in society, focusing on the following actions:

(a) Population stabilizations;

(b) Efficient and effective use natural resources;

(c) Determining environmental limits;

(d) Refining market economies;

(e) Waste reduction and pollution prevention;

(f) New technologies and technology transfer;

(g) Perception attitude and behavioural changes;

(h) Social and cultural development;

(i) Education for all;

(j) Women empowerment;

(k) Integrated environmental system management

Development to be sustainable must meet three fundamental objectives :

1) An economic objective : Production of goods and service through efficiency.

2) An environmental objective : The conservation and prudent management of natural resources (preserving biodiversity and maintaining biological integrity).

3) A social objective : The maintenance and enhance of quality of life (equity being the main characterization).

These objectivesshould take into account the inter-relationship between people, resources, environment and development.

1.4.5 Global Dimensions of Sustainable Development

Numerous international attempts to promote conservation and sustainable development have already been mentioned. These include the establishment of 'UN Environment Programme', the recommendations of organizations, such as the *World Commission on*

Environment and Development, and many international agreements such as the conventions on biological diversity and climate changed signed at UNCD. These and other initiatives have all made a positive contribution, but they have done little to address one of the major underlying difficulties in achieving global sustainability: poverty and the unequal distribution of resources.

Inequalities exist at all levels, but on the global scale an obvious imbalance is evident between North and South. Some minor, if insignificant, attempts have been made to address both debt problems and environmental problems in developing countries by covering part of the external debt of a country into a domestic obligation to support a specific programme.

1.4.6 The Sustainable future

It is important to realize that sustainable development does nit mean no human impact on the environment. Such a situation is impossible to achieve so long as there are people on the planet The ideal scenario to strive for is one in which all environmental impacts can be undertaken consciously, in the full knowledge of the costs and consequences, even though this situation is a long way off, not least because we still have much to learn about the operation of nature. There is a considerable debate over the limits of sustainability but there is a general consensus that we must learn to live together within the means of nature. Ecological sustainability is the simple part of SD concept But socio-economic sustainability is more difficult and potentially contentious concept. The question who gets what (and how) raises the spectre of potential conflict both within and between nations. So far as the sustainability question is concerned the need for shared justice and associated conflict is the scariest and politically taxing part. In other words SD means achieving in an integrated comprehensive pattern the economic health, environmental protection and social equity objectives. SD is in reality concerned about equal consideration between :

i) economic development and environmental quality

ii) technological innovation and community stability

iii) investment in people and investment in infrastructure

Above all it is important to realize that a sustainable future lies in our hands. The need to alter values, beliefs and behaviour should by now be clear.

As a part of Agenda 21 of Rio Summit 1992 the global plan for sustainable development was emphasized as development that embraces economic growth, social

development and environmentl protection. During the Johannesburg Summit (August, 2002) on SD according to the UN Secretary Kafl Annan's report it was highlighted "Progress towards to goals established at Rio has been slower than anticipated and in some respects conditions are worse than they were ten years ago". In Johannesburg Conference UN Secretary General Kafi Annan calling political will "the key issue* said "it was necessary to find practical steps and partnerships, combined with a renewed spirit of global cooperation and solidarity, to create major changes in the way policies and programmes for SD are designed and implemented*'. The Johannesburg Summit report also found that many steps can be taken to make globalisation work for and SD and to jump start implementation efforts. The report also provides a ten-point programme that countries business leaders, non-governmental organizations and leaders of other stakeholders could consider during the preparatory negotiations of the summit. The report put forward the following main factors for which implementation of Agenda 21 have been hampered :

(i) Lack of integrated approach towards policies and programmes related to economic, social and environmental concerns.

(ii) Global utilization of resources beyond the carrying limits of the ecosystem,

(iii) In coherent policies in areas of finance, trade, investment and technology.

(iv) Difficulties in obtaining new technologies by developing countries and fall in developmental assistance.

A large trend of disparities detrimental to the concept of equity, solidarity and global cooperation has been emphasized in the report. These include:

(i) 15% of the world's population who live in high-income countries account for 56% of all the world's consumption, while poorest 40% live in the developing countries account for only 11% consumption. Average household expenses in Africa are 20% less than it was 25 years ago.

(ii) 1.1 billion people still lack access to safer drinking water and about 2.4 billion lake adequate sanitation. Infant death in developing countries amount to 8% of the children population.

(iii) 113 million primary-age school children in developing countries (60% of them girls) are not in school.

(iv) 815 million people in the world are undernourished out of which 777 million in developing regions. The number is declining in Asia but increasing in Africa.

(v) More than 80% of all disease in developing countries are caused by contaminated water, and inadequate sanitation.

(vi) The world will need 17% more fresh water to grow food for growing populations in developing countries and total water use will increase by 40%

(vii) By 2025 two-thirds of the world would live in areas facing moderate to severe water stress.

(viii) 500% of world's major fisheries are fully utilized and 25% are over fished.

(ix) The estimated rate of present day deforestation is 14.6 million hectare a year. Net deforestation rates are highest in South America and in Africa.

(x) Use of energy in developed countries is ten times as much person as people in developing countries.

(xi) Globalisation is yet to be made to work for SD.

(xii) Improvement of livelihood and eradication of poverty in rural and urban areas are essential for SD.

(xiii) Unsustainable pattern of productionand consumption needs to be changed.

(xiv) Improvement health through safe and affordable access to fresh water, a reduction in lead in gasoline and improved air quality.

(xv) Development ofmore renewable and energy efficient technologies and providing access to energy.

(xvi) Fresh water supply improvement, management and its equitable distribution.

(xvii) Providing financial resources and environmentally sound technologies.

(xviii) Strengthening international governance for SD.

Part - n : Ecotourism

1.4.7 Concept of Tourism & Eco-tourism

History of the development of Tourism as an industry : The two words 'Travel' and Tour' maynot be synnymous but they mean almost the same and the most common hobby of man. Traveling is perhaps the oldest hobby and certainly the common habit of human beings maintained ever since the beginning of civilisation. In the ancient times groups of people traveled from place to place in search of better life conditions. Thereafter came the period when many travelers started moving round the world through the continents and over the oceans to discover lands for trading as well as to find better places to live. In the 18th and 19th centuries many geo-scientists and scholars conceded to extensive traveling to enrich their geographical knowledge. German scientist Alexander

Humboldt traveled round the world and wrote as many as forty books. In his famous book *Cosmos* he explained geographically everything he explored in different places. Afterwards his follower Carl Ritter also traveled extensively and on the basis of his wide range of findings composed the famous book ***Erdkunde***.

The studies concerning travel and tour have attracted contemporary geo-scientists, sociologists and economists because of their close association with socio-economic aspects. Today the scientists have identified some basic difference between the usages of the words 'travel' and 'tour'. While travel has some association with activities related with earning, tour is organized purely for enjoyment and pleasure of visiting places of interest Tourism is recognised as the outcome of leisure but all travels cannot be taken as tour.

The concept of tourism in true sense developed in 1937 when a committee of statistical experts of the League of Nations as this committee defined tourists' as people who travel for a period of one day or more in a country other than that in which they reside, and the persons visit a place outside his residential area for a period of less than 24 hours would be identified as *excursionists'.

First authentic book on tourism was published in Switzerland (now the universally famous country for tourism) in 1942 by Prof. Hunzlkar and Prof, Krapf. In 1963, at the UN Conference on Travel and Tourism, held in Rome the basic difference between tourists and excursionists was recommended as follows:

a) Tourists - those making overnight stay at a place on travel for visit

b) Excursionists - Those making only a day visit to a place

The *World Tourism Organisation (WTO)* in 1990 identified the following five motivations for travel and tourism :

a) Educational and Cultural,

b) Social and Historical,

c) Religious and Ethnic,

d) Health and Sports,

e) Relaxation and pleasure.

1.4.8 Tourism versus Eco-Tourism : A conceptual framework

Up till 1950s tourism as a moneymaking industry for many countries (*Viz*. Switzerland, Scotland etc. in Europe and many South-East Asiatic countries) maintained a reasonably clean and attractive image as a harmless business that could bring financial benefits to

their places of origin. However, from 1960s numerous case snidies uncovered the fact that tourism could also upset the ecosystem balance of the environment of a given area. Although apparently tourism is a harmless industry it cannot be considered as completely pollution-free. Uncontrolled tourism can create two-fold environmental pollution : *a) physical,* as well as *b) sodo-cultural.* Physical environmental pollution due to tourism is obvious, as influx of a large number of tourists (i.e. temporary visitors with little care for maintenance of the place to visit) means dumping of additional garbage in the environment in the form of litters on the land surface, destruction of surface vegetation and emissions in the atmosphere. Environmental pollution at the sodo-cultural leel is alarming. If tourism is viewed as a phenomenon of interaction between host and guest cultures, it makes little effect on the culture of guests but the culture of guests leave considerable impression on the host's mind. The structure of society and economy in a particular tourist location, particularly in the developing countries, have been found to be changing rapidly under the growing pressure of high spending and free-living affluent tourists from the developed parts of the world.

Escalation of concern of the quality deterioration of the total environment prompted the WTO (World Tourism Organisation) to make a joint declaration with UNEP (United Nation's Environment Programme) in-1982 as: *"The protection, enhancement and improvement of the various components of man's environment are among the fundamental conditions for the harmonious development of tourism. Similarly, rational management of tourism may contribute to a large extent to protecting and developing the physical environment and cultural heritage as well as improving the quality of life"*

The concept of eco-tourism is the outcome of this global concern over tourism. ***In true sense all forms of tourism appreciating and preserving the environmental quality without disturbing the maintained resource base are considered to be eco-tourism.*** Thus eco-tourism is the development of tourism in a place of interest by maintainingits ecological set up; hence the influx of tourists at any given time must not exceed its total carrying capacity. Eco-tourism offers a form of tourism development, which accepts the principles of sustainability as well as offers economic opportunities.

At present tourism is the largest growing industry in the world accounting for 11% of the world's GDP but India's share is only 0.04% in total international arrivals. In order to earn formidable amount of foreign exchange from tourism to upgrade the country's economy India should concentrate on catering eco-tourists.

The concept of eco-tourism generates a new tourist group in the global tourism

market. These eco-tourists would be the travelers who would be more interested in people, place, customs and culture rather than instant comforts (air-conditioned hotels and bars). Through eco-tourism tourists learn to leave sites of their visits undisturbed and it will be possible to keep tourist places eco-friendly.

1.4.9 Model Questions

1) Describe the need for Sustainable Development in the context of the present resource crisis of the world.

2) Discuss the key elements of Sustainable Development.

3) Make a discussion on the key elements inthe context of themajor transformation in the present society.

4) Write an essay on the global dimension of Sustainable development

5) Discuss the background in which the concept and need of Ecotourism has developed.

6) Assess the key elements and directives to promote ecotourism.

1.4.10 Select Readings

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Unit 2.1 ❑ Soil, Air, Water and Noise Pollution

Structure

The present generation and the coming generations have to solve three grave problems, namely, population, poverty and pollution if they have to survive. Pollution being the most dangerous problem likes cancer in which death is sure but slow. Environment pollution is assuming dangerous proportions all through the globe and India is not free from this poisonous disease. This is the gift of modern living, industrialization and urbanization. Unless timely action is taken we have a forbid and bleak future for the world.

2.1.1 Soil Pollution

As the demand for food has grown very high, there is an increase in field size and mechanization. The increase in Meld size makes it economically viable for the fanner but results in loss of habitat and shelter for wildlife, as hedgerows and copses disappear. When crops are harvested, the naked soil is left open to wind after the heavy machinery has compacted it. Another consequence of more intensive agriculture is the move to monoculture. This is unnatural; it depletes the soil nutrients, allows diseases and pests to spread and, in short, brings into play the use of chemical substances foreign to the environment.

Hence **Soil pollution** is caused by the presence of man-made chemicals or other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage tanks, application of pesticides, percolation of contaminated surface water to subsurface strata, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. The occurrence of this phenomenon is correlated with the degree of industrializations and intensities of chemical usage.

The concern over soil contamination stems primarily from health risks, both of direct contact and from secondary contamination of water supplies. Mapping of contaminated soil sites and the resulting cleanup are time consuming and expensive tasks, requiring

extensive amounts of geology, hydrology, chemistry and computer modeling skills.

2.1.1.1 Ecosystem effects

Not unexpectedly, soil contaminants can have significant deleterious consequences for ecosystems. There are radical soil chemistry changes which can arise from the presence of many hazardous chemicals even at low concentration of the contaminant species. These changes can manifest in the alteration of metabolism of endemic microorganisms and arthropods resident in a given soil environment. The result can be virtual eradication of some of the primary food chain, which in turn have major consequnces for predator or consumer species. Even if the chemical effect on lower life forms is small, the lower pyramid levels of the food chain may ingest alien chemicals, which normally become more concentrated for each consuming rung of the food chain. Many of these effects are now well known, such as the concentration of persistent DDT materials for avian consumers, leading toweakening of egg shells, increased chick mortality and potentially species extinction.

Effects occur to agricultural lands which have certain types of soil contamination. Contaminants typically alter plant metabolism, most commonly to reduce cro yields, This has a secondary effect upon soil conservation, since the languishing crops cannot shield the Earth's soil mantle from erosion phenomena. Some of these chemical contaminants have long half-lives and in other cases derivative chemicals are formed from decay of primary soil contaminants.

2.1.1.2 Causes and Sources of Soil Pollution

- ***Pesticides***

A pesticide is a substance or mixture of substances used to kill a pest A pesticide may be a chemical substance, biological agent (such as a virus or bacteria), antimicrobial, disinfectant or device used against any pest Pests include insects, plant pathogens, weeds, molluscs, birds, mammals, fish, nematodes (roundworms) and microbes that compete with humans for food, destroy property, spread or are a vector for disease or cause a nuisance. Although there are benefits to the use of pesticides, there are also drawbacks, such as potential toxicity to humans and other animals. Pesticides are used to control organisms which are considered harmful. For example, they are used to kill mosquitoes that can transmit potentially deadly diseases like west nile virus, yellow fever, and malaria They can also kill bees, wasps or ants that can cause allergic reactions. Insecticides can protect animals from illnesses that can be caused by parasites such as fleas. Pesticides can prevent sickness in humans that could be caused by mouldy food or diseased produce.

- ***Herbicides***

Herbicides are used to kill weeds, especially on pavements and railways. They are

similar to auxins and most are biodegradable by soil bacteria. However one ?roup derived from trinitrophenol (2:4 D and 2:4:5 T) have the impurity dioxin, which is very toxic and causes fatality even in low concentrations. It also causes spontaneous abortions, haemorrhaging and cancer. Agent Orange (50% 2:4:5 T) was used as a defoliant in Vietnam. Eleven million gallons were used and children born since men to America! soldiers who served in mis conflict, have shown increased physical and mental disabilities compared to the rest of the population. It affects the head of the sperm and the chromosomes inside it.

Another herbicide, much loved by murder story writers, is Paraquat. It is highly toxic but it rapidly degrades in soil due to the action of bacteria and does not kill soil fauna.

- ***Insecticides***

Insecticides are used to rid farms of pests which damage crops. The insects damage not only standing crops but also'stored ones and in the tropics it is reckoned that one third of the total production is lost during food storage. As with fungicides, the first insecticides used in the nineteenth century were inorganic e.g. Paris Green and other compounds of arsenic. Nicotine has also been used since the late eighteenth century. There are now two main groups of synthetic insecticides–

OrganoMorines : Organochlorines include DDT, Aldrin, Dieldrin and BHC. They are cheap to produce, potent and persistent DpT was used on a massive scale from the 1930s, with a peak of 72,000 tonnes used 1970, Then usage fell as the harmful environmental effects were realized, ft was found worldwide in fish and birds and was even discovered in the snow in the Antarctic. It is only slightly soluble in water but is very soluble in the bloodstream. It affects the nervous and endocrine systems and causes the eggshells of birds to lack calcium causing mem to be easily breakable. It is thought to be responsible for the decline of the numbers of birds of prey like ospreys and peregrine falcons in the 1950s - they are now recovering.

As well as increased concentration via the food chain, it is known to enter via permeable membranes, so fish get it through thir gills. As it has low water solubility, it tends to stay at the water surface, so organisms that live there are most affected. DDT found in fish that formed part of the human food chain caused concern, but the levels found in the liver, kidney and brain tissues was less than Ippm and in fat was 10 ppm which was below the level likely to cause harm. However, DDT was banned in Britain and America! to stop the further build up of it in the food chain. The USA exploited this ban and sold DDT to developing countries, who could not afford the expensive replacement chemicals and who did not have such stringent regulations governing the use of pesticides. Some insects have developed a resistance to insecticides.

Organopbosphates : Organophosphates, e.g. parathion, methyl parathion and about

40 other insecticides are available nationally. Parathion ishighly toxic, methyl-parathion is less so and Malathion is generally considered safe as it has low toxicity and is rapidly broken down in the mammalian liver. This group works by preventing normal nerve transmission as cholinesterase is prevented from breaking down the transmitter substance acetylcholine, resulting in uncontrolled muscle movements.

Entry of a variety of pesticides into our water supplies causes concern to environmental groups, as in many cases the long term effects of these specific chemicals is now known.

Restrictions came into force in July 1985 and were so frequently broken that in 1987, formal proceedings were taken against the British government. Britain is still the only European state to use Aldrin and organochlorines, although it was supposed to stop in 1993. East Anglia has the Worst for pesticide contamination of drinking water. Of the 350 pesticides used in Britain, only 50 can be analyzed, which is worrying for the global community.

- ***Mining***

Modern mining projects leave behind distrupted communities, damages landscapes, and polluted water. Mining also affects ground and surface waters, the aquatic life, vegetation, soils, animals, and the human health. Acid mine drainage can cause damage to streams which in return can kill aquatic life. The vast variety of toxic chemicals released by mining activities can harm animals and aquatic life as well as their habitat The average mine disturbs over a thousand acres of land.

- ***Burial***

Burial is the technique used by Jews, Muslims, Christians and other religions with Abrahamic influence, to dispose off the corpse of dead humans and animals. This process leads to regular soil erosiondue to loosening of soil. Also, the decomposing fluids act as poisonous herbicides, pesticides and may even lead to epidemics in surrounding areas. It leads to soil pollution, soil erosion and even water pollution.

- ***Construction***

Construction often puts sediments in rivers and bodies of water. By doing this, natural water filters are damaged. Natural water filters help break down many pollutants before they reach other water bodies. Some harmful chemicals that may run off with water and sediments from construction sites are oils, debris, and paint This can cause damage to soil, aquatic life, and promote hazordous chemicals toget into drinking water. California Integrated Waste Mnagement Board provides more “green building basics” that educates readers about healthy construction.

- ***Increased waste disposal***

In Scotland in 1993,14 million tons of waste was produced. 100,000 tons was special waste and 260,000 tons was controlled waste from other parts of Britain and

abroad 45% of the special waste was in liquid form and 18% was asbestos - radioactive waste was not included. Of the controlled waste, 48% came from the demolition of buildings, 22% from industry, 17% from households and 13% business - only 3% were recycled. 90% of controlled waste was buried in landfill sites and produced2 million tons of methane gas. 1.5% was burned in incinerators and 1.5% were exported to be disposed of or recycled. There are 748 disposal sites inScotland.

Landfills produce leachate, which has to be recycled to keep favourable conditions for microbial activity, methane gas and some carbon dioxide.

