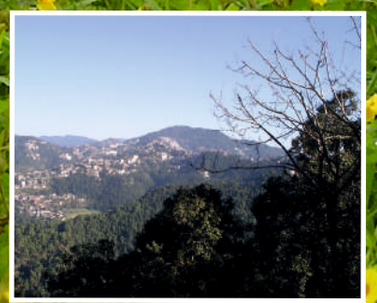

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SHIVAJI UNIVERSITY,
KOLHAPUR

ENVIRONMENTAL STUDIES

(Based on the UGC compulsory course for the under graduate classes)

Edited by
Dr. P. D. Raut
Department of Environmental Science

Estd. 1932
"A++" Accredited by NAAC (2021)
with CGPA 3.52

SHIVAJI UNIVERSITY, KOLHAPUR

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Foreword

The rate of environmental degradation has crossed the limits of resilience capacity of mother earth since last century. No doubt, human activity is highly responsible for damaging the environment. The voracious use of natural resources and fossil fuels are leading the earth towards an unending problems of global warming and climate change. Human community is stepping towards alarming environmental conditions due to everlasting environmental problems like deforestation, biodiversityloss, pollution, use of non-biodegradable product etc. This situation is jeopardising the long-term health and security of animals, plants and humans.

Therefore, it is necessary to understand our responsibility to improve the quality of environment. We need to take measures to protect the planet and hopefully rectify some of the damage, already caused by human society. Sustainable use of natural resources and judicious national policies can be the major solutions for environmental problems. Another essential aspect which should be considered very seriously, is behavioural change in human society through environmental awareness. Such awareness should be perculated towards the children and youth through the environmental education. The future generations will be most affected by our today's actions. Environmental awareness through educational means can ensure the better lives of our future generations and will be helpful in the journey towards achieving the sustainable development.

Hon. Supreme court has taken initiatives by directing UGC to introduce the compulsory Environmental Studies course at undergraduate level, all over country. Shivaji University has implemented this course from the academic year 2005-2006. The basic objective behind of implmentation of this course is to aware the students about the basics of environment and motivate to participate in environmental conservation activities.

I am sure that Prof. (Dr.) P. D. Raut, Dr. (Mrs.) A. S. Jadhav and the team have prepared this comprehensive book on Environmental Studies as a resource material will definitely give new insights to the students, Not only students but the individuals interested in knowing environmental concepts will also get benefitted through this book.

Dr. D. T. Shirke
Vice-Chancellor
Shivaji University, Kolhapur

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Editorial

I am glad that Seventh revised edition of the book "Environmental Studies" for second year undergraduate students is ready. The subject Environmental studies' has been compulsory to the students from primary to graduation under the order of Hon'ble Supreme Court to acquire basic knowledge of environment. Under these circumstances Shivaji University constituted a committee to implement the guidelines issued by Hon'ble Supreme Court and University Grant Commission and prepared a syllabus in the subject "Environmental Studies" for second year graduation students. Further University had given responsibility of preparation of book 'Environmental Studies' to the Department of Environmental Science. The book was published in the academic year 2005 as publication of Shivaji University and around 45,000 copies in Marathi and English been distributed to the students of second year graduation of all the faculties of the University, every year.

I am very much thankful to Hon'ble Vice-Chancellor Prof. (Dr.) D. T. Shirke for giving us opportunity to revise this book. Prof J. S. Samant was like a tonic during this exercise. Dr. (Mrs.) A. S. Jadhav, had also taken pain to compile this book. Contributory authors Prof. J. S. Samant, Dr. (Mrs.) A. S. Jadhav, Dr. (Ms.) N. P. Desai, Dr. N. M. Ghadge, Dr. A. V. Mane, Mr. C. A. Chandagade, Dr. V. V. Jadhav, Dr. S. G. Chonde, Prof. B. K. Pawar, Dr. A. J. Samant, Mrs. P. R. More, Dr. Sandip Manglekar, Dr. Vishwajeet Patil, Dr. Rohan Lad, Dr. P. R. Bhosale from the Department of Environmental Science without whom this work was not possible.

The book contains eight units. Each unit focuses on every fact, problem and solutions of environment. Field study is very important part of Environmental Studies. Eighth unit deals with scope, methods, list of projects and format of field study report which will be

useful to the students to implement their project. Every unit is provided with precise objectives of the topic. End of the book is provided with comprehensive list of books, websites, common terms (Marathi/ English) used in Environmental Studies and important days celebrated related to environment.

I am thankful to Dr. (Mrs.) A. S. Jadhav, Chairman Ad-hoc. Board of Studies in Environmental Science who took immediate steps to revise syllabus. Editorial team is also thankful to all university anthorities and bodies for their time to time co-operation and encouragement. I am also thankful to officers and staff from BOS Department. I am also thankful to Uniiversity Press staff for excellent data handling, compilation and printing. Thanks are also due to those nature lovers who have contributed beautiful photographs in this book.

I hope this book will be useful to the students of Environmental Studies. Doubts or clarifications about this book are always welcome from students, teachers and nature lovers.

April, 2021
Kolhapur.

Dr. Prakash D. Raut
Ex. Head,
Department of Env. Science,
Shivaji University, Kolhapur.

CONTENTS

Chapter : 1

Nature of Environmental Studies

1.1 Introduction :

Rapid loss of environmental quality today is perhaps the most serious threat humanity has ever faced in the history of mankind. Environmental degradation is a global problem and is directly related to natural resource depletion in quality and quantity. This is as a result of population explosion and industrialisation related unsustainable and changing life styles of the modern society. The situation is causing overuse, depletion and degradation of the finite and non-replenishable vital resources.

Lack of environmental awareness and concern in the society is basically responsible for the degradation of environment. Wrong priorities and resource overexploitation, encouraged initially in the developed, and now in developing, societies is causing socio-economic stress and even geo-political conflicts. It is often forgotten that human existence and also life of other creatures is solely dependent on the health of the planet earth. It is therefore essential for every person to know about the impacts of his daily acts on environmental health, locally as well as globally. In order to protect the present and the future generations from the difficulties faced today i.e. resource crunch, degradation, pollution, biodiversity loss and population exploitation, that there should be at least minimum understanding about man and his interactions with environment.

The subject environmental studies is a truly multidisciplinary and at the same time holistic, covering diverse and interrelated subjects from different academic disciplines namely science, social science and humanities. Since it does not only deal with physical nature but also with human behaviour and attitudes as well. We must understand that environmental degradation is a complex and long term process with no easy or immediate solutions.

Despite the technological advancement and material development, the modern societies are facing serious environmental problems due to the negative impacts of human activities. It is therefore very much necessary to approach the issues arising out of the situation with proactive rather than reactive attitudes.

1.2 Definition, Scope and Importance

Environmental degradation is the severe and growing problem faced by the modern humanity today the world over. Though there has been gradual increase in the awareness about the causes and impacts of environmental decline on human life in the developed countries, such awareness and resultant actions are grossly lacking in the developing countries. This is being attributed to the different developmental priorities of these countries, mainly fighting population growth, poverty and illiteracy.

However, the recent studies have shown that these factors are more interlinked and responsible to further damage of the environment. Knowing about the nature around us and human interaction with it, is therefore essential for every human being. Our existence depends on the health and the well being of the physical and living environment around us. Every action of ours, individually or collectively, directly or indirectly, leaves

some impacts on the environment. Therefore, it is necessary for every one to understand the functioning, structure, associations of natural phenomenon and their role in our daily life.

The trends of environmental changes suggest that unless serious, committed and consistent actions are taken by everyone today to protect and improve the environment around us, the future generations will have to face difficult scenarios of resource crunch, pollution, population explosion and resultant socio-economic and political stress. It is therefore recommended by the environment and education experts and thinkers that the younger generation, need to be made aware of the entire gamut of the man and environment interrelationship. This can best be achieved by exposing the students to environmental studies at an early age. So by the time they grow they will take more eco-friendly decisions and make long term sustainable use of the then available resources for every one ensuring a more just and sustainable and peaceful human society.

The different perspectives of the environmentally conscious society about the human development from the physical, social and spiritual angles will look at the environment in different dimensions and views. In the modern industrialised society, with the technology advancement, the perception of environment has changed drastically away from the traditional view about the man and environment interrelationships where the traditional wisdom about nature and coexistence has been ignored or even forgotten. Environmental studies are expected to bring all these aspects in brief into notice of the students.

1.3 Multidisciplinary nature of Environmental Studies

Though, man has been knowing about natures a great

deal since its early existence, this knowledge was restricted to only a few species of useful organisms as food, fibre, fodder, medicine or aesthetic value. Subsequently, the understanding about environmental forces was added but still limited to various forces of nature and the seasons. Later, it was more about domestication of plants and animals. In the last few centuries it revolved around discovering new resources for the industrial development. However, till recently the holistic nature of ecology or environmental science was not recognised. Only in the mid twentieth century environment became a matter of concern due to the problems of pollution and other related environmental issues the world over.

Now, it is well accepted that environmental studies has to have multidisciplinary approach for better understanding of the environmental issues as well as for effective actions to protect it. This approach requires better knowledge of the concepts from various disciplines, such as science, social science and even humanities, as man and environment interactions are many folds, at different levels and are also complex. Therefore, environmental studies is a holistic study of man and his environment, which includes interrelationship of all the living and non-living components of nature. This basic knowledge is must for every human for his healthy life today and for the future generations.

1.4 Need for Public Awareness

Environmental degradation is basically a result of negative impact of human activities on environment. Most of the human activities for daily life as well as long term developmental activities, without consideration from environmental health, have altered the environment to a great extent. It is revealed that in most cases this change in environmental quality and quantity is long term, permanent and irreversible. Even today

with the technological advancement our understanding about nature and its dynamics is very limited. People in general are not aware about the facts of the finite nature of the resources and the negative impact of day to day human activities, which are slowly, and gradually eroding the quality of the life support systems.

Therefore, it is essential that the public, a common man, is made aware of the impact of the human activities on environment. This awareness is particularly of the changing lifestyles which are not Eco-friendly, and adopted under the disguise of 'development'. People should also be made aware of the immediate priorities and available resources and the development possible under the concept of 'carrying capacity' of the earth. They should also be made aware of the limitations of technology as well as laws of nature, which can not be violated by man beyond a certain limit. The concern for the future generations, their needs and options left to them need to be cleared in the efforts to make people aware about human impact on environment at personal, local as well as global level.

Since environmental degradation is the collective impact of human activities on nature, every component of the society must know the consequences of its activities on nature and other fellow species. Today due to the revolution in information technology, huge amount of information related to environmental issues is made available by print and electronic media. Also due to satellite and other technologies there is better understanding of the environmental processes at regional and global level than ever before.

The environmental awareness with common man must be based on scientific understanding and ethics of conservation. This awareness about environmental protection and nature

conservation should reflect in every day, personal and collective, positive actions. Since man is the cause of environmental degradation seen today, he is also the solution for improving the conditions. There is no short cut for improving environment, even with new technologies or strict legislation, unless well informed public takes conscious decisions to restore the degraded environment by changing personal attitudes and adopting Eco-friendly lifestyles with peoples participation.

◆ ◆ ◆

Chapter : 2

Natural Resources and Associated Problems

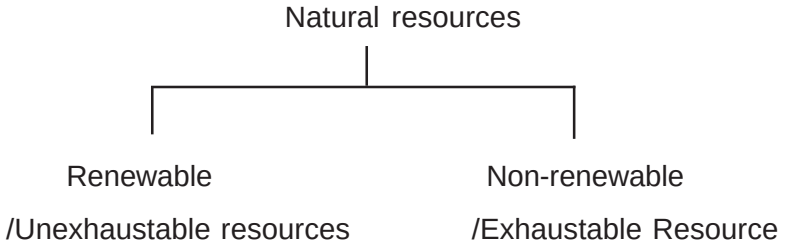
2.1 Introduction

The environmental factors which fullfill the needs of human and help to improve life style are called as resources. Development of any any nation depends upon the quality and quantity of the resources. From last couple of years increasing industrialisation and urbanization caused deterioration of natural resources. There is always lmbalance developing between increasing population and limited natural resources. Changing lifestyle causes over-use of natural resources which leads to environmental deterioration. If it continues like this then in future, human will be unable to fullfill their basic needs. There is need of sustainable development without imbalancing environment. For future point of view, considering the limit of growth of natural resources, the suitable distribution of natural resources is neccessary, this is need of not only present but also future generation.

A) Reversible Resources / Non-Exhaustable resources

The resources which are ample in nature or if they are used once then these resources regenerated by natural processes or by human activities, such resources are called as **Renewable resources**

e.g. Solar energy, wind energy, OTEC, Geothemal etc.



Human activities don't affect renewable resources but abuse detoriats the quality of these resources.

e.g. Water Pollution, Air Pollution

B) Non-renewable/Exhaustable Resources :

These resources are available in limited quantities on earth. These resources which are exhausted after using once they can-not be regenerated easily are called as Nonrenewable, Non-exhaustable resources e. g. coal, oil etc.

2.2 Forest resources

Forest is one of the important natural resource used by man. Right from its primitive stage man has depended on forests for his survival. Forests are known to perform several ecological functions such as continuous cycling of air and water. They strengthen the hydrological systems by retaining underground water and reducing floods. They prevent soil erosion and also provide food, fuel, fodder, particularly to local poor. Millions drive their livelihood from collecting minor forest produce that is available without cutting of trees and process on wood. A large population is employed in industries which use forest products as raw material.

In the industrialised world forest is still one of the vital resource. But for the tribal communities, who live in forests and millions of people who stay on the boundary of the forest,

it is the only source of sustainance directly or indirectly as all of their basic requirements are met by the forests and associated ecosystems.

Use and over exploitation

Some of the major causes of the forest degradation and shrinkage in the world today are diversion of forest land to agriculture, commercial exploitation, fuel-wood extraction, cattle ranching, irrigation, hydroelectric and other projects. The traditional use of the local forest resource mainly dependent on the modest needs of the local populations, which was within the carrying capacity and regeneration limits of the vital biotic system. However, with the growing needs of the ever increasing populations in the developing countries and industrial needs of the developed countries, have over exploited the forest resources not only locally but globally. Thus, further depriving the poor countries and local communities of their forest resources uncontrollably in the world trade of timber and paper and other commercial uses.

Deforestation

The main causes of deforestation i.e. removal of natural vegetation is due to clear felling, shifting cultivation and agriculture expansion and anti environment practices like 'raab', and developmental projects such as dams, mining, roads, harbours etc. Diversion of forest land for agriculture is one of the major reason for deforestation. This is primarily done by clearing of forests for agriculture purpose either by extraction of trees or by shifting cultivation practice, both being equally detrimental to forest health. Mining for minerals in the ecologically sensitive hills has also contributed significantly in the process of deforestation in the country in the last few decades.

The developing countries depend heavily on labour intensive agriculture techniques to meet their growing demand for food. Shifting cultivation and related practices have reduced forest cover to a great extent in the hilly regions in India i.e., Western Ghats and North Eastern Himalaya, the are as extremely rich in biodiversity and therefore known to be 'hot spots' in the world. Besides biodiversity loss, ecological degradation due to deforestation of the earlier vegetated areas leads to desertification, which most of the times is a non reversible process. It is revealed that in most of the foot hills of Himalayas and in the Western Ghats the degradation of forest is converting the areas into semiarid lands. Large part of Gujrat and Madhya Pradesh adjoining Rajasthan is being desertified due to removal of tree cover and overgrazing.

Timber extraction

Traditionally, forest resources are primarily considered for timber and then for fuel wood, industrial and domestic. Though forest dwellers and the locals have been using trees for house construction, agriculture implements and as raw material for artisans, the use had always been very modest. Only after industrialisation, during the colonial rule in India timber extraction from specific trees like Teak, Sal started on a mass scale for building of boats in the nineteenth century and later for railway sleepers and housing. In the 20th century most of the natural forests were reduced to fragmented patches and the vast areas were brought under mono culture plantations for commercial purpose of timber extraction. This reduced the diversity of plant and animal species existed in the earlier forests. After independence, the process continued with increasing demand for timber for housing from the urban centres. Due to restrictions for clear felling of trees from the forests, as they are threatened , the country imports part of its timber requirement from south east asian countries.

Mining

Mining is a very location specific and often a one time activity and thus causes permanent environmental transformation. May it be for the minerals or quarrying, it is often in the forested areas with strip or open cast mining type i.e. bauxite, manganese, iron etc. The mineral deposits being shallow and closer to the earth's surface, the forest vegetation on the vast area needs to be removed first. The non useable earth or over burden is pushed on the slopes of the hills and which destroys the rich vegetation on the slopes as well as streams and springs in the valley. The transportation of the ore requires road network through forest. Settlement of the workers, workshops and industrial machinery create noise and air pollution which is detrimental to flora and fauna on the site and in the vicinity.

Mining activities in Indian forest have been proved to be detrimental to the flora and fauna in Madhya Pradesh, Rajasthan, Himachal Pradesh, Assam, Arunachal and Western Ghats region in Maharashtra, Karnataka, Goa. This includes forested areas in and around Protected Areas such as wildlife sanctuaries and national parks as well. Unfortunately, though mining regulations and management require restoration of the natural forest by plantation of trees after the mining operations, it is often ignored by the concerned. And even if done, in rare cases, it can not compensate for the original natural vegetation. Thus mining causes permanent and non repairable damage to the natural forest ecosystems.

Dams and their effects on forests and tribal people

Large areas of pristine forests, normally in the ecologically sensitive areas near the origin of rivers in the upper catchments are being cleared for the construction of large dams for irrigation

and hydroelectric projects. This is very common phenomenon in India in the hilly regions like the Western Ghats. It is revealed that most of the dam projects have been responsible, directly or indirectly, for degradation of the forests in upper catchments. The forest area which comes under submergence is not necessarily the only forests affected but right from dam construction planning, earth moving, road construction, labour colonies and their fuel wood requirements etc. take toll of the forests around the dam sites in the once remote areas. These projects attract settlements, industries and associated activities causing further stress on the already shrinking forest resources. Thus permanently damaging their regeneration or future recovery.

The locals, particularly tribals, who are closely associated with the forest habitats and the resources therein in the areas where dams are constructed, are the worst affected. They gradually loose their traditional habitat and the livelihood which is based on the local resources available within the neighbouring forest ecosystems. Their dependence on the forest for subsistence and cultural needs is almost non separable due to well evolved coexistence for centuries. When they are displaced due to dam or related developmental activities, it is virtually impossible to rehabilitate them not because they do not always get the due compensation and proper rehabilitation, but because their social and cultural linkages with forest are permanently severed.

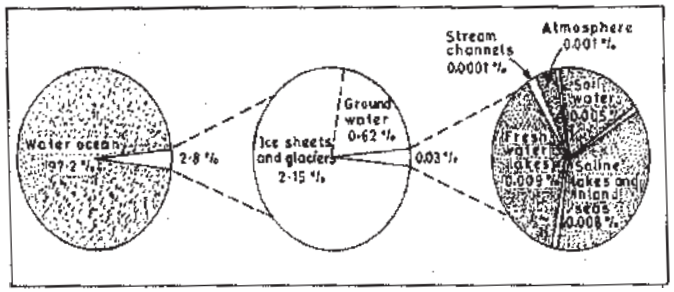
2.3 Water Resources

Water is one of the most essential requirement of life. Our earth is called as 'Water Planet'. About 70% of earth's surface is covered by water. But only a small fraction of fresh water is available in the form of surface water or ground water.

Global Distribution of Water

Table No. Global Distribution of Water

Sr.No.	Distribution	Percentage (%)
1.	Ocean, Sea	97.1%
2.	Frozen Ice	2.15%
3.	Ground Water	0.65%
4.	Surface Water	0.03%



We should know that water resource is not uniformly distributed on earth. In India, Cherapunji receives highest precipitation (1200 mm) while the arid Rajsthan receives the lowest precipitation (200 mm) annually.

Now a days, the increased use of water and changing life styles are deteriorating the valuable resource. Water consumption has increased many folds particularly for domestic, agricultural and industrial sector. Presently, there is overuse or misuse of this precious resource.

The surface water on earth is present in the form of oceans, seas, rivers, streams, lakes, ponds, etc. This water is used for many purposes.

Use and over utilization of surface water :

About 65% of human body is composed of water. Water is required for various metabolic functions of cell. It is used for domestic use, industrial use, agricultural irrigation, animal husbandries, etc. Also, for Hydropower generation, water transportation, sewage and effluent discharge.

Though there are many uses, water is abused due to anthropogenic activities. The quality of water is decreasing day by day at local, regional and global level. For the domestic purpose people use the treated water for vehicle washing, flushing, gardening. Easy availability of tapwater aggravated the overuse and wastage of water. Industries discharge their toxic effluents in the nearby waterbodies which further leads to many pollution problems. Disposal of solid waste containing wooden rags. household refuse, plastics, metal parts, decrease the aesthetic beauty of water body and leads to spread of waterborne diseases. Modern agricultural practices causes bioaccumalation and biomagnification of chemical pesticides and heavy metals during water runoff. Also, overuse of water for irrigational purposes cause the problem of waterlogging in many areas.

Use and overutilization of ground water :

Ground water resources are restricted, site specific and limited. Few years ago groundwater was supposed to be a safe water source but due to anthropogenic activities, this resource is on the verge of depletion. More and more ground water is consumed for domestic, agricultural and industrial sector. The use of ground water beyond it's recharge capacity is posing threat to this resource. The over exploitation resulted in the lowering of ground water table by several hundred feet thus becoming more expensive to harvest it. Changes in water runoff and infiltration patterns as a result of deforestation

are the main reasons of ground water depletion. Ground water resources built up in large time span but are exhausted in much shorter time span. It is necessary to recharge these resources with care and long term management of the resource with the help of advanced technology.

In last few years, India has experienced more and more desertification, thereby increasing drought conditions in many areas of country.

Intensive cropping pattern and increased exploitation of scarce water resources has converted drought prone areas to desertified areas.In Maharashtra, cashcrop sugarcane is responsible for overexploitation of water and inviting the drought conditions.

- **Mitigation of droughts :**

1/3rd of the world's population directly or indirectly suffer's the effects of drought. UNISEF, WHO, FAO, UNO these international organisations help the affected population by providing food, water, medicinal aid, economic support. There are some mitigation measures like

1) Increasing the green cover to enhance the water holding capacity of soil.
2) Proper planning and management of water resources.
3) Mixed agricultural practices.

- **Effects of Drought**

1) Scarcity of water and disturbance in hydrological cycle
2) Agricultural loss and famine
3) Soil erosion
4) Problem of rehabilitation

Conflicts over Water

Traditionally water has been considered as a common natural resource and to be shared by all alike. Now a days due to change in developmental priorities, attitudes of people towards this resource are changed. Today not only quantity but quality of available water is responsible for regional or global conflicts. The various cases of conflict over water are increasing between households, communities, villages or states, as seen all over country today. Out of 18 major rivers in India, 17 are shared between different states. The conflict on Cauvery water between Tamilnadu and Karnataka is almost hundred years old. Similarly, disputes over Satlaj-Yamuna link, Krishna River water conflicts are some of the examples.

The conflict revolving around sharing of river water needs to be tackled with greater understanding and objectivity. It is essential to conserve and use this resource judiciously.

Dam-benefits and problems

Dams are constructed for the purpose of irrigation, flood control, city water supply, electricity generation. India has the largest number of river valley projects. These dams are often regarded as a symbol of development. These have tremendous potential for economic upliftment and growth.

They can help in checking floods and famines, provided drinking water in remote areas and promote navigation, fishery, etc.

Though there are many benefits of dams, the problems associated with dams are many and specific to the local situations.

The problems include displacement of tribal people, loss of forests, flora and fauna, stagnation and water logging near reservoir, breeding of vectors and vectorborne diseases, reservoir induced seismicity, microclimatic changes, flash floods.

Thus, although dams are built to serve the society with multiple uses, it has several side effects. It is necessary to shift towards construction of small dams or minihydle projects.

2.4 Mineral Resources :

All rocks on the earth's surface, as well as in it's interior, are made up of an aggregate of minerals. Mineral resources are the one, from which usable material are extracted economically from the concentrated elements, compounds, minerals or rocks of the earth. These minerals are site specific and finite hence they should be harvested with great care and planning without disturbing environment.

Use and exploitation :

A variety of minerals both metals and non metals are exploited by the mankind over countries. Mineral resources are of several types viz. Metalic minerals and non-metalic minerals or industrial minerals include a variety of substances which comprise the building materials such as rock, sand, gravel, cement and day. The non-metalic minerals are fertilizers which supply NPK are essential to increase agricultural yield. These metals are (a) Structural metals : Iron, Aluminium. (b) Scarce metals : Copper, lead, Zinc, Nickel, Mercury, Magnesium (c) Precious Metals : Platinum, Gold and silver. Some mineral resources are necessary for life such as salt. Other mineral resources are essential for maintaining required level of technology. Mineral resources are finite, so it is required to use them carefully.

One of the reasons for disparities in the development among nations of the world is the unequal distribution in the types of resources available. Besides the contrasts in physical environment such as climate, soils, regetation, animal resources, power resources are distributed unevenly. Besides uneven distribution of resources, their is also disparity in the

development of resources. Development of a resources, like water, power needs technical inputs and other infrastructure facilities.

With increasing populations and increasing per capita consumption the resources are being exhausted. The mineral resources are non-renewable, therefore one has to see the availability of a specific mineral when it becomes limited. As easily accessible and high grade ore are getting depleted, there is a need for identifying more sources. Recycling the metals or substituting the metals can also be possible.

Modern specialised industries use minerals such as mica, Kainite, graphite and rare minerals such as germanium, zirconium, cerium etc. From a first group of minerals various metalic, non ferrous and ferrous natural products viz. Iron, manganese, chromium. From second group of minerals which fulfil the requirement of industries, commerce, transport and daily requirement of an organised and industrial society. Very recently a third group of minerals is introduced in the field - atomic minerals group which is important for generation of power plant production of warfare weapons.

In India, mineral resources have very unequal distribution. Alluvial plains of Northern India do not have mines of economic minerals. Bihar and orissa have huge concentration of ore deposits of iron, managanese, Copper, thorium, uranium, aluminium, chromium, industrial minerals such as mica, sillimanite, phosphate and major coal reserves. Madhya Pradesh is the second mineral rich state having huge reserves of iron and managanese ores, coal, limestone and bauxite. Tamilnadu has deposits of manganese, magnesium, mica, limestone and lignite. Karnataka has all the gold deposit of India as well as good quantities of Iron, porcelain clays and chromium ores. Kerala has huge deposits of heavy mineral sands of limonite, monazite, zircon, rutile and zinc deposits

as well as uranium, mica, stellate, beryllium and precious gemstones. Gujarat and Assam have petroleum and coal deposits. Coal resources are mainly found in West Bengal. In Maharashtra there are off shore deposits of Petroleum and Bauxite in Kolhapur, Ratnagiri. Andhra Pradesh has good deposits of low grade coal and good source of various industrial minerals and diamond of industrial and gem variety.

The mineral deposits are generally exploited from peculiarly high concentrations of earth material. The formation and spatial distribution of mineral resources is interrelated to the history of the geological cycle. The crust, outer most part of the earth, is not of uniform concentration of elements. The crust is formed of oxygen, silicon, aluminium, iron, calcium, sodium, potassium and titanium which constitute 99% by weight. Other elements are constituted in trace concentration.

The different processes in nature have acted to concentrate the ore minerals into various degree of concentration resulting into rich, poor and marginal grade of ore mineral deposits. Plate tectonic play important role in the mineral deposits. Minerals are considered to be concentrated in the crust both where tectonic plates separate and where they come together. Mercury and Sulphur deposits mainly occur within the volcanic regions that come near to convergent plate boundaries.

Magma is the main source of mineral deposits. During casting of magma heavier minerals crystals first and slowly sink to the bottom of the magma chambers and lighter minerals that crystallize later forms the top portion of magma chamber. Chromite deposits are considered to be formed in this way. Diamonds may be formed from small quantity of carbon in magma, which at depth undergo very high pressure during slow cooling. Magmatic hot waters moving within the crust may be the source of many ore deposits.

There are also various other processes such as sedimentary processes, biological processes, weathering processes forming mineral deposits. Oceans and seas which form 2/3 part of the earths surface at the bottom, are full of mineral resources such as sulphite deposits, manganese nodules, coral deposits and petroleum deposits.

Exploitation of Mineral Resources :

The main problem of mineral resources extraction is the liberation of harmful trace elements to the surrounding area. The mining and processing of minerals have an important environmental impact on land, water, soil and biological resources as well as it has a social impact.

The large scale mining gives rise to inflow of mine workers into once remote and undisturbed areas. Therefore, there is increase in burden on water supplies, sewage and solid waste disposal system and housing. There is shift in land use from open range, forest and agriculture to industrial and urban utilization. The mining activity affects near by water stream through sediment pollution, change in water quality where runoff of the over burden is more. Air is also polluted due to more transportation and dust from mining activity, power generation and construction. Due to close distance from nearby towns and villages it shows adverse effects.

So far as the causes of mineral losses are concerned, soil erosion and cropping are considered to be the most significant. Most of the soil nutrient's remain on the upper part of the soil and many fertile minerals of upper soil are carried away by rapid winds or running water and soil becomes deficient of fertile minerals. We know that the soil is the most important irreparable resource of nature. It is essential for human existence which provides the basic requirements to man.

Case studies :

1) Bauxite deposits of Kolhapur are found in hill tops, blow soil and laterite cover or as pockets in laterite. Bauxite and laterite actually form the aquifers in the ground water but when it is exploited ground water conditions are changed as well as at places cutting of trees is done before exploitation, thus there is loss of plants. Therefore after mining of bauxite rehabilitation work is essential. Bauxite deposits are exploited by open cast mining as it is not occurring at great deposit. Thus, afforestation after the mining is essential to restore the degraded environment.

2) Kudremukh iron ore mining in Karnataka the first systematic effort has been done to control the environmental pollution. This is the largest open cast mine in India. The general topography is hilly excluding the rally along the Bhadra river. In this area annual rainfall varies from 6000 to 7000 mm and precipitation is during June to September.

For the environmental protection and pollution control, the master plan has been in force along with the mine construction in the following steps :

1) Afforestation on the mining site
2) Formation of contour trenches in the mining area
3) Afforestation of tailing dam catchment area.
4) Formation and Green Belt along the roads and
5) Parks and Gardens in the township area and green belt around it is developed.

These measures are required to control soil wash from mining operation comming into Bhadra river, reduce sound and air pollution. Similar measures have been taken for environmental protection in other areas of iron ore mining in

India. However, the recent report reveal that these control measures are far from satisfactory as the environmental damage is permanent.

2.5 Food Resources

World food problem

Food has become a symbol of our collective human endeavour to create a better world for all. However, the victory has been partial, and neither the challenges nor the opportunities that food presents have been fully addressed. It is of crucial importance not only to the poor but also to the peace and stability of global society, that we complete the task of vanishing famine and hunger once and for all. Hunger anywhere threatens peace every where. Hunger leads to political instability, social unrest, massive migrations, rebellions, civil war, crime and violence.

Contrary to the fears raised in earlier centuries and revived in recent decades, today, the world does not possess the capacity to feed everyone. This is so, even at current levels of food production. Current projects however indicate that the growth rate in world agricultural out put will continue to exceed population growth over the next two decades. Increased production of other food crops is also expected to raise per capita availability in the developing world. These achievements have not been uniform throughout the developing world. Per capita food production has actually declined in more than half of the developing countries over the past fifteen years.

The idea that hunger cannot be conquered because we are running out of land to support rapidly burgeoning population is contradicted by facts. Globally there is no correlation between population density and hunger. There are powerful social forces active in the world today that can stimulate significantly greater growth in both food demand and food production.

Changes caused by agriculture and overgrazing

Rising incomes are accompanied by a diversification in diet which generates great demand for wheat, meat, dairy products, fish, vegetables, fruits and processed foods. Changing agricultural crops as per demands and supply policy are also highly appreciated and accelerated due to the tremendous research like green house plantation, tissue culture, Bio-fertilizer crops etc.

Effects of modern agriculture

Modern systems of agriculture use large amounts of fossil fuel energy, water, chemical fertilisers and pesticides to produce huge quantities of crop or live stock. Mechanised and chemical based farming, commercial farming, contract farming and genetic farming swing biotechnology are the types of modern agriculture.

Globalisation and the new market economy has influenced the dietary habits of the people in the developing countries. The new diverse demands of exotic species of crops, vegetables and fruits have introduced changes in the traditional agriculture patterns and practices. Similarly demand for more animal products in the changed diets have resulted into increased production of farm animals. This is achieved in the European countries and South America by converting agricultural and forest land into pastures for raising cattle for meat. In India overgrazing is a problem due to the large population of less productive livestock which degrades woodlands, pastures and agriculture lands alike.

A number of factors are posing serious obstacles to productivity, growth and threaten even current levels of agriculture production. Quality farmlands are being lost at an astonishing rate to diversion for non-farm uses. Desertification, deforestation, Soil erosion, Salination, climate changes,

depletion and pollution of water resources. These factors have resulted in the degradation of nearly one billion hectares of land world-wide since the second world war.

Air pollution, Soil compaction, aquifer depletion, the loss of soil organic matter, the water logging and salting of irrigated land are all slowing the rise in food outputs. At the same time over-grazing has exceeded the carrying capacity of grasslands as well.

Rapid and sustained expansion of food and agricultural production cannot be achieved without conceited efforts to address these facts. At the same time there are a number of positive factors as well that offer opportunities to increase productivity. Greater attention is needed to conserving and applying organic sources of manure and raising nitrogen-fixing crops, as well as to the use of bio-fertilizers. Environmentally sustainable field practices which are neither costly nor technology intestine should be widely propagated.

Fertilizers – pesticide problems

In order to increase the fertility of soil as well as the production, chemical fertilizers are used in large amounts. There has been a transition in the types of fertilizers in the past few decades, earlier the widely used cow dung manure was later accompanied by chemical fertilizers and today we have certain products produced only on Bio-fertilizers. Organic fertilizers, like compost and vermi-compost have been propagated on a large scale and have also proved to be most efficient, nitrogen – fixing, phosphate solubalizing (dissolving), cellulose decomposing micro-organisms. When these fertilizers are applied to seed or soil, they enhance availability of nutrients to plants and offer an eco-friendly, economically viable socially acceptable means of reducing soil pollution and water pollution caused due to agricultural run- off.

Pesticides are “Biocides” that is designed to kill unwanted life. However, the indiscriminate use of hazardous pesticides has resulted in a reduction in the bio-diversely of natural pest enemies and friendly organisms. It has increased outbreak of secondary pests, development of resistance to pesticides and contamination of food and ecosystems. During the past century there has been an almost 100% increase in the number of pest insects and mites due to the indiscriminate use of pesticides.

Pesticides are used to control unwanted harmful species or control their population. Since most pesticides are not very specific they also kill many non-target organisms as well. Similarly rodenticides also kill other animals along with rodents. Pesticides also have an effect on natural pest control mechanism like frogs, snakes, birds, etc. Pesticides not only kill pest alone but also harm human beings through the slow poisoning process, Although the use of pesticides is comparatively low in India to other countries, yet it is estimated that 20% of Indian food products contain pesticides.

The effectiveness of a pesticide is found to reduce when used for a longer period of time. In India out of the 133 pesticides for regular use 34 are those which are either banned or restricted in other countries. The use of pesticides and their discharge in to water holes with rainwater indirectly affects the people through bathing, washing and some times even if used for drinking. Individuals spraying these pesticides are also victims of its effects.

Considering the ill effects of indiscriminate use of chemical pesticides, Bio-intensive Integrated Pest Management (BIPM) a more feasible and economical method of pest management and has become popular, particularly among small and marginal farmers. Through this method of conservation and augmentation of natural enemies of crop pest occurs.

The methods include: Host plant resistance, this involves breeding varieties with desirable economic tracts but less attractive for pests. Among cultural measures are: selection of appropriate site for crops, ploughing (for exposing soil inhabiting fauna to adverse climatic conditions, tractor operating cultivation, use of healthy seeds, thinning and topping, clipping of affected leaves and twigs, picking of leaves containing egg masses, burning of debris, application of bio-fertiliser, crop rotation, Planting of trees like Neem on bundhs to attract predator birds etc.

Water logging and salinity

Irrigation without proper consideration for the drainage of excess water has proved dangerous due to water logging. When water is added at a rate greater than the rate at which it can drain out specially in cases where the water table is within 1.5 to 2.1 meters below ground level water logging is a major problem.

Water logging is associated with another problem – salination. In regions of scarce rainfall, the soil contains a large amount of unleashed salts. Excessive irrigation brings those salts to the surface and leaves behind a residue when the water evaporates. It can also cause unleashed salts to accumulate in the upper layer of the soil. This excessive salt build – up in the soil is called salination. In the recent years vast tracts of agriculture lands in the country are facing this problem due to over irrigation of cash crops like sugarcane. The problem is further aggravated with increasing number of new dams and network of canals which is influencing the local farmers to go for more water intensive and exotic crops which may not be suited to the local agro-climatic conditions.

It is now revealed that salination diminishes the productivity of the soil and in extreme cases, ruins it for ever. Both these

conditions, water logging and salination, can lead to subsequent desertification. The rich alluvial plains of Uttar Pradesh and Punjab suffer seriously from desertification caused by excessive irrigation. In western Maharashtra also, in many places like Digraj in Sangli district, thousands of hectares of fertile land has become saline and thus permanently lost its productive use.

2.6 Energy Resources :

Energy is one of the central issues of the 21st century. Development of any country largely relies on the energy use. Energy is the vital force powering business, manufacturing and the transportation of goods and services to serve world economies. We find a large variation in per capita energy use between developed and developing countries. Energy supply and demand plays an increasingly vital role in national security and the economic output.

Growing energy need :

Agriculture, industry, mining, cooling, transportation, lighting, heating etc. needs energy. Our life style is changing very fast and we are shifting towards luxurious life style. We have to find a way of satisfying the growing needs of the human population - the vast of which still living in poverty. The first problem we face is the explosion in demand. It is due to increase in population and the efforts of some of the most densely populated regions of the world to develop their economies. Developed countries like U.S.A. and Canada constitute about 5% of the world's population but consume one fourth of global energy resources. An average person there consumes 300 GJ (Giga Joules = 60 barrels of oil) of energy per year. By contrast an average man in a poor country like Bhutan, Nepal or Ethiopia consumes less than 1 GJ in a year. The World Energy Council forecasts that global energy

consumption will rise by 50 per cent between 1990 and 2020. And this would only be a partial narrowing of the gap between 1990 and 2020. This would only be a partial narrowing of the gap between the developing and industrialized world's energy use. Fortunately, there are not abundant immediate energy resources, 200 years of coal reserves, 40 years of oil, and 70 years of gas. We see that the unequal distribution of hydrocarbon resource around the world is already a cause of global conflict. Nevertheless, fossil fuels are still used for transport, many other fuel needs and more than 60 per cent of global electricity generation. Since 1992 Rio Summit, carbon dioxide emissions have increased by an average 100 million tones a year. This presents enormous challenges to the human society.

Renewable and Non Renewable energy Sources

A source of energy is one that can provide adequate amount of energy in a usable form over a long period of time. These sources can be of two types.

1) **Renewable Resources can be generated continuously in nature and are inexhaustible** e.g. solar energy, wood, wind energy, tidal energy, biomass energy, geothermal energy and hydrogen. These resources can be used again and again in an endless manner.

2) **Non Renewable Resources have accumulated in nature over a long span of time and can not be quickly replenished when exhausted** e.g. coal, petroleum, natural gas and nuclear fuels like uranium and thorium.

B) Renewable Energy Resources (Alternate Energy Resources)

Renewable energy effectively uses natural resources

such as sunlight, wind, rain, tides and geothermal heat, which are naturally replenished. Renewable energy technology range from solar power, wind power, hydroelectricity/micro hydro, biomass and biofuels for transporation.

In 2006, abouit 18 percent of global final energy consumption came from renewables, with 13% coming from traditional biomass, like wood-burning. Hydropower was the next largest renewable source providing 3%. Modern technologies, such as geothermal, wind, solar, and ocean energy together provided some 0.8% of final energy consumption. The technical potential for their use is very large, exceeding all other readily available sources. Renewable energy technologies are sometimes criticized for being unreliable or unsightly, yet the market is growing for many forms of renewable energy.

The manufacturing output of the photovoltaks industry reached more than 2,000 MW per year in 2006 and PV power plants are particularly popular in Germany. Solar thermal power stations are well operated in the USA and Spain. The world's largest geothermal power installation is in California, with a reted capacity of 750 MW. Brazil has one of the largest renewable energy programs in the world, involving production of ethanol fuel from sugar cane, and ethanol now provides 18 percent of the country's automotive fuel. Ethanol fuel is also widely available in the USA.

Main Renewable Energy Technologies

The majority of renewable energy technologies are directly or indirectly powered by the sun. Renewable energy flows involve natural phenomena such as sunlight, wind, tides and geothermal heat. Each of these sources has unique characteristics which influence how and where they are used.

1. Wind power

The wind energy is harnessed by making use of wind mills. The rotational motion of the blades drives a number of machines like water pumps, electric generators and flour mills. A large number of wind mills are installed in clusters called **wind farms**. The minimum wind speed required for the satisfactory working of a wind generator is **15km/hr.** Modern wind turbines range from around 600kW to up to 5 MW of rated power. The turbines with rated output of 1.5 to 3 MW have become the most common for commercial use. The power output of a turbine is a function of the cube of the wind speed so as wind speed increases, power output increases dramatically. Areas where winds are stronger and more constant, such as coastal regions, open grasslands, hilly regions are the preferred locations for wind farms. Wind power is the faster growing among the other renewable energy technologies, though it currently provides less than 0.5 percent of global energy. It is very useful and does not cause and air pollution. Wind strengths near the Earth's surface vary and thus cannot guarantee continuous power unless combined with other energy sources or storage systems.

2. Hydropower

Energy in water, in the form of motive energy can be harnessed and used. The water flowing in a river is collected by constructing a big dam where the water is stored and allowed to fall from a height to rotate the turbines. Since water is about 800 times denser than air, even a slow flowing stream of water can yield considerable amounts of energy. Hydroelectric energy is a term usually reserved for large scale hydroelectric dams. Micro hydro systems are hydroelectric power installations that typically produce up to 100 kW of power, for which minimum height of the water falls should be 10 meters. They are often used in water rich areas as a Remote Area Power Supply (RAPS).

3. Tidal Energy

This is the energy harnessed from the tides produced in the ocean. A difference of several meters is required between height of high tide and low tide to spin the turbines. Wave power has now reached commercialization.Tidal power captures energy from the tides in a vertical direction. Tides come in, raise water levels in a constructed basin and roll out, with the spin of turbines usually using underwater plant just like a small wind turbine and generate electricity. Around low tide the water in the basin is discharged through a turbine.

4. Ocean Thermal Energy Conversion (OTEC)

This technique uses the temperature difference between the warmer surface of the ocean and the colder lower regions. A difference of 20^0C or more is required between surface of water and deeper water of the ocean for the operation of OTEC. High vapour pressure is produced by the boiling the liquid like ammonia which inb turn used to rotate the turbine. OTEC has not been field tested on a large scale.

5. Solar energy

In this context, 'solar energy' refers to energy that is collected from sunlight. Solar energy can be applied in many ways to

i) Heat water or air for domestic hot water and space heating needs using solar-thermal panels.

ii) Generate electricity in geosynchronous orbit using solar power satellites.

iii) Heat buildings, directly, through passive solar building design.

iv) Generate electricity using photovoltaic solar cells

v) Heat and cool air through use of solar chimneys.

vi) Heat foodstuffs, through solar ovens.

vii) Solar air conditioning.

Some important solar energy harvesting devices are discussed here.

a) Solar heat collectors : These can be passive or active in nature. Passive heat collectors are natural materials like stones, bricks etc. while active heat collectors pump a heat absorbing air or water as medium through a small collector.

b) Solar cells : They are also known as photovoltaic cells or simply PV cells. These are made by using thin semi conductor materials like silicon or gallium. The potential difference produced by a single PV cell of 4 cm^2 size is about 0.4 to 0.5 Volts and produces a current of 60 milli amperes. Solar cells are widely used in calculators, electronic watches, street lightening, traffic signals, water pumps, artificial satellites, running radio and television etc.

c) Solar cooker : It make the use of solar heat by reflecting the solar radiations using a mirror directly on to a glass sheet which covers the black insulated box within which the raw food is kept. Due to slow heating the food cooked in solar cooker is more nutritious.

d) Solar water heater : It consists of an insulated box painted black from inside with a glass lid to receive and store solar heat. The black painted copper coil heats the water which is stored in storage tank.

e) Solar power plant : Solar energy is harnessed on a large scale by using concave reflectors which cause boiling of water to produce steam. A solar power plant of 50 kW has been installed at Gurgaon, Harayana.

f) Solar furnace : Thousands of small plane mirrors arranged by using concave reflectors. They collect solar heat and produce high temperature up to 3000^0C.

6. Liquid biofuel

Liquid biofuel is usually either a biolacohol such as ethanol fuel or bio oil such as biodiesel and straigh vegetable oil. Biodiesel can be used in modern diesel vehicles with little or no modifications to the engine. It can be made from waste and virgin vegetable and animal oil and fats. Virgin vegetable oils can be used in modified diesel engines. A major benefit of biodiesel is lower emissions The use of biodieset reduces emission of carbon monoxide and other hydrocarbons by 20 to 40%. In some areas corn, cornstalks, sugarbeets, sugar cane, and switchgrasses are grown specifically to produce ethanol (grain alcohol) Liquids are more portable because they have high energy density, and they can be pumped, which makes handling easier. This is why most transportation fuels are liquids.

Use of ethanol for transportation

Brazil has one of the largest renewable energy programs in the world, involving production of ethanol fuel from sugar cane and ethanol now provides 18 percent of the country's automotive fuel. Most cars on the road today in the U.S. can run on blends of up to 10% ethanol and motor vehicle manufacturers already produce vehicles designed to run on much higher ethanol blends.

a) **Gasohol** is a common fuel used in Brazil and Zimbabwe to run buses and cars. E-85 is a fuel composed of 85% ethanol and 15% gasoline that is sold to consumers. Nowadays biobutanol is being developed as an alternative to bioethanol.

b) **Methanol is** very useful as it burns at lower temperatures than gasoline or diesel.

7. Solid biomass

Biomass is the organic matter produced by the green plants or animals. It may be of following types.

a) **Agriculture waste biomass :** Crop residues, bagasse, coconut shells, peanut hulls, animal dung, fishery and poultry wastes, cotton stalks are the examples of agricultural waste biomass. Sugar cane residue usually used directly as a combustible fuel, producing 10 to 20 MJ/kg. of heat. Its forms and sources include wood fuel, the biodegradable municipal solid waste or the unused portion of field crops. Cow manure contains two thirds of the original energy consumed by the cow. One type of biomass is wood, which has been used for millennia in varying quantities and more recently is finding increased use. Wood and its byproducts can now be converted through process such as gasification into biofuels such as woodgas, biogas, methanol or ethanol fuel.

8. Biogas and Anaerobic digestion

Biogas is a mixture of methane, carbon dioxide, hydrogen and hydrogen sulphide. The major and fuel constituent of biogas is methane. It is non polluting, clean and low cost fuel. Biogas plants used in our country are basically of two types.

a) **Floating gas holder type** biogas plant has well shaped digester tank which is placed under the ground and made up of bricks. The digester has partition wall, one of which receives dung, water mixture while other side discharges the slurry. In digester tank, over the dung slurry an inverted steel drum floats to hold the biogas produced. Sometimes gas holder leads to leakage of biogas. The tank has to be painted timely.

b) **Fixed dome type biogas plant** is similar to that of previous type. Here instead of steel gas holder there is

dome shaped roof made of cement and bricks. It is with only single unit with inlet and outlet chambers.

Biogas can easily be produced from current waste streams such as paper production, sugar production, sewage, animal waste, municipal waste and so forth. These various waste streams are slurried together and allowed naturally to ferment, producing methane gas. This can also be carried out by converting current sewage plants into biogas plants. The sludge that remains behind after the biogas production can be used as a better fertilizer than the original biomass. Alternatively biogas can be produced via advanced waste processing systems such as mechanical biological treatment. These systems recover the recycleable elements of household waste and process the biodegradable fraction in anaerobic digesters. Renewable natural gas is a biogas that has been upgraded to a quality similar to natural gas.

9. Geothermal energy

Geothermal energy is energy obtained by tapping the heat from interior of the earth, usually from kilometers deep into the earth's crust. Three types of power plants are used to generate power from geothermal energy 1) Dry steam plants 2) Flash steam plants and 3) Binary plants.

Dry steam plants take steam out of fractures in the ground and use it directly to drive a turbine that spins a generator. **Flash plants** take hot water, usually at temperatures over 200^0C, below the ground and allow it to boil as it rises to the surface and then runs the steam turbine. In **binary plants,** the hot water flows through heat exchangers, boiling an organic fluid that spins the turbine. The condensed steam and remaining geothermal fluid from all three types of plants are injected back into the hot rock to pick up more heat.

The geothermal energy from the core of the Earth is closer to the surface in some areas than in others. Where hot underground steam or water can be tapped and brought to the surface to generate electricity. Such geothermal power sources exist in certain geologically unstable parts of the world such as Iceland, New Zealand, United States, Philippines and Italy. There is also the potential to generate geothermal energy from hot dry rocks. Holes at least 3 km deep are drilled into the earth.The heat resource consists of hot underground radiogenic granite rocks, which heat up when there is enough sediment between the rock and the earth surface. Several companies in Australia are exploring this technology.

10. Hydrogen

Due to high energy content hydrogen can serve as an Excellent fuel. It contains 150KJ/g of energy. It is produced by

a) Thermal dissociation of water at 3000^0K.

b) Thermochemically, hydrogen is produced by chemical reaction of water with some other chemicals.

c) Electrolytic method dissociates water into hydrogen and oxygen. At present hydrogen is used in the form of liquid hydrogen as a fuel in spaceship.