There are very few vacant or derelict land sites in the north east of Scotland, as there are few traditional heavy industries or coal/mineral extraction sites. However some areas are contaminated by aromatic hydrocarbons (500 cubic meters).

The Urban Waste Water Treatment Directive allows sewage sludge to be sprayed onto land and the volume is expected to double to 185,000 tons of dry solids in 2005. <!-information should be updated-> This has good agricultural properties due to the high nitrogen and phosphate content In 1990/1991,13% wet weight was sprayed onto 0.13% of the land, however this is expected to rise 15 fold by 2005. There is a need to control this so that pathogenic microorganisms do not get into water courses and to ensure that there is no accumulation of heavy metals in the top soil.

2.1.13 Cleanup options

Cleanup or remediation is analyzed, by environmental scientists who utilize field measurement of soil chemicals and also apply computer models for analyzing transport and fate of soil chemicals. Thousands of soil contamination cases are currently in active cleanup across the U.S. as of 2006. There are several principal strategies for remediation :

- Excavate soil and take it to a disposal site away from ready pathways for human or sensitive ecosystem contact. This technique also applies to dreadging of bay muds containing toxins.
- Aeration of soils at the contaminated site (with attendant risk of creating air pollution)
- Thermal remediation by introduction of heat to raise subsurface temperatures sufficiently high to volatiz chemical contaminants out of the soil for vapour extraction. Technologies include ISTD, electrical resistance heating (ERH), and ET-DSP^{tm}.
- Biorernedianon, involving microbial digestion of certain organic chemicals. Techniques used in bioremediation include landfarming, biostimulation and bioaugmentating soil biota with commercially available microflora.
- Extraction of groundwater or soil vapour with an active electromechanical system, with subsequent stripping of the contaminants from the extract.
- Containment of the soil contaminants (such as by capping or paving over in place).

2.1.1.4 How to Reduce Land Pollution

There are many ways to help reduce land pollution. Some ideas are listed below.

- Use reusable materials
- Do not litter
- Recycle
- Purchase products with little packaging to throw away (buy in bulk if possible)
- Use safer alternative pesticides
- Buy organic grown fruits
- Buy biogradeable products

2.1.2 Water Pollution

Water pollution is the contamination of water bodies such as lakes, rivers, oceans, and groundwater. All water pollution affects organisms and plants that live in these water bodies and in almost all cases the effect is damaging either to individual species and populations but also to the natural biological communities. It occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful constituents.

Water pollution is a major problem in the global context. It has been suggested that it is the leading worldwide cause of deaths and diseases, and that it accounts for the deaths of more than 14,000 people daily. In addition to the acute problems of water pollution in developing countries, industrialized countries continue to struggle with pollution as well. In the most recent national report on water quality in the United States, 45 percent of assessed stream miles, 47 percent of assessed lake acres, and 32 percent of assessed bay and estuarine square miles were classified as polluted.

Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, like serving as drinking water, and/ or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish. Natural phenomena such as volcanoes, algae blooms, and earthquakes also cause major changes in water quality and the ecological status of water. Water pollution has many causes and characteristics.

2.1.2.1 Water pollution categories

Surface water and groundwatr have often been studied and managed as separate resources, although they are interrelated. Sources of surface water pollution are generally grouped into two categories based on their origin.

- ***Point source pollution***

Point source pollution refers to contaminants that enter a waterway through a discrete conveyance, such as a pipe or ditch. Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain. The U.S. Clean Water Act (CWA) defines point source for regulatory enforcement purposes.

- ***Non-point source pollution***

Non-point source (NFS) pollution refers to diffuse contamination that does not originate from a single discrete source. NFS pollution is often accumulative effect of small amounts of contaminants gathered from a large area. Nutrient run off in storm-water from "sheet flow" over an agricultural field or a forest are sometimes cited as examples of NFS pollutioa

Contaminated storm-water washed off of parking lots, roads and highways, called urban runoff, is sometimes included under the category of NFS pollution. However, this runoff is typically channeled into storm drain systems and discharged through pipes to local surface waters, and is a point source. The CWA definition of point source was amended in 1987 to include municipal storm sewer systems, as well as industrial storm-water, such as from construction sites.

- ***Groundwater pollution***

Interactions between groundwater and surface water are complex. Consequently, groundwater pollution, sometimes referred to as groundwater contamination, is not as easily classified as surface water pollution. By its very nature, groundwater aquifers are susceptible to contamination from sources that may not directly affect surface water bodies, and the distinction of point vs. non-point source may be irrelevant. A spill of a chemical contaminant on soil, located away from a surface water body, may not necessarily create point source or non-point source pollution, but nonetheless may contaminate the aquifer below. Analysis of groundwater contamination may focus on soil characteristics and hydrology, as well as the nature of the contaminant itself.

The substances which degrade water quality are known as water pollutants. The major sources of pollutants are: ***1) Natural sources,*** and ***2) Anthropogenic sources.*** *Natural sources* of water pollutants include soil erosion, landslides, coastal and cliff erosion, volcanic eruption and decomposition of plant and animal bodies. *Anthropogenic sources* are the real sources of water pollution today. These include industrial, urban and agricultural sources.

Urban sources contributes water pollutants such as sewage, huge quantity of municipal and domestic garbage, and industrial effluents from the industrial units located in the urban centres, fallouts of paniculate matter at automobile exhausts etc.

Various types of chemicals used in the chemical fertilizers, pesticides and herbicides

are the pollutants, which are derived *from* agricultural sources. These chemical substances are brought to the rivers and lakes through surface runoff caused by rainfall and are also moved downward by infiltrating rainwater to reach ground water.

Industrial sources pollute streams, rivers, lakes and coastal waters through industrial effluents, solid and dissolved chemical pollutants and numerous metals. Besides, fallout of radioactive substances is very dangerous source of both air and water pollution.

2.1.2.2 Identification of Sources of Pollution

The important sources of water pollution, as have been identified, are ***(i) sewage and other waste, (ii) industrial effluents, (iii) agricultural discharges,*** and ***(iv) industrial wastes*** from chemical industries, fossil fuel plants (thermal power plants) and nuclear power plants. Each of these sources of pollution carries a variety of pollutants that enter our water bodies. Following are the sources of water pollution and kind of the pollutants spread by them :

(i) Sewage and other waste

Sewage is the watr borne waste derived from domestic waste and animal or food processing plants. It includes human excreta, paper, cloth, soap, detergents etc. These are a major proportion of pollutants entering in our water. There is uncontrolled dumping of wastes of rural areas, towns and cities into ponds, lakes, streams or rivers. Due to continuous accumulation of sewage and other wastes in these water bodies, they loose the ability to recycle them and self-regulatory capability is lost Decomposition of these wastes by aerobic microbs decreases due to higher level of pollution. The self-purifying ability of the water is lost and water becomes unfit for drinking and other domestic uses.

Phosphates are the major ingredients of most detergents. They favour the luxuriant growth of algae which form water blooms. This extensive algal growth also consumes most of the available oxygen from water. This decrease in O_2 level becomes detrimental to growth of other organisms, which produces a foul smell upon decay. Some decomposing plants are known to produce toxins as strychnine, which kills animals including cattle.

One of the most common primary sources of water pollution is the discharge of untreated or partly treated sewage in water bodies, sometimes due to improper sewage handling procsses of municipal bodies. This is not uncommon in major cities. Such adischarge of sewage and other wastes in water results into depltion of oxygen levels of water, and stimulation of algal growth.

Biological oxygen demand (BOD)

BOD is the amount of oxygen required for biological oxidation by microbes in any unit volume of water. The test is done at 20°C for at least five days. BOD values generally approximate the amount of oxydisable organic matter, and are therefore, used a measure of

degree of water pollution and waste level. Thus mostly BOD value is proportional to the amount of organic waste present in water. Hence due to addtion of sewage and waste, oxygen level declines, which is reflected in terms of BOD value of water.

BOD values are thus useful in evaluation of self-purification capacity of a water body and for possible control measures of pollution. The quantity of oxygen in water (Dissolvd Oxygen—DO) along with BOD is indicated by the kind of organisms present in water. Thus fish becomes rare at DO value of 4 to 5 ppm of water. Further decrease in DO value may lead to increase in anaerobic bacteria.

Eutrophication

Due to addition of domestic waste (sewage), phosphates, nitrates etc. form wastes or their decomposition products in water bodies, toey become rich in nutrients, phosphates and nitrate ions. Thus with the passage of these nutrients through such organic wastes the water bodies become highly productive or eutrophic and the phenomenon is known as eutrophication. It must be remembered that ponds lakes etc. during their early stages of formation are relatively barren and nutrient-deficient thus supporting no or very poor aquatic life. This state of these bodies is known as oligotrophic. With the addition of nutrients, there is stimulated luxuriant growth of algae in water. There is also generally a shift in algal flora, blue-green algae begin to predominate. These start forming algal blooms, floating scum or blankets of algae. The algal blooms compete with other aquatic plants for light for photosynthesis. Thus oxygen level is depleted. Moreover, these blooms also release some toxic chemicals, which kill fish, birds and other animals, thus water begins to stink.

***(ii) Industrial effluents* :**

A wide variety of both organic and inorganic pollutants are present in effluents from breweries, tanneries, dying textiles, paper and pulp mills, steel industries, mining operations etc.. The pollutants includes oils, gases, plastics, plasticisers, metallic wastes, suspended solids, phenols, toxins, acids, salts, dyes, cyanides, DDT etc, many of which are not readily susceptible to degradation and thus cause serious pollution problems.

(iii) Agricultural discharges :

These include chiefly the chemicals used as fertilizers and the pesticides used in disease control. Their discharges reach into the water bodies. As compared to developed countries India has relatively a low use of these chemicals, thus discharges into water are still low. But the rate at which their use is being increased now it is apparent that this would enhance pollution in the coming years.

a) Artificial Fertilisers : Modem agriculture rely heavily on a wide range of synthetic chemicals which include different types of fertilizers and biocides (pesticides, herbicids

etc). These chemicals along with waste are wasted off lands through irrigation, rainfall, drainage etc. reaching into the rivers, lakes streams etc. where they disturb the natural ecosystem.

Artificial fertilizers crowd out useful minerals naturally present in the topsoil. The microbes (bacteria, fungi, worms etc) in top soil enrich the humus and help to produce nutrients to be taken up by the plant and later by animals. But fertiliser-enriched soil cannot support microbial life and hence there is less humus and less nutrients and the soil can easily become poor and eroded by wind and rain.

b) Pesticides and biocides : Pesticides are the chemicals used with water for killing the plant and animal pests. It is a general term that includes bactericides, fungicides, nematicides, insecticides and herbicides. .The long-range effects of such biocides are in fact a threat to our ecological security.

(iv) Industrial wastes

The two chief water pollutants of this category are heat and radioactive substances. These are the wastes chiefly from power plants—thermal and nuclear, which use large quantities of water. Some other industries also give of wastewater after use. Nuclear power plants are the source of radionuclide.

The quantity of wastewater is highest in the thermal power plants in the country. This waste water is returned after use at very high temperatures to the streams, rivers and lakes. This affects the aquatic life in these water bodies.

This is also known as ***thermal pollution*** since heat acts as a pollutant. Similarly nuclear power plants, besides causingfallout problems, also release waste heat. This also contributes to thermal pollution. Some plants and animals are killed outright by the very hot water. Though wastewater from nuclear power plant not as hot, but still has adverse effects on aquatic life.

2.1.2.3 Ground Water Pollution

As the industrialisation progressed most of the underground sources of drinking water, especially in the outskirts of larger cities and villages of the developing countries have become polluted to a certain extent. For instance Trans-Yamuna areas of Delhi face drinking water pollution problem at regular intervals. There had been epidemics of cholera, dysentery and other diseases over the last five years. This has been mainly due to inadequate water supply system in these areas. Ground water is now threatened with pollution from seepage pits, refuse dumps, septic tanks and different other pollutants. Important sources of ground watr pollution are sewage and other water otherwise. Raw sewage is dumped in shallow soak pits. This gives birth go cholera, hepatitis, dysentery etc, especially in areas with high water table. The industries of woolens, bicycles in aras of Punjab (Ludhiana) and Haryana (Ambala, Sonepat) contribute high amounts of Ni,

Fe, Cu, Cr and Cyanides to ground water.

2.1.2.4 Marine Pollution

The condition of marine pollution continues to aggravate in the present day. The main source of marine pollution (pollution in the coastal water) is the rivers discharging waters in the sea. All that what do rivers carry ultimately ends up in the seas. On their way to the sea, rivers receive huge amounts of sewage, garbage, agricultural discharge, and biocides, including heavy metals. These all are added to the sea. Besides this discharge of oils and petroleum products and dumping of radionuclides waste into sea also cause marine pollution. Huge quantity of planstic is being added to sea and oceans. Over 50 million pounds plastic packing material is being dumped in the sea of commercial fleets, whereas over 300 million pounds entering through inland waterways in USA. Many marine birds ingest plastic that causes gastrointestinal disorders. The chemical principle in PCBS causes more damage as thinning of eggshell and tissue damage of egg. Radionuclide waste in sea includes Sr-90, Csl37, Pu-239 and Pu-240.

In marine water the most serious pollutant is oil, particularly when afloat on sea. Spill in oil and petroleum product due to accidents or due to deliberate discharge of oil-polluted waste brings about pollution. About 285 million gallons of oil are spilled in the ocean each year, mostly from transport tankers. This is enough to coat a beach 20 ft wide with half an inch oil layer for 8,633 miles. Oil pollution cause damage to marine flora and fauna including algae, fish, birds, and invertebrates. About 50,000 to 25,000 birds are killed every year by oil. Hydrocarbons and benzpyrene accumulate in food chain and consumption of fish by man may cause cancer.

2.1.2.5 Mercury Pollution

Mercury enters water naturally as well as through industrial effluents. It is a potent hazardous substance. Both inorganic and organic forms are highly poisonous. Methyl mercury gives off vapours. Mercury was responsible for the Mina Mata epidemic that caused several deaths in Japan and Sweden. The tragedy had occurred due to consumption of heavily mercury-contaminated fish by the villagers. The source of mercury to the bay was a single chloride producing plant, using Hgel2 as a catalyst. In Sweden many rivers and lakes are already polluted due to widespread use of mercury compounds as fungicides and algaecides in paper and pulp industries and in agriculture. Chloral alkali plants sem to be the chief source of mercury contaminating effluents. Paper and pulp industries of Japan and Canada also cause mercury pollution. Effluents of industris making switches, batteries, thermometer, fluorescent light tubes and high intensity street lamps also contain mercury.

The symptom of Mina Mata includes malaise, numbness, visual disturbance, dysphasia, ataxia, mental deterioration, convulsions and finally death. Mercury readily

penetrated in the central nervous system of children born in Mina Mata causing teratogenic effects. Methyl mercury penetrates through placenta. Swedish fish eaters have high mercury content in blood.

2.1.2.6 Lead Pollution

The chief source of lead to watris the effluents oflead and lead processing industries. The children may chew lead toys. Painters also have a risk oflead consumption. In some plastic pipes lead is used as stabiliser. The water may become contaminated in these pipes. Lead is also used in insecticides, food, beverages, ointments and medicinal concoctions for flavouring and sweetening.

Lead pollution causes damage to liver and kidney, reducing in hemoglobin formation, mental retardation and abnormalities in fertility and pregnancy. Chronic lead poisoning may cause three general disease syndromes: i) gastrointestinal disorders, ii) neuromuscular effects (leadlapsy)-weakness, fatigue, muscular atrophy, and iii) central nervous system effects or CNS Syndrom that may result to coma and death.

2.1.3.7 Fluoride Pollution

Fluoride, as in the case of air, may regularly present in water and soil. In nature it is found as fluoride. The crop plants grown in high-fluoride soils in agricultural, non-industrial areas had fluoride content as high as high as 300 ppm. In Haryana and Punjab consumption of fluoride-rich water from wells caused epidemic fluorisis. In Andhra Pradesh also high fluoride content caused dental fluorisis. In our country this problem has more severe in Rajasthan. This has already crippled about 3.5 lakh persons in state. Many people in Rajasthan have humped back due to high fluoride content in water sources in arid and semi-arid zopes. Prolonged intake of fluoride containing water stiffens the bone joints, particularly of spinal cord.

2.1.2.8 Biological Pollution

There are three main sources of Biological Pollution : i) urban liquid and solid waste (largest amount of pollution), ii) dead bodies of animals and humans, and iii) wallowing of cattle.

The urbanwaste is mostly in the form of shear faucal matter that also goes into the river as surface run off. Since the river is used for mass bathing at Rishikesh, Hardwar and Allahabad, there is problem of water-borne diseases. The problem is particularly serious with downstream of Kanpur.

2.1.2.9 Prevention and control of Water Pollution

Biodegradable pollutants alone are not responsible for water pollution though these indicate level of pollution (through BOD values). Besides these a substantial pollution

load is contributed by non dgradable and slow degrading pollutants, such as heavy metals, mineral oils, biocides, plastic materials etc. that are dumped into water. For biodegradable pollutants, pollution may be controlled at sources by their treatment for rescue and recycling. The non-degradable toxic substances can be removed from water by suitable method.

In addition to these methods, some standards, conditions and requirements are to be legally enforced by the government through Acts. The various ways and techniques suggested for control of water pollution are as follows :

a) Stabilisation of the ecosystem

This is the most scientific way to control water pollution. The basic principles involved are the reduction in waste input (thus control at source), harvesting and removal of biomass, trapping of nutrients, fish management and aeration. Various methods may be used (biological as well as physical) to restore species diversity and ecological balance in the water body to prevent pollution.

b) Re-utilisation and recycling of waste

Various kinds of waste which, include industrial effluents (as paper pulp or other industrial chemicals), sewage of municipal and other systems and thermal pollutants (waste water etc) may be recycled to beneficial use. For instance urban waste may be recycled to generate cheaper fuel gas and electricity. The NEERI, Nagpur could develop technology .for management of radioactive wastes and chemical wastes of atomic power plants, reclamation of wastewater and to supply cheap piped gas and generate electricity by recycle of urban waste. In Okhla, New Delhi one large treatment plant for sewage recycles is already in operation. NEERI is also involved in development of suitable technology for wastewater reclamation through aquaculture, utilisation of domestic and industrial wastewaterin agriculture and detoxification of phenol and cyanides in waste by biological means. One distillery of Gujarat is able to treat 450,000 litres of waste daily and generating energy equal to the produced by ten tons of coal.

c) Removal of pollutants

Various pollutants (radioactive, chemical, and biological) present in the water body can be removed by appropriate methods-such as adsorption, electro dialysis, ion exchange, reverse-osmosis etc. Reverse-osmosis is based on the removal of salts and other substances by forcing the water through a semi permeable membrane under a pressure exceeding the osmotic pressure. Due to this, flow occurs in reverse direction. For this, we use a powers membrane that attracts the solvent and repulses the solute. Reverse osmosis is commonly used to desalinate the brackish water and can also be used to desalinate the brackish Water and can also be used for purifying water from sewage.