2.7 Environmental considerations

Most of the renewable energy sources do not produce pollution directly, but the materials, industrial processes and construction equipment used to create them may generate waste and pollution. Some renewable energy systems actually create environmental problems. Another environmental issue, particularly with biomass and biofuels, is the large amount of land required to harvest energy which otherwise could be

used for other purposes or left as undeveloped land. However these fuels may reduce the need for harvesting non renewable energy sources. Hydroelectric power is now more difficult to site in developed nations because most major sites within these nations are either already being exploited or may be unavailable for other reasons such as environmental considerations. A wind farm has one of the least environmental impacts of all energy sources. It occupies less land area per kilowatt per hour of electricity generated than any other energy conversion system. Greenhouse gas emissions and air pollution produced by its construction are very little and declining. No any emissions or pollution produced by its operation. Continuous improvement in design of modern wind turbines making them to rotate slowly and without any noise. They also cause a minimum hazard to birds. Birds are severely impacted by fossil fuel energy; examples include birds dying from exposure to oil spills, habitat loss from acid rain and mountaintop removal due to coal mining, and mercury poisoning.

Renewable electricity (green energy)

Renewable electricity is a term used for electricity primarily produced from the renewable resources (solar, wind.... energy). It is generally labeled as green energy.

B) Non renewable resources

A non renewable resource is a natural resource that cannot be re-made, regrown or regenerated on a scale comparative to its consumption. It exists in a fixed amount in nature. Fossil fuels such as coal, petroleum and natural gas and nuclear power are non renewable resources as they do not naturally reform at a rate that makes the way we use them.

1. Coal

It is a fossil fuel formed in nature where remains of the plants were saved by water and mud from oxidation and biodegradation under high pressure and temperature. Coal is a readily combustible black or brownish rock. It is a sedimentary type of rock, but the harder form anthracite coal is as metamorphic rock because of later continuous exposure to elevated temperature and pressure. It is composed primarily of carbon. It is the largest single source of fuel for the generation of electricity all over the world and ultimately a largest source of carbon dioxide emissions. India has about 5% of the world's coal and Indian coal is not very good in terms of heat value. The coal states of India are Jharkhand, Orissa, West Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra. There are mainly four types of coal namely peat, lignite, bituminous and anthracite. Anthracite is with the highest calorific value and is primarily used for residential and commercial space heating. Environmental effects of coal mining and burning includes release of carbon dioxide and methane, interference with groundwater and water table levels, dust nuisance, wastes which contains uranium, thorium and other heavy metals.

2. Petroleum

It is a naturally occurring, flammable liquid. It is found in porous rock formations in the upper strata of some areas of the earth's crust. It is contains complex mixture of hydrocarbons of various molecular weights along with other organic compounds. The hydrocarbons in crude oil are mostly alkanes, cycloalkanes, and various aromatic hydrocarbons. It has to be purified and refined by the process of fractional distillation where the different constituents are separated at different temperatures. It is usually black or dark brown. In

the reservoir it is usually found in association with natural gas while saline water remains underside of the crude oil. Petroleum is used mostly to produce fuel oil and gasoline (petrol). At current consumption levels known recoverable reserves would gone only around 2040, potentially leading to a global energy crisis. The oil gives out the polluting wastes along with artificially induced sesmicity while drilling and exploration.

Liquefied Petroleum gas : The main component of it is butane, the other being propane and ethane. Due to its high energy density and easy transportability it has become the world's most important source of energy since the mid 1950s. It is odourless, but the domestic gas cylinders give a foul smell a ethyl mercaptan is added to LPG so that leakage can be detected.

3. Natural gas

It is a gaseous fossil fuel primarily consists of methane (95%) along with ethane, propane, butane and pentane. It is the cleanest fossil fuel. It is found as an isolated natural gas field or in coal beds. The primary component of natural gas is methane, the shortest and lightest hydrocarbon molecule.

a) **Compressed Natural Gas (CNG)** is considered to be an environmentally 'clean' alternative to other polluting fuels and much safer than others. It is made by compressing natural gas. It is stored and distributed in hard containers usually in cylindrical or spherical shapes to maintain equal pressure on the walls of the containers. Compressed natural gas is used in light duty passenger vehicles and medium duty trucks, in transit and school buses. Delhi has totally switched over to CNG where buses and auto rickshaws run on this new fuel.

b) **Synthetic Natural Gas (synfuel)** is a liquid fuel obtained from coal and natural gas. It is a mixture of carbon monoxide and hydrogen. Low grade coal is initially transformed into synthetic gas by catalytic conversion to methane.

4. **Nuclear Energy** is obtained by the splitting or fusing the nuclei of atmos. The conversion of nuclear mass to energy is associated with the mass, energy equivalence formula $E = mc^2$ in which E = energy release, m - mass and c = speed of light in a vaccum. Nuclear energy is released by the exothermic process.

a) **Nuclear fission** is the splitting of the nucleus of an atom into parts (lighter nuclei) often produces free neutrons and other smaller nuclei, which again produce photons (Gamma rays). Fission releases tremendous amount of energy. Nuclear fission produces energy for nuclear power and to drive the explosion of nuclear weapons. The amount of free energy contained in nuclear fuel is millions of times the amount of free energy contained in a similar mass of chemical fuel such as gasoline. The products of nuclear fission are radioactive and require proper management of wastes.

Nuclear reactors make use of nuclear chain reaction. In order to control the rate of reaction, only one neutron released is allowed to strike for splitting another nucleus. **Nuclear power** is a nuclear technology involving the controlled use of nuclear reactions, usually fission reactions to release energy and generate electricity. Nuclear energy is produced by a controlled chain reaction and creates heat which is used to produce steam and drive a steam turbine. The turbine can be used for mechanical work and also to generate electricity.

b) **Nuclear fusion** occurs between two isotopes of a lighter element which forced together at extremely high temperature (1 billion ^{0}C) until they fuse to form a heavier nucleus releasing enormous energy. The deuterium - tritium (D-T) fusion reaction is considered the most promising for

producing fusion power. They combine to create an unstable helium-5 nucleus.Two hydrogen (Deuterium) atoms may fuse to form the nucleus of Helium at 1 billion ^{0}C and release a huge amount of energy. Nuclear fusion occurs naturally in stars.

2.8 Land Resources

The most important land resource upon which all human activity is based since time immemorial, is land. It forms about one fifth of the earth surface, which is largely covered with natural forest, grasslands, wetlands, agricultural land and urban and rural settlements.

The fertile surface layer of earth capable of supporting plant life is called as soil. Soil is most important resource and it take decades or even centuries for the development of soil horizon having different physio-chemical properties.

India has 2.4% land of the world, supporting 16% of the total population i.e. per capita land availability is 0.48 ha only.

Major land use Categories in India.

	Categories of Land	Million hectare
1)	Cultivated	142
2)	Forest	67
3)	Non Agricultural	20
4)	Barren and pasture	55
5)	Fallow	25

Land Degradation :

Land degradation can be defined as any change in the land that reduces it's condition or quality and hence it's productivity or productive potential. It occur whenever the natural balances in the land scape are changed by humic activity through misuse or overuse. There is a direct link between a degraded environment and poverty of the region. As the land resource become less productive food security is compromised and competition for dwindling resources increases and the seeds of potential conflict are sown. In such a region the species diversity is lessened and often lost as lands are cleared and converted to agriculture due to unsustainable land management depletion of nutrients takes place which lead to permanent damage of soil. According to the global assessment of land degradation project about 15% of the global land area between 72^{0}N and 57^{0}S is degraded of which a area less than the India about 300 million hectare is strongly degraded. As a result of deforestration inappropriate land management of cropped land and overgrazing land degradation is an challenging environmental problem. The effect of soil degradation are not restricted to the soil alone, but have a number off site implications, for ex. is often associated with increased incidence of flooding, siltation of river etc.

Due to overpopulation forest are cut and land is used. As a result of forest cutting rate of soil erosion increases. As many big dams are created the use of water increases which creat soil salinity problem. Due to overuse of artificial fertilizers, pesticides the soil resource get polluted. Due to overgrazing, the grassland and land resource get degraded. In urban area where solid waste and hazardous solid waste get dumped in soil is responsible for soil pollution. The consequences of improper utilisation of land surface by human activities is

subjected to landslides and its impact may range from minor damage in extremely fortunate cases to total destruction of structures and loss of life. All these manmade activities are responsible for land degradation.

In 1981 world soil chapter called for commitment by government agencies and land users to manage the land for long term advantages rather than short term expendiency. To solve the land degradation problem a combined, holistic and multidisciplinary approach involving collaborative and coordinated efforts of ecologist, agronomists, soil scientists, hydrologists, engineers, sociologits and economist is required.

Soil erosion :

The removal of top soil from it's place by various agencies like wind, water etc. is called soil erosion. The presence of plant cover significantly reduces soil erosion. Human activity accelerate soil erosion by removing natural plant cover, soil erosion is a naturally occuring process on land. It may be slow process but it is continuous and relatively unnoticed or it may occur of topsoil. Destruction of natural vegetation cover by over felling and overgrazing is the genesis of soil erosion Water and wind are the principle cause for the removal of soil from one place to another. The loss of soil from farmland may be reflected in reduced crop production potential, lower surface water quality, damaged drainage networks, reduction in soil compaction, lowering of organic matter, loss of soil structure etc. The soil erosion is of 4 types -

1) Wind erosion :

Soil erosion due to wind is very common in dry region like Rajasthan where soil is chiefly sandy and the vegetation is very poor or even totally absent. In India, erosion by wind effects approximately 50 million hectors of land.

2) Sheet erosion :

It is wide spread of soil and surface debris by overland flow due to slope the land. It is common in rainy season and it is also called sheet wash such a type of erosion can be seen in the heavy quantity of silt that deposits elsewhere.

3) Rill erosion :

Removal of soil by running water and in this process inumerous tiny channels (rill) are created which are few centimeters in depth. The erosion found in semihumid region of the world.

4) Gully erosion :

It takes place when storming rains produce concentrated runoff by which removing soil and other poorly consolidated sediments. The example of gully erosion is seen at chambal valley in VP, Tennessee valley in USA etc. to control such gully erosion the vegetation cover has to be maintained.

Soil Conservation :

Soil conservation (Latin con-together, servate - guard) refer to the measures and practices which protect the soil against loss and help in maintaining it's fertility with a view to establish sustainable agriculture. Soil erosion can be controlled by adopting land management practices and also by changing the pattern of human activity.

The art of soil conservation is based on following basic principles.

1. Protection of soil from impact of rain drops.
2. To slow down the water from concentrating and moving down the slop in a narrow path.
3. To slow down the water movement, when it flows along the slope.

4. To increase the size of soil particle.
5. Reduction in the wind velocity near the ground by growing vegetation cover and ridging the land and
6. To grow the strips of stubble or other vegetation cover, which ight catch and hold the moving particle of soil.

Keeping in view the above said principles, scientists have devised several methods to prevent the loss of soil due to its erosion like organic farming, crop rotation, afforestration etc.

Desertification :

Desertification is a systematic processes of conversion of productive land to unproductive arid land. It is basically a man made problem which result to environmental degradation of fertile land.

The major cause of desertification are inappropriate land use practices, cultivation on marginal land affecting adjacent fertile land, over exploitation of water and land resources through intensive farming, uncontrolled grazing, deforestration, inappropriate irrigation practices, excessive mechanization of agricultural practices, chemical contamination by fertilizers or pesticides and the intensification of single crop agriculture (monocultured) are few factors of land degradation and desertification. Increased population and livestock pressure on marginal land has also accelerated desertification.

Remedies for controlling the desertification are efficient use of existing water resources and control of salination and improving arid lands. Construction of larger scale "Green wall" around the large deserts of the world to protect sand dunes movement. The fight against desertification requires the joint involvement of local communities, governments and all sectors of civil society in the elaboration and implementation of sustainable development and poverty reduction strategies.

2.9 Role of an individual in conservation of natural resources

Role of an individual in conservation of natural resources in any country is directly related to the country's own particular social, cultural economic and ecological conditions. In a developing country like India, the adverse effects of environmental destruction have been felt but never clearly mentioned by the people. The rich people are not bothered about the effects of their high consumerist life style. The poor due to their very struggle for existence are forced to use local resources unsustainability, although they may not wish to degrade the natural life support systems they directly survive on.

Protection of the environment has been mentioned in the constitution of the country as the basic responsibility of every citizen. It is also stressed in the National Policy of education (1986) as a value to be promoted in the "Common core" of education throughout the country. However, it took year 2004 for the supreme court to remind the state governments of its ealier 1991 directives and to finally issue instructions to all educational institutions for compulsorily incorporating Environmental Studies in the syllabus at every level of education.

The need for every individual's participation in the process of nature conservation and environmental protection is deeply felt due to the present status of our resources which are degrading in quality and quantity, and the improper ratio of these reducing resources as well as population explosion. Over 90% of the population growth in the world is taking place in developing countries. The next increase in population is only dependent on Asian and African countries. The developing countries specially India has failed in controlling human species which it must overcome as we are least in a

position to cope with the resource crisis. Population stabilization is the only solution.

In India 70% of the available fresh water in not potable. In the country 90% of the urban waste water in discharged into rivers without any treatment and over 80% have to drink polluted water. Only every sixth person gets sufficient water. Estimated over 3.5 million people die due to the consumption of polluted water every year in the world. As per the energy status it is estimated that India has resources sufficient only for the next 30 years. Within the next five years there will be 30% more shortage of energy supplies. The misuse of fuel has touched the sky and will rise still higher. India pays Rs. 90,000 crores in foreign exchange every year for purchase of oil. Who is responsible for this and the future status? It is each and every individual and thus the role of every individual is very crucial in environmental protection and conservation, however small it may be for a better future.

3.0 Equitable use of resources for sustainable lifestyles

What really geared up the sustainable movement was the publication in 1987 of "Our Common future" by the United Nations world commission on Environment and Development. The Commission consisted of 22 eminent participants from both developed and developing nations, they were charged with identifying international long-term environmental strategies. This report defines sustainable development in simple but clear terms as "the development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs." The strong understanding in sustainable development is that it is equal for all i.e. it is based on equity and justice and is with optimal use of the natural resources as a common property.

Sustainable Development guarantees that future generations have access to the "Social Capital" people and natural resources to create a life that is at least equal to that of the present generation.

The report proposed twelve key priorities necessary to "Sustain human progress into the distant future".

1) Achieve population control
2) Decrease poverty inequality and debts in developing countries
3) Develop sustainable agriculture
4) Protect the vanishing wilderness and genetic diversity
5) Protect ocean and coastal resources
6) Protect fresh water quality and improve water efficiency
7) Improve energy efficiency
8) Develop renewable energy resources
9) Control greenhouse gases and other air pollutants
10) Protect the stratospheric ozone layer
11) Minimize wastes.
12) Reduce military spending, so that money can be diverted to funding sustainable development

It is thus concluded that the perception of a stable human environmental society as a sustainable society should be one that lives with in the self-perpetuating limits of its environment. That society is not a 'no-growth' society. It is whether, a society that recognizes the limits of growth - a society that looks for alternative ways of growth. A society, which seeks development that is likely to achieve lasting satisfaction of human needs and improvement of the quality of life by integrating conservation into the development process.

Today the society is divided into have and have nots, the unequal, unsustainable distribution and utilization of natural resources coupled with environmental degradation costs some countries10% of their GNP. We can no longer afford to borrow from the future to pay for the present. National accounting systems calculate economic advancement and there is no proper accounting of environment degradation.

In the above scenario the role of every individual in the process of conservation through eco-friendly life styles is very crucial. If there is a lesson in the study of the environmental crisis, it is that the crisis is complete and pervasive. There are connections between vanishing wilderness, pollution, poverty, over population, war and justice. In this scenario the concept of sustainability for a healthy future is the only solution. The idea of a society in balance with its surroundings, a self sustainable system.

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Chapter : 3

Ecosystems

3.1 Introduction

Ecology is a science of interrelationship and deals with the relationship of living organisms and non-living components of environment. The living organisms and their non-living environment are inseparably interrelated and interacted with each other. Keeping this view in mind the term 'ecosystem' was coined by British ecologist A. G. Tansley in 1935, and defined it for first time as "The system resulting from the integration of all the living and non-living factors of the environment". The ecosystem includes the complex of living organisms and physical factors, which forms the environment. The term ecosystem is constituted from 'eco' and 'system'. The word 'eco' implies the environment and 'system' implies interacting and interdependent complex.

3.2 Concept of ecosystem

The concept of ecosystem is very broad, and gives an idea about interrelationship of living organism with the complex physical environmental components and have interdependence among them. The interrelationship and interdependence couples to form the wholeness in the functional unit. Operationally the functional units are inseparable from ecosystem. As long as the major components present in ecosystem they operate together and give functional stability to ecosystem. One of the unique features of all the ecosystems such as terrestrial, freshwater, or marine ecosystem is that, the interaction between autotrophic(self nourishing) and

heterotrophic (other nourishing) components. e.g. photosynthesis predominantly takes place in autotrophs and accumulate energy in the form of biomass and the accumulated biomass is consumed by herbivore organisms (heterotrophs) and synthesize secondary biomass, on which subsequent food chain sustains. Hence, the interaction between autotrophs and heterotrophs is responsible for having unique structure to the ecosystem.

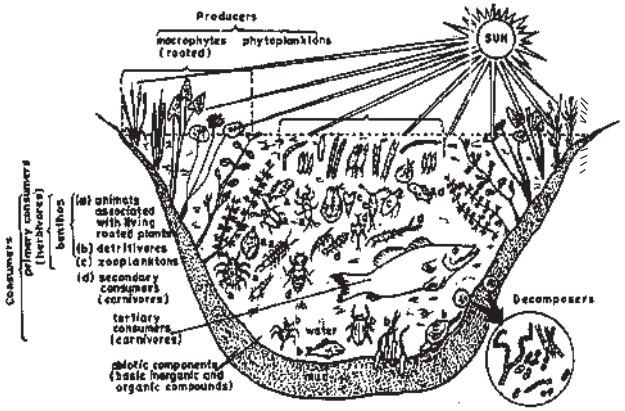

Fig. 3.1 : The Pond ecosystem.

The abiotic (non living) components of ecosystem govern and control the biotic (living) components, and up to some extent, the biotic components of ecosystem alters the abiotic component significantly.

As a general principle the living and non-living parts of the ecosystem are so interwoven in to fabric of nature that it is difficult to separate them. For example the most vital elements such as C, N, H, O, S, P etc. from abiotic component of ecosystem are bound to form organic compounds such as carbohydrates, proteins and lipids etc. in living component of ecosystem and thus maintain a constant flux between non-living and living component of ecosystem. The ecosystem represents a distinct combination of air, soil and water (habitat)

along with plants, animals and microbes forming a self sustaining unit. Thus, any unit, that includes all the living organisms i.e. communities in a given area, interacts with the physical environment so that the flow of energy leads to well organized trophic structure which cycles the nutrient material within the ecosystem.

For the survival of living organisms, all must have to adjust to the changing physical and chemical conditions of the environment. The first living organisms which evolved in water had to adjust with its physical and chemical properties. Through the adjustment and adaptations, development of new and varied ecosystems must have occurred.

Individual organism, their populations and communities of different populations exist and operate as a part of ecosystem. The organisms do not live singularly in nature but live in association with other living plant and animal communities. The association between plant and animal is not haphazard and according to habitat utilize the energy and minerals present in their habitat. The fig. 3.1 of pond ecosystem shows the generalised scheme of relationships present in a ecosystem. The nutrients and minerals from non-living component are generally required to produce or to synthesize the biomass in living organisms and to accumulate the chemical energy. The accumulated chemical energy links the living organisms through food link (i.e. food chain and food web). The flow of energy through food link leads to clearly defined trophic structure and depict material cycle. Hence, an ecosystem represents the highest level of interaction in the environment.

The ecosystem is normally open type of system where we see the interaction between organism and environment. In this open system the input is of an energy and nutrients and output is organized and stabilized structure of ecosystem which is essential for maintenance of life on earth. Different types of

ecosystems are present on planet earth and there are no sharp boundaries between the ecosystems but they contain ecotone. The 'ecotone' is the transition zone between two or more adjoining ecosystems and this narrow region is represented by the species diversity from all the ecosystems. At times ecotone has its own diversity which is absent in the neighbouring ecosystems. Therefore conservation of these ecotone areas is of great significance. The natural ecosystems are, over the period of years, stabilized and balanced. If there is any change in the structure, character or function of the ecosystem, which is responsible for disturbing the well established and sensitive balance, the change or damage may be permanent. There are a large variety of ecosystems in biosphere mainly grouped into aquatic ecosystem and terrestrial ecosystem.

3.3 Structure and functions of an ecosystem

Any assemblage of plants and animals able to co-exist within an area form a biotic community. In this community the different species tend to interact with one another and to modify the conditions of life within which each exists. They therefore develop the inter relationships and inter dependence which constitutes an ecosystem. Four constituents comprise an ecosystem.

1) Abiotic substances : Basic inorganic compounds of an organisation, habitat or an area like carbon dioxide, water, nitrogen, calcium, phosphate all of which are involved in the material cycles are called inorganic components. Whereas, organic components of an ecosystem are proteins, amino acids, lipids and carbohydrates which are synthesized by the biotic counterpart of an ecosystem.

2) Biotic components

1) **Producers** : Autotrophic organisms largely green plants, which are able to manufacture food from simple inorganic substance are called producers. Chemosynthetic bacteria, photosynthetic bacteria, algae of various types, grasses, mosses, shrubs, herbs and trees contribute in the total production of an ecosystem.

2) **Consumers** : These are the heterotrophic organisms, chiefly animals that eat other organisms or organic matter. They may be herbivores or carnivores. They are also called as macro consumers.

3) **Decomposers or reducers** : Heterotrophic organisms, chiefly bacteria and fungi, that breakdown the complex compounds of dead protoplasm, absorb some of the products and release simple substances usable by the producers are called as decomposers or reducers. They are also called as micro consumers.

From the functional point of view ecosystems has two components.

1) **Autotrophs** (Self nourishing)

Autotrophs fix light energy using simple inorganic substances and build up of complex substances predominates. The component is constituted mainly by green plants, including photosynthetic bacteria. To some lesser extent, chemosynthetic microbes also contribute to the build up of organic matter. Members of the autotrophic component are known as producers.

2) **Heterotrophs** (other nourishing)

In these organisms utilization, rearrangement and decomposition of complex material predominate. The organisms involved are known as consumers, as they consume the matter built up by the producers.

Pond as an Ecosystem

The ecosystem is the basic functional unit in ecology, since it includes both the biotic communities and abiotic environment, each influencing the properties of the other and both necessary for maintenance of life as we see it on earth. A lake or pond is a classical example of the ecosystem. Figure 3.1

Let us consider the pond as an ecosystem. It is not only a place where aquatic plants and animals live but make the pond what it is. It can be divided into four basic units.

a) Abiotic substances :- These are water, carbon dioxide, oxygen, calcium, nitrogen, phosphorus, amino acids and humic acid etc. A part of these vital nutrients is in solution and is readily available to organisms while much larger portion is held in reserve in particulate matter.

b) Producers :- Producers in a pond are of two types i) rooted or large floating plants generally growing in the shallow water ii) Minute floating algae called phytoplankton – distributed as deep as light penetrates. When in abundance phytoplankton give greenish colour to the water. They are more important in the production of basic food for the ecosystem.

c) Consumers :- Animals such as insect larvae, crustaceans and fish feed directly on living plants or their remains and are called as primary consumers. Whereas the carnivores e.g. carnivorous fish that feed on the primary consumers are called as secondary consumers.

d) Decomposers :- Aquatic bacteria and fungi are distributed through out the pond. When temperature conditions are favourable, they decompose the dead organisms and the materials are released for reuse.

The entire pond can be divided into two strata. An upper

"Production zone" and a lower "decomposition – nutrient regeneration zone". Organic detritus is consumed and decomposed on the bottom of the pond. Thus a pond is considered as a balanced ecosystem.

3.4 Energy flow in the ecosystem

The energy used for all plant life processes is derived from solar radiation. A fraction i.e. about 1/50 millionth of the total solar radiation reaches the earth's atmosphere. Solar radiation travels through the space in the form of waves, wavelength ranging from 0.03 A^o to several km. While most radiation's are lost in space, those ranging from 300 mm to 10 m and above 1cm (radio waves) enter the earth's outer atmosphere (Which is about 18 miles or 28 km altitude). The energy reaching the earth's surface consists largely of visible light (390-760 mm) and infra-red component. On a clear day radiant energy reaching the earth's surface is about 10% UV, 45% visible and 45% infra-red. Plants strongly absorb the blue and red light (400-500 mm and 600-700 mm respectively).

In ecological energetics, we study (i) quantity of solar energy reaching an ecosystem, (ii) quantity of energy used by green plants for photosynthesis and (iii) the quantity and path of energy flow from producers to consumers.

About 34% of the sunlight reaching the earth's atmosphere is reflected back into its atmosphere, 10% is held by ozone layer, water vapour and other atmospheric gases. The rest, 56% reaches the earth's surface of which 1 to 5% is used by green plants for photosynthesis and the rest is absorbed as heat by ground vegetation or water. In fact, only about 0.02% of the sunlight reaching the atmosphere is used in photosynthesis. Nevertheless, it is this small fraction on which all the organisms of the ecosystem depend.

The behavior of energy in ecosystem can be termed as energy flow due to unidirectional flow of energy. From energetics point of view it is essential to understand for an ecosystem (i) the efficiency of the producers in absorption and conversion of solar energy, (ii) the use of this converted chemical form of energy by the consumers, (iii) the total input of energy in form of food and its efficiency of assimilation, (iv) the loss through respiration, heat, excretion etc. and (v) the gross net production.

Single-channel energy model

The principle of food chains and the working of the two laws of thermodynamics can be better made clear by means of energy flow diagrams shown in Fig. 3.2.

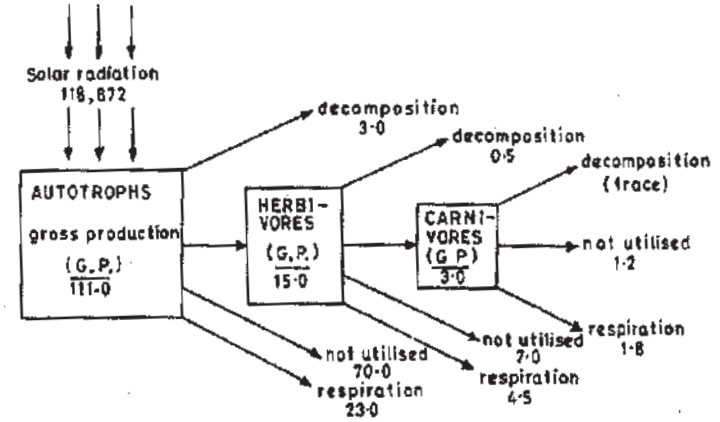

Fig. 3.2 : Energy flow diagram for a lake ecosystem

The Fig. 3.2 shows out of the total incoming solar radiation (118,872g cal/cm^2/yr) remain unutilized, and thus gross production (net production plus respiration) by autotrophs is 111 gcal/cm^2/yr with an efficiency of energy capture of 0.10%. It may also be noted that 21% of this energy, or 23 gcal/cm^2/yr is consumed in metabolic reactions of autotrophs for their growth, development, maintenance and reproduction. It may

be seen further that 15 gcal/cm^2/yr are consumed by herbivores that graze or feed on autotrophs – this amounts to 17% of net autotroph production. Decomposition (3 gcal/cm^2/yr) accounts for about 3.4% of net production. The remainder of the plant material, 70 gcal/cm^2/yr or 79.5% of net production, is not utilized at all but becomes part of the accumulating sediments. It is obvious, then that much more energy is available for herbivores than is consumed. It may also be noted that various pathways of loss are equivalent to and account for total energy capture of the autotrophs i.e. gross production.

Also, collectively the three upper 'fates' (decomposition, herbivory and not utilized) are equivalent to net production. Of the total energy incorporated at the herbivores level, i.e. 15 gcal/cm^2/yr, 30% or 4.5 gcal/cm^2/yr is used in metabolic reactions. Thus, there is considerably more energy lost via respiration by herbivores (30%) than by autotrophs (21%). Again there is considerable energy available for the carnivores, namely 10.5 gcal/cm^2/yr or 70%, which is not entirely utilised, in fact only 3.0 gcal/cm^2/yr or 28.6 % of net production passes to the carnivores. This is more efficient utilisation of resources than occurs at autotroph herbivore transfer level. At the carnivore level about 60% of the carnivore's energy intake is consumed in metabolic activity and the remainder becomes part of the not utilised sediments only an insignificant amount is subject to decomposition yearly. This high respiratory loss compares with 30 % by herbivores and 21% by autotrophs in this ecosystem.

From the energy flow diagram shown in Fig. 3.2, two things become clear. Firstly, there is one-way street along which energy moves (unidirectional flow of energy). The energy that is captured by the autotrophs does not revert back to solar input, that which passes to the herbivores does not pass back to the autotrophs. As it moves progressively through the

various trophic levels it is no longer available to the previous level. Thus due to one way flow of energy, the system would collapse if the primary source, the sun, were cut off. Secondly, there occurs a progressive decrease in energy level at each trophic level. This is accounted largely by the energy dissipated as heat in metabolic activities and measured here as respiration coupled with unutilised energy.

Y-shaped energy flow model

Figure 3.3 presents one of the first published energy flow models as pioneered by H.T. Odum in 1956. There it shows a common boundary, and in addition to light and heat flows; the import, export and storage of organic matter are also included. Decomposers are placed in a separate box as a means of partially separating the grazing and detritus food chains. Decomposers are in fact a mixed group in terms of energy levels.

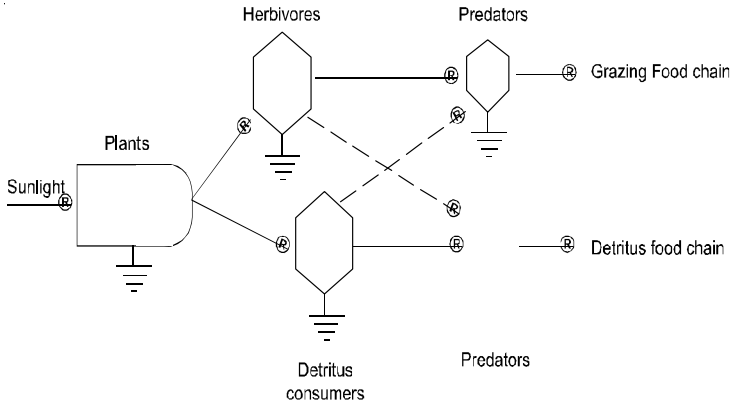

Fig. 3.3 Y-shaped energy flow model showing linkage between the grazing and detritus food chains.

3.5 Ecological Succession (Community Dynamics)

Although a typical community maintains itself more or less in equilibrium with the prevailing conditions of the environment, in nature this is hardly true. Communities are never stable.They are dynamic, changing more or less regularly over time and space. They are never found permanently in complete balance with their component species or with the physical environment. Environment is always kept on changing over a period of time due to (i) variations in climatic and physiographic factors, and (ii) the activities of the species of the communities themselves. These influences bring about marked changes in the dominants of the existing community, which is thus sooner or later replaced by another community at the same place. This process continues and successive communities develop one after another over the same area, until the terminal final community becomes more or less stable for a period of time. This occurrence of relatively definite sequence of communities over a period of time in the same area is known as ecological succession. Some scientists have defined succession as "the natural process by which the same locality becomes successively colonised by different groups or communities of plants."

Odum preferred to call this orderly process as ecosystem development rather than the more often known ecological succession "ecosystem development'' or what is more often known as 'ecological succession'. He defined it as orderly process of community development that involves changes in species structure and community processes with time, it is reasonably directional and therefore, predictable.

Causes of Succession

Since succession is a series of complex processes, it is natural that there may not be a single cause for this. Generally there are three main causes :

1. Initial or initiating causes : These are climatic as well as biotic. The former includes factors, such as erosion and deposits, wind, fire etc., caused by lightning or volcanic activity, and the latter includes the various activities of organisms. These causes produce the bare areas or destroy the existing populations in an area.

2. Continuing causes or Ecesis : These are the processes such as migration, aggregation, competition, reaction etc. which cause successive waves of populations as a result of changes, chiefly in the 'edaphic' features of the area.

3. Stabilising causes : These cause the stabilisation of the community. According to some, climate of the area is the chief cause of stabilisation, other factors are of secondary value.

An ecological succession proceeds along the following four lines. (i) a continuous change in the kinds of plants and animals, (ii) an increase in the diversity of species, (iii) an increase in the organic matter and biomass supported by the available energy flow, and (iv) decrease in net community production or annual yield.

Types of Succession

The various types of succession have been grouped in different ways on the basis of different aspects. Some basic types of succession are, however, as follows.

1. Primary succession : In any of the basic environments (terrestrial, fresh water, marine) one type of succession is primary succession which starts from the primitive substratum, where there was no previously any sort of living matter. The first group of organisms establishing they are known as the pioneers, primary community or primary colonisers.

2. Secondary succession : Another general type of succession is secondary succession which starts from previously built up substrata with already existing living matter. The action of any external force, as a sudden change in climatic factors, biotic intervention, fire etc., causes the existing community to disappear. Thus, area becomes devoid of initial living matter but its substratum, instead of primitive, is built up. Such successions are comparatively more rapid.

3. Autogenic succession : After the succession has begun, in most of the cases, it is the community itself which, as a result of its reactions with the environment, modifies its own environment and thus causing its own replacement by new communities. This course of succession is known as autogenic succession.

4. Allogenic succession : In some cases, however, the replacement of the existing community is caused largely by any other external condition and not by the existing organisms. Such a course is referred to as allogenic succession.

On the basis of successive changes in nutritional and energy contents, successions are sometimes classified as :

5. Autotrophic succession : It is characterized by early and continued dominance of autotrophic organisms like green plants. It begins in a predominantly inorganic environment and the energy flow is maintained indefinitely. There is gradual increase in the organic matter content supported by energy flow.

6. Heterotrophic succession : It is characterized by early dominance of heterotrophs, such as bacteria, actiomycetes, fungi and animals. It begins in a predominantly organic environment and there is a progressive decline in the energy content.

Process of succession

The entire process of a primary autotrophic succession is actually completed through a number of sequential steps, which follow one another. These steps in sequence are as follows.

(I) Nudation

This is the development of a bare area without any form of life. The area may develop due to several causes such as landslide, erosion, deposition, or other catastrophic agency. The cause of nudation may be :

1. Topographic : Due to soil erosion by gravity, water or wind, the existing community may disappear. Other causes may be deposition of sand, landslide, volcanic activity and other factors.

2. Climatic : Glaciers, dry period, hails and storm, frost, fire etc. may also destroy the community.

3. Biotic : Man is most important, responsible for destruction of forests, grasslands for industry, agriculture, housing etc. Other factors are disease epidemics due to fungi, viruses etc. which destroy the whole population.

(II) Invasion

This is the successful establishment of a species in a bare area. The species actually reaches this new site from any other area. This whole process is completed in the following three successive stages:

1. Migration (dispersal) : The seeds, spores, etc. of the species reach the bare area. This process, known as migration, is generally brought about by air, water etc.

2. Establishment : After reaching to new area, the process of successful establishment of the species, as a

result of adjustment with the conditions prevailing there. In plants, after migration, seeds germinate, seedlings grow, and adults start to reproduce. Only and few of them are capable of doing this under primitive harsh conditions, and thus most of them disappear. Thus, as a result few individuals of species become established in the area.

3. Aggregation : After establishment, as a result of reproduction, the individuals of the species increase in number, and they come close to each other. This process is known as aggregation.

(III) Competition and co-action

After aggregation of a large number of individuals of the species at the limited place, there develops competition (inter- as well as intra-specific) mainly for space and nutrition. Individuals of a species affect other's life in various ways and this is called co-action. The species, if unable to compete with other species, if present, would be discarded. To withstand competition, reproductive capacity, wide ecological amplitude etc.are of much help to the species.

(IV) Reaction

This is the most important stage in succession. The mechanism of the modification of the environment through the influence of living organisms on it is known as reaction. As a result of reactions, changes take place in soil, water, light conditions, temperature etc. of the environment. Due to all these the environment is modified, becoming unsuitable for the existing community which sooner or later is replaced by another community (seral community). The whole sequence of communities that replaces one another in the given area is called a 'sere', and various communities constituting the sere, as 'seral stages'. The pioneers are likely to have low-nutrient requirements, more dynamic and able to take minerals in

comparatively more complex forms. They are small sized and make less demand from environment.

(V) Stabilisation (Climax)

Finally, there occurs a stage in the process, when the final terminal community becomes more or less stabilised for a longer period of time and it can maintain itself in equilibrium with the climate of the area. This final community is not replaced, and is known as 'climax community' and the stage as 'climax stage'.

Generalised process of succession and different plant communities appearing in the process with developing environmental complex are shown in Fig. 3.4 taking hydrosere as a model. General process of succession as outlined above will show that the whole process involves several stages, each stage having characteristic organisms together with their environment. The seral stages in fact continuous with each other and the whole sequence form beginning till the climax stage is known as a sere. The species which colonise the bare area in the beginning of succession are called 'pioneers'.

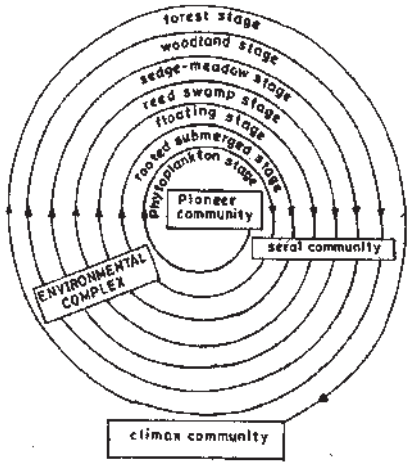

Fig. 3.4 : General process of succession

Some ecologists have talked of 'retrogressive succession' in which continuous biotic influences have some degenerating influence on the process. Due to destructive effects of organisms, sometimes the development of disturbed communities does not occur and the process of succession instead of progressive becomes retrogressive. As for example, forest may change to shrubby or grassland community. This is called retrogressive succession.

Sometimes due to changes in local conditions as soil characteristics or microclimate, the process of succession becomes deflected in a different direction than that presumed under climatic condition of the area. Thus the climax communities are likely to be different from the presumed climatic climax community. This type of succession is called 'deflected succession'.

In India, with a monsoon type of climate, in some habitats like temporary ponds, pools etc., it is common to observe each year the development of different kinds of communities in different seasons of the year. Man made changes in the local conditions can also affect the succession process to a great extent .

3.6 Food chain, food web and ecological pyramids

Food chains

The transfer of food energy from the producers, through a series of organisms (herbivores to carnivores to decomposers) with repeated eating and being eaten, is known as a 'food chain'. Producers utilise the radiant energy of sun which is transformed to chemical form ATP during photosynthesis. Thus green plants occupy, in any food chain, the first trophic (nutritional) level, the producers level, and are called the 'primary producers'. The energy, as stored in food matter manufactured by green plants, is then utilised by the

plant eaters the herbivores which constitute the second trophic level, the primary consumers level, and are called the 'primary consumers' (herbivores). Herbivores in turn are eaten by the carnivores, which constitute the third trophic level, the secondary consumers level, and are called the 'secondary consumers' (carnivores). These in turn may be eaten still by other carnivores at tertiary consumers level i.e. by the tertiary consumers (carnivores). Some organisms are omnivores eating the producers as well as the carnivores at their lower level in the food chain. Such organisms thus may occupy more than one trophic levels in the food chain.

This classification of all the living organisms of any ecosystem is one of their functions and not of species. Species that are taxonomically widely different from each other may occupy the same trophic level as they all have the similar function in the food chain. *Typha, Nympharea, Chara, Volvox, Nostoc, photosynthetic bacteria*, although taxonomically much different but all belong to the same trophic level, the producers level, as all have a common function i.e. the fixation of radiant energy into chemical form. In any food chain, energy flows from primary producers to primary consumers (herbivores), from primary consumers to secondary consumers (carnivores), and from secondary consumers to tertiary consumers (carnivores/omnivores) and so on.

This simple chain of eating and being eaten away is known as food chain. A food chain in grassland ecosystem starts with grasses and herbs and goes through grasshoppers, the frogs, the snake, the hawk in an orderly sequential arrangement based on the food habits, whereas in a pond the order would start with phytoplankton, zooplankton, going through water fleas, smaller fish, bigger fish, birds, larger animal and so on.

In nature, we generally distinguish two general types of food chains :

1. Grazing food chain : This type of food chain starts from the living green plants, goes to grazing herbivores (that feed on living plant materials with their predators), and on to carnivores (animal eaters). Ecosystems with such type of food chain are directly dependent on an influx of solar radiation. This type of chain thus depends on autotrophic energy capture and the movement of this captured energy to herbivores. Most of the ecosystems in nature follow this type of food chain. From energy standpoint, these chains are very important. The phytoplanktons → zooplanktons → fish sequence or the grasses → rabbit → fox sequence are the examples of grazing food chain.

2. Detritus food chain : This type of food chain goes from dead organic matter into microorganisms and then to organisms feeding on detritus (detritivores) and their predators. Such ecosystems are thus less dependent on direct solar energy. These depend chiefly on the influx of organic matter produced in another system. For example, such type of food chain operates in the decomposing accumulated litter in a temperate forest.

As shown in Fig. 3.5 the fallen leaf fragments (acted on by saprotrophs as fungi, bacteria, protozoa etc. and colonized mainly by phytoplanktonic and benthic algae) are eaten and re-eaten (coprophagy) by a key group of small animals. These animals include crabs, copepods, insect larvae, grass shrimps, mysids, nematodes, amphipods, bivalve molluscs etc. All these animals are detritus consumers. These detritivores are the key group of small animals, comprising only a few species but very large number of individuals. They ingest large amounts of the vascular plant detritus. These animals are in turn eaten by some minnows and small game fish etc. i.e. the small carnivores, which in turn serve as the main food for larger game fish and fish – eating birds which are the large (top) carnivores. The

mangroves considered generally as of less economic value make a substantial contribution to the food chain that supports the fisheries, an important economy in that region. Similarly, detritus from sea grasses, salt marsh grasses and seaweeds support fisheries in many estuarine areas.

Thus, we see that the detritus food chain ends up in a manner similar to the grazing food chain (big fish eat little fish), but the way in which the two chains begin is quite different.

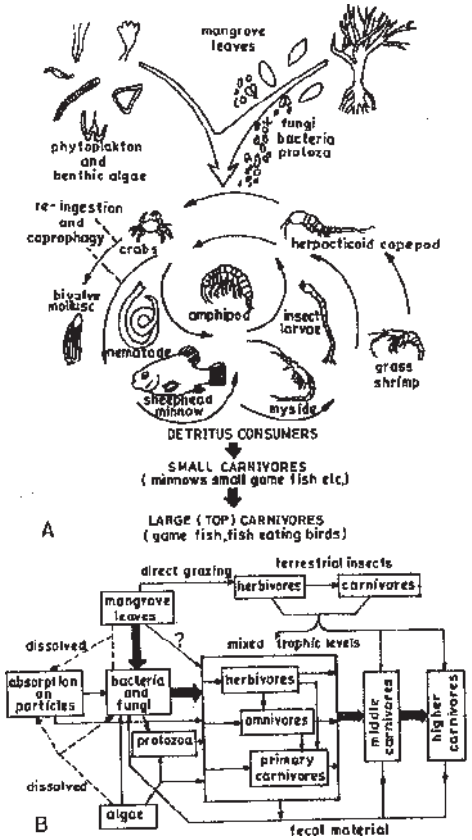

Fig. 3. 5 : Detritus food chain based on mangroves leaves falling into shallow estuary waters.

As shown in Fig. 3.5, in detritus chain, the detritus begin is quite different. As shown in Fig. 3.5, in detritus chain, the detritus consumers, in contrast to grazing herbivores, are a mixed group in terms of trophic levels. These include herbivores, omnivores and primary carnivores. As a group, the detritus feeders obtain some of their energy directly from plant material, most of it secondarily from microorganisms, and some tertiary through carnivores (e.g. by eating protozoa or other small invertebrates that have fed on bacteria that have digested plant material).

But under natural situations, a system must always be self sufficient. In fact this type of food chain (detritus type) is simply a sub-component of another ecosystem. And, the above said two types of food chains in nature are indeed linked together belonging to the same ecosystem.

Food web

However, food chains in natural conditions never operate as isolated sequences, but are interconnected with each other forming some sort of interlocking pattern, which is referred to as a 'food web'. Under natural conditions, the linear arrangement of food chains, hardly occurs and these remain indeed interconnected with each other through different types of organisms at different trophic levels. For example, in grazing food chain of a grassland, in the absence of rabbit, grass may also be eaten by mouse. The mouse in turn may be eaten directly by hawk or by snake first which is then eaten by hawk. Thus, in nature there are found alternatives, which all together constitute some sort of interlocking pattern the food web.

In such a food web in grassland, there may be seen as many as five linear food chains, which in sequences are:

Grass → Grass hopper → Hawk

Grass → Grasshopper → Lizard → Hawk

Grass → Rabbit → hawk

Grass → Mouse → Hawk

Grass → mouse → Snake → Hawk

Besides those shown in Fig. 3.6, there may also be present some other consumers as vultures, fox and man in grasslands, and if so, the food web may be even more complex than shown here. However, these all five chains are interlinked with each other at different points, forming food web.

The broken arrows show how the two chains are linked into a food web. Real food webs usually have hundreds of species interlinked by their feeding habits.

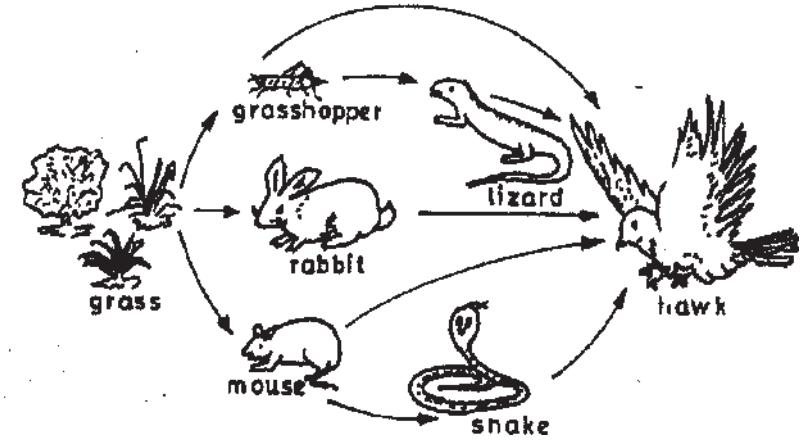

Fig. 3.6 : A food web in a grassland ecosystem.

The food webs are very important in maintaining the stability of an ecosystem in nature. For example, decrease in the population of rabbit would naturally cause an increase in

the population of alternative herbivore, the mouse. This may decrease the population of the consumer (carnivore) that prefers to eat rabbit. Thus alternatives (substitutes) serve for maintenance of stability of the ecosystem, Moreover, a balanced ecosystem is essential for the survival of all living organisms of the system. For instance, had primary consumers (herbivores) not been in nature, the producers would have perished due to overcrowding and competition. Similarly, the survival of primary consumers is linked with the secondary consumers (carnivores) and so on. Thus, each species of any ecosystem is indeed kept under some sort of a natural check so that the system may remain balanced.

The complexity of any food web depends upon the diversity of organisms in the system. It would accordingly depend upon two main points: (i) length of the food chain. Diversity in the organisms based upon their food habits would determine the length of food chain. More diverse the organisms in food habits, more longer would be food chain. (ii) alternatives at different points of consumers in the chain. More the alternatives, more would be the interlocking pattern. In deep oceans, seas etc. where we find a variety of organisms, the food webs are much complex.

Ecological Pyramids

Trophic structure, i.e. the interaction of food chain and the size metabolism relationship between the linearly arranged various biotic components of an ecosystem is characteristic of each type of ecosystem. The trophic structure and function at successive trophic levels, i.e. producers – herbivores – carnivores, may be shown graphically by means of ecological pyramids where the first or producer level constitutes the base of the pyramid and the successive levels, the making the apex. Ecological pyramids are of three general types.

(i) Pyramid of numbers, showing the number of individual organisms at each level, (ii) Pyramid of biomass, showing total dry weight and other suitable measure of the total amount of living matter, and (iii) Pyramid of energy, showing the rate of energy flow and or productivity at successive trophic levels. The pyramids of numbers and biomass may be upright or inverted depending upon the nature of the food chain in the particular ecosystem, whereas pyramids of energy are always upright.

1**. Pyramids of numbers** : They show the relationship between producers, herbivores and carnivores at successive trophic levels in terms of their number.

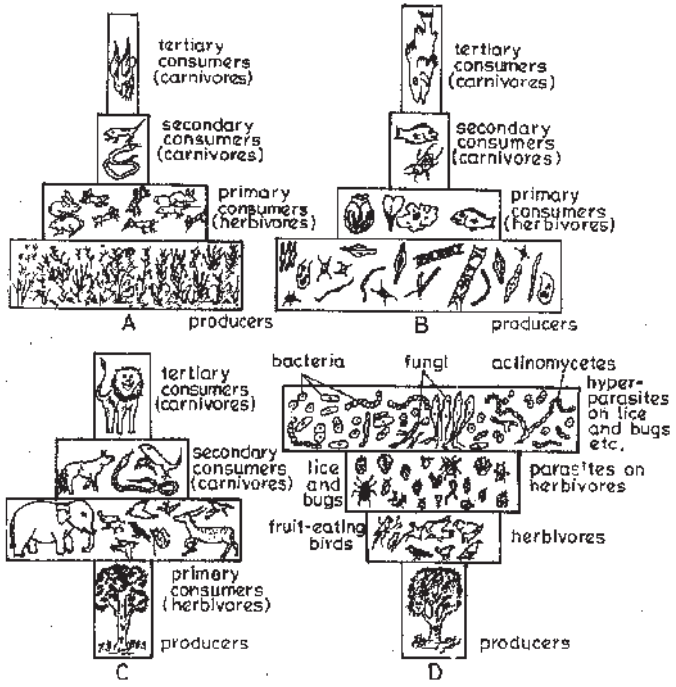

Fig. 3.7 : Pyramids of numbers (individuals per unit area) in different kinds of ecosystems / food chains. A- grassland ecosystem, B - pond ecosystem, C - forest ecosystem in A-C parasitic microorganisms and soil animals are not included, D- parastic food chain.