2.1.3 Air Pollution

Our atmosphere is a gaseous envelope which surrounds the earth and air is a mechanical mixute of a number of gases, mainly nitrogen (78.09), oxygen (20.95%), argon (0.93%) and carbon dioxide (0.03). The atmosphere has always been a sink or a place for deposition and storage for gaseous or paniculate wastes. When the amount of waste entering the atmosphere in an area exceeds the ability of the atmosphere to disperse or degrade the pollutants, problems occur. In general sense air pollution may be defined as the disequilibria condition of the air caused due to introduction of foreign elements from natural as well as anthropogenic sources to the air so that the air looses its freshness and become injurious to communities of biosphere in general and human community in particular. The main target of this module is to explain:

- to find the major categories and sourcs of air pollutants.
- to find the conditions of how air pollution problems vary from place to place.
- to find the conditions of human activities polluting the air exceeding the natural abilities of atmosphere to remove wastes.
- to find the environmental impacts of the acid rain and discover the controlling condition for its reduction
- to find the methods which are useful in the collection, capture or retention of pollutants before they ener the atmosphere.

2.1.3.1 Sources and Types of Air Pollutants

Many of the pollutants in our atmosphere have natural as well as human rlated origins. Major sources of air pollution are Natural Sources (volcanic eruption, deflation of sands and dusts, wild firs etc.) and Man-made Sources (industries, urban centres, automobiles, aircrafts, agriculture, power plants etc, A General outline of the pollutants of natural and anthropogenic (man-made) sourcs is given below :

(I) ***Pollutants from natural sources :***

Pollutants from natural sources can be classified as follows:

a) from volcanoes : dust, ashes, smoke, carbon dioxide, and other gases.

b) from extra-terrstrial bodies : cosmic dust, dust produced due to collision of asteroids, meteors, comets etc. with the earth.

c) from green plants : vapour through evaporation, pollen of plant flowers, carbon dioxide from bacteria.

d) From fungi : fungal spores; viruses.

e) From land surface : salt spray from seas and oceans, dusts and soil particles from ground surface.

(II) Pollutants from anthropogenic sources :

Pollutants from man-made sourcs are the following :

a) gases from kitchen and domestic hating, industries, incineration of domestic and municipal garbage, automobiles, mostly from coals and diesel engines, air crafts etc.

b) solid or particulat matter from industries, mines and urban centres

c) radio-active substancs from nuclear plants, nuclear fuel releases, nuclear explosions.

d) heat from industries and domestic kitchens.

2.13.2 Categories on the basis of the nature of pollutants

Air pollutants can also be divided in terms of categories on the basis of the nature of pollutants. They are : ***1) Particulate matter pollutants, and 2) Gaseous pollutants.***

1. Particulate air pollutants

Particulate air pollutants are identified as *a) Aerosols,* those fine particls which are around one micron to 10 microns in size; these are added to the atmosphere by industry, power generation, automobiles, space heating, agricultural activities; ***b) Smokes,*** Soot and Fumes are smaller than aerosols in size and are added to the atmosphere through the incineration of municipal and domestic wastes, power plants and almost all types of manufacturing procsses; and, ***c) Dusts,*** include those solid particles which are larger than aerosols in size. These are added to the atmosphere from all types of combustions and agriculture. Particulate pollutants are also divided into *i) viable of living type* (such as bacteria, pollen grain, fungal and other spores, all of which belong to the category of natural air pollutants), and *ii) non-living type* (all of the pollutants whether gases or particulat from man-made sources as referrd to above).

2. Gaseous air pollutants

These are identified as *a) Carbon dioxid* (CO_2), *Carbon monoxide* (CO) from combustion of fossil fuls; transportation, industrial processes and garbage disposal; *b) Hydrocarbons,* from incomplete combustion of fuels; *c) Fluorocarbons* from aerosol cans, and refrigration systems; *d) Sulfur compounds* such as sulfur dioxide (SO_2) and sulfur trioxide (SO_3), Hydrogen Suiphid (H_2S) and H_2SO_4 (sulfuric acid) from the burning of sulfur containing fossil fuls; *e) Nitrogen oxides* and other nitrogenous compounds such, as Nitrous oxide (N_2O), Nitric oxide (NO), nitrogen oxide (NO_2) and Nitrogen trioxide (NO_3) from high-flying air crafts, combustion of fuels and chemical fertilizers; *f*) *Aldehydes* from thermal decomposition of fats, oils or glycerol and *g) Chlorine* from bleaching cotton cloths and flour and many other chemical procsses.

It may be pointed out that burning of fossil fuels (coal, petroleum and natural gas) in the factories, in the automobiles, diesel rail engines, air crafts and at homes releases most of the gaseous pollutants such as carbon monoxide (CO), carbon dioxide (CO_2), various oxides of nitrogen (NO, NO_2, NO_3) and particulate matter such as ash, dusts, moke, soot, water vapour into the atmosphere and thus these pollutants constitute major portion of air pollutants.

2.1.3.3 Major Gases and Matters Contributing to Air Pollution

Air polluting gases are usually classified in terms of their levels of influence, thy are : ***Primary*** land ***secondary***.

Primary pollutants arc those emitted directly into the air. They include *participates, sulfuric oxid, carbon monoxide, nitrogen oxides* and *hydrocarbons.* **Secondary pollutants** are pollutants produced through reactions btween primary pollutants and normal atmospheric compounds. For exampl, ozone forms over urban areas through reactions of primary pollutants sunlight and natural atmospheric gases. Thus *ozone* is a secondary pollutant that is producd on bright sunny days in areas where there is much primary pollution. Again the primary pollutants that account for nearly all air pollution problems are *carbon monoside, particulates, hydrocarbons, nitrogn oxids,* and *sulfur oxides.* Each year well over a billion metric tons of these materials enter the atmosphere from ***human-relatedprocsses.*** Typical air pollutants have been discussed below :

- ***Sulfur Dioxide (SO_2)***

Sulfur dioxide (SO_2) is a colourless and odorless gas normally present at the earth's surface at low concentration. One of the significant featurs of SO_2 is that one it is emitted into the atmosphere it may be converted through complex reactions to fine particulate sulfate (SO_4). The major anthropogenic source of sulfur dioxid is the burning of fossil fuels, mostly coal in power plants. Another major source comprises of a variety of industrial processes, ranging from petroleum refining to the production of paper, cement and aluminum.

Adverse effects associated with sulfur dioxide depend on the dose or concentration present and include corrosion of paint and metals and injury or death to animals and plants. Crops such as *alfalfa,* cotton and barley are espcially susceptible. Sulfur dioxide is capable of causing sever damage to human and other animal lungs, particularly in the surface form. It is also an important precursor to acid rain.

- ***Nitrogen Oxides (NO_X)***

Nitrogen Oxides (NO_X) are emitted in several forms (NO, NO_2, NO_3 and NO_X refers to the number of oxygen atoms present in the gas molecule). The most important of these is nitrogen dioxide (NO_2), which is a visible yellow brown to reddish brown gas.

A major concern with nitrogen dioxide is that it may be converted by complex reactions in the atmosphere to fine paniculate nitrate (NO_3). Additionally nitrogen dioxide is one of the main pollutants that contribute to the development of smog, as is nitrogen dioxide, NO. Nearly all nitrogen dioxide is emitted from anthropogenic sources: the two major contributors are automobiles and power plants that bum fossil fuels.

The environmental effects of nitrogen dioxides on humans are variabl but include the irritation of eyes, nose, throat, and lungs and increased suscptibility to viral infections, including influenza. Nitrogen oxides suppress plant growth and damage leaf tissue. When the oxides are converted to their nitrate form in the atmospher, they impair visibility. However, when nitrat is deposited on the soil, it can promote plant growth.

- ***Carbon Monoxide (CO)***

Carbon monoxide (CO) is a colourless odorless gas that at very low concntrations is extremely toxic to humans and other animals. The high toxicity results from a striking physiological effect, namely, that carbon monoxide and hemoglobin in blood have strong natural attraction for one another. Hemoglobin in our blood will take up carbon monoxide nearly 250 times more rapidly than oxygen. Therefore, if there is any carbon monoxide in the vicinity, a person will take it in very rapidly with potentially dire effects. Many people have been unintentionally asphyxiated by carbon monoxide produced from incomplete combustion of fuels in campers, tents and houses. The effect depends on the dose or concntration of exposur and range from dizziness and hadaches to death. Carbon monoxid is particularly hazardous to people with known heart disease, anemia, or respiratory disease. In addition it may cause birth defects, including mental retardation and impairment of growth of the fetus. Finally, the effects of carbon monoxide tend to be worse at higher altituds, where oxygen Ivels are naturally lower.

Approximately 90% of the carbon monoxide in the atmosphere comes from natural sourcs, and the other 10% comes mainly from fires, automobiles and otheer sourcs of incomplt burning of organic compounds. Concntrations of carbon monoxide can build up and cause serious health effects in a localized area.

- ***Photochemical Oxidants***

Photochemical oxidants result from atmospheric interactions of nitrogen dioxide and sunlight. The most common photochemical oxidant is ozone (03), a colourless gas with a slightly sweet odor. In addition to ozone, a number of photochemical oxidants known as PANs occur with photochemical smog.

Ozone is a form of oxygen in which three atoms of oxygen occur togther rathr than the normal two. Ozone is relatively unstable and reeleases its third oxygen atom readily, so that it oxidizes or burns things more readily and at lower concntrations than does normal oxygen. Ozone is sometimes used to sterilize; for example, bubbling ozone gas

through water is a method used to purify water. The ozone is toxic to and kills bacteria and other organisms in the water. When it is realised into the air or produced in the air, ozone may injure living things.

Chemically ozone is very active, and it has a very short average lifetime in the air. Because of the effect of sunlight on normal oxygen, ozone forms a natural layer high in the atmosphere (Stratosphere). This ozone layer protects us from harmful ultraviolet radiation from the sun. Ozone is considered a pollutant when present above the National Air Quality Standard threshold concentration of 0.12 ppm in the lower atmosphere, but is beneficial in the stratosphere.

The major sources of the chemicals that produce oxidants, and particularly ozone, ate automobiles, fossil fuel burning, and industrial processes that produce nitrogen dioxide. *The* adverse environmental effects of ozone and other oxidants, as with other pollutants, depend in part on the dose or concentration of exposure and include damage to plants and animals as well as to materials such as rubber, paint and textiles.

The effects of ozone on plants can be subtle. At very low concentrations, ozone can reduce growth rates while not producing any visible injury. At higher concentrations, ozone kills leaf tissues, eventually killing entire leaves and if the pollutant levels remain high, killing whole plants. Ozone's effect on animals, including man involves various kinds of damage, especially to the eyes and the respiratory system.

- ***Hydrocarbons***

Hydrocarbons are compounds composed of hydrogen and carbon. There are thousands of such compounds, including natural gas or methane (CH_4), butane (CH_4H_{10}) and propane (CH_3H_8). Analysis of urban air has identified manydifferent hydrocarbons, some of which are much more reactive with sunlight: producing photochemical smog) than others. The potential adverse effects of hydrocarbons are numerous: many at a specific dose or concentration are toxic to plants and animals or may be converted to harmful compounds through complex chemical changes that occur in the atmosphere. Over 80% of the hydrocarbons (which are primary pollutants) that enter the atmosphere are emitted from natural sources. The most important anthropogenic source is the automobile. Hydrocarbons may also escape to the atmosphere when a car's tank is being filled with gasoline or gasoline or gasoline is spilled and it evaporates. Vapour recovery systems on the hoses that feed the gasoline to the tank are now required in many urban areas and heelping to reduce the problem of hydrocarbons escaping while tanks are being filled.

- ***Hydrogen Sulfide***

Hydrogen sulfied (H_2S) is a highly toxic and corrosive gas, easily identified by its rottenegg odor. Hydrogen sulfide is produced from natural sources, such as geysers, swamps, and bogs, as well as from human sources, such as petroleum refining and metal

smelting. The potential effects of hydrogen sulfide include functional damage to plants and health problems ranging from toxicity to death for humans and other animals.

- ***Hydrogen Fluoride***

Hydrogen fluoride (HF) is a gaseous pollutant that is released primarily by aluminum production, coal gasification, and the burning of coal in power plants. Hydrogen fluoride is extremely toxic, and even a small concntration (as low as 1 ppb) may cause-problems for plants and animals.

- ***Other Hazardous Gases***

It is almost a regular feature that the newspapers carry stories of truck or train accident that releases toxic chemicals in a gaseous form into the atmosphere. In these incidents it is often necessary to evacuate people from the area until the leak is repaired. Chlorine gases are often the culprits, but a variety of other materials used in chemical and agricultural processes may be involved.

Another source of air pollution is sewage treatment plants. Urban sewer systems deliver a termendous variety of organic chemicals, including paint thinner, industrial solvents, chloroform and methyl chloride for treatment plants. These materials are not removed in the treatment plants; in fact the treatment processes facilitate the evaporation of the chemicals into the atmosphere, where people may inhale them. Many of the chemicals are toxic or are suspected of causing cancer. It is an alarmingly real fact that treatment plants designed to control water pollution are now becoming sources of air pollution. This situation adds to our understanding that although some pollutants can be moved from one location to another and can even change form (from liquid to gas), we really can not get rid of them as easily as once we thought.

Some chemicals are so toxic that extreme care must be taken to ensure that they do not enter the environment. The danger of such chemicals was tragically demonstrated on December 3, 1984, when a toxic chemical (stored in liquid form) at a pesticide plant leaked, vaporized and formed a toxic cloud that settled over a 641 cm2 area of Bhopal in Madhya Pradesh. The gas leak lasted less than one hour, yet over 2,000 people were killed and more than 15,000 were injured by the gas, which causes severe irritation (burns on contact) to eyes, nose, throat and lungs. Breathing the gas, in concentrations of only a few parts per million, causes violent coughing, swelling of the lungs bleeding and death. Exposure to lower concentrations can cause a variety of problems, including loss of sight.

- ***Paniculate Matter***

Paniculate matter encompasses the small particles of solid or liquid substances that ate releases in to the atmosphere by many activities. Modern farming adds considerable amounts of particulate matter to the atmosphere, as do desertification and volcanic eruptions. Nearly all industrial processes, as well as the burning of fossil fuels, release

pariculate into the atmosphere. Much particulate matter is easily visible as smok, soot or dust; other particulate matter is not easily visible. Included with the particulates are materials such as airborne asbestos particles and small particles of heavy metals, such as arsenic, copper, lead and zinc, which are usually emitted from industrial facilities such as smelters.

Of particular importance with reference to particulates are the very fine particle pollutants less than 2.5 Jim in diameter (2.5 millionths of ammeter). Among the most significant of the fine particulate pollutants are sulfurs and nitrates. These are mostly secondary pollutants produced in the atmosphere through chemical reactions between normal atmospheric constituents and sulfur dioxide and gen oxides. These reactions are particularly important in the formation of sulfuric and nitric acids in the atmosphere. When measured, particulate matter is often referred to as total suspended particulates (TSP).

Particulates affect human health, ecosystems, and the biosphere profoundly. Particulates that enter the lungs may lodge there and have chronic effects on respiration. Certain materials, such as asbestos, are particularly dangerous in this way. Dust raised byroad building and deposited on the surface of green plants may interfere with their absorptions of carbon dioxide and oxygen and their release of water. Heavy dust may affect th breathing animals. Particulates associated with large construction projects may kill organisms and damage large areas, changing species composition, altering food chains and generally affecting ecosystems. In addition, modem industrial processes have greatly increased the total suspended particulates in the earth's atmosphere. Particulates block sunlight and may cause changes in climate. Such changes have lasting effects on the biosphere.

2.1.3.4 Air Pollution in Urban Areas

Wherever there are many sources of air pollutants over a wide area—if we talk about automobile emissions in the great city of Kolkata, mere is a potential for the development of smog. Formation of pollution depends on the topography and on weather conditions, because these factors determine the rate at which pollutants are transported away from their sources and converted to harmless compounds in the air.

Influences of weather condition and topography : Weather conditions can determine whether air pollution is a nuisance or a major health problem. The primary adverse effects of air pollution are damage to green plants and aggravation of chronic illness in people; most of these effects are due to relatively low-level concentrations of toxins over a long period of time.

In the lower atmosphere, restricted circulation associated with inversion layers may lead to pollution events. An ***atmospheric inversion*** occurs when wanner air is found above cooler air, and it poses a particular problem when there is a stagnated air mass. Evaluating meteorological conditions can be extremely helpful in predicting which areas

have potential smog problems. Cities situated in a valley or topographic bowl surrounded by mountains are more susceptible to smog problems than are cities in open plains. Surrounding mountains and the occurrence of temperature inversions prevent the pollutants from being transported by winds and weather systems.

2.1.3.5 Factor considered potential for Urban Air Pollution

The potential for air pollution in urban areas is determined by the following factors:

i) the rate of emission of pollutants per unit area,

ii) the distance of downwind tha a mass of air may move through an urban area,

iii) the average speed of the wind, and finally

iv) the height to which the potential pollutants may be thoroughly mixed in the lower atmosphere.

The concentration of pollutants inthe air is directly proportional to the first two factors as entioned above. That is, as either the emission rate or downwind travel distance increases so will the concentration of pollutants inthe air. The Los Angeles basin in the western U.S.A. provides a good example. If there is a wind from the ocean the coastal side of cities such as Santa Monica or Malibu will experience much less air pollution man will the inland side of those cities. Conversely, if there is a Sana Ana wind coming off the desert and down from the mountains the air will be more polluted at the coast.

Smog (mixture of smoke and fog): There are two major types of smog: Photochemical smog, which is sometimes called L.A.-type smog, or brown air, and sulfurous smog, which is sometimes referred to as London-type smog, gray air, or' industrial smog. Solar radiation is particularly important in the formation of photochemical smog. The reactions occuring in the development of photochemical smog are complex and involve both nitrogen oxides (NO) and organic compounds (hydrocarbons). The development of photochemical smog is directly related to automobile use. Early in the morning when commuter traffic begins to build up, the concentrations of nitrogen oxide (NO) and hydrocarbons begin to increase, At the same time, the amount of nitrogen dioxide NO2 may decrease, because sunlight breaks it down to NO plus atomic oxygen (NO + 0). The atomic oxygen (0) is then free tocombine with molecular oxygen (02) to form ozone (03), so the con concentration of ozone also increases after sunrise, Shortly thereafter, oxidized hydrocarbons react with NO to increase the concentrations of NO2 by mid morning. This reaction causes the NO concentration to decrease and allows ozone to build up, producing the mi-day peakin ozone and minimum in NO. As the smog matures visibility may be greatly reduced owing to light scattering by aerosols.

Sulfurous smog is produced primarily by burning of coal andoil at large power plants. Sulfur oxides and particulartes combine under certain meteorological conditions

to produce concentrated sulfurous smog.

2.1.3.6 Controlling Measures of Air Pollution in Urban Areas

The optimistic view concerning future air pollution in urban areas is that air quality will improve because we know so much about the sources of air pollution and have developed effective ways to reduce pollution. The pessimistic view, however, is that even though we know a lot about the sources and how to reduce pollution, population pressure and econouiics will dictate what is likely to happen hi many parts of the world, and the result will be poorer air quality (more airpollution) in many locations. The actual situation in the beginning of this 20th century and onwards is likely to be a mixture of the optimistic and pessimistic points of view. Large urban areas in developing countries like India will probably experience a reduction in air quality even as they attempt to improve the situation, because the population and economic factors will likely outweigh pollution abatement

Larger urban areas in developed and more affluent countries, however, may well experience improved air quality in thecoming years. A new multifaceted air quality plan involves the entire urban region and includes the following aspects.

- Strategies to discourage automobile use and reduce the number of cars;
- Stricter emission controls for automobiles;
- A requirement for a certain number of zero-pollutant automobiles (electric cars);
- A requirement for gasoline to be reformulated to burn cleaner;
- Improvements in public transportation and incentives for people to use it;
- Mandatory carpooling; and
- Increased controls on industrial activities and household activities that are known to contribute toair pollution.
- Use of clean fuel in cars.
- More use of mass transport.

At the household level, for example, common materials such as paints and solvents will be reformulated so that their fumes will cause less air pollution, and eventually there may be a ban on certain equipment', such as gasoline-powered lawn mowers.

2.1.3.7 Condition of air pollution in the Developing Countries

Cities in the developing countries with burgeoning populations are particularly susceptible to air pollution now and in the future. They do not have adequate financial base to fight air pollution because they are more concerned with basic survival and finding ways to house and feed their growing populations. A good example is the metropolitan city of kolkata with a present population over 16 millions is the largest

urban complex in India next to Mumbai. Cars, buses, trucks, industry and power plants in the Greater Kolkata Metropolitan City emit hundreds of thousands of metric tons of pollutants into the atmosphere each year. It is becoming a rare day, particularly in the drier months of the year, when the stars in the night sky can be seen- clearly, and physicians report that there has been a steady increase in respiratory diseases. Headaches, irritated eyes and sore throats are common when the pollution settles in.

2.13.8 Suggested measures to Control Air Pollution

For both stationary and mobile sources of air pollutants, the most reasonable strategies for control have been to reduce, collect, capture or retain pollutants before they enter the atmosphere. From an environmental viewpoint, reduction of emissions via energy efficiency and conservation measures (burning less fuel) is the preferred strategy. Pollution problems vary in different regions of the world; reducing air pollution requires that strategies that is to be specific sources and type of pollutants.

1) Control on emission of Participates : Particulates emitted from fugitive, point or area stationary sources are much easier to control than are the very small particulates of primary or secondary origin released from mobile sources, such as automobiles. A variety of settlling chambers or collectors are used to control emissions of coarse particulates from power plants and industrial sites by providing a mechanism that causes particles in gases to settle out in location where they may be collected for disposal in landfills. Particulates *from* fugitive sources (such as a waste pile) must be controlled on site so that the wind does not blow them into the atmosphere.

2) Control on Automobile Pollution : Control of pollutants such as carbon monoxide, nitrogen oxides, and hydrocarbons in urban areas is best achieved through pollution-controlled measures for automobiles. Control of these materials will also regulate the ozone in the lower atmosphere, where it forms by reactions with nitrogen oxides and hydrocarbons in the presence of sunlight. The control of nitrogen oxides from automobile exhausts is accomplished by recalculating exhaust gas, diluting the air-to-fuel mixture being burned in the engine. The dilution reduces the temperature of combustion and decreases the oxygen concentration in the burning mixture thus producing fewer nitrogen oxides. The most common device used to remove carbon monoxide and hydrocarbon emissions from automobiles is the exhaust system’s catalytic coverter. Another approach to reducing urban air pollution produced by vehicles revolves around a number of options, most of which aim to reduce the number of cars on the roads.

3) Control on Acid Rain : Acid rain is a particularly troublesome problem because the pollutants that cause it may be emitted long distances—sometimes across national boundaries, from where the actual acid rain falls. The cause of acid precipitation is known. It is known that the only long-term solution involves decreasing emissions of

sulfur dioxide and nitrogen oxides. From an environmental point of view the best strategy is increasing energy efficiency and conservation measures that result in burning less coal in power plants and utilizing nonpolluting alternative energy sources.

4) Control on emission of Sulfur dioxide : Sulfur dioxide emissions can be reduced by abatement measures performed before, during or after combustion. The technology to clean up coal so that it will burn cleanly is already available, although the cost of removing th sulfur makes the fuel more expensive. Cleaning from higher-sulfur coal to lower-sulfur coal seems an obvious solution to reducing the emissions of sulfur dioxide into the atmosphere.

2.1.3.9 Laws of Air Pollution Control

Clean Air Act Amendments of 1990 are comprehensive regulations that address acid rain, toxic emissions, ozone depletion, and automobile exhaust. In confronting acid deposition (acid rain), the amendments establish limits on the maximum permissible emission of sulfur dioxide from utility companies burning coal. The legislation gave the mandate that the emissions be reduced by about 50% to 10 million tons a year by 2000. Toxic emissions into the atmosphere are targeted to be reduced by as much as 90%. Toxins targted are those thought to have the mosf potential for damaging human health, including cancer. Abatement depends heavily on pollution control equipment that will be required for large manufacturers and small businesses alike. Certainly this requirement would undoubtedly result in an increase in the cost of many goods and services, there should be a compensating improvement in the health of people.

Regarding ozone depletion in the atmosphere, the Clean Air Amendments have the goal of ending the production of all *chloflurocarbons* (CFCs) and other chlorine chemicals in steps from the year 2000 to the year 2030.

Airpollution in urban areas is most commonly related to automobile exhaust, Strategis outlined in the legislation include more stringent emission controls on automobiles and requiring cleaner-burning fuels. The aim is to reduce the occurrence the urban smog. Expected impacts of the legislation include increases in the cost of automobile fuels and the price of new automobiles.

2.1.4 Noise Pollution

Noise **pollution (**or **Environmental** noise) isdispleasing human-, animal- or machine-created sound that disrupts the activity or balance of human or animal life. A common form of noise pollution is from **transportation,** principally motor vehicles. The word *noise* cornes from the Latin word *nausea* meaning seasickness.

The source of most noise worldwide is transportation systems, motor vehicle noise, but also including aircraft noise and rail noise. Poor urban planning may give rise to noise pollution, since side-by-side industrial and residential buildings can result in noise pollution in the residential area.

Other sources are ear alarms, emergency service sirens, office equipment, factory machinery, construction work, groundskeeping equipment, barking dogs, appliances, power tools, lighting hum, audio entertainment systems, loudspeakers and noisy people.

2.1.4.1 Measurement of Noise Pollution

A decibel is the standard for the measurement of noise. The zero on a decibel scale is at the threshold of hearing, the lowest sound pressure that can be heard, on the scale. According to Smith, 20 db is whisper, 40 db the noise in a quiet office, 60 db is normal conversation, 80 db is the level at which sound becoms physically painful.

The Noise quantum of some of the cities in our country indicate their pitch in dcibel in the noisiest areas of corresponding cities, e.g. Delhi - 80 db, Kolkata-87, Bombay-85, Chenai-89 db etc.

Three sources of Noise Pollution :- Noise pollution like other pollutants is also a byproduct of industrialization, urbanizations and modern civilization.

Boadly speaking, the noise pollution has two courcs, i.e. industrial and non-industrial. The industrial source includes the noise from various industries and big machines working at a vry high speed and high noise intensity. Non-industrial source of noise includes the noise includes the noise created by transport/vhicular traffic and the neighborhood noise. Noise pollution can also be divided in to two categories, namely, natural and manmad. Most leading noise sources will fall into the following categories: roads traffic, aircraft, railroads, construction, industry, noise in buildings, and consumer products.

2.1.4.2 Sources of Noise Pollution

Following are the major sources of noise pollution:

1. Road Traffic Noise

In the city, the main sources of traffic noiseare te motors and exhaustsystem of autos, smaller trucks, buses, and motorcycle. This type of noise can b augmented by narrow streets and tall buildings, which produce a canyon in which traffic noise reverberates

2. Air Craft Nouse

Now-a-days, the problem of low flying military aircraft has added a new dimension to community annoyance, as the nation seeks to improve its nap-of the earth aircraft operations over national parks, wilderness areas, and other areas previously unaffected by aircraft noise has claimed national attention over recent years.

3. Noise from railroads

The noise from locomotive engines, horns and whistles, and switching and shunting operation in rail yards can impact neighboring communities amd railroad workers. For example, rail car retarders can produce a high frequency, high level screech that can reach peak levels of 120 dB at a distance of 100 feet, whicfc translate to levels as high as 138, or 140 dB at the railroad worker's ear.

4. Construction Noise

The noise from the construction of highways, city streets, and building is a major contributor to the urban scene. Construction noise sources include pneumatic hammers, air compressors, bulldozers, loaders, dump trucks (and their back-up signals), and pavement breakers.

5. *Noise in Industry*

Although industrial noise is one of the less prvalent community noise problems, neighbors of noisy manufacturing plants can b disturbed by sources such as fans, motors, and compressors mounted on the outside of buildings Interior noise can also be transmitted to the community through open windows and doors, and even through building walls. These interior noise sources have significant impacts on industrial workrs, among whom noise induced beaming loss is unfortunately common.

6. Noise in building

Apartment dwellers are often annoyed by noise in their homes, especially when the building is not well designed and constructed. In this case, internal building noise from plumbing, boilers, generators, air conditioners, and fans, can be audible and annoying. Improperly insulated walls and ceilings can reveal the sound of amplified music, voices, footfalls and noisy activities from neighborning units. External noise from emergency vehicles, traffic, refuse collection, and other city noises can be a problem for urban residents, especially when windows are open or insufficiently glazed.

7. *Noise from Consumer products*

Certain household equipment, such as vacuum cleaners and some kitchen appliances have been and continue to be noismakers, although their contribution to the daily noise dose is usually not very large.

4 Harmful Effects

On Human Being, Animal and Property : Noise has always been with the human civilization but it was never so obvious, so intense, so varied & so pervasive as it is seen in the last of this century. Noise pollution makes men more irritable. The effect of noise pollution is multifaceted & intr related. The effects of noise pollution on human being, animal and property are as follows :

2.1.43 Human health effects of Noise Pollution

Noise affects health and behaviour. The unwanted sound is called noise. This unwanted sound can damage physiological and psychological health. Noise pollution can cause annoyance and aggression, hypertension, high stress levels, tinnitus, hearing loss, sleep disturbances, and other harmful effects. Furthermore, stress and hypertension are the leading causes to health problems, whereas tinnitus can lead to forgetfulness, severe depression and at times & panic attacks.

Chronic exposure to noise may cause noise-induced hearing loss. Older males exposed to significant occupational noise demonstrate significantly reduced hearing sensitivity than their non-exposed peers, though differences in hearing sensitivity decrease with time and the two groups are indistinguishable by age 79. A comparison of Maaban tribesmen, who were insignificantly exposed to transportation or industrial noise, to a typical U.S. population showed that chronic exposure to moderately high levels of environmental noise contributes to hearing loss.

High noise levels can contribute to cardiovascular effects and exposure to moderately high levels during a single eight hour period causes a statistical rise in blood pressure of five to ten points and an increase in stress and vasoconstriction leading to the increased blood pressure noted above as well as to increased indidenceof coronary artery disease.

Noise pollution is also a cause of annoyance. A 2005 study by Spanish researchers found that in urban areas households are willing to pay approximately four Euros per decibel per year for noise reduction.

2.1.4.4 Environmental effects

Noise can have a detrimental effect on animals by causing stress, increasing risk of mortality by changing the delicate balance in predator/prey detection and avoidance, and by interfering with their use of sounds in communication especially in relation to reproduction and in navigation. Acoustic overexposure can lead to temporary or permanent loss of hearing.

An impact of noise on animal life is the reduction of usable habitat that noisy areas may cause, which in the case of endangered species may be part of the path to extinction. One of the best known cases of damage caused by noise pollution is the death of certain species of beached whales, brought on-by the loud sound of military sonar.

Noise also makes species communicate louder, which is called Lombard vocal response. Scientists and researchers have conducted experiments that show whales' song length is longer when submarine-detectors are on. If creatures don't "speak" loud enough, their voice will be masked by anthropogenic sounds. These unheard voices might be wanings, finding of prey, or preparations of net-bubbling. When one species begins louder,

it will mask other species' voice, causing the whole ecosystem to eventually speak louder.

European Robins living in urban environments are more likely to sing at night in places with high levels of noise pollution during the day, suggesting that they sing at night because it is quieter, and their message can propagate through the environment more clearly. Interestingly, the same study showed that daytime noise was a stronger predictor of nocturnal singing than night-time Light pollution, to which the phenomenon is often attributed.

Zebra finches become less faithful to their partners when exposed to traffic noise. This could alter a population's evolutionary trajectory by selecting traits, sapping resourcs normally devoted to other activities and thus lead to profound genetic and evolutionary consequences.

2.1.4.5 Mitigation and control of noise

Technology to mitigate or remove noise can be applied as follows :

There are a variety of strategies for mitigating roadway noise including: use of noise barriers, limitation of vehicle speeds, alteration of roadway surface texture, limitation of heavy vehicles, use of traffic controls that smooth vehicle flow to reduce braking and acceleration, and tyre design. An important factor in applying these strategies is a computer model for roadway noise, that is capable of addressing local topography, meteorology, traffic operations and hypothetical mitigation. Costs of building-in mitigation can be modest, provided these solutions are sought in the planning stage of a roadway project.

Aircraft noise can be reduced, to some extent by design of quieter jet engines, which was pursued vigorously in the 1970s and 1980s. This strategy has brought limited but noticeable reduction of urban sound levels. Reconsideration of operations, such as altering flight paths and time of day runway use, have demonstrated benefits for residential populations near airports. FAA sponsored residential retrofit (insulation) programs initiated in the 1970s has also enjoyed success in reducing interior residential noise hi thousands of residences across the United States.

Exposure of workers to Industrial noise has been addressed since the 1930s. Changes include redesign of industrial equipment, shock mounting assemblies and physical barriers in the workplace.

2.1.4.6 Legal Control

a) Constitution of India

Right to life : - Article 21 of the Constitution guarantees life and personal liberty to all persons. It is well settled by repeated pronouncements of the Supreme Court that right to life enshrined in Article 21 is not of mere survival or existence. It guarantees a

right of persons to life with human dignity. Any one who wishes to live in peace, comfort and quiet within his house has a right to prevent the noise as pollutant reaching him.

Right to Information :- Every one has the right to information know about the norms and conditions on which Government permit the industry which effect the environment.

Right to Religion and Noise :- Right to religion does not include right to perform religious activities on loud speaker and electronic goods which produce high velocity of noise.

Directive Principal of State Policy :- The state has the object to make the environment pollution tree.

Fundamental Duties :- every citizen of the country has the fundamental duty to keep clean environment

b) Cr. P.C. Section 133

Here Section 133 is of great importance. Under Crpc. Section 133 the magisterial court have been empowered to issue order to remove or abate nuisance caused by noise pollution Sec 133 empower an executive magistrate to interfere andremove a public nuisance in the first instance with a conditional order and then with a permanent one. The provision can be utilized in case of nuisance of environment nature. He can adopt immediate measure to prevent danger or injury of a serious land to the public. For prevention of danger to human life, health or safety the magistrate can direct to abstain from certain acts.

c) LP.C. Public Nuisance 26S-29S

Chapter IV of Indian Penal code deals with offences relating to public health, safety, ...decency, morals under Sections 268, 269, 270, 279, 280, 287, 288, 290, 291, 294. Noise pollution can be penalized with the help of above section. Private remedies suits in the area may related to public nuisance under A299. This article includes punishment in case of Public nuisance law of torts covers. A person is guilty of public nuisance who does any act or is guilty of an illegal omission which causes any common injury, danger, or annoyance to the public or to the people in general who dwell or occupy property in the vicinity or which must necessarily cause injury, obstruction danger or annoyance to persons who may have occasion to use any public right A common nuisance is not excused on the ground that it causes some convenience or advantage. Who ver commits a public nuisance in any case not otherwise punishable by this code, shall be punished with fine, which may extend to Rs. 200/-.

d) Law of Torts Noise pollution is considered as civil wrong

Under law of torts, a civil suit can be filed claiming damages for the nuisance. For filing a suit under law of torts a plaintiff is required to comply with some of th requirement of tort of nuisance

e) Factories Act Reduction of Noise and Oil of Machinery

The Factories Act does not contain any specific provision for noise control However, under the Third Schedule Sections 89 and 90 of the Act, noise induced hearing losses mentioned as notifiable disease. Similarly, under the Modal Rules, limits for noise exposure for work zone area have been prescribed.

f) Motor Vehicle Act. Provision Relation to use of horn and change of Engine

In-Motor vehicle Act, rules regarding use of horns and any modification in engine are made.

g) Noise Pollution Control Rule 2000 under Environment Protection Act 1996

Further for better regulation for noise pollution there are The Noise Pollution (Regulation and Control) Rules, 2000 - in order to curb the growing problem of noise pollution the government of India has enacted the noise pollution rules 2000 that includes the following main provisions :

- The state government may categories the areas in the industrial or commercial or residential.
- The ambient air quality standards in respect of noise for different areas have been specified.
- State government shall take measure for abatement of noise including noise emanating from vehicular movement and ensure that the existing noise levels do not exceed the ambient air quality standards specified under these rules.
- Areas not less than 100m around hospitals, educations institutions and court may declare as silence area for the purpose of these rules.
- A loud speaker or a public address system shall not be used except after obtaining written permission from the authority and the same shall not be used at night. Between 10 pm to 6 am.
- A person found violating the provisions as to the maximum noise permissible in any particular area shall be liable to be punished for it as* per the provision of these rules and any other law in force.

2.1.4.7 Conclusions

We have made the law relating to noise pollution but there is need to create general awareness towards the hazardous effects of noise pollution. Particularly, in our country the people generally lack consciousness of the ill effects which noise pollution creates and how the society stand to beneficiary preventing generation and emission of noise pollution. The target area should be educational institutions and more particularly school. The young children of impressionable age should be motivated to desist from

playing with firecrackers, use of high sound producing equipments and instruments on festivals, religious and social functions, family get-togethers and clebrations etc. which cause noise pollution. Suitable chapters can be added into textbooks, which teach civic sense to the children and teach them how to be good and responsible citizen which would include learning by heart of various fundamental duties and that would obliviously include learning not to create nose pollution and to prevent if generated by others. Holding of specil talks and lectures can be organized in the schdbls to highlight the menace of noise pollution and the role of the children in preventing it For these purpose the state must pay its role by the support and cooperation of non-government organizations (NGOs) can also be enlisted.

2.1.5 Model Questions

1) Describe the sources and ecosystem effects of soil pollution.
2) Discuss the role of pesticides, herbicides and insecticides on soil pollution.
3) Discuss how mining, burial, construction and unplanned waste disposal contribute to soil pollution.
4) Suggest the measures of a clean-up operation and reduction of soil pollution.
5) Describe the categories of water pollution with particular reference to ground water.
6) Identify the different sources and their gravity in water pollution.
7) Discuss the characteristics of mercury, lead and fluoride pollution and their impacts on human health.
8) Suggest the measures to control water pollution.
9) Describe the different sources and types of air pollution.
10) Make a discussion on the major gases and matters contributing to air pollution.
11) Discuss the characteristics of air pollution in urban areas and suggest measures of control.
12) What is noise pollution? How is it measured? Identify the major sources of noise pollution.
13) Discuss the effects of noise pollution on human health and suggest mitigative measures and control of noise pollution.