The pyramids of numbers in three different kinds of ecosystems are shown in Fig. 3.7 (A-C). In a grassland (Fig. 3.7.A) the producers, which are mainly grasses, are always maximum in number. This number then shows a decrease towards apex, as the primary consumers (herbivores) like rabbits, mice etc. are lesser in number than the grasses; the secondary consumers, snakes and lizards are lesser in number than the rabbits and mice. Finally, the top (tertiary) consumers hawks or other birds, are least in number. Thus, the pyramid becomes upright. Similarly, in a pond ecosystem (Fig. 3.7B) the pyramid is upright. Here the producers, which are mainly the phytoplanktons as algae, bacteria etc. are maximum in number; the herbivores, which are smaller fish, rotifers etc. are lesser in number than the producers; and the secondary consumers (carnivores), such as small fish eating each other, water beetles etc. are lesser in number than the herbivores. Finally, the top (tertiary) consumers, the bigger fish are least in number.

In a forest ecosystem (Fig. 3.7C), however, the pyramid of numbers is somewhat different in shape. The producers, which are mainly large-sized trees, are lesser in number, and form the base of the pyramid. The herbivores, which are the fruit eating birds, deer etc. are more in number than the producers. Then there is a gradual decrease in the number of successive carnivores, thus making the pyramid again upright. However, in a parasitic food chain (Fig. 3.7 D) the pyramids are always inverted. This is due to the fact that a single plant may support the growth of many herbivores and each herbivore in turn may provide nutrition to several parasites, which support many hyper-parasites. Thus, from the producer towards consumers, there is a reverse position, i.e. the number of organisms gradually shows an increase, making the pyramid inverted in shape.

Actually, the pyramids of numbers do not give a true picture of the food chain as they are not very functional. They do not indicate the relative effects of the 'geometric', 'food chain' and 'size' factors of the organisms. They generally vary with different communities with different types of food chains in the same environment. It becomes sometimes very difficult to represent the whole community on the same numerical scale (as in forests).

2. Pyramids of biomass : They are comparatively more fundamental, as they, instead of geometric factor, show the quantitative relationships of the standing crops. The pyramids of biomass in different types of ecosystem are shown in Fig. 3.8 (A-C).

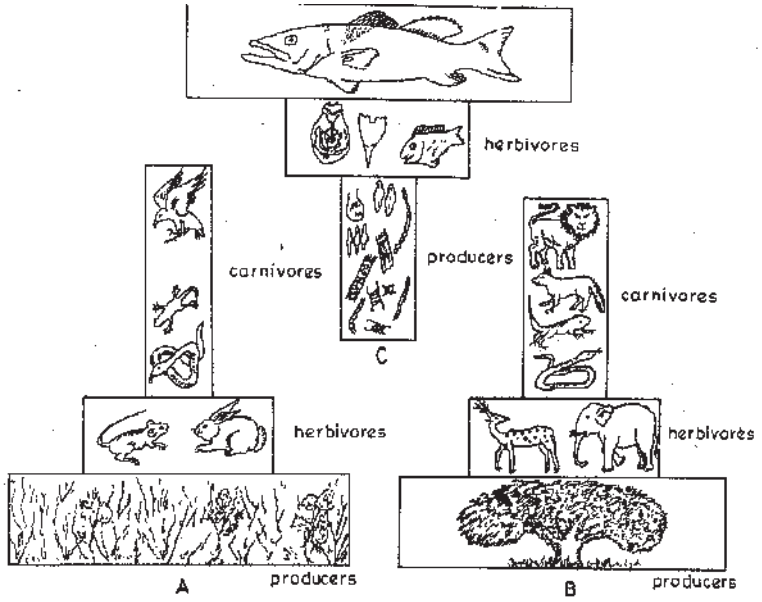

Fig. 3.8 : (A-C) Pyramids of biomass (g dry wt. per unit area) in different kinds of ecosystems. A - grassland, B- forest, C- pond.

In grassland and forest (Fig. 3.8 A, B), there is generally a gradual decrease in biomass of organisms at successive

levels from the producers to the top carnivores. Thus pyramids are upright. However, in a pond (Fig.3.8C) as the producers are small organisms, their biomass is least, and this value gradually shows an increase towards the apex of the pyramid, thus making the pyramid inverted in shape.

3. Pyramid of energy : Of the three types of ecological pyramids, the energy pyramids give the best picture of overall nature of the ecosystem. Here, number and weight of organisms at any level depends not on the amount of fixed energy present at any one time in the level just below but rather on the rate at which food is being produced. In contrast with the pyramids of numbers and biomass, which are pictures of the standing situations (organisms present at that moment), the pyramid of energy (Fig.3.9) is a picture of the rates of passage of food mass through the food chain. In shape it is always upright, as in most of the cases there is always a gradual decrease in the energy content at successive trophic levels from the producers to various consumers.

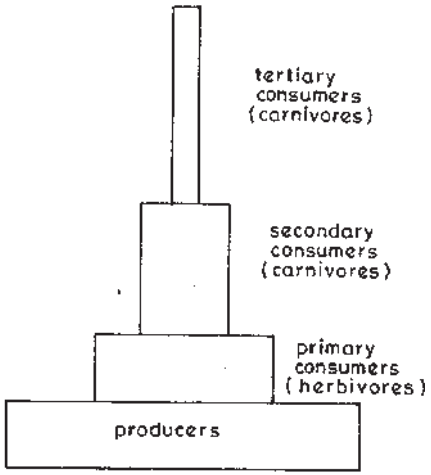

Fig. 3.9 : Pyramid of energy (K cal per unit area within unit time season or years) in an ecosystem.

The species structure includes not only the number and kinds of species but also the diversity of species i.e. the relationship between species and number of individuals or biomass, and the dispersion (spatial arrangement) of individuals of each species present in the community.

3.7 Major Ecosystems of the World

Biome is the largest unit of a land community. Regional climates interact with regional biota and substrate to produce large easily recognisable communities called as biomes. Each biome is characterized by a uniform climax vegetation. The climax vegetation of grassland ecosystem is grass, although species of dominant grasses may vary in different parts of the biome. Although biomes are largely complete community, they are not necessarily sharply separated from one another instead each blends with the next through a fairly large transition zone called as 'Ecotone'. Climate plays an important role in the distribution of biomes. Principal biomes of the world have been described as follows.

a) Forest ecosystem

The prominent forest ecosystems in the world include the Boreal coniferous forest, temperate deciduous forest, temperate evergreen forest, tropical rain forest etc. These natural biomes in the recent years have been subjected to severe human impact and are being altered or degraded.

Boreal coniferous forest

The moist cool, transcontinental coniferous forest biome or great North Woods lie between 45^{o}N and 57^{o}N altitudes. The climate is cold with greater precipitation, occurring mostly in summer. Boreal forest soils are characteristically acidic and mineral deficient. The prominent vegetation is trees like white spruce and balsam. Other conifers such as tamarack

and black spruce are common in moisture situations. Jack pine is found in drier and fire burnt areas. The standing crop of producers in this biome is impressive, if the harvest regeneration and nutrient cycles can be maintained. Understory associates are orchids and shrubs like the blueberry.

Temperate deciduous forest

Temperate deciduous forest originally covered eastern North America, entire Europe, part of Japan, Australia and tip of South America. These areas have abundant and evenly distributed rainfall (30-60 inches) and moderate temperatures that exhibit a distinct seasonal pattern. Although the deciduous forest regions are not as extensive as coniferous forest regions, they represent one of the most important biotic regions of the world because "White man civilisation" has developed in these areas. This biome, has therefore been greatly modified by man and much of it has been replaced by cultivated and forest edge communities. There are large number of plants that produce pulpy fruits and nuts. Animals include deer, bears, squirrels, grey foxes, bobcats, woodpeckers etc. The dominant carnivores are like large wolf and mountain lion, the Puma. The predominant plant genera are the maple, beech, oak, hickory, basswood, cottonwood, etc. There are not many epiphytes except some species of mosses, algae and lichens growing on tree trunks and a few vines. The understory of shrubs and herbs is very well developed and diversified.

Temperate evergreen forest

Many parts of the world that have dry summers and cool-moist winters are commonly inhabited by low evergreen trees with broader leaves or hard needles "Chaparral" of North America, "encinar" of Spain and "melle scrab" of Australia are the temperate evergreen forests. Fire is an important factor in this type of ecosystem. However, plants are very well adapted

and quick regeneration often follows. The characteristic animals are mule deer, brush rabbits, wood rats and lizards. Small-hoofed ungulates are the dominant herbivores.

Tropical rain forest

Tropical rain forests occupy low lying areas near the equator. Rainfall exceeds 80-90 inches per year. Central and south America, Central and Western Africa, South and South East Asia, and north west Australia particularly have this type of biome. The largest continuous mass of rain forest occur in the Amazon basin in South America. In these regions variations in temperature between winter and summer are less than that between night and day. Seasonal periodicities in breeding and other activities of plant and animals are largely related to variations in rainfall or regulated by inherent rhythms. Tropical and sub-tropical evergreen and moist deciduous forests are found in India, particularly in the Western Ghats and north east Himalayas.

Trees are evergreen, tall, shallow rooted and often have swollen bases. Epiphytes often hide the outline of the trees. The number of species of plants is very large. The tropical rain forest is the ultimate in "jungle" growth. However, low light intensity results in poor development of herbaceous vegetation on the ground. Stratification of communities is very well developed.

In addition, to arboreal mammals, chameleons, iguanas, geckos, arboreal snakes, frogs and birds are abundant. Ants, butterflies and moths are ecologically important. Symbiosis between animals and epiphytes is wide-spread. Flora and fauna of the rain forests is incredibly rich in species diversity. Nocturnal and arboreal habit are most common amongst mammals. Rain forest changes into cloud forest at about 2000 feet elevation. Flora and fauna diminishes. Hanging mosses,

ferns, lichens and orchids dripping with moisture give the forest a characteristic appearance.

High altitude or the alpine forests

The distribution of biotic communities in mountains is controlled by physical conditions. Irregular stands of major communities are generally observed. Different biomes may be present on a given mountain. There is a closer contact between biomes. On the other hand similar communities may remain isolated due to discontinuous mountain ranges. As a result of isolation and topographic differences, many species are unique to mountain communities.

The characteristic features of high altitude environment are low air density, high ozone content, low oxygen and carbon dioxide, high transparency, high wind velocity, cold and snow. Alpine zone that exists at the height of 3600 m is characterized by few animal groups. Invertebrates occur in lakes, streams and ponds. Amongst vertebrates, fish, amphibians and reptiles are greatly impoverished. However, representative and dominant vertebrates are the crow, snow partridge, snow leopard, Tibetan yak, Tibetan sheep, and Persian wild goat

b) Grassland ecosystems

Grasslands occupy major part of the terrestrial ecosystems. Many early civilisations developed in grassland regions. Man selected the major food plants from grasses namely rice, wheat, maize etc. Grasslands occur where rainfall is too low to support the forest life but is higher than that will result in desert. It ranges between 10 to 30 inches depending upon temperature and seasonal distribution. Grassland soils contain large amounts of humus. Some of the important perennial species can be classified according to the height of the grasses.

Tall grasses : Their height ranges from 5 to 8 feet. They include species like Indian grass (*Sorghastrum nutans*), slough

grass (*Spartina pectinata*), switch grass (*panicufn virgatum*) and big bluestem (*Andropogon gerardl).*

Mid grasses : Their height ranges from 2 to 4 feet. They include the species like needlegrass (*Stipa spartea*), drop seed (*Sporobolus heterolepis),* western wheat grass (*Agropyron smithit*), tune grass (*Koeleria cristata*) and Indian rice grass (*Oryzopsis)* and many others.

Short grasses : Their height goes maximum upto 1.5 feet. Buffalo grass (*Buchloe dactyloides*), blue grass (*Sporobolus heterolepis*), are some of the important species.

Grasslands occur in the interior of continents. Great plains, Praire of North America, Steppes of Eurasia, Veldt and Savannah of Africa and Pampas of South America are the examples of typical grassland biomes.

In addition, different species of grasses, certain composites and legumes collectively called as “Forbs” also comprise as the producer of the biomass in climax grasslands. Mammals of grasslands live in colonies or herds. Burrowing rodents such as ground squirrels, prairie dogs, and gophers are important animals. Characteristic birds are chickens, meadowlarks, long spurs, horned larks, and rodent eating hawks. Grazing mammals are the dominant species.

c) Desert Ecosystem

Deserts consist of bare-ground or bush covered dry land. The annual rainfall is generally less than ten inches. Central Sahara and north Chili are the absolute deserts where little or no rain falls. Three types of plants are adapted to desert. (i) The annuals which avoid drought by growing only when there is adequate moisture, (ii) the succulents such as the cacti which store water, (iii) the desert shrubs. These plants are able to be dormant for longer periods.

On the basis of temperature, deserts can be divided into two types viz. the cool desert and hot desert. Major hot deserts of the world are situated near the tropic of Cancer and Capricorn where as Sahara Arabia and Gobi desert complex forms the cold deserts. Hot type of deserts that occur in India are in Sind-Rajasthan desert where as the cold desert are in Laddakh and Tibet.

Desert animals and plants are adapted to dry conditions. Reptiles and insects have impervious integument. Plants have small leaves and that are shed in dry conditions. Roots are well developed and occur in top layer of the soil. In general, large animals are very uncommon except, mule, deer and some species of gazelle. All these animals have cursorial, fossorial and saltatoreal adaptations. Certain rodents like kangaroo rat, and the pocket mouse can live indefinitely on dry seeds and do not require drinking water. They remain in burrows during the day and conceive water for a longer period. Man is very poorly adapted in deserts.

Actual working of desert ecosystems is very poorly known. Productivity turnover rates of various populations, the action of limiting factors, environmental hormones etc. are not at all known. Man has failed to understand desert and often faces trouble when he attempts to irrigate or modify the desert. Therefore, functional studies would be of immense practical importance since arid and semi-arid areas make up large portions of earth's surface, including India.

The Thar, the great Indian desert is an area in which the vegetation cover is sparse and the ground surface is exposed to the atmosphere and the associated physical forces. The desert exhibits a spectacular and unique biological diversity owing to it's evolutionary history and geographical location.

d) Aquatic Ecosystems

Our world is awash with water. No other planet as far as we know has anything like a sea. Seven -tenths of the earth is covered by great oceans. The water being held to the earth may occur as a gas, a liquid or a solid depending upon temperature. As a liquid, it forms hydro-sphere, which covers approximately three-fourths of the earth's surface. It tends to flow downward due to gravitational force into the lowest depressions on the surface of lithosphere, forming streams, lakes and oceans.

Interchange of water between earth's surface and atmosphere is governed by a cycle known as hydrologic cycle. Significant amounts of water are incorporated by ecosystems in protoplasmic synthesis and there is a substantial return to the atmosphere by transpiration. The relative and absolute amounts of precipitation and evaporation dictate a good deal about the structure and function of ecosystems, According to one estimate world precipitation amounts to about 4.46×10^{20} g, on ocean surfaces. Water contents of various parts of the earth has been exhibited by the following table.

Table 3.1 Water content of the various parts of the earth.

(from Hutchinson, 1957).

	Contents (gms)
Primary lithosphere	$250{,}000 \times 10^{20}$
Ocean	$13{,}800 \times 10^{20}$
Sedimentary rocks	$2{,}100 \times 10^{20}$
Polar caps and other ice	167×10^{20}
Circulating ground water	2.5×10^{20}
Inland waters	0.25×10^{20}
Atmospheric water vapour	0.13×10^{20}
Total	**$2{,}66{,}069.88 \times 10^{20}$**

Furthermore, aquatic habitat can be divided into sub-habitats, (Fig. 3.10)

1. **Littoral Zone** : This is the shallow water region where light can reach upto the bottom. It is chiefly occupied by rooted plants.
2. **Limnetic zone** : This is the open water zone up to the depth of effective light penetration. The community of this zone comprises plankton, nekton and sometimes neustons. Total illuminated stratum including littoral and limnetic zones is called as euphotic zone.
3. **Profundal Zone** : The bottom of the deep water area where light does not penetrate is called as profundal zone. This zone is often absent in ponds.

Organisms of fresh water may be conveniently classified as producers, consumers and decomposers. Organisms those living in the bottom sediments are called as benthos, those living on the projected surfaces such as stems and leaves are called as periphyton, those swimming freely with the water current are called as plankton. There are other smaller organisms that can swim and navigate at will known as nekton. Organisms resting or swimming on the surface are called as neustons.

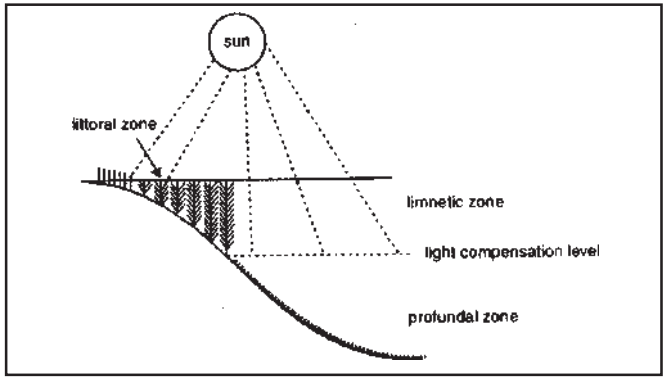

Fig. 3.10 The three zones of a lake

Fresh Water Environment

Fresh water is a home for numerous organisms. As a habitat, we can divide it into two groups:

1) Standing or lentic water eg. Lake, pond, swamp or bog.
2) Running or lotic water eg. Springs, stream and river.

Ponds

Those water bodies that have large littoral zone, where limnetic and profundal zones are absent, are called as ponds. They are found in the regions of sufficient rainfall. Following types of ponds can be recognised.

1. **Flood plain ponds** : Ponds found in stream, flood plains are called as flood plain ponds. They are quite productive due to accumulation of organic matter.
2. **Temporary ponds** : These ponds are seasonal, during rainy season and are dry for most part of the year but support a unique community. Organisms in such ponds must be able to survive a dormant stage during dry periods or be able to move in and out of ponds.
3. **Artificial ponds** : These ponds are the result of damming of a stream basin by man. They are artificially managed.

Lakes

Fresh water bodies where the limnetic (standing water) and profundal zones are relatively large are known as lakes. There are three types of lakes.

1. **Oligotrophic lakes** : Typical Oligotrophic lakes are deep, with hypolimnion larger than epilimnion and have low primary productivity. They are still and geologically young. These lakes have low productivity. Such lakes may change into eutrophic lakes which are shallower and have greater primary productivity.

2. Eutrophic lakes : These lakes are shallower and have high nutrient enrichment represented by diverse aquatic flora where littoral vegetation is more abundant and plankton population are denser. Because of heavy organic content, summer stagnation may be severe enough to exclude cold water fishes. These clean oliogotrophic lakes with high oxygen content become eutrophic due to artificial nutrient enrichment as a result of domestic, agriculture or industrial pollution. Most of the natural lakes in the country are rapidly becoming eutrophic. i.e. Dal, Ular lakes in Kashmir and lakes in the north east. Urban wetlands is a good example of eutrophication.

3. Impoundment These are the artificial water bodies characterised by fluctuating water levels and high turbidity. Impoundments are basically man made, though natural impoundments by land slides in hilly regions are not uncommon, in the form of large dams, water supply reservoirs, tanks, etc.

Rivers and streams

Rivers and streams provide a 'lotic' (running water) habitat for communities. They possess definite and continuous water current. It makes a big difference between lakes and rivers. Land water interchange is relatively more extensive in streams, resulting in a more open ecosystem and a heterotrophic type of community metabolism. Moreover, oxygen tension is uniform in streams. There is thermal or chemical stratification. These factors determine the nature distribution of lotic communities. The lotic systems are represented by springs, stream, rivulets, rivers, manmade canals, and even water falls.

India's wealth of inland wetlands includes both natural as well as man made wetlands. In fact, the proportion of the country's land area under man made wetlands (numbering 65,252) is about 1.8 times higher than its area under natural wetlands (numbering 2167). In addition, the major eastward

flowing rivers such as Ganga, Yamuna, Mahanadi, Brahmaputra, Godavari, Krishna, Cavery and the westward flowing rivers like Narmada and Tapi and their tributaries have a network of more than 17,500 km.

According to the Ministry of Environment and Forests, Govt. of India, in the recent years there has been a significant increase in the number and extent of human made wetlands. However, the natural wetlands with far greater biodiversity are on decline in size and quality as these shallow wetlands rich in fish and waterfowl are grossly underestimated and subjected to reclamation, drainage, pollution and urbanisation.

Estuaries and Marine Environment

An estuary is the mouth of river where tidal action brings about a mixing of salt and fresh water. Shallow bays, tidal marshes and bodies of water behind barrier beaches are included under the heading "estuarine waters". All the rivers do not open into estuaries, some simply discharge their run off into the ocean.

Estuaries

Salinity of estuaries varies between 0.5 to 0.35 percent. Estuaries often prove to be more productive than the adjacent ocean, apparently due to the nutrient trap produced by mixing of water of different salinity and the favourable action of oscillating tidal currents in transporting nutrients, food and waste material.

The temperature in estuaries fluctuate considerably diurnally and seasonally. The upper layer of estuarine water may be cooler in winter and warmer in summer than the bottom.The type and extent of estuaries depends on the physiography of the coast, the substrate and amplitude of the tides. When a bay or part of a river mouth is temporarily cut off from the sea

by a sand bar, salinity increases due to evaporation and species that tolerate high salinities become abundant. Estuaries serve as nursery grounds for most marine species. They make a major contribution to the productivity of coastal waters.

Ocean Ecosystems

Seventy percent of the earth's surface is covered by the sea. The marine habitat is much thicker as well as greater in area than the land and fresh water portions of the biosphere. Total marine biomass (living weight) is far greater than the combined biomass of land and fresh water. Sea influences the climates of land areas but is dominated by waves and tides produced by the pull of moon and sun. The tide range varies from less than one foot in the open sea to 50 feet in certain enclosed bays.

The sea water is salty. In average salt content is 3.5 percent usually written as 35% where as fresh water has a salinity of less than 0.5%.

The Indian ocean occupies an area of 28,400, 000 mi.sq.. Indian eastern coast has a relatively narrow continental shelf as compared to the western coast which is rich in fish resources. Monsoon brings major changes in the hydrology and biology of the oceans and seas around Indian sub-continent Which is around 7000 km wide and represents a little over 20 % of the total area of the global oceans.

India has a large coast line of around 7000 km including eastern and western coasts and Andaman and Nicobar and Lakshdweep island systems. The Indian marine waters are rich in flora and fauna i.e. planktons, algae, sea grasses, mangrove associated diversity, corals, fishery and ocean associated animal diversity.

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Chapter : 4

Biodiversity and its conservation

4.1 Introduction

Since the human species first became fully conscious of the natural world, nature has usually seemed un oassessable and abundant with plant and animal life, from mountains, to oceans, to plateaus and grasslands. Over the course of the twentieth century, however, this view has changed. Man's power over nature, assisted by machines, has grown, and human population has increased exponentially. For centuries, nature has been in retreat in face of human settlement, but in the last 50 years, destruction of the natural world has picked up speed as never before.

Scientists believe that when human development and agriculture reduce the natural world, the loss is not simply a matter of size. The remaining natural areas, it is believed, harbor much fewer species and complex ecosystems. Scientists have revealed that many wild species are now increasingly becoming extinct, and this extinction of wild species, many of them still unknown or not well understood, will threaten the future of the planet.

Since beginning of agriculture, human survival has been based on the domestication for food purpose of wild plants and animals, yet many wild species of plants are continuously destroyed in the wild, before their food or medicinal value can be assessed. The continuation of wild or partially wild varieties of plants is necessary to the future health of domesticated varieties.

In addition, whole ecosystems, such as riverine estuaries, coral reefs, mountain, forest and the creatures that live in them are under great stress due to human caused pollution, exploitation or overdevelopment, yet these ecosystems, in all their marvellous complexity, clean pollutant from water, provide the fresh air we breath, and produce much of our food, making human existence possible. In effect, the vast web of biological diversity, with its millions of species on the planet, is what has made human survival possible, and human life fulfilling.