2.1.6 Select Readings

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Unit 2.2 ❑ Conservation of Forests, Wetlands and Biodiversity

Structure

2,2.1 Forest Conservation

The *word* ***forest*** was borrowedby Noddle Englshfrom Old Frenchand Medieval Latin *foresis,* literally meaning "outside". Uses of the word "forest" in English to denote any uninhabited area of non-enclosur are now considered archaic. The word was introduced by th Norman rulers of England as a legal trm (appearing in Latin texts like the Magna Carta) denoting anuncultivatd ara Igally set aside for hunting by feudal nobility. Thes hunting forests were not necessarily wooded land. However, as hunting forests did often include considerable areas of woodland, the word "forest" eventually came to mean wooded land more generally. By the start of the fourteenth century the word appeared in English texts, indicating all three senses : the most common one, the legal term and the archaic usage.

The scientific study of forest species and their interaction with the environment is referred to as forest ecology, while the management of forests is often referred to as forestry. Forest management has changed considerably over the last few cnturies, with rapid changes from the 1980s onwards culminating in a practice now referred to as sustainable forest management, Forest ecologists concentrate on forest patterns and processes, usually with the aim of elucidating cause and effect relationships. Foresters who practice sustainable forest management focus on the integration of ecological, social and economic values, often in consultation with local communities and other stakeholders.

Anthropogenic factors that can affect forests include logging, human-caused forest fires, acid rain, and introduced species, among other things. There are also many natural

factors that can cause changes in forsts over time including forest tires, insects, diseases, weather, competition between species, etc. In 1997, the World Resources Institute recorded that only 20% of the world's original forests remained in large intact tracts of undisturbed forest. More than 75% of these intact forests lie in three countries - the Boreal forests of Russia and Canada and the rainforest of Brazil. In 2006 this information on intact forests was updated using latest available satellite imagery.

Natural forests contain mainly natural patterns of biodiversity in established serial patterns, and they contain mainly species nativ to the region and habitat. The natural formations and processes have not been affected by humans with a frequency or intnsity to change the natural structure and components of the habitat.

Anthropogenic forests have been created by humans or sufficiently affected by humans to change or remove natural serial patterns. They often contain significant elements of species which were originally from other regions or habitats.

2,2,2 Wetland Conservation

2.2.2.1 Definition of Wetlands

In true sense, Wetlands are swamps and marshes formed in low-lying areas but can not be called permanent water bodies. There is much ambiguity about the definition of wetlands. In England, wetlands comprises of large tracts and therefore are synonymous with the name of the region itself like the Fens, Broads, Carrs, Mosses and Levels. Terms such as moors and bogs were often used to describe a particular landscape comprising peat lands and swamps.

2.2.2.2 Importance of Wetlands

Wetlands are one of the most productive ecosystems, comparable to tropical evergreen forests in the biosphere and play a significant role in the ecological sustainability of a region. They are an essential part of human civilisation meeting many crucial needs for life on earth such as drinking water, protein production, water purification, energy, fodder, biodiversity, flood storage, transport, recreation, research-education, sinks and climate stabilizers. The values of wetlands though overlapping, like the cultural, economic and ecological factors, are inseparable. The geomorphological, climatic, hydrological and biotic diversity across continents has contributed to wetland diversity. Across the globe, they are getting extinct due to manifold reasons, including anthropogenic and natural processes. Burgeoning population, intensified human activity, unplanned development, absence of management structure, lack of proper legislation, and lack of awareness about the vital role played by these ecosystems (functions, values, etc.) are the important causes that have contributed to their decline and extinction, With these,

wetlands are permanently destroyed and lose any potential for rehabilitation. This has led to ecological disasters in some areas, at large-scale devastations due to floods etc.

2.2.2.3 Conservation and Management of Wetlands

From the above discussions itcan be realized that with increase in knowledge on wetlands and simultaneous realization that they are rather invaluable to mankin. Thus sonservation and management of wetlands are absolute essential. A range of policies has been adopted depending upon the state of knowledge and the scientific and human capabilities.

The UNCED conference on environment and development as well as global conservation organizations, including RAMSAR convention, have identified the aquatic biodiversity tobe the most threatened of all biodiversities. There is, therefore, an urgent and felt need to conserve the aquatic biodiversity including the ecosystem processes. Wetlands cover an area of about 5.5 million ha, of which 1.5 million ha enjoy complete protection and 1.6 million ha partial protection. India being a developing country supporting the second largest population in the world, having mainly agrarian economy, has a significant impact on all natural resources including that of wetlands. It is in this context, an inventory of th important wetlands is essential. The directory of Asian Wetlands (1989) lists 93 Wetlands of International importance in India. Information on the type and extent of wetlands is lacking in India. Hence, this information is a baseline requirement for forming protected area ntwork and conservation.

However, so far in India there has been no systematic attempt to evolve conservation prserves analogous to terrestrial protected areas. While many developing countries such as China and south-ast Asian countries have progrssed substantially in formulating an action plan for conserving aquatic biodiversity, similar task of identifying such reserves for India is lacking. While acountry like UK could dsignate 161 Ramsar sites, obviously India beinga mga diverse country will have have many morethan the 20 stes presently identified by the national wetland programme. Such a task is daunting given the size, diversity of India. In this paper, we outline a possible approach for identifying important wtland sites taking into account the trmendous advancs made in spatial technology tools. In particular, we demonstrate how tools of remote sensing and geographic information system combined with an extremely well coordinated and organised field programme could contribute to formation of viable national level wetland conservation and monitoring programme.

2.2.3 Biodiversity and Its Conservation

Biotechnology involves the use of all life forms for human welfare. Therefore, extinction of wildspecies and destruction of ecosystms has been a major concern of policy makers and biotechnologists alike. One of the major efforts has been to conduct a survey

and conserve country's biodiversity, so as to save, wild plants andanimals from extinction.

National parks and sanctuaries have been established in many countries to meet this objective. Undere the auspices of the United Nations also, funds are being established and other efforts being made for conservation of germless at the global level. Biodiversity studies thus include the following :

(i) a systematic examination of the full array of organisms on this globe and

(ii) a study of the methods by which diversity can be maintained and used for the benefit of mankind.

A discussion on biodiversity in a book on biotechnology is relevant, because biodiversity is being utilized to provide genes from wild species for biotechnology exercises. In recent years, a discussion on biodiversity has become important also because countries in the North of the hemisphere (developed countries) have been utilizing biodiversity available in the South (developing countries) without paying any compensation.

Several Biodiversity Conventions* were held in 1992 for discussions on measures required to be taken by developing developed countries to preserve the biodiversity at the global level. In this connection the latest Biodiversity Convention was held in May, 1992 at Nairobi to formulate a treaty that was desired to be signed at the UN Conference on Environment and Development (UNCED) later held in Brazil in June 1992.

In this treaty, an agreement was sought by the developed countries to allow, as a matter of right, access of every on the germless or biodiversity available anywhere in the world. Since tropical countries are far richer than temperate countries, such a treaty would benefit only the developed nations.

In view of this, the South (particularly India) had rejected such a treaty desired to be signed in this convention. Such a rejection was also based on the argument that while the convention was meant to globalize the natural resources, it did not want to globalize the benefit derived from biotechnology inventions.

Instead, the developed countries wanted to privatize biotechnology through patents and other intellectual property right (IPR; consult next two chapters for details).

Similarly, to the disadvantage of developing poor countries, the concept of Plant Breeder's Rights (PBRs) was recognized in the North ignoring the Farmers' Rights for compensation desired to be given to poor farmers in the developing countries. Although, most countries agree to the need of preserving biodiversity, there is disagreement on the issue of who will pay for it.

Ecological Reasons for the need of Biodiversity conservation

Individual species and ecosystems have evolved over millions of years into a complex interdependence. This can be viewed as being akin to a vast jigsaw puzzle of inter-locking pieces. If you remove enough of the key pieces on which the framework

is based then the whole picture may be in danger of collapsing. We have no idea how many key 'pieces' we can afford to lose before this might happen, nor even in many cases, which are the key pieces. The ecological arguments for conserving biodiversity are therefore based on the premise that we need to preserve biodiversity in order to maintain our own life support systems.

Two linked issues which are currently of greeat ecological concern include world-wide deforestation and global climate change.

Forests not only harbour untold numbers of different species, but also play a critical role in regulating climate. The destruction of forest, particularly by burning, results in great increases in the amount of carbon in the atmosphere. This happens for two reasons. Firstly, there is a great reduction in the amount .of carbon dioxide taken in by plants for photosynthesis and secondly, burning rleases huge quantities of carbon dioxide into the atmosphere. (The 1997 fires in Indonesia's rain forests are said to have added as much carbon to the atmosphere as all the coal, oil and gasoline burned that year in western Europe.) This is significant because carbon dioxide is one of the main greenhouse gases implicated in the current global warming trend.

2.2.4 Model Questions

1) Examine the need and suggest the measures for forest conservation.

2) Discuss upon the need and management of wetland conservation for maintaining natural and biological ecosystems.

3) Make a discussion on the need and suggested process for Biodiversity conservation

2.2.5 Select Readings

- Mukhopadhyay, A. D. (2003) : Perspectives and Issues in Environmental Stadies, Vidyasagar University, Medinipur.
- Santra, S. C. (2001) : Environmental Science, Nfew Central Book Agency, Kolkata.
- Sharma, P. D. (2000) : Ecology and Environment, Rastogi, Publications, Meerut.
- Singh Savindra (2000) : Environmental Geography, Prayag Pustak Bhawan, Allahabad.
- Frank B. Golly : A Primer for Environmental Literacy. Universities Press, Hyderabad.

Unit 2.3 ❑ Important Protocols at the International Level

Structure

2.3.1 Kyoto Protocol

2.3.1.1 Definition and Introduction

The Kyoto Protocol is a protocol to the United Nations Framework Concention on Climate Change (UNFCCC or FCCC), an international environmental treaty with the goal of achieving stabilization of greenhouse gas concentrations in the atmospher at a level that would prevent dangerous anthropogenic interference with the climate system. The Kyoto Protocol establishes legally binding commitment for the reduction of four greenhouse gases (carbon dioxide, methane, nitrous oxide, sulphur hexafluoride), and two groups of gases (hydrofluorocarbons and perfluorocarbons) produced by “annex I” (industrialized) nations, as well as general commitments for all member countries. As of

January 2009, 1 83 parties have ratified the protocol, which was initially adoptd for use on 11 December 1997 in Kyoto, Japan and which entered into force on 16 Febiuary 2005. Under the Kyoto Protocol, industrialized countries agreed to reduce their collective gren house gas (GHG) emissions by 5.2% from the level in 1990. National limitations range from the reduction of 8% for the European Union and others to 7% for the United Scales, 6% for Japan, and 0% for Russia. The treaty permitted the emission incrases of 3% for Australia and 10% for Iceland.

Kyoto includes defind “flexible mechanisms” such a; Emissions Trading, the Clean Development Mechanism and Joint Implementation to allow annex I economies to meet their GHG emission limitations by purchasing GHG emission reductions credits from elsewhere, through financial exchanges, projects that reduce emissions in non-annex I economies, from other annex I countries, or from annex I countries with excess allowances. In practice this means that non-annex I economies have no GHG emission restrictions, but have financial incentives to develop GHG emission reduction projects to receive “carbon. credits” that can then be sold to annex I buyers, encouraging sustainable development. In addition, the flexible mechanisms allow annex I nations with efficient, low GHG-emitting industries, and high prevailing environmental standards to purchase carbon credits on the world market instead of reducing greenhouse gas emissions domestically. Annex I entities typically will want to acquire carbon credits as cheaply as possible, which non-annex I entities want to maximize the value of carbon credits generated from their domestic Greenhouse Gas Projects.

Among the annex I signatories, all nations have established Designated National Authorities to manage their greenhouse gas portfolios; countries including Japan, Canada, Italy, the Netherlands, Germany, France, Spain and others are actively promoting government carbon funds, supporting multilateral carbon funds intent on purchasing carbon credits from non-annex I countries, and are working closely with their major utility, energy, oil and gas and chemicals conglomerates to acquire greenhouse gas certificates as cheaply as possible. Virtually all of the non-annex I countries have also established Designated National Authorities to manage the Kyoto process, specifically the “CDM process” that determines which GHG Projects they wish to propose for accreditation by ifce CDM Executive Board.

23.1.2 Objectives

Kyoto is intended to cut global emissions of greenhouse gases. The objective is the stabilization and reconstruction of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Th objective of the *Kyoto climate change conference* was to establish a legally binding international agreement, whereby all the participating nations commit themselves

to tackling the issue of global wanning and greenhouse gas emissions. The target agreed upon was an average reduction of 5,2% from 1990 levels by the year 2012.

The Intergovernmental Panel on Climate Change (IPCC) has predicted an average global rise in temperature of 14°C (2.5°F) to 5.8°C (10.4°F) between 1990 and 2100.

Proponents also note that Kyoto is a first step as requirements to meet the UNFCCC will be modified until the objective is met, as required by UNFCCC Article 4.2 (d).

The treaty was negotiated in Kyoto, Japan in December 1997, opened for signature on 16 March 1998, and closed on 15 March 1999. The agreement came into force on 16 February 2005 following ratification by Russia on 18 November 2004. As of 14 January 2009, a total of 183 countries and one regional economic organization (the EC) have ratified the agreement (representing over 63.7% of emissions from annex I countries).

According to article 25 of the protocol, it enters into force on the ninetieth day after the date on which not less than 55 Parties to the Convention, incorporating Parties included in annex I which accounted in total for at least 55% of the total carbon dioxide emissions for 1990 of the Parties included in annex I, have deposited their instruments of ratification, acceptance, approval or accession. Of the two conditions, the “55 parties” clause was reached on 23 May 2002 when Iceland ratified The ratification by Russia on 18 Novmber 2004 satisfied the 55% clause and brought the treaty into force, effective 16 February 2005. Australian Prime Ministr Kevin Rudd ratified the Kyoto protocol on 3 December 2007. This came into effect after 90 days (the end of March 2008), as is stated in the guidelines set by the United Nations.

The five principal concepts of the Kyoto Protocol are :

- commitments to reduce greenhouse gases that are legally binding for annex I countries, as well as general commitments for all member countries;
- Implementation to meet the Protocol objectives, to prepare policies and measures which reduce greenhouse gases; increasing absorption of these gases and use all mechanisms available, such as joint implementation, clean development mechanism and emissions trading; being rewarded with credits which allow more greenhouse gas emissions at home;
- minimizing impacts on developing countries by establishing an adaptation fund for climate change;
- accounting, reporting and review to ensure the integrity of the Protocol;
- compliance by establishing a compliance committee to enforce compliance with the commitments under the Protocol.

23.13 Details of the agreement

According to a press release from the United Nations Environment Programme :

After 10 days of tough negotiations, ministers and other high-level officials from 160 countries reached agreement this morning on a legally binding Protocol under which industrialized countries will reduce their collective emissions of greenhouse gases by 5.2%. The agreement aims to lower overall emissions from a group of six greenhouse gases by 2008-12, calculated as an average over these five years. Cuts in the three most important gases - carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) - will be measured against a base year of 1990. Cuts in three long-lived industrial gases - hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and Sulphur hexafluoride (SFs) can be measured against either a 1990 or 1995 baseline.

National limitations range from 8% reductions for the European Union and others, to 7% for the US, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland.

The agreement is an amendment to the United Nations Framework Convention on Climate Change (UNFCCC, adopted at the Earth Summit in Rio de Janeiro in 1992). All parties to the UNFCCC can sign or ratify the Kyoto Protocol, while non-parties to the UNFCCC cannot. The Kyoto Protocol was adopted at the third session of the Conference of Parties to the UNFCCC (COP3) in 1997 in Kyoto, Japan. Most provisions of the Kyoto Protocol apply to developed countries, listed in annex I to the UNFCCC. Emission figures exclude international aviation and shipping.

23.1.4 Common but differentiated responsibility

The United Nations Framework Convention on Climate Change agreed to a set of a common but differentiated responsibilities. The parties agreed that:

1. the largest share of historical and current global emissions of greenhouse gases originated in developed countries;
2. per capita emissions in developing countries are still relatively low;
3. the share of global emissions originating in developing countries will grow to meet social and development needs.

China, India, and other developing countries were not included in any numerical limitation of the Kyoto Protocol, because they were not main contributors to the greenhouse gas emissions in the pre-treaty industrialization period China has since become the largest, greenhouse gas emitter. However, even without responsibility under the Kyoto target, developing countries were to shar the common responsibility of the countries to reduce emissions.

The protocol defines a mechanism of compliance as a monitoring compliance with the commitments and penalties for non-compliance.

2.3.1.5 Financial commitments

The Protocol also reaffirms the principle that developed countries have to pay billions of dollars, and supply technology to other countries for climate-related studies and projects. The principle was originally agreed in the UNFCCC.

2.3.1.6 Emissions trading

Kyoto provides for a 'cap and trade' system which imposes national caps on the emissions of annex I countries. On average, this cap rquires countries to reduce their emissions 5.2% below their 1990 baseline over the 2008 to 2012 period. Although these caps are national-level commitments, in practice, most countries will evolve their emissions targets to individual industrial entities, such as a power plant or paper factory. One example of a 'cap and trade' system is the EU ETS. Other schemes may follow suit in time.

The ultimat buyers of credits are often individual companies that expect emissions to exceed their quota, their assigned allocation units, AAUs or 'allowances' for short. Typically, they win purchase credits direectly from another party with excess allowances, from a broker, from a JI/CDM developer, or on an exchange.

National governments, some of whom may not have devolved responsibility for meeting Kyoto obligations to industry, and that have a net deficit of allowances, will buy credits for their own account, mainly from JI/CDM developers. These deals are occasionally done directly through a national fund or agency, as in the case of the Dutch government's ERUPT programme, or via collective funds such as the World Bank's Prototype Carbon Fund (PCF). The PCF, for example, represents a consortium of six governments and 17 major utility and energy companies on whose behalf it purchases credits.

Since allowances and carbon credits are tradable instruments with a transparent price, financial investors can buy them on the spot market for speculation purposes, or link them to futures contracts. A high volume of trading in this secondary market helps price discovery and liquidity, and in this way helps to keep down costs and set a clear price signal in COj which helps businesses to plan investments. This market has grown substantially, with banks, brokers, funds, arbitrageurs and private traders now participating in a market valued at about $60 billion in 2007. Emissions Trading PLC, for example, was floated on the London Stock Exchange's AIM market in 2005 with the specific remit of investing in emissions instruments.

Although Kyoto created a framework and a set of rules for a global carbon market, there are in practice several distinct schemes or markets in operation today, with varying degrees of linkages among them.

Kyoto enables a group of several annex I countries to create a market-within-a-market together. The EU elected to be treated as such a group, and created the EU Emissions Trading Scheme (ETS). The EU ETS uses EAUs (EU Allowance Units), each

equivalent to a Kyoto AAU. The scheme went into operation on 1 January 2005, although a forward market has existed since 2003.

The UK established its own learning-by-doing voluntary scheme, die UK ETS, which ran from 2002 through 2006. This market existed alongside the EU's scheme, and participants in the UK scheme have the option of applying to opt out of the first phase of the EU ETS, which lasts through 2007.

The sources of Kyoto credits are the Clean development Mechanism (COM) and Joint Implementation (JO) projects. The COM allows the creation of new carbon credits by developing emission reduction projects in non-annex I countries, while JI allows project-specific credits to be converted from existing credits within annex I countries. CDM projects produce Certified Emission Reductions (CERs), and JI projects produce Emission Reduction Units (ERUs), each equivalent to one AAU. Kyoto CERs are also accepted for meeting EUETS obligations, and ERUs will become similarly valid from 2008 for meeting ETS obligations (although individual countries may choose to limit the number and source of CER/JIs they will allow for compliance purposes starting from 2008). CERs/ ERUs are overshelmingly bought from project developers by funds or individual entities rather than being exchange-traded like allowances.

Since the creation of Kyoto is subject to a lengthy process of registration and certification by the UNFCCC, and the projects themselves require several years to develop, this market is at this point largely a forward market where purchases are made at a discount to their equivalent currency, the EUA, and are almost always subject to certifications and delivery (although up-front payments are sometimes made). According to IETA, the market value of CDM/JI credits transacted in 2004 was EUR 245 m; it is estimated that more than EUR 620 m worth of credits were transacted in 2005.

Several non-Kyoto carbon markets are in existence or being planned, and these are likely to grow in importance and numbers in the coming years. These include the New South Wales Greenhouse Gas Abatement Scheme, the Regional Greenhouse Gas Initiative and Western Climate Initiative in the United States and Canada, the Chicago Climate Exchange and the State of California's recent initiative to reduce emissions.

These initiatives taken together may create a series of partly linked markets, rather than a single carbon market The common theme is the adoption of market-based mechanisms centered on carbon credits mat represent a reduction of CO_2 emissions. The fact that some of these initiatives have similar approaches to certifying their credits make it possible that carbon credits in one market may in the long run be tradable in other schemes. The scheme would broaden the current carbon market far more than the current focus on the CDM/ JI and EU ETS domains. An obvious precondition, however, in a realignment of penalties and fines to similar levels, since these create an effective ceiling for each market.

2.3.1.7 Revisions

The protocol left several issues open to be decided later by the sixth Conference of Parties *(COP).* COP6 attempted to resolve these issues at its meeting in the Hague in late 2000, but was unable to reach an agreement due to disputes between the European Union on the one hand (which favoured atougher agreement) and the Unitd States, Canada, Japan and Australia on the other (which wanted the agreement to be less demanding and mor flexible).

In 2001, a continuation of the previous meeting (COP6) was held in Bonn where the required decisions were adopted. After some concessions, the supporters of the protocol (led by the European Union) managed to get Japan and Russia in as well by allowing more use of carbon dioxide sinks.

COP7 was held from 29 October 2001 through 9 November 2001 in Marrakech to establish the final details of the protocol.

The first Meeting of the Parties to the Kyoto Protocol (MOP1) was held in Montreal from 28 Nobember to 9 December 2005, along with the 11th conference of the Parties to the UNFCCC (COP11). See United Nations Climate Change Conference.

The 3rd December 2007, Australia ratified the protocol during the first day of the COPlSinBali.

Of the signatories, 36 developed C.G. countries (plus the EU as a party in the European Union) agreed to a 10% emissions increase for Iceland; but, since the EU's member states each have individual obligations, much larger increases (up to 27%) are allowed for some of the less developed EU countries.

23.1.8 Enforcement

If the enforcement branch determines that an annex I country is not in compliance with its emissions limitation, then that country is required to make up the difference plus an additional 30%. In addition, that country will be suspended from making transfers under an emissions trading program.

2.3.2 Montreal Protocol

23.2.1 Definition and Introduction

The *Montreal Protocol* on *Substances that Deplete the Ozone Layer* (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion. The treaty was opened for signature on September 16,1987 and enterd into force on January 1,1989 followed by a first meeting in Helsinki, May 1989. Since then, it has undergone seven revisions, in

1990 (London), 1991 (Nairobi), 1992 (Copenhagen), 1993 (Bangkok), 1995 (Vienna), 1997 (Montreal), and 1999 (Beijing). It is believed that if the international agreement is adhered to, the ozone layer is expected to recover by 2050. Due to its widespread adoption and implementation it has been hailed as an example of exceptional international co-operation with Kofi Annan quoted as saying that perhaps the single most successful international agreement to date has been the Montreal Protocol.

2.3.2.2 Terms and purposes of this treaty

The treaty is structured around several groups of halogenated hydrocarbons that have been shown to play a role in ozone depletion. All of these ozone depleting substances contain either chlorine or bromine (substances containing only fluorine do not harm the ozone layer). For a table of ozone-depleting substances see: For each group, the treaty provides a timetable on which the production of those substances must be phased out and eventually eliminated.

- ***Chlorofluorocarbons (CFCs) Phase-out Management Plan***

The stated purpose of the treaty is mat the signatory states recognizing that worldwide emissions of certain substances can significantly deplete and otherwise modify the Ozone layer in a manner that is likely to result in adverse effects on human health and the environment This trteaty is determined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it, with the ultimate objective of their elimination on the basis of developments in scientific knowledge. It has acknowledged that special provision is required to meet the needs of developing countries and shall accept a series of stepped limits on CFC use and production, including: from 1991 to 1992 its levels of consumption and production of the controlled substances in Group I of Annex A do not exceed 150 percent of its calculated levels of production and consumption of those substances in 1986; from 1994 its calculated level of consumption and production of the controlled substances in Group I of Annex A does not exceed, annually, twenty-five percent of its calculated level of consumption and production in 1986, from 1996 its calculated level of consumption and production of the controlled substances in Group I of Annex A does not exceed zero.

There is a slower phase-out (to zero by 2010) of other substances (halon 1211,1301, 2402; CFCs 13, 111, 112, etc) and some chemicals get individual attention (Carbon tetrachloride; 1,1,1- trichloroethane). The phasing-out of the less active HCFCs started only in 1996 and will go on until a complete phasing-out is achieved in 2030.

- ***Hydrochlorofluorocarbons (HCFCs) Phase-out Managment Plan (HPMP)***

Under the Montreal Protocol on Substances that Deplete the Ozone Layer, expecially Executive Committee (ExCom) 53/37 and ExCom 54/39, Parties to this Protocol agreed to set year 2013 as the time to freeze the consumption and production of HCFCs. They

also agreed to start reducing its consumption and production in 2015. ‘Hie time of freezing and reducing HCFCs is then known as 2013/2015.

The HCFCs are transitional CFCs replacements, used as refrigerants, solvents, blowing agents for plastic foam manufacture, and fire extinguishers. In trem of Ozone Depleting Potential (OOP), in comparison to CFCs that have ODP 0.6 - 1.0, these HCFCs ODP have less OPD, i.e. 0.01 - 0.5. Whereas in term of Global Wanning Potential (GWP), in comparison to CFCs that have GWP 4,680-10,720, HCFCs have less GWP, i.e. 76 -2,270.

There are a few exceptions for essential uses, where no acceptable substitutes have been found (for example, in the metered dose inhalers commonly used to treat asthma and other respiratory problems) or “Halon fire suppression systems used in submarines and aircraft (but not in general industry).

The provisions of the Protocol include the requirement that the Parties to the Protocol base their future decisions on the current scientific, environmental, technical, and economic information mat is assessed through panels drawn *from* the worldwide expert communities. To provide that input to the dcision making process, advances in understanding on these topics were assessed in 1989,1991,1994,1998 and 2002 in a series of reports entitled Scientific assessment of ozone depletion.

Several reports have fcfeen published by various governmental and non-governmental organizations to present alternatives to the ozone depleting substances* since the substances have been used in various technical sectors, like in refrigerating, agriculture, energy production, and laboratory measurements.

2.3.2.3 Ratification

At present, 195 of 196 United Nations member states have ratified the original Montreal Protocol (see external link below). That one that has not as of April 2009 is Timor-Leste. Fewer countries have ratified each consecutive amendment Only 154 countries have signed the Beijing Amendment.

In the United States, the Clean Air Act Amendments of 1990 (P.L. 101-549) contain provisions for implementing the Montreal Protocol, as well as explicit, separate authority for the EPA to regulate ozone depleting chemicals.

2.3.2.4 Impact

Since the Montreal Protocol came into effect, the atmospheric concentrations of the most important chlorofluorocarbons and related chlorinated hydrocarbons have either leveled off or decreased. Halon concentrations have continued to increase, as the halons presently stored in fire extinguishers are released, but their rate of increase has slowed and their abundances are expected to begin to decline by about 2020. Also, the concentration of the HCFCs increased drastically at least partly because for many uses CFCs (e.g. used

as solvents or refrigerating agents) were substituted with HCFCs. While there have been reports.of attempts by individuals to circumvent the ban, e.g. by smuggling CFCs from undeveloped to developed nations, the4overall level of compliance has been high. In consequence, the Montreal Protocol has often been called the most successful international environmental agreement to date. In a 2001 report, NASA found the ozone thinning over Antarctica had remained the same thickness for the previous three years. However, in 2003 the Ozone hole grew to its second largest size. The most recent (2006) scientific evaluation of the effects of the Montreal Protocol states. The Montreal Protocol is working. There is clear evidence of a decrease in the atmospheric burden of ozone-depleting substances and some early signs of stratospheric ozone recovery.

Unfortunately, the hydrochlorofluorocarbons, or HCFCs, and hydrofluorocarbons, of HFCs, are now thought to contribute to anthropogenic global warming. On a molecule-for-molecule basis, these compounds are up to 10,000 times more potent greenhouse gases than carbon dioxide. The Montreal Protocol currently calls for a complete phase-out of HCFCs by 2030, but does not place any restriction on HFCs. Since the CFCs themselves are equally powerful as greenhouse gases, the mere substitution of HFCs for CFCs does not significantly increase the rate of anthropogenic global warming, but over time a steady increase in their use could increase the danger that human activity will change the climate.

2.3.3 Model Questions

1) Discuss the main theme and objectives of Kyoto Protocol.
2) Account for the details of agreement reached under the Kyoto Protocol.
3) What is the main theme of Montreal Protocol? Examine the terms and purposes of Montreal Protocol.

2.3.4 Select Readings

- Mukhopadhyay, A. D. (2003): Perspectives and Issues in Environmental Stadies, Vidyasagar University, Medinipur.
- Santra, S. C. (2001): Environmental Science, New Central Book Agency, Kolkata.
- Sharma, P. D. (2000): Ecology and Environment, Rastogi, Publications, Meerat
- Singh Savindra (2000): Environmental Geography, Prayag Pustak Bhawan, Allahabad.
- Frank B. Golly : A Primer for Environmental Literacy. Universities Press, Hyderabad

Unit 2.4 ❑ Environmental Impacts of Big Dams and Urban-Industrial Expansion

Structure

2.4.1 Environmental Impacts of Big Dams

2.4.1.1 Introduction

The main purposes for which big dams are constructed upon major rivers are: 1) to control flood and ensure perennial supply of water for irrigation in agriculture an 2) to generate hydroelectricity for industrial and domestic purposes. People have constructed dams to harness water resources for at least 5,000 years.

The most active phase of large dam construction, defined by the *International Commission on Large Dams* as structures above 15 m in height, was in the 1950s, 1960s and early 1970s, when 373 dams were completed each year. At the end of 1960, there were 7,408 such dams registered. By 1986, the total had reached 36,562. Of those constructed, 64 per cent were in Asia, with no less than half of the would total in China.

Excluding China, most of the new structures have been built in the temperate zone, but tropical and subtropical countries such as Brazil, Mexico, India, Thailand, Indonesia, Zimbabwe, Nigeria, Cote d'lvoire and Venezuela have also become prominent in dam construction. Seventy-nine per cent of these dams are less than 30m in height, and only 4 per cent exceed 60m.

2.4.1.2 Benefits of big dams

There is no doubt mat many big dam schemes have been successful in achieving their primary objectives. Egypt's Aswan High Dam, completed in 1970, illustrates some of the benefits of big dam construction. Hydroelectricity generated by the dam, a renewable energy source which does not produce any harmful atmospheric pollution, is cheap to operate after the initially high capital costs of dam construction and saves on the purchase of fossil fuels from abroad. Hie Aswan High Dam generates about 20 per cent of Egypt's electricity.

The natural discharge of the Nile is subject to wide seasonal variations, with about 80 per cent of the annual total received during the flood season from August to October, and marked high and low flows depending upon climatic conditions in the main catchment area in the Ethiopian highlands. The dam allows management of the flow of the Nile's discharge, evening out the annual flow below the dam and protecting against floods and droughts. Management of the Nile's flow has also had benefits for navigation and tourism, rsulting from the stability of water levels in the river's course and navigation channels. Irrigation water for cropland is also provided by the dam's reservoir storage, which has allowed 400000 hectares of cropland to convert from seasonal to perennial irrigation and the expansion of agriculture onto 490000 ha of new land, a particularly important aspect for a largely hyper-arid country with just 3 per cent of its national area suitable for cultivation.

Large dams are often seen as symbols of economic advancement and national prestige for many developing nations but the huge initial capital outlay needed for construction often means that agendas are set to varying extents by foreign interests. A key element in the financing of Ghana's *Akosombo* Dam, completed in 1965, was the sale of cheap electricity to die Volta Aluminium Company, a consortium with two US-owned companies that produces aluminium from imported alumina, despite the fact that Ghana has considerable reserves of alumina of her' own. The construction of the *Cahora Bassa* Dam in Mozambique in the 1970s, when the country was still a Portuguese colony, was also largely catering to outside interests. Most of the electricity is sold to South African industry, and part of the original reason for flooding the 250 km-long Lake *Cahora Bassa* was to establish a physical barrier against *Frelimo* guerillas seeking independence. The plan for the dam also envisaged the settlement of up to 1 million white farmers in the region, who, it was thought, would fight to protect their new lands.

Within the country, too, concerns have often been raised about the main benefits of a new dam being directed towards urban areas. Wall (1988) points out that although the Bayano Hydroelectric Complex in Panama provides 30 per cent of the country's electricity; no less than 83 per cent of national production is consumed in Panama City and Colon, so that the dam is reinforcing the concentration of wealth in the urban areas.

Hence, it is clear that the undoubted benefits of big dams are not always gained solely by the country where the dam is located, and that within the country concerned, the demands of urban populations can outweigh those of rural areas. Many of the drawbacks of such structures, however, are borne by the rural people of the country concerned. Despite the success of many big dams in achieving their main economic-aims, their construction and associated reservoirs create significant changes in the pre-existing environment, and many of these changes have proved to be detrimental. It is the negative side of environmental impacts that have pushed the issue of big dams to a prominent position in the eyes of environmentalists and many other interest groups.

2.4.13 Environmental Impacts of Big Dams

The environmental impacts of big dams and their associated reservoirs are numerous, and environmental scientists have outlined the main areas that they influence (Table 1).

Table 1 : Areas of influence of dam and reservoir projects

Serial	***Aspects***
1.	The catchments contributing to the reservoir or project area and the area below the dam to the estuary, coastal zone and offshore
2.	All ancillary aspects of the project such as power transmission corridors, pipelines, canals, tunnels, relocation and access roads, borrow and disposal areas and construction camps, as well as unplanned developments stimulated by the project (e.g. logging or shifting cultivation along access roads')
3.	Off-site areas required for resettlement or compensatory tracts
4.	The air-shed, such as where air pollution may enter or leave the area of influence
5.	Migratory routes of humans, wildlife or fish, particularly where they relate to public heath, economics, or environmental conservation

Scarce : Goodland (1990)

The temporal aspect of environmental impacts within a certain area is also important The river basin itself can be thought of as a system which will respond to a major change, such as the construction of a dam, in many different ways and on a variety of timescales. While the creation of a reservoir creates an immediate environmental change,

the permanent inundation of an area not previously covered in water, the resulting changes in other aspects of the river basin, such as floral and faunal communities, and soil erosion, will take a longer time to readjust to the new conditions.

The range of environmental impacts consequent upon dam construction, and their effects on human communities, can be considered under the following three headings which reflect the broad spatial regions associated with any dam project : ***a) the dam and its reservoir; b) the upstream area;*** **and** ***c) the downstream area.***

i) The Dam and its Reservoir

The creation of a reservoir results in the loss of resources in the land area inundated. Flooding behind the *Balbina* Dam north of Manaus, Brazil has destroyed much of a centre of plant endemism. In some cases the loss of wilderness areas threatened by new dam projects has raised considerable debate, both nationally and internationally. A case in point was the Nam *Choan* Dam Project on the Kwae Yai River in western Thailand, first proposed in 1982. The proposed reservoir lay largely within the *Thung Yai Wildlife Sanctuary;* one of the largest remaining relatively undisturbed forest areas in Thailand, containing all six of the nation's endangered mammal species. Debate over the destructive impact of the project resulted in it being shelved indefinitely in 1988.

Some resources, such as trees for timber or fuel wood, can be taken from the reservoir site prior to inundation, although this is not always economically feasible in remote regions. There are dangers inherent in not removing them, however. Anaerobic decomposition of submerged forests produces hydrogen sulphide which is toxic to fish and corrodes metal that comes into contact with the water. Corrosion of turbines in Surinam's Brakopondo reservoir has been a serious problem. In a similar vein, decomposition of organic matter by bcteria in the *La Grande 2* reservoir in Quebec, Canada has released large quantitis of mercury by methylation. Mercury has bioaccumulated in reservoir fish tissue to levels often exceeding the Canadian standard for edible fish of 0.5 mg/kg.

Cultural property may also be lost by the creation of a reservoir twenty-four archaeological sites dating from 70-1000 AD were inundated by the Tucurui Dam reservoir in Brazil, for example - although in some cases such property is deemed important enough to be preserved. Lake Nasser submerged some ancient Egyptian monuments but major ones - including the temples of Abu Simbel, Kalabsha and Philae were moved to higher ground prior to flooding.

Big dams often necessitate resettlement programmes if there are inhabitants of the area to be inundated, and the numbers of people involved can be very large. Some of the biggest projects in this respect have been in China. The *Sanmen Gorge Project* on the Huang Ho River involved moving 300,000 people and the proposed Three Gorges Dam on the Yangtze River may involve the displacement of up to 1.2 million people. Some

indication of the trade-off between land lost, people displaced and power generated is indicated in Table 2 for a selection of big dam projects.

Table 2; Hydel power generated per hectare inundated, and mimbr of people displaced for selected big dam projects in the world

Projects and country	***Approx rated capacity (MW)***	***Normal area of Reservoir (ha)***	***Kilowatts per hectare***	***People relocated***
Pehuenchi (Chile)	500	400	1250	
Guavio (Columbia)	1,600	1,500	1067	
Itaipu (Brazil & Paragua	12,600	1,35,000	93	8,000 families
Syaonogorsk (Russia)	6,400	80,000	80	
Churchill Falls (Canada)	5,225	66,500	79	
Tarbela (Pakistan)	1,750	24,300	72	86,000
Grand Cuelee (USA)	2,025	32,400	63	
Tucurui (Brazil)	6,480	2,16000	30	30,000
Keban (Turkey)	1,360	67,500	20	30,000
Three Gorges (China)	13,000	1,10,000	12	1,300,000
Batang Ai (Sarawak, Borneo)	92	8,500	11	3,000
Cahora Bassa (Mozambique)	2,075	2,66,000	8	25,000
Aswan High Dam (Egypt)	2,100	40,000	5	1,00,000
BHA (Panama)	150	35,000	4	4,000
Kariba (Zimbabwe & Zambia)	1,500	5,10,000	3	50,000
Akosombo (Ghana)	833	8,48,000	09	80,000
Brokopondo (Surinam)	30	1,50.000	02	50,000

Source: Barrow (1981), Goldsmith A Hildyard (1984), Wall (1988), Dixon et.ai (1089) A Goodland (1990)

For people who are displaced, the move can be a traumatic one. The resettlement of 57000 members of the Tonga tribe from the area of the *Kariba Dam* on the Zambezi illustrates some of the adverse effects for the people concerned. Some scientists describe the culture shock suffered in moving to very different communities and environments. Drawn-out conflicts over land tenure resulted between the new settlers and previous residents, and since the resettlement area was drier than the Tongan homelands, problems with planting and the timing of harvests were faced. Deprived of fish and riverbank rodents which traditionally supplemented their cultivated diet, the Tongas faced severe food shortages. When the government sent food aid to relieve the suffering, the food distribution centres became transmission sites for trypanosomiasis.