Definition

Earth is known to be the only living planet due to the life it supports. "Biodiversity" or "biological diversity" is refered to the vast range of life forms, from simple, microscopic, unicellular to the evolved, complex and multi - cellular forms on earth. These include all the living organisms i.e. millions of plants, animals and micro-organisms. The biodiversity is broadly described in three levels

Genetic diversity

This is the diversity represented in the organisms in the basic hereditary information units "Genes" within a species, which are passed down to generations. Genetic diversity results in variations. This diversity gives rise to different "varieties" of rice or other crops. A large number of varieties in the species can be seen or sensed by colour, taste, flavour but most are invisible such as disease resistance, behavioural patterns etc. Genetic diversity is important in breeding crops and livestock.

Species diversity

Species is genetically isolated unit of organism which is used to classify millions of different plant and animal forms on earth. As each species is distinct from other species in form and character such as cow and goat. Only similar species

can produce fertile offspring. Species diversity is measured in terms of species within a given area. Species diversity is the most common level to describe biodiversity of any given area. Based on this level of diversity some countries like India are included in “mega-diversity” countries.

Ecosystem diversity

‘Ecosystem’ concept includes living organisms (plants, animals, micro-organisms) and non living things (air, soil, water, minerals etc.) in a given area, with exchange of material and interaction between them. Ecosystem diversity is therefore the diversity of “habitats”. Habitat is a place or site where an organism or a population of organisms naturally occur.

4.2 Bio-geographical classification of India

India has one of the most diverse geo-physical, geographical and agro climatic conditions in the world. From the highest mountain range like Himalaya, to island systems like Andaman and Nicobar, from lush green evergreen forests of Arunachal in the north east to the dry Rajasthan desert, very long coast on the east and west of the country doted with numerous estuaries, back waters, and deltas like the Sundarban, large number of diverse inland wetlands comprising of marshes, swamps, lakes, rivers and man made reservoirs. The country is bestowed with most diverse ecosystems and habitats which supports equally diverse flora and fauna. The rich biogeography of India can be seen from the biota it represents.

Indian Biogeography can broadly be divided into seven prominent regions namely cold Himalayan mountain region, arid and semi-arid region in central and the western part, Gangatic plains, long coastal belt on the east and west, Deccan plateau, and island ecosystems of Andaman, Nicobar and Lakhshdweep. Depending on the geography and the

prevalent climatic conditions, the flora and fauna of these regions has been evolved with special adaptations. Many of the local species are endemic to the region, i.e. restricted to this region only. Thus due to biogeographical diversity of habitats India represents one of the rich biodiversity of flora and fauna.

4.3 Value of Biodiversity

Biodiversity is a product of continuous process of evolution and natural selection. The nature maintains an equilibrium by loss of some and creation of others more suitable to meet the changed environment. This process takes millions of years. Due to increasing negative human impact on environment, knowingly or unknowingly, the biodiversity today is being degraded at an alarming rate. Unless value of biodiversity is known by all there will not be serious efforts for its conservation.

Generally when biodiversity is refereed people tend to consider either its consumptive or aesthetic use. However, there are several other important values of biodiversity, though regionally their emphasis depend on the local physical conditions, availability and local needs. The value of biodiversity can be described in the following broad categories.

Consumptive Value

Every species of plant or animal has a potential value to humans. The habitats and ecosystems is a valuable resource that provides for human needs today and is essential for human survival in the future. Man totally depends on other species of plants and animals for food, medicine, fiber, and fodder requirements which ultimately determines its wellbeing and the quality of life.

Productive

Biodiversity provides the necessary raw material for domestic and industrial use which supports human civilization. It is estimated that around 80% population from the developing countries like India, depend on traditional medicine for primary health care, most of which is derived from plant resources. Over 20,000 plants are used for this purpose in these countries. Even around 25% of the drugs, including 21 indispensable mainstream drugs, used in the developed countries are made from plant materials.

The loss of crop species has severe implications for regional and global food security. The agriculturist need a variety of diversity of species, mainly wild, in order to cross breed them to produce new high yielding and disease resistant strains. Therefore future food security depends on conservation of the wild strains of plants.

Social value

This is perhaps the most significant of the biodiversity values, particularly in developing countries, where a large proportion of the population depends on local biodiversity for their daily needs and survival. This direct or indirect dependence for food, fodder, fiber, medicines is so crucial that if the ecosystems and the diversity within is lost there is emigration, of these tribal and rural who have lost future, to the cities creating excess pressure on them. The traditional communities, tribal and local coexist with nature and their cultural richness is a reflection of the biodiversity with which they coexist.

Ethical value

In the traditional oriental culture, practices and rituals lot of importance is attributed to the ethical value of biodiversity. It is believed that each species is a unique creation of nature

(god) and has every right to exist and is to be respected. This thought has been depicted in almost every religion. This point of view has strong and growing influence in the modern society as well. Therefore the view has been adopted by the United Nations in the World Charter for Nature in1982.

Aesthetic value

Apparently the most commonly attributed value to biodiversity is the aesthetic value. Ever since the early man the beauty of nature has attracted his attention and has created a special place in life. Each species and ecosystem adds to this richness of beauty of life on the earth. Once a species is extinct or the ecosystem damaged beyond repairs, it is gone for ever and is impossible to be recreated. The value people attribute to the aesthetic function of nature is increasing as it is related to the level of material richness and quality of life. Tourism is considered to be one of the largest and fastest growing industries in the world, where nature tourism plays significant role. It also provides diverse job opportunities and livelihood to the locals in a number of ways.

Option value

It is believed that the biodiversity of plants and animals, we see around us today, though not fully understood, gives us immense options to meet our varied domestic and industrial demands. However, in the light of the rapidly changing environmental scenario, it is likely that many of the vital species of plants and animals, which sustain humanity today as life support system, will be reduced in the near future in quality as well as quantity. This will further degrade the human life on the planet. Scientist worry, since much of the biodiversity is being lost even before knowing its importance to human life, a day is not far when we will realise that we

have reduced most of the natural options for food, medicine, raw material etc. This in particular will create serious conditions for the future generations who will not be left with many options to cope up with their own new demands for survival and development with the degraded and limited biodiversity.

4.4 Biodiversity at global, national and local levels

Biodiversity which is considered to be most vital of the life support system on the planet has been estimated to be from 1.5 to 3 million, as many of the new species, micro organisms and lower forms in the classification are yet to be discovered and classified from the remote areas and better understood. To get some idea about the biodiversity of the plants and animals at the global and national level comparisons are given below. India has significant percentage of the over all biodiversity.

It is evident from the above table that many of the rare lower forms of animals are found in India at much higher percentage compared to the world and therefore need immediate attention for their conservation.

4.5 India as a mega diversity nation

India has rich heritage of species and genetic strains of flora and fauna. Overall 6% of world species are found in India. It is estimated that India is 10th among the plant rich countries of the world, 11th in terms of endemic species of higher vertebrates and 6th among the centers of diversity and origin of agro-diversity. The total number of living species identified in India so far is 1,50,000. Out of the 18 biodiversity hot spots in the world, India has two, the 'Western Ghats' and the 'North eastern Himalayas'.

Number of plant species in the world and India

Type	No. of sp. in India	No.of sp. in the World	% in India
Flowering plants	17,000	250,000	6.80
Non-flowering plants	28,000	6,750,000	4.15

Estimated number of faunal species in the world and India

	India	World	% in India
Total sp.	77,452	1211584	6.39

Some of the taxa in terms of their diversity richness in India as compared to the world are given below .

Taxa	Number	world %
Siphonophora	118	65.56
Echiura	33	25.98
Notostraca	11	73.33
Stomatopoda	124	68.89
Mollusca	5043	6.30
Annelida	1093	8.66
Arthropoda	57525	6.04
Crustaces	2970	12.18
Insecta	50717	6.04
Xiphosura	2	50.00
Chaetognatha	30	30.00
Pisces	2546	11.72
Amphibia	204	3.97
Reptilia	428	3.97
Aves	1228	13.61
Mammalia	372	8.79

It is evident from the above table that many of the rare lower forms of animals are found in India at much higher percentage compared to the world and therefore

4.6 The Western Ghats as a biodiversity region

The Western Ghats (WG), or locally known as 'Sahyadri" in its northern portion, mountain range run to a full length of

1600 km, more or less parallel to the west coast, starting from the mouth of the river Tapti in Dhule district of Maharashtra and ending at Kanyakumari. The entire region covers an area of around 1,60,000 sq km and supports a population of over 45 million. It is the origin of several big and small east and west flowing rivers such as Krishna, Bhima, Tungabhadra, Kaveri, Kali, Sharawati, etc. These rivers provide 200 billion cubic meters (bcm) of water, i.e. 20% of the utilisable water available in India. Because of its strategic location, the Western Ghats influences the south west Monsoon and the climate of peninsular India. The Ghats receive 2000 – 7000 mm of rainfall a year, 80% of it during the monsoon months alone.

The varied rainfall to the east and west of the crest line of the mountain range has given rise to a rich variety of forest systems i.e. evergreen, semi-evergreen, moist and dry deciduous, and subtropical hill forest. The forests abound in the medicinal plants, orchids, grasses, trees and many other species, altogether nearly 4500 species of flowering plants. The Western Ghats is home to many rare and important species of animals such as the tiger, elephant, leopard, bear, gaur, lion-tailed macaque, Nilgiri langur and Nilgiri Thar. Wyanad laughing thrush, Malabar Grey Hornbill are some of the 400 bird species recorded in the region.

Table 4.1 Biodiversity of Sahyadri

	Butterflies	Fishes	Amphibians	Reptiles	Birds	Mammals	Flora
Order	—-	6	2	4	13	8	—
Family	—-	14	6	15	47	24	76
Genera	55	38	13	46	186	54	285
Species	79	73	21	79	333	84	618

The flora of the region is rich in density and diversity. So far over 1500 species of flowering plants and hundreds of ferns and mosses have been reported from the entire Western Ghats indicating rich floral diversity of the plants reported from peninsular India, 618 are known to be endemic to the area. The floral diversity status is shown in Table 4.1. More than 600 medicinal plant species are also found in the Sahyadri region. The current status of the faunal diversity is presented in Table 4.2.

4.2 : Status of Biodiversity In Sahyadri

	Butterflies	Fishes	Amphibians	Reptiles	Birds	Mammals	Flora
Order	—-	6	2	4	13	8	—
Family	—-	14	6	15	47	24	76
Genera	55	38	13	46	186	54	285
Species	79	73	21	79	333	84	618

Recognition to the importance of the Western Ghats

Wildlife International, Cambridge, UK, has classified the WG area as one of the significant “endemic bird areas (EBA)” of the world. The National Geographic Society, Washington DC, in its publication “Diversity of Life” in 1999, has described this area in the following words: “A large number of endemic species, some traced back to forebears on the ancient supercontinent of Gondwana, have evolved on India’s isolated Western mountain ranges. 16 bird species and at least 1500 plant species live only here.”

In 1992, at the Earth Summit at Rio, the United Nations Conference classified the Western Ghats as one of the 18 ecological ‘hotspots’ of the planet on the grounds that the area had one of the highest concentrations of flora and fauna. Only three other areas have comparable ecological

endowments: Peninsular Malaysia, South America and Africa.

The rich biodiversity and pristine wilderness of the entire Western Ghats region is reflected by the large number of protected areas such as wildlife sanctuaries, national parks and project tiger reserves in the states of Tamilnadu, Kerala, Karnataka, Goa and Maharashtra. In Maharashtra alone there are Radhanagari Wildlife Sanctuary, Chandoli National Park and Koyna Wildlife Sanctuary besides many protected forests in Sahyadri region. However, a large areas of forests and wildlife habitats, particularly connecting these protected areas as vital corridors or adjoining areas, are not included in this protected area network. This has serious limitations in protecting wildlife in the region. The increasing man and wildlife conflicts in the area is an indication of the need of improvement in wildlife management to minimise this problem.

The Planning Commission has identified the problems of the Western Ghats as, "The ecological and environmental problems of the Western Ghats area include increasing pressure of population on land and vegetation; submergence of forest areas under river valley projects; encroachment on forest lands; clear felling of forests for raising tea, coffee, rubber and other plantations; mining operations; soil erosion; landslides; shifting cultivation; and declining wildlife population". The Zoological Survey of India (ZSI) has made a survey of the Western Ghats and established that the present rate of deforestation in the area varies from 60 to 110 sq.km every year. The ZSI has warned that if immediate conservation measures are not initiated the Western Ghats ecology will be wiped out in the next five decades.

The major threats to the wildlife in the region are habitat destruction, competition from exotic species and poaching. The great mosaic of wildlife habitats in the region ranging from riparian woodlands, hill forest, meadows, arboreal, etc.

are under increasing threat due to various developmental processes and related human impacts. Changing land use practices, including traditional shifting agriculture, is equally responsible for the habitat loss. The shrinkage and degradation of habitats have direct and indirect impact on the biology and behavior of the sensitive wildlife species, resulting in loss of recruitment in the next generation, population vigor, migration etc.

It is felt that protection should immediately be given to one of the areas which is the richest in biodiversity, and also critically threatened. The choice for such area, named the Sahyadri Ecologically Sensitive Area (SESA) is proposed to the central government by Sahyadri Ecology Forum (SEF) comprising of over twenty five environmental NGOs from Maharashtra, Goa and Karnataka in 2002. The SESA proposal aims at protecting, preserving and promoting what is left of the Western Ghats

4.7 Hot spots of biodiversity

In biodiversity there are two major concepts of 'megadiversity' and 'biodiversity hot spots'. Megadiversity concept covers the broad frame of biodiversity concept which emphasizes more on species richness, threatened species, and endemic species. Where as the hot spot concept emphasizes more on the exponential concentration of endemic species besides the eminent threats of habitat destruction. Megadiversity phenomenon of at least 70% of all being confined to 17 megadiversity countries in the tropics.

The Hot spots, originally 18 and now 25 in number, provide a means of focusing on those areas where threats to biodiversity are most extreme and conservation efforts are urgently needed. In 1980's the 18 localised biodiversity hotspots were identified on the basis of endemism and threats.

Fourteen of the hotspots are in the in tropical moist forests and 4 in the Mediterranean type zone. Out of these hotpots two are in India, in one the Western Ghats or Sahyadri and other being the north eastern Himalayas. This indicates the global importance of the biodiversity in our country. Initially only high plant species were considered for identifying the hotspots but later not only the higher plants but also the birds, mammals, reptiles and amphibians have been considered to add the number which is now up to 25.

4.8 Threats to biodiversity

Biodiversity crises is considered to be the greatest challenge faced by humanity today. Considering the 50 million years of earth's life and very long evolutionary process through which present day life has evolved, Biodiversity is more threatened now than ever before in the history of the planet. Some call it as the second mega extinction after the Dinosaur became extinction.

Habitat loss

Major threats to the biodiversity are habitat loss, pollution, poaching of wildlife, and man – wild life conflicts. This is true in India as well. India's population has risen from 370 million in 1947 to 880 million in 1994 which constituted 18% of the world's population. India has over 15% of world's livestock, but only 2% of the geographical area, 1% forest area and 0.5% pasture lands. Now the populations is estimated to be grown beyond 1.4 billion in 2004 but the land mass is the same, may be more degraded than before and creating a serious threat to the natural systems.

India has forest cover on 19.5% of its total land area as against 33%, as per the National Forest Policy of 1988. In 1997 per capita forest cover in India was 0.08ha against the world average of 0.8 ha. by year 2000 it was reduced to 0.07

due to the population rise. The Ministry of Forests and Environment, Govt. of India in June 2005 has officially declared that there is substantial decline in the forest cover in the past two years despite growing awareness and serious efforts.

The livestock population in the country increased from 292 million in 1951 to 470 million in 1992 and the trend continues. This has increased pressure on grasslands and forests. Due to excess grazing, natural regeneration is either absent or inadequate in 52.8% of the forests in the country.

Due to the ever increasing human pressure, it is estimated that in the worldwide perspective slightly over 1000 animal species and sub-species are threatened with an extinction rate of one per year, while 20,000 flowering plants are thought to be at risk. (Fig. 4.1)

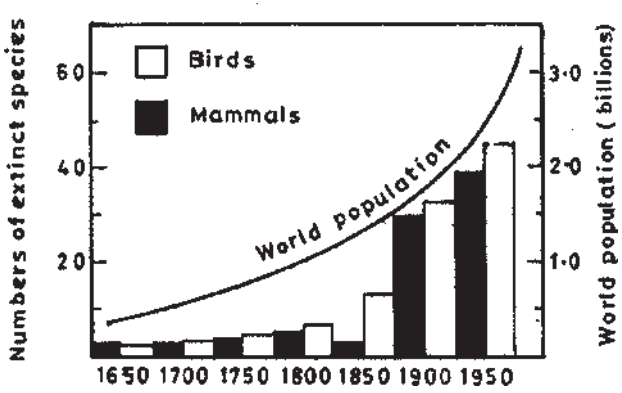

Fig. 4.1 : Human population and extinction of birds and mammals.

Poaching of wildlife

Wildlife has traditionally been the main source of animal protein for forest dwellers. The hunting of wildlife had always remained limited for subsistence and at time as a social or ritual practice of the tribals till recently. With decrease in wilderness areas and wildlife therein, there has been

increasing pressure on wildlife from the locals as well as outsiders. The illegal hunting or poaching of wildlife has gained momentum recently because of the commercial value attributed to the body parts of wild animals i.e. skin, horns, bones, organs etc. for so called medicinal value or for trophy purpose in the international markets. The poaching of tusker elephants for ivory by Virappan or recently discovered poaching of tigers in the Sariska and other wildlife sanctuaries clearly indicates the threat to wildlife even in the protected areas like Wildlife Sanctuaries, National Parks and Project tiger area. Though this has links in the international wildlife trade, incidents in the local poaching and illegal trade of the medicinal plants can not be ignored. If not dealt with strictly, soon biodiversity from the fragmented forests and the wilderness areas is likely to vanish.

Man-wildlife conflict

Man and wildlife has been coexisting ever since the primitive man appeared on the scene. The relationship was more of a pray and predator type till early agrarian culture evolved when man left the hunter gatherer life and settled with agriculture and domesticated animals. With further development in agriculture practices vast wilderness areas were converted into agriculture lands and the wildlife habitat were reduced to fragmented patches. Industrialisation soon took major toll of wildlife by enhancing the pace by habitat destruction through mechanisation and pollution.

Therefore today's man – wildlife conflict has a new dimension. It is mainly the wildlife from the fragmented and degraded habitats coming out for crop raiding and cattle lifting. The agriculture encroachments in the earlier forest habitats and wildlife migration corridors leaves no alternative for the wild animals but to move out of the reduced fragmented forest for survival. The communities living on the

periphery of the forest and protected areas, mainly farmers, and not tribal who to coexist with wildlife, face the conflict and complain of the crop raiding and at times loss of cattle and life. This is without realising the earlier existence of their ancestors in the region in harmony with wildlife when it was much prolific than today. We need to ensure that there are no encroachments in the forests and wildlife is well protected in their natural habitats with sufficient shelter and food so there will not be man and wildlife conflict as it is perceived today.

4.9 Endangered and endemic species of India

It should be remembered that in nature some species are always less in number, rare or uncommon, because of their requirements, structure, behaviour etc. where as others are more common or even abundant. The distribution of these organisms can also be universal, regional or very much localised. The species which are naturally found in a specific area and no where else in the world are termed as endemic. This endemism is a critical criteria in biodiversity conservation as they are being localised and therefore are much vulnerable to local human impact and environmental changes and can be lost forever.

The above table of faunal species in India suggests that a good number of these species are endemic to India. For example in larger mammals Asiatic lion, one horned Indian rhino etc. are restricted to a limited range and are found nowhere else in the world. The terms threatened and endangered indicate the degree of intensity of threat to the well being of these organisms in their natural surroundings. Increasing pressure for food and space, competition, predation, habitat loss, disease etc. are some of the factors which threaten the life of the organism. In extreme cases of these threats, singularly or collectively, the populations of the

threatened organisms are further endangered and even may become locally extinct.

Rare and threatened species plants (vascular) in India

Category	Approximate number	%
Rare	237	40
Vulnerable	117	20
Endangered	170	29
Possibly extinct	38	7
Extinct	21	4

Rare and threatened species of animals (vertebrate) in India

Category	Approximate number	%
Rare	32	20
Vulnerable	58	37
Endangered	62	39
Possibly extinct	03	2
Extinct	03	2

The above table gives an indication of the present status of rare, vulnerable, endangered, possibly extinct and extinct species of vascular plant and vertebrate animal species from India.

4.10 Conservation of biodiversity

There are different views and priorities about conservation of biodiversity. However, there is no difference of opinion that biodiversity must be conserved. Some feel it should be conserved as a matter of principle, others feel it

should be protected as a matter of survival while some feel it should be as a matter of economic benefit.

There are immediate causes as well as ultimate causes of biodiversity destruction. The immediate causes being over exploitation, habitat degradation and destruction. The ultimate causes, even if not directly visible, are equally important. These causes include :-

- Inequities in the distribution of power,
- Information and resources,
- Effects of global market forces and market failures,
- That miss-value natural resources,
- Separation of environmental conservation and economic development.,
- Decline of the indigenous systems of resource management,
- Unsustainable levels of resource demand at global level,
- Lack of ethical commitment to sustainability,
- Inequities within and between societies and countries.

It must be remembered that every one benefits from biodiversity conservation. But lower income population, since they directly depend on local biodiversity for their survival, bear a vastly disproportionate share of the costs of biodiversity loss. It is therefore interesting to ask the following questions to one self in the context of biodiversity conservation and try to find out answers from the past history and experience.

Why conserve Biodiversity ?

Is the distribution of costs and benefits the major problem ?

Who benefits from over-exploitation ?

Who pays the costs of over-exploitation ?

Who earns the benefits from conserving biological diversity ?

Who pays the opportunity costs of conserving biological diversity ?

The biodiversity can normally be conserved in two ways i. e. in-situ conservation and ex-situ conservation. Both the methods have own merits and limitations in the present situation.

In-situ conservation

In–situ conservation is referred to as conservation of flora and fauna, particularly wild, in their natural habitats. India has a long history of in-situ conservation in the form of the concepts 'Abhayaranya' (wildlife sanctuary) and 'Devraai (sacred groves). These concepts of conservation have been practiced by the local communities for centuries. The present wildlife management practice of 'Protected Areas" for wildlife conservation has been implemented in the country since independence. The country today has over 520 national parks, wildlife sanctuaries, project tiger area. National Parks are granted high degree of protection and no human interference is allowed in the protected area. Sanctuaries are accorded a lesser level of protection and activities such as grazing, habitation, private holding, fire wood collection, minor forest produce etc. are allowed for locals.

Biosphere reserve is another concept of in-situ conservation. The idea of UNESCO, suggested in 1973, is to declare a vast area as a reserve where wildlife would be protected when local communities would be allowed to continue to leave and pursue their traditional activities within the reserve / protected area. Industries and environment damaging commercial, developmental projects would not be allowed. However, there are certain controversies in the concept particularly when now it is proved that some major

traditional practices of land use are detrimental to biodiversity conservation.

Project Tiger is another concept to conserve in-situ the entire food chain of tiger along with the associated flora and fauna, there are 23 tiger reserves in India thus giving total protection to several wild species of plants and animals. The recent mass scale poaching of tigers even within the project tiger areas have raised serious questions about their effectiveness in conserving biodiversity.

Ex-situ conservation

The ex-situ conservation of plants and animals (i.e. preserving them / gene pool away from their natural habitat) is being carried out as a last alternative to in-situ conservation, however, this can never be the substitute to it. The collection and preservation of genetic material of wild varieties of crops, domestic animals, economic and medicinal species, etc. is done in several national institutes and laboratories / bureaus of genetic material for germ plasm. The idea of ex-situ conservation is to protect the germ plasm of the endangered species, or from an endangered habitat for reintroduction to another near natural suitable habitat. However, in absence of such suitable habitats, for example in case of Asiatic lion or cheetah, the ex-situ conservation has limited success.

The Critical issues in the implementation of biodiversity conservation

There are several issues involved in the conservation of biodiversity and they can be addressed successfully by :

- transforming attitudes and practices of people concerning biodiversity,
- building a regional and global alliance to conserve biodiversity, as biodiversity does not have man made boundaries,

- empowering local communities to conserve biodiversity and use it sustainability,
- Integrating conservation of biodiversity with economic development at national, regional and local level,
- reducing and stabilising human impact on biodiversity, wherever possible.

The earth's genes, species and ecosystems are the product of over 300 million years of evolution, and are the basis for the survival of our own species. Biological diversity is valuable because future practical values are unpredictable, because variety is inherently interesting and more attractive, and because our understanding of ecosystems is insufficient to be certain of the impact of removing any component. Genetic diversity, which provides the variability to enable species to adapt to changing conditions, is important to all species, but genetic variability in cultivated and domesticated species has become a significant socio-economic resource. Without the genetic variability which enables plant breeders to develop new varieties, global food production would be far less than it is present, and far less able to adapt to the future environmental changes which are certain to come.

Further, biological resources-including genetic resources, organisms or part of organisms, populations or any other biotic component of any ecosystem with actual or potential use to humanity-are renewable, and with proper management can support human needs indefinitely. These resources, and the diversity of the systems which support them, are therefore the essential foundation of sustainable development.

The available evidence indicates that human activities are eroding biological resources and greatly reducing the planet's biodiversity. Estimating precise rates of loss, or even the current status of species, is challenging, because no

systematic monitoring system is in place, and much of the baseline information is lacking, especially in the species rich tropics. Little data is available to access which genes or species are particularly important in the functioning of ecosystems, so it is difficult to specify the extent to which people are suffering from the loss of biodiversity.

While the loss of wild species and habitat receives most public attention, the genetic variety of many cultivated species is also being lost. Thereby reducing the ability of agriculture to adapt to environmental changes. The remaining gene pools in crops such as rice, wheat, maize and many fruits amount to a small fraction of the genetic diversity they harboured only a few decades ago, even though the species themselves may occupy more habitat than ever before. If these trends continue, agriculture will have a far narrow genetic base, and many fewer varieties of fruits and vegetables will reach the market. The available varieties will be less well adapted to local conditions, requiring larger investments in pesticides and fertilisers to maintain productivity.

The loss of biodiversity is due above all to economic factors, especially the low values given to biodiversity and to the ecological functions such as watershed protection, nutrient cycling, pollution control, soil formation, photosynthesis and evolution-upon which human welfare depends. Therefore. Virtually all sectors of human society have an interest in the conservation of biodiversity and the sustainable use of biological resources. However, no single sector can, by itself, ensure that biological resources are managed to provide sustainable supplies of products, rather, co-operation is required between the various sectors, ranging from research to tourism.

The environment is already heavily utilised by people , but given the projected growth in population and economic

activity, the rate of loss of biodiversity is far more likely to increase than stabilise. Research in Stanford University has estimated that almost 40% of the Earth's net primary terrestrial photosynthetic productivity is now directly consumed, converted or wasted as a result of human activities.

A very considerable body of work in the field of conservation biology over the past several decades has shown that reducing the area of habitat reduces not only the population of each species (and hence its genetic diversity), but also the number of species the habitat can hold, as a broad general rule, reducing the size of the habitat by 90% will reduce the number of species that can be supported in the long run by about 50%. It might be concluded that major habitat changes and associated losses of biodiversity are the inevitable price the people are willing to pay for progress as humans become an ever more dominant species, but society has cause for concern when habitats are degraded to lower productivity, especially when accompanied by species loss, which can have world-wide ramifications.

Sustainable goals for Biodiversity

The desired future is one where the entire landscape is being managed to conserve biodiversity, and where biological resources are used sustainably for the benefit of the current and future generations. In fact this is the only sustainable future for our planet; where less than sustainable use of biological resources will lead inevitably to a decline in productivity and quality of life.

Elements in this sustainable future include

- A well-informed public, aware of the status and trends of the ecosystems of their own country and of the rest of the world, and conscious of the impact their levels of resource consumption have on biological resources.

- A system of legislation, economic incentives, and supporting regulations which encourage people to use biological resources sustainably and promote the conservation of biodiversity.
- A collective relationship between governments, scientists, local communities, and the private sector which supports the process of conserving biodiversity.
- A well-managed system of protected areas established in each country, including representative ecosystems and the widest possible range of a country's biodiversity, and
- A comprehensive data base on soils climate, topography, geology and biodiversity to monitor status and trends of genes, species and ecosystems, and to predict the impact of future changes.

Our most challenging times are still ahead, as the human population continues to increase, agricultural pests continue to breed resistance to our chemical warfare, our abuse of the atmosphere begins to change the climate, and our desire for material comfort further encourages us to ever higher levels of competition of limited resources.

Further, the earliest economic development activities have already been implemented, so acceptable solutions to social and economic problems are likely to become increasingly difficult in the coming years. In the times of ecological, social, and economic instability that are just around the corner, if not upon us already, the renewable and locally available biological resources and the knowledge of how to use these resources sustainable- will be more important than ever.

But it is time to go on offensive, to stop fighting the biodiversity crises as if it were a series of battles over species extinction. We need to get in front of the problems, and attack them at their social, economic and political source.

Nature is an essential partnership

- essential, because each species has its space and role, and performs a function essential to the whole;
- a partnership, because the living components of nature – the species – can only thrive and survive together, because together they create a dynamic equilibrium.
- Nature is a dynamic entity that is never the same, that changes, that adapts, that evolves;
- an equilibrium that remains, in essence, unchanged, because it always accommodates evolution and diversity.

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Chapter : 5

Environmental Pollution

5.1 Introduction :

Environmental degradation is one of the important issue at global level. It was decided that degrading environment cannot foster sustainable development and healthy future of next generation at the Rio-D-Janerio in World Earth Summit in 1992. Pollution is main cause of Environmental degradations and this concept is used generally in media and public forum. Any issue concerned with environment does not ends without description of pollution.

5.2 Introduction and Definition

From last few decades world is aware of pollution and its harmful effect. Pollution is becoming a hot issue all over the world. All the countries have taken a serious action to control the pollution. Each and every nation has been engaged in preparation of National Environmental Policy for sustainable development and conservation of natural resources.

All types of pollution are becoming a serious problems to all living creature. Pollution is also responsible for the degradation of natural resources.

Earth Summit held on Environment and Development at Rio de Janerio in 1992 concluded that the continous degradation of environment will never achieve sustainable development.

Definition :

Pollution is defined as, 'undesirable change in the physical, chemical or biological characteristics of natural water, air, or soil, which can adversely affect the life or can create a potential health hazards to any living organisms or can cause damage to non living things, material or property'.

Pollution is contamination of air, water or soil by substance that are harmful to living organisms. In simple manner any direct or indirect alteration in any property, any component from the environment, which disturbs the original functioning of the same. This change is also harmful to man or any living organism is known as pollution.

Pollutant means the substance in any form of matter. i.e. solid, liquid or gasious which cause the pollution.

The list of pollutants includes, dust particles, metals, chemical vapor, chemicals, biological pathogens, etc.

In general pollution can be divided into two basic categories i.e. Natural pollution and Man-made pollution which is based on the origin of pollutant. If pollutant generates due to natural activities like storm, forest fires, volcanoes it is natural pollution. If the pollutants come into nature due to man made activities and pollute the environment is known as man made pollution. e.g. chemical fumes or effluents from the factories. This is simply discharge of unhealthy material in the environment due to man-made activities.

Pollution is categorized into three categories, depending upon the nature of pollutant and their effect on environment. These major types of pollution are air, water and soil pollution. There are many other types of pollutant depending upon the specific nature of the pollution. Many of them are classified as a separate category such as Noise Pollution, Nuclear waste pollution, Oil Pollution, Thermal pollution etc.

5.3 Air Pollution

As we know that our planet earth is only one place which provides life supporting system. Biospheres contains all life supporting system for all creatures. Biosphere is an inter linked sphere and includes air, water, soil, sunlight.

Atmosphere plays a vital role in biosphere. It provides suitable condition for better and healthy environment. It provides life supporting gases i.e. Oxygen CO_2, N_2 and many trace gases. After industrial revolution, air pollution has became a serious problem.

Air pollution is defined as 'unwanted or undesirable change in natural quality and composition of air due to addition of pollutants from various sources. This unwanted change is responsible to cause adverse effect on living organism as well as infrastructure properties.

Classification of air pollutants :

Air is essential for the survival of living organisms but day by day quality of the air has been changing because of the addition of air pollutant. There are different types of pollutants classified as follows :

1) Classification based on the origin of source
2) Classification based on the addition in to atmosphere.
3) Classification based on the state of matter.
4) Classification based on the chemical composition.

1) Classification based on the origin of source

This classification is based on source of pollutant entering in to atmosphere and again divided into two groups as

i) Natural source ii) Man-made source

i) Natural source : In this type pollutants are added into

atmosphere by natural process like volcanoes, forest fire, pollination, microbial degradation etc.

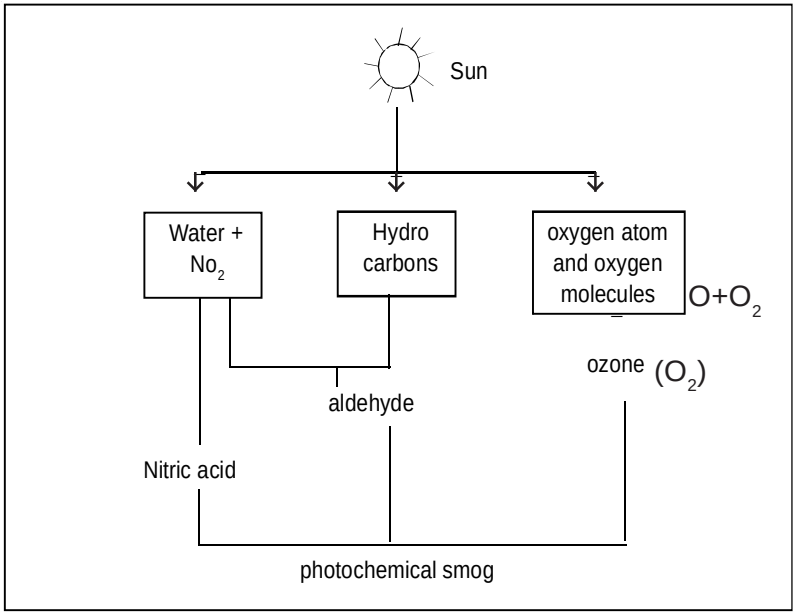
ii) **Man made source :** Man-made sources responsible for air pollution are industrialization, urbanization, population explosion, cutting of forest, increased number of vehicles, modern agricultural practices, nuclear testing, etc.

2) Classification based on the addition into atmosphere

Pollutant addition into the atmosphere classified is done as 1) Primary Pollutant and 2) Secondary pollutant.

Primary pollutants : These type of pollutants are natural and man made also. They are directly mixed into the atmosphere without changing their physical, chemical and biological properties. They are also not converted in to other form like oxides. They enter into atmosphere as it is, in their natural form. e.g. pollen grains, bacteria, virus, dust, due to air pollutant from various industries, smoke, gases which include SO_2, SO_3, NO, NO_2, Cl_2, CO, CO_2 etc. Above mentioned pollutant mix directly into the atmosphere. They pollute atmosphere without combining with other pollutant. Individualy they are strong enough to affect adversely on atmosphere.

Secondary pollutant : Secondary pollutants are the out put or final product of the chemical reaction between one or more primary pollutants with the other atmospheric component like water vapour, humidity, etc. e. g. Ozone, PAN, NOx_2, photochemical smog, acid rain. As compared to primary pollutants, secondary pollutant are more toxic and harmful, as shown in figure, the formation of photochemical smog as a secondary air pollutant



III) Classification based on the state of the matter

The classification based on the state of matter depends upon the physical nature of the pollutant. e. g. Solid or gaseous state Gaseous pollutant includes gas like CO, CO_2, SOx, NOx, etc. Particulate matter includes dust particles, droplet nuclei, pollen grain, etc.

IV) Classification based on the chemical composition

This classification differs pollutants in two category i.e. organic pollutant and inorganic pollutant. It depends upon the chemical nature of the pollutant. Inorganic pollutant includes CO, CO_2, NO_2, H_2. Organic pollutant include hydrocarbon, aldehyde, etc.

Sources of air pollution

Control of air pollution is a main concern of every nations agenda because of its hazards and long term effect. Air

pollution does not affect only at local or regional level but also shows effect at global level e.g. global warming, acid rain, ozone depletion etc.

Many times sources of air pollution are man made. Simultaneously there are some natural source for the same. Natural source includes, volcanic eruption which add particles of dust, water vapor in atmosphere. dust storms. Decomposition of organic matter emmites gases like CO_2, NH_3, H_2S, etc. Another natural sources are pollen from flowering plants, fungal spores, forest fire, etc.

Man made pollutants contribute more in air pollution as compared to natural. Man made sources pollute air by two way one is addition of gaseous pollutant and addition of dust in atmosphere. Gases and particles released from burning of fossil fuel like coal, petrol, kerosene used for the domestic and industrial activity. Vehicles are also a major sources of air pollution, Vehicles emmit gases like NOx, SO_2, CO, Unburn hydrocarbon etc. These gases are released from automobiles due to incomplete combustion of fossil fuel.

Industrial process, modern agricultural activity, mining, energy generation, construction contribute to air pollution. Industries such as sugar factories, also paper and pulp industries, fertilizer plant, textile mill, all small and big scale industries are responsible for air pollution. Transportation plays leading role in air pollution world wide. It includes different modes of travels such as air craft, ships, railways, buses, cars.

Domestic activities like cooking and heating agricultural activities such as spreading of chemical fertilizers and pesticides also pollute the atmosphere. Mining activity generate more dust as compared to gaseous pollution. In thermal power plants, during energy generation burning of

fossil fuel release air pollutant like SO_2, CO_2 and dust. Nuclear weapons and nuclear tests are known source of radioactive material and harmful radiations. War is also a cause of air pollution but it is not very common.

Effects of air pollution

Today whole world is experiencing effects of air pollution like, global climate change, stratospheric ozone depletion, green house effect, global warming acid rain, etc.

Generally oxides of various gases affect atmosphere adversely which include oxides of nitrogen, sulphur dioxide, oxides of carbon, hydrocarbon, particulate matter, etc. NO_2 is more toxic among all these oxides. NO_2 cause irritation of eyes and mucus membrane. It is also responsible for lung cancer and respiratory problem. Oxides of nitrogen (NOx) combines with haemoglobin and reduces oxygen transport efficiency of blood. Carbon dioxide and Carbon monoxide are the oxides of carbon. CO is extremely harmful. It shows symptoms like headache, nausea, dizziness, difficulty in breathing. At high cencentration, it reduces oxygen carring capacity of blood by formation of carboxy haemoglobin. Sulphur dioxide (SO_2) in highly polluted area cause respiratory tract problem, responsible for lung cancer, asthma and allergic infection. It also cause watery nasel discharge, sneezing, coughing, irritation of eyes, etc.

Cyclic and alicyclic hydrocarbons are less toxic as compared to aromatic hydrocarbon. Hydrocarbon (HC) causes irritation of mucus membrane, nose and throat. High concentration of HC shows carcinogenic effect Particulate matter also shows adverse effect on human health. A serious disease Asbestosis is caused due to asbestos fibers inhaled into lungs. Lead from the vehicular exhaust causes lead poisoning with serious effect.

5.4 Water Pollution

Water is the most essential component for human existance. The earth is called as 'Blue Planet' because of water which covers almost three fourth of earth's surface. Water is not only essential for survival of all living things but is also the source of economic wealth and the creator of beautiful environment. Water is needed to meet various other needs for human survival. Now a days, this precious resource is facing the two serious problems : pollution and acute shortage. Fresh water and marine water, both are facing the problem of deterioration due to anthropogenic activities like industrialisation, urbanisation and population explosion.

Definition

The adverse change in physical, chemical and biological properties of natural water due to addition of pollutants causing adverse effects on aquatic life and other living being, including man is called water pollution.

Sources and Types of water pollution

The waste coming from different sources alter the natural quality of water. The sources of water pollution can be domestic sewage, industrial effluent, heat from thermal power plant, radioactive waste materials, agricultural runoff, oil spills, accidental leakage of oil, etc.

The classification of water pollution can be done on the basis of

1) Origin of pollution
2) Source of pollutants
3) Nature of pollutants
4) Habitat and storage site.

The origin of pollution involves two forms of sources point source and non point source. The point source of pollution involves the specific source which could be easily

identifiable such as effluent discharge pipe of an industry or known sewage disposal plant pipe outlet. Since this source is known, efficient treatments can be given to reduce the pollution. The nonpoint source of pollution involves origin of pollution from several diverse and scattered sources. Since these sources are difficult to check out, the effective treatment cannot be given to reduce pollution. e.g. agricultural runoff, leachate from large municipal solid waste dumping site, industrial complexes, etc.

The cumulative impact of the nonpoint sources can be very dangerous than point sources since it may contain different types of effluents.

The water pollution can be studied on the basis of nature of pollutants like physical pollution, chemical pollution and biological pollution. The water pollution can be studied on the basis of habitat and storage site in which the water resource is divided into surface water pollution and ground water pollution. The surface water pollution involves the river water pollution, lake water pollution, estuarine water pollution, sea water pollution, etc. The ground water pollution involves change in water quality of hand pumps, bore wells, open wells, etc.

To check the pollution load and water safety for different uses, regular monitoring is required. Water quality is determined by different parameters like pH, turbidity, dissolved oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Nitrates, Phosphate Sulphate, Chlorides, etc. The biological parametes involves Most Probable Number (MPN) and Standard Plate Count (SPC), detection of pathogens. Also some phytoplankton and zooplankton are used as pollution indicator species.

Effects of Water Pollution :

1) The domestic sewage contain many pathogenic and non pathogenic micro-organisms and many viruses. Water

borne diseases like cholera, typhoid, dysentry, poliomylitis, etc. are spread by contaminated water.

2) Toxic compounds like heavy metals, pesticides, cyanides, many organic and inorganic compounds are harmful to living system. Mercury and Cadmium causes diseases like 'Minamata' and 'Itai-Itai' respectively. Chemical pesticides undergoes biotransformation through food chain.

3) Various agrochemicals like nitrates and phosphates coming from field runoff causes nutrient enrichment of water body. It favours laxurient and rapid growth of aquatic weeds. This process is known as 'Eutrophication'. Here, the dissolved oxygen in the waterbody get depleted and leads to suffocation of aquatic life. Higher levels of nitrates in water is responsible for 'Methahaemoglobinemia'.

4) Oil pollution in water forms a distinct layer on upper surface which inhibits the mixing of dissolved oxygen. Again, the aquatic animals and birds get killed as the oil coats the body surface and prevents the gas exchange.

5) Radioactive waste in aquatic bodies leads to genetic damages, mutation and mortality.

6) Polluted water affects the recreational value as well as asthetic beauty of any water body.

Prevention and control of water pollution :

As compared to nonpoint pollution sources, it is easy to control the pollution from point sources. The following points can be useful to reduce water pollution :

i) Reduction in unnecessary water use and overuse ultimately reduce the waste water. If such personal practice used in each house and muilty story building there will be less pressure on sewage treatment plant.

ii) The various primary treatments, secondary treatments (Biological treatment) and tertiary treatments (Chemical treatment) are used to treat waste water.

iii) Prevention of mixing of agrochemical residue in waterbody can reduce the problem of eutrophication.

iv) Plantation can reduce the pollution by sediments and also prevent soil erosion.

v) Proper chlorination or ozonation should be done for disinfection of harmful bacteria and viruses.

5.5 Soil pollution

Soil is one of the most important ecological resource in the terrestrial ecosystems. All plants are dependent for their nutrient, water supply and anchorage upon the soil material. It is the upper layer of the earth crust, which is formed by weathering of rocks.

Soil plays a very important role in providing food for human being as well as animals. Good soil and climate for more crop production are valuable things for any nation. The increasing population, industrialization and changing life style have negative effect on soil and responsible for soil pollution.

Alternation in physical, chemical and biological characteristics of soil, which has adverse effect on living and non-living things, is known as soil pollution.

Sources of Soil pollution

Some of the processes or sources that are responsible for the soil pollution are as follows:

1) Industrial wastes :

Disposal of industrial wastes is the major problem of soil pollution. Effluents (Waste water) and solid waste are industrial

waste discharge on the soil from various industries like pulp and paper mills, chemical industries, sugar factories, textiles, metal processing industries, etc. These wastes consist of organic, inorganic substances that are non-biodegradable. Some industrial wastes also consist of heavy metals such as Cd, Cr, Hg, Pb, Zn and other toxic substances contaminating the soil.

2) Urban Wastes :

In India, soil pollution problem have contributed to a great extent due to waste disposal and unplanned industrial progress in and around urban areas. Urban waste consists of commercial and domestic wastes. Leachates from waste dumping sites and sewage tanks are harmful and toxic which pollute the soil.

3) Modern Agricultural Practices :

Modern agricultural practices such as application of chemical synthetic fertilisers, pesticides, herbicides and soil conditioning reagents are responsible for soil pollution. Today's practices like over-irrigation, over cultivation; monoculture has become a problem of soil degradation. This practice converts the fertile soil into non-fertile soils. Some of the critical pollution problems are raised due to excessive use of fertilisers, pesticides, herbicides, etc.

4) Mining :

In mining activity, top soil and sub surface soil layer are removed. The huge quantity of fertile part of soil i.e. topsoil is discarded as overburden. Thus environmental degradation is occurring due to vegetation cover loss.

5) Radioactive Pollutants

The sources of the radioactive substances in the soil are explosion of radioactive devices, nuclear wastes,

atmospheric fallout from nuclear dust penetrate in soil and causes soil pollution. These radioactive substances reach the soil and persist for long time and keep on emitting radiation

Effect of Soil pollution

Industrial waste contains variety of chemicals that are harmful to the living things. If the acidic or alkaline nature of industrial waste is disposed on soil it directly it affect the quality of soil. Agricultural crops and soil texture is adversely affected by such type of the wastes.

Sometimes the heavy metals from the wastes are leached out into ground water causing water pollution. Excessive use of fertilisers and pesticides in the agriculture field deteriorates soil texture and reduces the content of the micro-nutrient from the soil. Elements from chemical fertilisers are absorbed by plant and remains in the plant body. Pesticides enter into the food chain resulting in bio-magnification. Bio-magnification is the process in which chemicals or heavy metals enter into food chain and begin to increase in their concentrations at successive trophic levels in food chain.

Nitrate and phosphates from the artificial fertilisers run-off from the agricultural fields and discharged into the nearest water bodies causing the eutrophication. Due to higher concentration of nitrates in the drinking water causes methahaemoglobinaemia in human being. Consumption of vegetable grown in NO_3 rich soil may cause this disease especially in children. Improper handling of the soild waste is also health hazards. Radioactive pollutants through the soil also enter into he living things. These pollutants remains active in soil for the thousands of years. Thus they cause a serious threat to health of several generations. On the other hand, mining leads to loss of grazing, fertile lands and biodiversity rich areas.

Control of Soil pollution :

1) Before disposal, industrial effluents should be properly treated.

2) Solid waste from industries, domestic as well as commercial sources should be segregated and treated using proper method before disposal in environment. New technique like bioremediation should be used for the proper treatment of toxic wastes.

3) Use of artificial fertilisers, pesticides and unscientific irrigation methods should be avoided. Instead of using these methods, biofertilisers, biopesticides should be applied in field for achieving sustainable agriculture development. Application of these materials will not be harmful to soil but it helps in improving the soil fertility.

4) Covering the soil with trees and grass to protect from rain and wind is the best solution.

5) When mining activity get finished the site should be immediately reclaimed by plantation to avoid soil erosion.

6) Radioactive pollutants should be disposed very carefully.

7) Environmental Protection Act, 1986 has laid down guidelines and rules to protect the various environmental segments including soil resource.

5.6 Marine Pollution

One third of the earth's surface is covered by oceans. The oceans play significant role in chemical and biological balance of life. These are very much essential for our food security, commerce and transportation. Now a days, the anthropogenic activities are posing threat to this precious resource in the form of marine pollution.

Definition :

Marine pollution can be defined as the changes in the physical, chemical and biological properties of sea water due to discharge of waste material or heat into the sea resulting harm to marine life, hazards to human health, fishery and impairment of quality for use of sea water.

The sources of pollution in the oceans are

1. **Industries** : Many industries situated in the coastal area directly or indirectly pollute the oceans by discharging different residues of toxic chemicals, colours, heavy metal residues, oil and grease, etc.
2. **Domestic waste :** World's largest population resides on the coastal areas in small towns and cities. The domestic pollution includes the disposal of community sewage, garbage, etc. Most of the coastal cities are not having their own sewage treatment plants.
3. **Agricultural runoff :** Variety of agrochemicals are used in the field which enter in marine environment along with runoff water and river flows. Many persistant chemical pesticides enter in the food chain and leads to bioaccumalation and biomagnification.
4. **Power Plant Effluent :** Large amount of water is required for cooling purpose, in thermal power plants and nuclear power plants. This high temperature waste water is discharged into sea. Also, the ash from the coal fired thermal power plants is discharged into the coastal waters which are the breeding grounds for marine flora and fauna. These marine flora and fauna get badly affected by such thermal pollution in sea.
5. **Oil spills :** The sources of oil in the oceans are accidental release from cargo's, tankers, ship accidents, washing of oil tankers, effluent from oil refineries, leakages from pipelines, oil transportation, etc.

6. **Ballast Water :** The sea water used for balancing the weight of ship is called as ballast water. The water is taken from one coast and discharged in another coast. Along this water, there is transportation of marine living biota. These exotic organisms acts as biological pollutants, damaging the local biodiversity of the other coast.

7. **Nonbiodegradable Waste :** The synthetic nets used for fishing purpose, plastic bottles, plastic bags, glass, etc. dumped into sea takes long time to degrade due to it's chemical properties.