Development following the construction of big dams can also act as a pull for migrants, bringing associated problems of pressure on local resources. The influx of migrants to the Aswan area has led to an increase in population from 2,80,000 in 1960 in 1960 to more, than 1 million by the late 1980s, mainly due to the increase in job opportunities.

Over the longer term, other effects of reservoir inundation become evident. The alteration of the environment can have significant impacts on local health conditions. In some cases these can be beneficial. Onchocerciasis or river blindness, for example, a disease which is common hi Africa, is caused by a small worm transmitted by a species of blackfly. The blackflies breed in fast-running, well-oxygenated waters and dam construction can reduce the number of breeding sites by flooding rapids upstream. This has been the case in Ghana's *Akosombo* and Nigeria's *Kainji* dams although the flies may find alternative breeding sites hi new tributary streams.

Malaria, conversely, is likely to increase as a result of water impoundment, since the mosquitoes which transmit the disease breed in standing waters. Local malaria incidence has increased around Tucurui, Brazil, although management by fluctuating water levels and stranding larvae can help as in the USA's Tennessee Valley Authority water management complex.

Schistosomiasis, also known as *bilhania*, a very debilitating though rarely fatal disease which is widespread throughout the Third World, is transmitted in a different way: by parasitic larvae that infect a certain aquatic snail species as the intermediate host Incidence of schistosomiasis was considerably increased by the construction of the *Akosombo* Dam, with infection rates among 5-19 year old children rising from 15 per cent to 90 per cent within 4 years of its completion. Similar figures have been repelled from other large dams, such as *Kariba* hi Zambia.

Other biological consequences of large reservoirs include the rapid spread of water-weeds that cause hazards to navigation and a number of secondary impacts, notably water losses through evapo-transpiration. Water-fern appeared hi Lake Kariba 6 months after the dam was closed and after 2 years had covered 10 per cent of the 420 km^2 lake area. **More** dramatic still was the spread of water hyacinth on Surinam's Brokopondo reservoir, which covered 50 per cent of the lake's surface within 2 years. Similar serious difficulties have been encountered at *Aswan* and *Pa Mong* in Viet Nam.

New reservoirs also have effects on geomorphological and, in some cases, tectonic processes. The trapping of sediment is a particularly important aspect of reservoir impoundment The siltation of reservoirs has a number of knock-on effects downstream of the dam (see below), but it can also seriously affect the useful life of the dam itself. Some examples of sedimentation rates in Chinese reservoirs are shown in Table 3. An extreme example of rapid sedimentation behind a dam is provided by China's *Sanmenxia* reservoir. River impoundment began in I960, but within just 7.5 years of operation the reservoir had lost 35 per cent of its total storage capacity of 9,700 million m^3 due to sedimentation.

Table 3: Rate of sedimentation in some Chinese reservoirs

Name of Reservoir	*Name of River*	*Total amount of sediment deposited (million m^3)*	*Period of record (years)*	*Storage lost (%)*
Sanmeroda	Huang Ho	3391	7.5	35
Quingtongxia	Huang Ho	527	5	84
Yanguoxia	Huang Ho	150	4	68
Liujiaxia	Huang Ho	522	8	11
Darjiangkou	Hangsuui	625	15	4
Guanting	Yongdinghe	553	24	24
Hongshan	Laohe	440	15	17
Gangnan	Hutuobe	185	17	12
Xingqiao	Hongliuhe	156	14	71

Source : Biswas (1990)

A wide range of techniques is available for reservoir de-siltation, the cost of which needs to be budgeted for. Scientists have document the case of the *Sefid-Rud* reservoir in northwestern Iran which lost over 30 per cent of its storage capacity in the first 17 years after construction. Desiltation successfully restored about seven per cent of total capacity in seven years, but the reservoir had tobe emptied during the non-irrigation season to enable sediment flushing. Emptying the reservoir released a highly erosive flow downstream of the dam and hydroelectricity generation was prevented during the operation.

Local heightening of water tables following reservoir impoundment can have deleterious affects .on new irrigation schemes through water logging and salinisation. Water logging is an occasional problem around the *Kuban* reservoir on the River Kuban, near Krasnodar in southern Russia, when the reservoir is filled above its maximum normal level to aid navigation and benefit rice cultivation. The result has been the ruin of over 100,000 ha of crops, and water damage to 130 communities, including 27,000 homes, 150 km of roads and even the Krasnodar airport. Local changes in groundwater conditions have also affected slope stability, causing landslides around some reservoirs. Water displaced by a landslip at the *Vaiont* Dam in Italy in 1963 overtopped the dam, killing more than 2,000 people in the resulting disaster.

The sheer size of some reservoirs can also create new gee-morphological processes. Artificial lakes behind dams on the Volga River are so large that storms can produce ocean-like wavs which easily erode the fine wind-blown soils lining the shores. When this process undercuts trees, or creates shoals, navigational hazards result.

The stress changes on crustal rocks induced by huge volumes of water impounded behind major dams have been suspected of inducing earthquakes in some regions. Nurek Dam on the Vakhish River in central Tajikistan is the best-documented example of a

large dam, in this case a 315-m-high earth dam, causing seismic activity. Filling of the dam, located in a thrust-faulted setting, began in 1967 and substantial increass in water level were mirrored by significant increases in earthquakes per quarter (3 months) during the first 8 years of the dam's lifetime.

The reservoirs behind the Hoover Dam in the USA and Canada's Manic 3 have also induced local seismic activity, although earthquake incidents suspected to have been caused by other big dams, such as those at the *Kenya* Dam near Bombay in India, Egypt's Aswan High Dam, and at the *Kurobe* Dam on Honshu Island, Japan are unlikely to be due to reservoir-induced stresses.

The creation of new water bodies with large surface areas is thought by many to affect local climate. Tharth and Tarn (1990) suggest that Lake Volta has shifted the peak rainfall season in central Ghana from October to July/August, for example, but few monitoring programmes have proved such effects conclusively, to date. Changes in th local temperature regime have, however been observed at the 45,000 ha *Rybinsk* reservoir north of Moscow in Russia, where the frost-free period has been extended by 5-15 days per year on average in an area of influence that extends for 10 km around the reservoir's shoreline. Evaporation from reservoir surfaces may affect local humidity and the incidence of fog has been observed to rise in some areas.

ii) The upstream area

A variety of upstream impacts can be induced or, exacerbated by big dam projects. Some of these, hi turn, may impact the dam project itself. Notable in this respect is the improved access to previously remote areas. Deforestation in the watershed above the *Ambukloo* Dam in the Philippines has led to sedimentation of the reservoir, reducing its useful life from 60 years to 32 years (UNEP, 1989b). Conversely, afforestation of catchments above dams has been carried out in many areas specifically to limit sediment accumulaton in reservoirs. In the UK, for example, many water authorities have bought land in upper catchments to plant new forests.

Hi) The downstream area

Downstream of a reservoir, hydrological regime of a river is modified. Discharge, velocity, water quality and thermal characteristics are all affected leading to changes in geomorphology, flora and fauna, both on the river itself and in estuarine and marine environments.

The trapping of sediment behind dams leads to reduced loads in the river downstream. The resulting flow downstream of the dam is highly erosive, with degradation of the bed and banks observed 480 km below the dam at *Xiantao.*

Similar effects on the River Nile have been noted, downstream of the Aswan High Dam, and the lack of silt arriving at the Nile delta has had effects on coastal erosion,

salinisation through marine intrusion and a decline in the eastern Mediterranean sardine catch. Expected further changes due to these factors are also shown, To some extent the loss of fisheries off the Nile delta has been offset by a new fishing industry in Lake Nasseiv which has provided employment to 7,000 fishermen. Downstream changes in salinity due to construction of the *Cahora Bassa* Dam in Mozambique are also threatening mangrove forests at the mouth of the Zambezi. Mangroves provide the breeding grounds for prawn and shrimp, amajor source of foreign currency, but strategic water release from the dam could be used to offset the possible deleterious effects on shrimp and prawn catches. The absolute reduction in volumes of flow following dam construction also affects the ecology of downstream seas, as the example of the Black Sea illustrates well.

Dam can also affect marine and lake fish populations through the barrier they create which effectively cuts off access to spawning grounds. This effect has been evident on salmon and aloses in the River Garonne and its tributaries in southwestern France since the middle Ages. In the twentieth century, decline in the landed catches of Caspian Sea sturgeon, a source of caviar, from 40,000 tons early this century to just 11,000 tons in the 1970s, is attributable primarily to large hydroelectric dams on the Volga and the consequent loss of spawning grounds. However, catches had largely recovered to pre-dam levels in the 1980s with the establishment of new sturgeon farms on the Caspian shores.

2.4.1.4 Political Impacts of Big Dams

Increasing public awareness of the environmental and social implications of big dams has generated some heated debates in recent years, in some cases leading to the shelving of construction plans. The Nam *Choan* Dam.

Project in Thailand has been mentioned in this, respect. Another example is the Tasmanian Franklin River Project which was stopped on environmental grounds in 1983. India’s Narmada and Tehri Dams and the Chinese Three Gorges Project have also come under severe criticism over their anticipated impacts. In such cases, the obvious benefits of dam construction must be carefully weighed against the costs measured in environmental and social terms, and the potential impacts predicted and ameliorated by sensible planning. There is little doubt that many of the adverse impacts of dams can be reduced greatly by good planning and anticipation, and aid agencies that finance such projects now require an Environmental Impact Assessment before approval of funding is given. Progress has also been made in the widening scope given to consultation prior to dam construction. Nevertheless a sensible operating schedule is also a key factor - many of the problems caused by dams are the result of operators aiming to maximise water use, through releases for hydroelectricity generation and irrigation, for example, to such an extent that other concerns are given too little consideration.

The building of dams on rivers flowing through more than one country brings

international political considerations onto the agenda of big dam issues. Such considerations are particularly pertinent in dry land regions where rivers represent a high percentage of water availability to many countries. The main issues at stake here are those of water availability and quality.

In several international river basins, peaceful cooperation over the use of waters has been achieved through international agreement. One such agreement, between the USA and Mexico over use of the Rio Grande, was signed in 1944 and is operated by the International Boundary and Water Commission. This body ensures equal allocation of the annual averapv flow between the two countries.

In other international basins, such as the Tigris-Euphrates in the Middle East, the lack of agreement represents a significant potential for conflict While there is currently a water surplus hi this region, the scale of planned developments raises some concern. Turkey's Southeastern Anatolian Project, a regional development scheme on the headwaters of the two rivers, centres on twenty-two dams. In early 1990, when tilling of the Afamnt Dam reservoir commenced, stemming the flow of the Euphrates, immediate alarm was expressed by Syria and Iraq, despite the fact mat governments in both countries had been alerted and discharge before the cut-off had been enhanced in compensation. Syria and Iraq nearly went to war when Syria was filling its Euphrates Dam. Full development of the Southestern Anatolian Project could reduce the flow of the Euphrates by as much as 60 per cent, which could severely jeopardise Syrian and Iraqi agriculture downstream. The three Tigris-Euphrates riparian have tried to reach agreements over the water use from these two rivers, and the need for such an agreement is becoming ever more pressing.

2,4.2 Environmental Impacts of Urban-Industrial Expansion

2.4.2.1 Introduction

Large numbers of people have lived in close proximity to each other in cities for thousands of years. The first urban cultures began todevelop about 5,000 years ago in Egypt, Mesopotamia and India, but the size of cities and their geographical distribution expanded dramatically after the Industrial Revolution in the present millennium. The growth rates of cities in recent decades have been unprecedented. In 1970, four world cities had a population of more than 10 million people; by the year 2010 there will be mor than 30 such cities. While there were thirty-five cities of greater than 3 million people in 1970, by 2020 that total will cross 100 by which time 60 per cent of the world's population will be living in urban areas. Many cities in the developed world, such as New York and London, will have grown little in the last 30-50 years of the prsent century, but cities in the industrialising world show remarkable growth over the same period. Estimates indicate that the populations of Mexico City, Sao Paulo, Karachi and Seoul will have grown by

more than 800 per cent in the second half of the twentieth century.

The phenomenal growth of some cities, and the high concentrations of people they represent (the urban density of Mexico City in 1980 was 14 082 people/km^2), has created some acute environmental problems both outside and within the city limits.

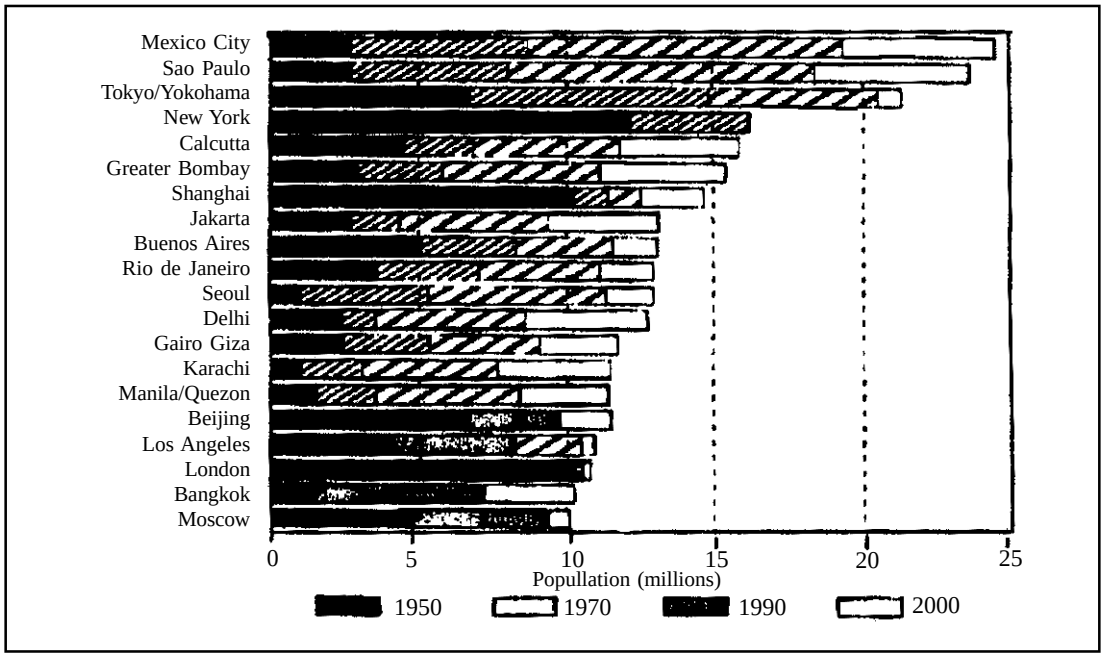


Fig. 1: Population growth pattern of 20 mega-cities in 1950,1970,1990 and 2000

(From *UN Report)*

2.4.2.2 Possible environmental problems with the Urban-industrial expansion

Cities represent a completely artificial environment; they absorb vast quantities of resources from surrounding areas and create high concentrations of wastes to be disposed of. The degree to which cities impinge on their hinterlands is indicated by a few examples. About 10 per cent of prime agricultural land has been lost to urbanisation in Egypt. The twentieth century growth of Sao Paulo was fuelled by the expansion of coffee plantations in south-east Brazil which reduced the forest cover of Sao Paulo State from 81 per cent in 1860 to 6 per cent in the late 1980s. The demand for water in Tehran spurred the construction of a series of dams and canals in the early decades of this century, to bring watr 50 km from the River Karaj to the west, reducing the watr available for rural agriculture. By the 1970s, supplies were again running low, so water was diverted more than 75 km from the River Lar to the north-east. In Rio de Janeiro's Guanabarra Bay, pollution from two oil refineries, two ports, 6000 industries, twelve shipyards, sixteen oil terminals, sewage and garbage dumps has reduced commercial

fishing by 90 per cent, mangrove cover by 90 per cent, led to outbreaks of water-borne diseases such as infectious hepatitis and typhoid, and is silting the bay by 81 cm/100 years.

The acute environmental problems that occur within many cities, particularly in the developing world, their underlying reasons, andihe scale of the clean-up task faced by urban authorities are well summarised hi the case of Manila Metro, capital of the Philippines. A 1990 population of 8 million rose to 13 million by the year 2000. All the city's rivers are biologically dead. Each day, 2000 tons of solid waste is left uncollected, to be burnt, thrown into waterways or moulder on the ground. Much of the garbage which is collected is dumped on 'Smokey Mountain', a 23-hectares open tip which represents a severe health hazard to the 20,000 people who reside oh its fringes and earn a living by scavenging from the dump. About 65 per cent of the country's 1,500 recognised industrial enterprises are locatedin the Manila Metro area, and only one-third to one-half of them are thought to comply with minimal air and water pollution emission standards. One million vehicles, more than half country's total, operate in the Manila Metro area. Just half of these vehicles are thought to meet even minimal emission standards. The annual cost to the economy due to congestion alone is estimated to be more than US$50 million, which is low by the standards of other Asian capitals, while the economic burden of air pollution may be an order of magnitude higher.

The basic cause of Manila Metro's severe environmental problems is that 8 million people are using infrastructure, much of which dates from the US colonial period, estimated to be adequate for about 2 million people, at most. A large proportion of the solid and liquid wastes are simply inaccessible for collection by virtually any means due to the density of squatter settlements, inappropriate collection systems and the simple lack of services such as septic tank dislodging. The problems of physical infrastructure are exacerbated by the government's inability to stop polluters, largely a function of serious understaffing at the metropolitan regulation agency (World Bank Report 1989).

2.4.2.3 Surface water resources

One of the most important environmental issues that stems from urban modifications to the hydrological cycle is that of poor water quality. Runoff from developing urban areas is usually choked with sediment during constructionphases, when soil surfaces are stripped of vegetation, and a finished urban zone greatly increases runoff due to widespread impermeable city surfaces of tarmac and concrete, and networks of storm drains and sewers. This drastically modified urban drainage network feeds large amounts of urban waste products into rivers and ultimately into oceans.

Many rivers that flow through urban areas are biologically dead. Hardoy *et.al* (1992-73) sum up the state of urban rivers in developing countries as follows: 'Most rivers in

Third World Cities are literally large open sewers'. They go on to point out that of India's 3,119 towns and cities, only 209 have partial sewage treatment facilities and just eight have full facilities. India's Jamuna Rivre, for example, contains 7,500 coliform organisms per 100 ml of water on entering New Delhi, a figure which rises to 24 million conform organisms per 100 ml after flowing through the city. For comparison, the WHO guidelines for such microbiological pollution are <10 coliform organisms per 100 ml for drinking water and <1000 per 100 ml for irrigation purposes. Industrial effluents combine with this domestic source of riverine pollution to make urban rivers the most polluted freshwater sources on Earth.

All the rivers flowing through Jakarta, Indonesia, are heavily polluted from numerous, mostly untreated, discharge sources: household drams and ditches, overflows and leaks from septic tanks, commercial buildings, and industries. Water-related diseases such as typhoid, diarrhoea and cholera increase in frequency downstream across th metropolitan are. Untreated sewage and discharge from 20000 classified water-polluting industries which feed into Bangkok's canal system have created a distinct sag in the dissolved oxygen profile of the Chao Phraya where the canals feed the river. Although the example of the Thames at London shows how such near-anaerobic river conditions can be improved, neither the money nor the political will are currently as forthcoming in Thailand.

The local hydrological impact of the Saudi capital, Riyadh, provides a very contrasting example to the depressing catalogue of river-incorporated disaster areas typically associated with large, rapidly growing cities. Discharge of Riyadh's wastewater feeds the Riyadh River, which scarcely existed 20 years ago, but now flows throughout the year down what was the seasonal Wadi Hanifa. The water, which is originally derivedfrom desalinated Gulf sea water, is partially treated before being released to flow down the steep-sided Wadi and enters open countryside, eventually disappearing 70 km from Riyadh. The new flow has created an attractive valley lined by tamarisk trees and phragmites which is becoming an important recreational site for Riyadh's 2.3 million populations. Beyond the Wadi, significant irrigated agriculture has grown up, drawing on the groundwatr around the river. This unique new feture is, however, under some threat from needs to further recycle the much-needed water resource.

Different types of environmental problems are encountered in permafrost areas where surface water and soil moisture is frozen for much, and in some places all, of the year. Frozen rivers and lakes mean that many of the uses such water bodies are commonly put to at more equable latitudes, such as sewage and other waste disposal, are not always available. The low temperatures characteristic of such regions also means mat biological degradation of wastes proceeds at much slower rates than those elsewhere. Hence, the impacts of pollution in permafrost areas tend to be more long-lasting than in other environments.

The nature of the permafrost environment also presents numerous environmental challenges to the construction and operation of settlements, challenges which have been encountered in urban developments associated with the exploitation of hydrocarbons and other resources in Alaska, northern Canada and northern Russia. Disturbance of the peimafosttrieniial equilibrium - irregular, hummocky ground. The heaving and subsidence caused can disrupt building foundations and damage pipelines, roads, rail tracks and airstrips. Terrain evaluation prior to development is now an important procedure in the development of these zones, following expensive past mistakes. Four main engineering responses to such problems have been developed: permafrost can be neglected, eliminated, preserved, or structures can be designed to take expected movements into account Preservation of the thermal equilibrium is achieved in numerous ways, such as by insulating the permafrost with vegetation mats or gravel blankets, and ventilating the underside of structures which generate heat (e.g. buildings and pipelines).

2.4.2.4 Ground Water

The water needs of urban population and industry is often supplemented by pumping from ground-water, and pollution of this source is another problem of increasing concern in many large cities. Seepage from the improper use and disposal of heavy metals, synthetic chemicals and other hazardous wastes such as sewage is a principal origin of groundwater pollution. The quantity of such compounds reaching groundwater from waste dumps in Latin America, for example, is thought to be doubling every 15 years (World Bank Report). Aquifers do not have the self-cleansing capacity of rivers and, once polluted, are difficult and costly to clean.

A frequent outcome of overusing groundwater is a lowering of water-table levels and consequent ground subsidence. In Mexico City, use of subterranean aquifers for rpore than 100 years has caused subsidence of up to 9 m in some central areas (Schteingart, 1989), greatly increasing the flood hazard in the city and threatening the stability of some older buildings, notably the sixteenth century cathedral.

Marked subsidence episodes in Tokyo have mirroDed phases of economic find industrial growth. The Tokyo Metropolitan Government suggests mat ground subsidence began in the city as economic activity grew after the First World War and came toa halt for some years in other coastal cities; depletion of aquifers has created problems of seawatar intrusion. Over pumping of groundwater hi the Tel Aviv urban area depleted groundwater levels to below sea level over an area of 60 km2 in the 1950s, requiring a programme of feeriwater injection along a line of wells parallel to the coast in an attempt to redress the saltwater/freshwater balance. The programme was successful, effectively stabilishing the aquifer and preventing saltwater intrusion.

A similar pattern of events occurred in Brooklyn, New York City, although here no attempt was made to prevent seawater intrusion. By 1947, pumping of the increasingly saline groundwater had ceased and all freshwater supplies were provided by surface sources. Cessation of pumping gradually allowed the water table, which had been reduced to about 1 1m below sea level, to rise again. During the half century of pumping however, deep basements, building foundations and subways had been sunk, and these were subject to flooding as die groundwater levels rose, necessitating expensive remedial measures.

Rising groundwater levels have become a critical problem for many ‘post-industrial* cities as manufacturing industries have given way to service industries which are much less demanding of watr, and legislation has been introduced to control subsidence problems. In London, where loss of water from aged pipes is an additional reason for groundwater levels rising, the period of change from a generally failing to a rising water table occurred in die late 1970s. The potential effects upon the fabric of London’s urban environment are now being assessed, with particular interest being shown by the insurance industry. A report issued by the Construction Industry Research and Information Association estimated that the cost of puming to maintain groundwater levels below the level at which serious damage would occur was up to 30 million.

The rising groundwater problem has ateo been reported from many Middle Eastern cities where rainfall is commonly low, potential evaporation high, and natural recharge small and sporadic. Inadvertent artificial recharge from leaking potable supplies, sewerage systems and irrigation schemes has caused widespread and costly damage to structures and services and represents a significant hazard to public health.

2.4.2.5 The urban atmosphere

Urban areas have a diverse catalogue of effects on local elements of climate which are well documented *(e.g.* Landsberg, 1981), but the most serious environmental issue pertaining to the urban atmosphere is that of quality. The principal sources of air pollution in urban areas are derived from the combustion of fossil fuels for domestic heating, for power generation, in motor vehicles, in industrial processes and in the disposal of solid wastes incineration. These sources emit variety pllutants the most common of which have long been sulphur dioxide (SO_2), oxides of nitrogen (NO and NO_2, collectively known as NQ_x), carbon monoxide (CO), suspended ‘articulate matter (SPM) and lead (P_b). Ozone (O_3), another ‘traditional’ air pollutant assoited with urban areas and the main constituent of photochemical smog, is not emitted directly by combustion, but is formed photochemically in the lower atmosphere from NO_X and volatile organic compounds (VOCs) in the presence of sunlight Sources of the VOCs include road traffic the production and use of organic chemicals such as solvents and the use of oil and natural gas.

These atmospheric pollutants affect human health, directly through inhalation, and

indirectly through such exposure routes as drinking water and food contamination. Most traditional air pollutants directly affect respiratory and cardiovascular systems. For example, CO has a high affinity for haemoglobin and is able to displace oxygen in the blood, leading to cardiovascular and neurobehavioural effects. High levels of SO2 and SPM have been associated with increased mortality, morbidity and impaired pulmonary function, and O_3 is known to affect the respiratory system and irritate the eyes, nose and throat andto cause headaches. Certain sectors of the population are often at greater risk: the young, the elderly and those weakened by other debilitating ailments, including poor nutrition.

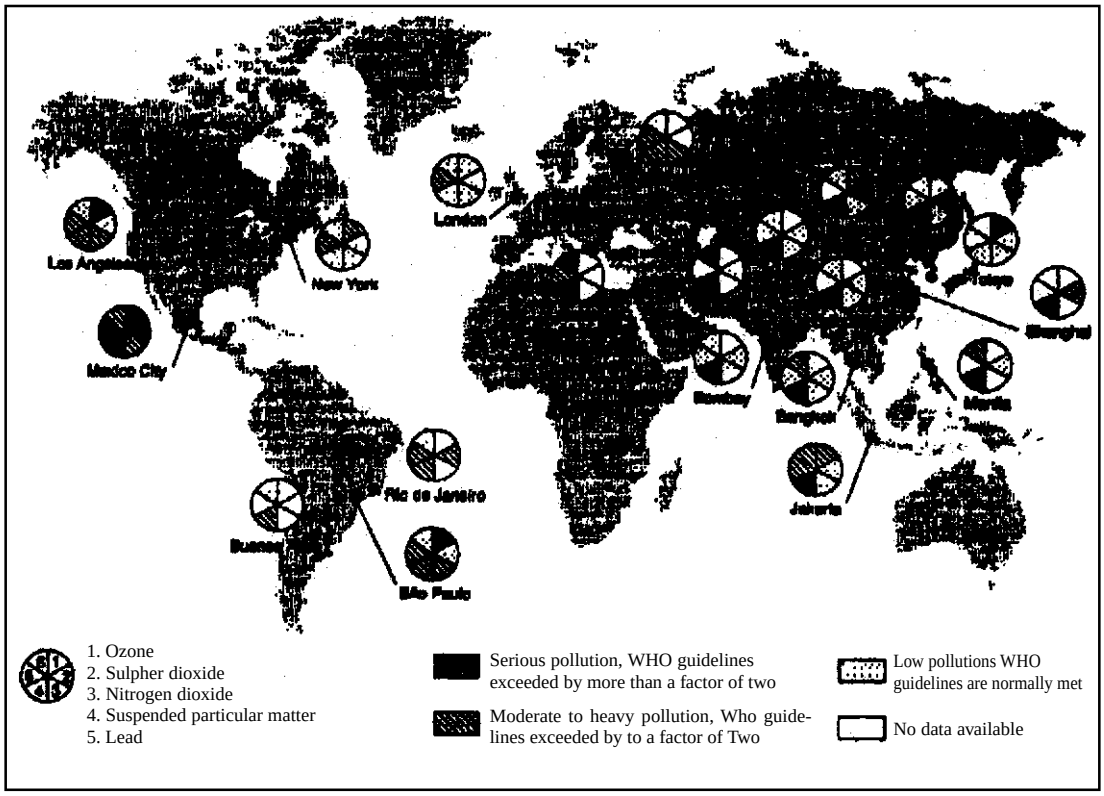
Elements of the natural and build environment can also be adversely affected Sulphur and nitrogen oxides are principal precursors of acid deposition (see Chapter 9), SO_2, NO_2 and O_3 are phototoxic - O_3, in particular, has been implicated in damage to crops and forests and damage to buildings, works of art and materials such as nylon and rubber have been attributed to SO_2 and O_3.

In more recent times, these traditional urban air pollutants have been supplemented by a large number of other toxic and carcinogenic chemicals which are increasingly being detected in the atmospheres of major cities. They include heavy metals (e.g. beryllium, cadmium and mercury), trace organics *(e.g.* benzene, formaldehyde and vinylchloride), radionuclides (e.g. radon) and fibres *(e.g.* asbestos). The sources of these pollutants are diverse, including waste incinerators, sewage treatment plants, manufacturing processes, building materials and motor vehicles. Concentrations of these chemicals are generally low, where they are measured, but this occurs at few sites to date.

Few long-term air quality monitoring programmes have been implemented in cities, and runs of available data are often characterised by changes in the location of sample stations, but data from the former Soviet Union indicate that urban areas with high concentrations of heavy industry using outdated technology have had a ‘calamitous* effect on air quality (Shahgedanova and Burt, 1994). Some of the commonest pollutants present in excessive concentrations are highly toxic: benzopyrene, a carcinogenic coal-tar by-product, phenol and formaldehyde.

However, it seems unlikely that the acute air pollution problems of these urban areas” will receive much attention as long as financial resources are limited and more pressing national problems such as housing and food supply continue to head government priorities.

Monitoring of urban air quality has been undertaken at a global network of mega-cities by-UNEP and the WHO since 1974. Available data indicate that while cities in the industrialised countries have made significant reductions in air pollution during the past four decades, rapidlygrowing urban areas in the industrialising countries pose serious threats to the millions of people who live in them. The clear distinction in urban air quality between rich and poor countries is indicated in Figure below.



Figure—2 : Air quality in 20 world mega-cities (WHO 1992)

Mexico City emerges as the worst affected city, with WHO guidelines exceeded by a factor of two or morefor levels of SO2 (see Fig. 14.4), SPM, CO and O_3. Levels of P_b and NO_2 are almost as bad, exceeding WHO limits by up to two times. The city's poor air quality is exacerbated by location, in an elevated mountain-rimmed basin where temperature inversions occur on average 20 days per month from November to March, which impairs dispersion of pollutants. Although data are sparse, no particular trends in the ,sjx pollutants monitored are discernible in Mexico City, despite the city's rapid growth. This can be attributed to use of cleaner fuels, better emission control, replacement of old industries, and technological improvements (Reports - UNEP/WHO, 1992). Older taxis, for example, are being replaced with newer models equipped with catalytic converters.

Not all efforts to control air pollution in the city hav been successes however. Concern over rising atmospheric P_b levels, which averaged 8 gm^3 in 1986 (five times the national standard), resulted in the national oil company reducing the lead content of gasoline sold in the city in September of that year. An unexpected side-effect was a dramatic increase in ozone concentrations, a result of the reaction between atmospheric oxygen and the replacement gasoline additivs in ultraviolet sunlight.

The severe pollution conditions observed at several mega cities could have been much worse if control measures had not already been introduced. Examples include Beijing, Delhi, Seoul and Shanghai, and the need for such measures is well illustrated at Shanghai where the male lung cancer mortality rate has doubled from twenty-one to forty-four per 100 000 men from 1963 to 1985.

The beneficial effects of tighter legislativ controls on air quality are indicated by London's annual mean SO concentrations, which have fallen from 300 - 400 g/m^3 in the mid 1960s to around 20 - 30 g/m^3 in the late 1980s. The introduction and enforcement of 'Smoke Control Orders' under the 1956 clean Air Act (amended in 1964 and 1968), a response to the infamous London smog of the 1950s, is the most important factor responsible for this steady 30-year fell in ambient concentrations. Similar successes have been recorded for most of the six pollutants measured in Los Angeles, New York and Tokyo, although Los Angeles still has the most serious O3 problem in the USA. Pollution rises with initial industrial development, to be brought under control through legislation on emissions. Air quality then stabilises and improves as development proceeds, to be reduced to below acceptable standards by high technology applications.

2.4.2.6 Garbage

The rapid, and often unauthorised, growth of urban areas has in many cases outpaced the ability of urban authorities to provide adequate facilities, such as the collection of household garbage. Many other urban areas similarly afflicted are not included due to lack of adequate information. Although the environmental problems associated with garbage do not disappear with its collection uncollected garbage exacerbates many of the environmental hazards covered in this chapter. It can be a serious fire hazard; it attracts pests and disease vectors, creating health hazards; and local disposal by burning or dumping adds to pollution loads and clogs waterways, so increasing the dangers of flooding. Several animal species, particularly rats, have become adapted to the urban environment by scavenging from urban refuse. Larger species, too, have been drawn to garbage bins and dumps, and are also regarded as pests, such as the urban foxes which inhabit many British cities and polar bears in Churchill, Manitoba, northern Canada. In Uganda's capital city Kampala, carnivorous Marabou storks roam about in the streets like normal citizens, living off garbage and doing a useful job in controlling smaller pests.

Some degree of waste recovery occurs in most cities. In many cities of the ceveloping countries, large numbers of residents are self-employed in the business of garbage recycling. Mexico City and Cairo are just two exampls where large squattr communities live and work on official or unofficial rubbish dump sites. In the case of Cairo, the Zabbaleari religious sect has cornered the market in garbage collection, scavenging and recycling, feeding edible portions to their domestic livestock and selling inorganic materials to dealers.

Elsewhere, metropolitan authorities run similar programmes. In Beijing, for example, a state-run recycling scheme has been in operation since the 1950s, and in New York City, Local Law 19, brought into force in 1989, requires all residents, institutions and businesses to separate a variety of materials for collection and recycling.

2.4.2.7 Hazards and Catastrophes

The high concentrations of people and physical infrastructure in cities make them distinctive in several ways with regard to hazards. Where money is available, cities are worth protecting because of the large financial and human investment they represent. Adequate provisions of water supply and sanitation are designed to offset the risks of disease, and other infrastructure, such as expensive flood protection schemes, protects against geophysical hazards.

In developing countries, where escalating urban growth rates and a lack of finance make such provisions inadequate, it is usually the poorest sectors of urban society that are most at risk from environmental hazards. Rapid urban growth and rising land prices have used up the most desirable and safest sites in most Third World cities, leaving increasingly hazard-prone land for poorer groups. Such hazards include the pervasive dangers of high pollution levels and the intensive dangers of industrial accidents. The accidental discharge from a pesticide production plant in Bhopal, northern India in 1984, for example, killed more than 3,000 shanty-town dwellers. It was primarily caused by inadequate management and lax safety procedures.

High concentrations of poor housing are built on slopes on hillsides prone to sliding (e.g. Caracas), or in deep ravines (e.g. Guatemala City); on river banks susceptible to flooding (e.g. Delhi), and on low-lying coastlines prone to marine inundation (e.g. Rio de Janeiro). Even the destruction caused by citywide hazards, such as earthquakes, can be magnified in these unstable sites: in Guatemala, 65 per cent of deaths in the capital caused by the 1976 earthquake occurred in the badly eroded ravines around the city.

In other situations, however, the damage and loss of life caused by earthquakes can be greatest in more built-up parts of the urban environment, when buildings themselves become hazardous if they are not constructed to withstand earth tremors. The widespread failure of relatively new constructions in urban areas of Armenia in the 1988 earthquake echoed the experiences of Mexico Cityin 1985. Seemingly, more sophisticated technology able to withstand tremors had not been incorporated into new buildings for reasons of cost Failure of urban infrastructure following earthquakes is one of the commonest causes of damage and loss of life. The most serious earthquake disaster in the USA, in San Francisco in 1906, was largely a function of infrastructural failure. Disruption of gas distribution and service lines caused the outbreak of many fires and interrupted water distribution, so making it difficult to put the fires out.

The most critical environmental problems faced in urban areas of the developing world, however, stem from the disease hazards caused by a lack of adequate drinking waer and sanitation. In 1990, at least 170 million people in urban areas worldwide lacked a source of potable water near their homes and 375 million did not have adequate sanitation (World Bank, Report in 1992).

Water-borne diseases (e.g. diarrhoea, dysentry, cholera and guinea worm), water-hygiene diseases (e.g. typhoid and trachoma) and water-habitat diseases (e.g. malaria and schistosomiasis) both kill directly and debilitate sufferers to the extent that they die from other causes. Again, it is the less-well-off sectors of urban society that are most at risk. The effect of improvements to water supply and wastewajer disposal on life expectancy have been clearly shown in the industrial countries, when services wee improved during the nineteenth and twentieth centuries, The trend shown for three major French cities is typical in this respect, with life expectancy increasing from about 32 years in 1850 to about 45 years in 1900, with the timing.

2.4.3 Model Questions

1) Make a discussion on the significant environmental impacts of the big dams.
2) Discuss the ways in which the big dams can be beneficial as well as detrimental for the natural and human environments.
3) Discuss the main problems with the big dams and their impacts upon the environments of the upstream and downstream areas of a river basin.
4) What do you consider the political impacts of the big dams?
5) Assess the major environmental problems that normally occur due to urban-industrial expansion.
6) Discuss the possible environmental hazards created by the urban expansion with particular reference to surface water resources, ground water and atmosphere.
7) Discuss with examples the problems of urban-industrial expansion that associate the problems of atmosphere and garbage.

2A4 Select Readings

- Cadman D. and Payne G. *eds.* (1990) : The living city: towards a sustainable future, Routledge, London.
- Hough M. (1989) : City from and natural process, Routledge, London.
- Hardoy J.E. and Milton D : Environmental problems in Third World cities, London, Eazthscan.