Effects of Marine Pollution :

1. The domestic sewage has high organic content, which leads to depletion of oxygen from the sea water. The lesser oxygen is responsible for suffocation of aquatic habitats. Also, different pathogens are spread in the ocean environment through sewage discharge.
2. The detergents present is the sewage and the residues of chemical fertilisers produce nutrient rich condition, Eutrophication which creates anaerobic environment. Here, the diversity of flora and fauna get reduced.
3. The chemical pesticides like DDT, BHC, heavy metals like mercury get accumalated in food chain and finally leads to biomagnification.
4. Oil pollution is the major threat to the oceans. Oil spreads on the water surface and reduces the light penetration, depletes oxygen and causes suffocation to aquatic animals. Oil forms coating on surface of aquatic animals and birds. Feathers of the birds become heavy, birds are unable to fly, the body temperature falls, fill cold. The asthetic beauty of coastal beaches reduces due to coating of rocks, water, soil, etc.

5. The ballast water is responsible for bioinvasion of exotic species. Due to invasion, the local ecosystem get affected. There are changes of modification in the ecosystem.
6. The nonbiodegradable plastic nets, ropes, plastic bags, thermocole interferes in swimming and movement of aquatic animals.

Control Measures

1. Proper treatment to the domestic sewage and industrial effluent before disposal into the sea is neccessary.
2. Ban on disposal of refuse like plastic bags, nets, ropes, thermocol, etc.
3. Precautionary measures for oil transporation should be taken.
4. Recycling and reuse of disposed hot water from thermal power plants.
5. Ban on transport and discharge of ballast water.
6. Preventing entry of oil through washing of vehicles, pipelines.
7. The legal provisions like Costal Regulation Zone (CRZ) and other acts can be used for protection of coastal areas.

5.7 Noise Pollution

Modern life has given rise to a new form of pollution; one such pollution is Noise pollution, which is grossly ignored. The word 'noise' is derived from the Latin word 'nausea' meaning a feeling of sickness at stomach with an urge to vomit. Noise is defined in a number of ways.

e.g. 1) Noise is sound without value.

2) Noise is unwanted, unpleasant or disagreeable sound that causes discomfort.

3) Noise is wrong sound, in the wrong place at wrong time.

4) Noise is that sound which is undesired by the recipient.

A particular sound may be musical for someone but noise to another, pleasant when soft but noise when loud. A sound at one place may be noise at other place. For example sound at market place may acts as noise at silent places such as hospitals.

So, the question is - what is the sound? Simply the sound is a mechanical form of energy consisting of wave motion (Longitudinal wave).

Definition :

Noise can be defined as any sound i.e. undesirable because it interferes within speech and hearing is intense enough to damage the hearing ability or is otherwise annoying.

Thus noise pollution can be defined as unwanted sound dumped forced into environment, which causes adverse effect on living and nonliving things.

Measurement of Noise :

There are several instruments used for the measurement of sound like Sound Level Meter (SLM), Octave band analyzer, Magnetic tape recorder and Noise analyzer. Sound Level Meter is most frequently used instrument to measure the Sound Pressure Level (SPL). The basic parts of most sound level meters include a microphone, amplifiers, weighting networks and a display meter reading in decibel (dB). Sound energy is usually measured in terms of relative units of energy or power on logarithmic decibel (dB) scale according to the response of ear. A 10 - fold increase in sound adds 10 units to the decibel scale and 100-fold increase adds 20 units.

The quality of unpleasantment of sound waves depends upon the certain factors like, frequency, intensity, time of exposure and intermitted of sound waves.

Sources of Noise Pollution :

Major sources of noise pollution are natural sources and

man-made or anthropogenic sources. Natural sources include thunder, windstorm, heavy rain, lightening, etc.

Man made sources are generally classified into two groups such as Non-industrial and Industrial sources.

a) Non-industrial sources :

It includes noise from domestic sources, aircraft's, motor vehicles, horns, railway traffic, crowded market noise, etc. Domestic sources of noise includes television, radio, kitchen appliances such as mixer grinder, washing machines, whistling of pressure cooker telephone air conditioners etc. Our festivals, cultural programs, carnivals are also responsible to create noise pollution.

b) Industrial sources :

In industry noise could be generated from various machines which involves in crushing of different materials grinding, drilling, cutting, waving, blasting operation, fabrication work, etc.

Noise level in some of the industries is shown in table No. 5.1

5.1 : Industrial sources (noise level in some industries)

Sr. No.	Industry	Noise level (dB)
1.	Saw mills	90-112
2.	Glass blowing	70-108
3.	Heavy vehicle industry	100-160
4.	Automobile (engine testing) industry	80-90
5.	Sugar industry	80-103
6.	Power plants	900-100
7.	Plastic industries	90-95
8.	Leather industry	75-80
9.	Heavy engineering unit	85-95
10.	Fabrication unit	80-95

However, Central Pollution Control Board (CPCB) recommended the permissible level of noise at various places, which is given in Table No. 5.2

* Ambient noise level limits for various areas :

Sr. No.	Category of area	Day time (6 to 9 a.m.)	Night time (9 to 6 p.m.)
1.	Industrial area	75	65
2.	Commercial area	65	55
3.	Residential area	55	45
4.	Silence or silent zone	50	45

Silence or silent zone is the area up to 100m around such premises as hospitals, educational institutions, courts etc.

- **Effects of Noise Pollution :**

Noise exposure is an additional stress. Effect of the noise pollution is observed on both living as well as non-living things. Effect of on non-living things such as building undergoes physical damage by cracks, broken windows, door and glasses, damaging surface material by sudden and explosive sound.

The effect of noise pollution on human being is classified into two groups as auditory and non-auditory effects. Auditory effect includes auditory fatigue and deafness i.e. defect in hearing capacity of man.

Non-auditory effect includes

- Contraction of blood vessels and muscles make the skin pain and also responsible for high blood pressure,

- It causes muscles to contract leading to nerve breakdown, tension and even insanity.
- It affect the efficiency and behaviour of person, it may cause damage to heart, brain, kidney, liver and may also produce emotional disturbance.
- Physiological disorders are also developed due to continous exposure to noise. These are neurosis, hypertension, increase in sweating and undesirable change in gastro-intenstinal activities, sleeplessness, hepatic diseases. It causes injuries to health of growing foetus also.

The noise pollution has negative effect on wildlife mainly on their behaviour and physiology with adverse effect on feeding and breeding habits.

Table No. 5.3 : Impact of Noise levels on human body

Sr. No.	Noise levels in dB	Health Hazards
1.	80	Annoying
2.	90	Hearing damage (8 hrs)
3.	95	Very annoying
4.	110	Stimulation of skin
5.	120	Pain threshold
6.	130-135	Dizziness, Nuisance, Vomiting
7.	140	Pain in ear
8.	150	Burning insinuation of skin, significant change in heart pulse rate.
9.	160	Other minor permanent disease or damage in prolonged.
10.	180	Major permanent damage to ear
11.	190	Major permanent damage to lungs

- **Prevention and control measures :**

Control on noise pollution can be achieved by different ways such as reduction of noise at source level, receiver level, along transmission path, creating awareness and implementing strong law.

1) **Reducing noise at source level :** It includes use of silencing devices, change in operation process, and replacement of noisy machines.

2) **Reduction at receiver level :** Use of personal protective equipment's such as earplugs, noise helmets, earmuffs and exposure control by rotation of workers in different shifts.

3) **Control along transmission path :** To reduce the intensity of noise by increasing distance between source and receiver. Use of barriers such as development of buffer zones, construction walls, enclosure around noisy machinery.

4) **Creating Awareness :** Creating awareness about noise pollution among people through newspaper, television, radio, workshops, and popular lectures is the best remedy.

5.8 Thermal Pollution

The term thermal pollution is self explainatory and clear. The term is related to pollution due to heat. Broadly the term is used to indicate degradation of water quality by an process that change ambient water temperature. Generally it is associated with harmful effects of sudden increase in ambient temperature in a stream, lake or ocean due to discharge of heated water or effluent from industrial process.Thermal pollution problem is mainly related to aquatic environment. Aquatic plants and organisms are very sensitive to change

in temperature. Power plants and industries use water for cooling purpose. Water used as a coolant is disposed into environment at a higher temperature.

Source

Heat and hot water from many industrial process is basic cause of thermal pollution. It is in particular byproducts of the activity of power station and nuclear power generation unit. Thermal power plant, Coal fired plant require huge amount of cooling water for heat removal. Condenser coil of this type industries are cooled with water from near by lake, river or suitable water supply station. After the cooling process hot water is discharged back into water system which increase the temperature of water to about 10-15^{0}C. There are many industries like sugar, paper, textile are responsible for thermal pollution.

Effects of thermal pollution

The primary effect of thermal pollution on aquatic ecosystem are direct thermal shock, change in dissolved oxygen and redistribution of organism in the local community. Cold water contain more oxygen than hot water. Increase in temperature, lowers the dissolved oxygen level and this low dissolved oxygen level lead to anaerobic conditions. In addition raising the water temperature increase the decomposition rate of organic matter, which also depletes dissolved oxygen.

Fresh water fauna population declines with rise in temperature. Only few species can exist above 40^{0}C. For any aquatic plant and organism there is specific temperature range called optimum temperature which can be tolerated by the species. Temperature above the tolerance level affects the metabolic activities in aquatic organism results in killing of fish juveniles which are vulnerable to small increase in temperature. Thermal pollution also affect the ecosystem

composition. The age of marine organism shortens with increase in temperature. Toxicity of many chemicals increase with increase in ambient temperature of water.

Control of thermal pollution -

The dilution of cooling water discharge can be effectively accomplished by various types of diffuser system in large bodies of water. Outlet water must be cool before discharge in water bodies. Simplest method to control thermal pollution is cooling ponds. Cooling pond water is exposed to atmosphere to decrease the temperature. After decrease in temperature water is discharged into river or lake. Cooling tower have been used extensively at various industries.

5.9 Nuclear Hazards

Radiations are the most damaging invisible killers released from the radioactive substances present in nature. Nuclear hazards have increased extensively as a result of the discovery of artificial radioactivity, development of nuclear weapons and newer techniques of harnessing nuclear energy. Though it is a cheapest source of energy, waste disposal is observed to be a great problem to the modern society. Nuclear disintegration of atoms releases energy from the nucleus in the form of radiations.The radiations are highly energetic and have a strong capacity to penetrate deep into nonliving as well as living cells. The radiations are of four types: alpha radiations, beta radiations and gamma radiations. Neutron radiations are also encountered in nuclear power plants and high-altitude flight and emitted from some industrial radioactive sources.

1. Alpha Radiations

Alpha radiations are heavy, very short-range particles and are actually an ejected helium nucleus. Characteristics

of alpha radiations are :

- Most alpha radiations are not able to penetrate human skin.
- Alpha-emitting materials can be harmful to humans if the materials are inhaled, swallowed, or absorbed through open wounds.
- Alpha radiations travel only a short distance (a few inches) in air.
- Alpha radiations are not able to penetrate clothing.

Examples of some alpha emitters: Radium, Radon, Uranium and Thorium.

2. Beta Radiations

Beta radiations are light, short-range particles and are actually an ejected electron. Some characteristics of beta radiations are :

- Beta radiations may travel several feet in air and are moderately penetrating.
- Beta radiations can penetrate human skin, where new skin cells are produced. If high levels of beta-emitting contaminants are allowed to remain on the skin for a prolonged period of time, they may cause skin injury.
- Beta-emitting contaminants may be harmful if deposited internally within the tissues.
- Clothing provides some protection against beta radiation.

Examples of some pure beta emitters: Strontium-90, Carbon-14, Tritium, and Sulfur-35.

3. Gamma Radiations

Gama radiations are highly penetrating electromagnetic

radiation. Some characteristics of these radiations are :

- Gamma radiations are able to travel many feet in air and many inches in human tissue. They readily penetrate most materials and are sometimes called **'penetrating'** radiations.
- Gamma radiations are electromagnetic radiations like visible light, radiowaves and ultraviolet light. These electromagnetic radiations differ only in the amount of energy they have. Gamma rays are the most energetic of these.
- Dense materials are needed for shielding from gamma radiation. Clothing provides little shielding from penetrating radiation, but will prevent contamination of the skin by gamma emitting radioactive materials.

Examples of some gamma emitters: Iodine-131, Caesium-137, Cobalt-60, Radium-226 and Technetium-99m.

Causes of nuclear hazards

1) Nuclear explosion tests are generally conducted in the air, on or below the ground. It is the major source of long living radionuclides to be released into the environment i.e. Uranium, Thorium, Strontium (Sr-89, Sr-90), Ceasium (Cs-137), Barium (Ba-141) and Iodine (I-131) along with unused explosives.
2) The radioactive dust that falls to the earth after atomic explosion is known as radioactive fallout. It mainly contains harmful radioactive elements and easily gets mixed with soil, water and vegetation.
3) Nuclear power plants produces low level, medium level and high level wastes. It consists of gaseous, particulate and some fission fragments of radioactive substances.
4) Atomic explosives used in war releases out radioactivity

in the environment in large proportion.

Effects of nuclear hazards :

1) The atomic bombings of Hiroshima and Nagasaki were nuclear attacks during World War II against the Empire of Japan, by the United States at the order of U.S. President Harry S. Truman. After six months of intense firebombing on 67 other Japanese cities, the nuclear weapon **'Little Boy'** was dropped on the city of Hiroshima on Monday, August 6, 1945, followed on August 9 by the detonation of the **'Fat Man'** over Nagasaki. These are two date of the only attacks with nuclear weapons in the history of warfare. The bombs killed as many as 1,40,000 people in Hiroshima and 80,000 in Nagasaki by the end of 1945, roughly half on the days of the bombings. In both cities, the majority of the dead were civilians. Since then, thousands more have died from injuries or illness attributed to exposure to radiation released by the bombs.
2) Strontium has a strong ability to react with air, water, soil that comes into the body of human beings through food chain and accumulates into the bones to cause cancer.
3) Radioactive Iodine-131 causes cancer of thyroid glands.
4) Radiations produced at the nuclear blast can result in the immediate death of cells and organisms.
5) Various skin diseases, genetic changes through mutations, cataracts, gastrointestinal disorders, blood disorders, damage to central nervous systems, impaired fertility can be seen in affected individuals. Thousands of living ones are attacked by radioactivity at a time.

Control Measures to prevent nuclear hazards :

Radioactive wastes are required to be disposed by

special disposal methods, so they are called as 'royal wastes' as radioactivity remains for thousands of years in the environment and do not smell bad or pollute the environment like all other wastes. There is Comprehensive Nuclear-Test-Ban-Treaty (CTBT) bans all nuclear explosions in all environments, for military or civilian purposes.

1) Each State Party undertakes not to carry out any nuclear weapon test explosion or any other nuclear explosion, and to prohibit and prevent any such nuclear explosion at any place under its jurisdiction or control.
2) Each State Party undertakes, furthermore, to refrain from causing, encouraging, or in any way participating in the carrying out of any nuclear weapon tests explosion or any other nuclear explosion.
3) Use of modern technology, trained workers, well planned management activities and construction of nuclear power plants away from residential areas with safety wall can reduce the fall out of radioactive elements.
4) Radioactive wastes are normally stored in underground sealed tanks made of stainless steel and deposited deep in earth or at the bottom of the seas.

5.10 Solid waste

Mankind has used the resource of this earth so lavishly and recklessly, that the whole life supporting system has been endangered. In the process of obtaining the food and energy, large amount of solid, liquid and gaseous waste have been produced. Solid waste is the waste material produced by household, commercial, institutional, industrial activities.

Solid waste defined, as any unwanted, discarded material other than gas and liquid. Waste is organic and inorganic matter in a wide variety of forms. The solid waste is not only produced at the end of any production process but it also

generated at intermittent processes due to improper utilization of raw material in the process.

Improper management or handling of solid waste will be the source of land, water and air pollution. With rapid urbanization, industrialization and population growth, the generation of huge amount of solid waste, which has been a serious treat to environment in recent year. In India, per capita waste generated is about 0.4 kg/day.

Generally the wastes are divided into two major groups for segregation as biodegradable and non-biodegradable. On the basis of waste generation it is classified into different categories like Municipal solid waste, Industrial waste, Mining wastes, Agricultural waste, Construction and demolish waste, Radioactive waste, Biomedical waste.

Sources of urban and industrial waste

Urban waste :

All urban waste commonly referred as refuse. Urban waste consists of both commercial and domestic waste.

1) Domestic waste :- contains a variety of discarded materials like polyethylene bags, empty metal and aluminum cans, scrap metals, glass bottles, waste paper, cloth/rags, food wastes, etc.
2) Wastes from shops :- mainly consists of waste papers, packaging material, cans, bottles, polyethylene bags, peanuts shells, tea leaves etc.
3) Biochemical waste :- includes anatomical waste, pathological waste and infectious waste, etc.
4) Construction and demolish waste : includes debris and rubbish wood, concrete, etc.

5) Horticulture waste and waste from slaughter houses includes vegetable parts, residues of slaughtered animals respectively.

The urban solid waste materials that can be degraded by microorganisms are called biodegradable waste. For examples vegetable wastes stale food, tea leaves, dry leaves etc. Wastes that cannot be degraded by microorganisms are called non-biodegradable wastes. For examples polyethylene bags, scrap metals, glass bottle, stones, coal, etc.

Industrial waste :

Industrial waste consists of a large number of materials including organic wastes, metals, packing materials, factory rubbish, etc. The composition of the waste generated in the industry is diverse in nature ranging from organic to inorganic and also includes hazardous waste. In some industry this waste may be recycled or reused. The main sources of the waste are agro-industries chemical industry, metals and minerals processing industries.

Problems associated due to improper disposal of solid waste

1) Due to imroper disposal system, it causes bad odour (smell) in surrounding environment. It also loss the aesthetic values of area.
2) Improper handling of urban as well as industrial solid waste will be the source of land, water and soil pollution.
3) Open dumping of solid waste is responsible for spreading of diseases which create unhygienic environmental conditions.
4) The leachate from solid waste dumping site contains pathogenic microbes, toxic chemicals that causes soil pollution as well as ground water contamination. Thus, accumulation of toxic substances in the soil and water

may enter into food chain and transfer to human being also.

5) Air pollution causes due to burning of solid waste.

Management of Solid waste

In urban waste, solid waste generated in community areas can be managed by five major steps : 1) Segregation of waste at source 2) Collection and storage 3) Transportation 4) Reuse and recovery 5) Treatment and disposal.

1) Implementation of Three 'R's

For waste management, three 'R's important are reduce, reuse and recycle before disposal and safe storage of waste.

- Reduction in use of raw materials will correspondingly reduce generation of solid waste.
- Reuse of the materials, which are discarded as the solid waste. e.g. refill the bottles or containers and reuse again. It helps in decreasing the production of solid waste.
- Recycling means reprocess the discarded materials into new useful products. e.g. bottles or any metals are melted and recast into new bottles and cans. Some waste are used as raw material to other industry. e.g. molasses is by-product of sugar factory but it is used as raw materials in distillery industry.

Implementation of three 'R's in practical life are helpful in saving money, energy, raw materials, land space and also reduce pollution.

2) Composting

This has been successfully used in India in many rural areas for disposal of biodegradable wastes. In this process,

biodegradable waste is allowed to degrade or decompose in an oxygen rich medium. Through this process we get good quality of manure which helps in improve fertility of soil.

3) Vermicomposting

This technique is same as composting only difference is here the earthworm are used for the degradation of waste. This technique is used for the disposal of solid waste like sewage sludge, domestic waste or agriculture waste.

4) Landfilling

Here Solid is waste spread in thin layers compacted and converted with clay or plastic foam. In modern landfills the bottom is covered with an impermeable liner to avoid the ground water contamination.

5) Incineration

Incineration is a combustion process means burning of unwanted waste at higher temperature. During burning process, the various gases are release into the environment. It is the main disadvantage of this technology. This process is mostly used in case of hazardous waste management.

5.11 Role of an individual in prevention of pollution

Respect for nature is a tradition and has heritage value for Indians. For centuries our Indian culture has flourished in the nature. All religions have insisted on the importance of nature conservation and environmental cleanliness. In fact, due respect to the nature was the important part of our civilization. But as years passed we have forgotten our culture. We have become very materialistic and self-centred. Life has become very fast. “Use and throw” has become our new age mantra. We are over using natural resources but are not recycling them. We are creating heaps of waste materials and putting extra burden on the carrying capacity of earth. However,

still it is not too late. We still can change this picture. But the problem is How we can prevent the pollution of the environment at the individual level?

There are some small, but very helpful things to prevent pollution. Let us start from our own house. First and foremost the important thing is our needs should have a priority, based on basic needs and not wants. The daily needs should be of sustainable nature i.e. they should be recyclable and should not deplete the nature’s capacity to replenish and endow the earth it’s capacity to reproduce and sustain itself and it’s resources. This will be very useful to our personal as well as collective economy. If we use just adequate fresh water, less energy resources (like electricity, petrol, etc.) and manage our local resources and wastes, then only we can save our natural resources and it will cause less pollution. The environment Mantra of the day is refuse, reduce, reuse and recycle Repair Respect Rethink Restructure of the scarce natural resources like water, soil, other natural resources etc.

In Indian Constitution also it is mentioned that protection of environment is the duty of each and every citizen. So if every individual decides and works accordingly we can tackle the present problem of pollution on personal level on micro-scale and also involve in keep sustainability on the macro-scale at the state or country level.

At domestic level we should use only required quantity of water without its wastage. Harvesting of rain water should be promoted wherever possible. We should take care that no extra drop of water will go waste. Thus we can save scarce freshwater and will generate much less amount of wastewater. The waste water which is generated in one activity at home should be recycled for different domestic purposes. We can thus use the same water for different activities and conserve the resource and energy.

Next, when we generate solid waste, we should segregate the waste at home only. Biodegradable solid waste (which can be degraded by microorganisms) should be separated from other type of solid waste (like plastic, metals, papers etc.) Burning of Solid waste should be avoided because it causes air pollution and it is a serious wastage of precious manure. People who have space can degrade the waste from kitchen, garden etc. at their house only. They can compost the domestic waste by using simple composting or vermi-composting (by using earthworms). Thus there are two advantages one is, biodegradable solid waste is degraded at source only and second is, good quality of manure is produced. For gardening of ornamental plants and for home grown vegetables the manure is ideal. In case of plastics, metals and papers, the materials can be easily recycled as it is collected by rag pickers. If solid waste is handled properly, our households will be free from garbage and exert less load on municipal authorities. Similar procedures can be applied at broader levels i.e. for colonies for villages or cities etc.

We should keep our colonies clean as it is the joint responsibility of the residents who are living in that colony. Household waste should be disposed off in community bins only. We need to keep our colonies green by planting trees by roadside. People should not litter in public places such as parks, open places, etc. but should deposit these things in the dustbins, meant for them.

The rivers, lakes and water bodies are nature's gifts to humanity. However, we are totally disregarding and abusing these gifts of nature. We dispose our wastewater, solid waste in the water bodies, we wash our clothes, cattle and also dump untreated sewage in this water. Most of the people, particularly rural poor, consume the same water for potable purposes. Then there is no surprise if epidemics like cholera,

diarrhoea, gastro spread among the population and take a heavy toll on public health system. This evil cycle could be stopped somewhere by individual and collective efforts even at a village or community level.

Let us think how we can save energy and prevent air pollution. Everyone knows that conventional sources of energy are depleting very fast so we should use them carefully. When there is urgent need only then we should depend on our private vehicles otherwise we should use public transport. This will save our precious fossil fuel petrol also will be less air pollution. We should keep our vehicles in good conditions so it will consume less fuel and will not exhaust harmful gases. At least once in a week we should avoid vehicles and use bicycles.

In case of electricity when we are not using lights, fans, geysers etc they should be switched off. Use of non-conventional sources like solar energy should be promoted, (which are pollution free) solar cookers, solar heaters, solar lamps are very promising which will save our fuels and will help to our household economy to become very strong.

Unnecessary blowing of horns on roads causes the noise pollution. Loud speakers during festivals, political – public gatherings also enhance the problem of noise pollution. We should take care that noise pollution can be avoided.

The products which are produced by killing wild animals, clearing forest areas should be banned boycotted by all of us. Because forests are lungs of the mother earth which purify the air all efforts should be made to protect them. This is not just to control pollution but preserve the biodiversity on mother earth. We have to adopt strategies to reduce our footprints on the planet.

Thus as a conscious citizens it is in our right and

responsibility to create an ambience for pollution free environment which will nourish us as well as safeguard interests of future generations to come.

5.12 Disaster management

Natural disasters are produced by processes that have been operating since the origin of the earth. Such processes are beneficial to humans because they are responsible for things that make the earth a habitable planet for life. For example: throughout Earth's history, volcanism has been responsible for producing much of the water present on its surface and for producing the atmosphere. Earthquakes are one of the processes responsible for the formation of mountain ranges, which help to determine river drainages and climate zones on the earth's surface. Erosional processes, including flooding, landslides and windstorms replenish soil and help to sustain life. However, such processes are considered hazardous only when they adversely affect human beings and their related activities.

Disasters may be defined as those extreme events either natural or man induced which exceed the tolerable magnitude within or beyond certain time limits, make adjustment difficult, result in catastrophic losses of property, and lives and become the headlines of different news paper or media at world level.

Types of Disasters

1. Natural Disaster

Natural disaster that occur as a result of natures extremities in the environment. Natural hazards and disasters that results can be divided into several different categories

Geologic Disasters : These include earthquakes, volcanic eruptions, tsunamis, landslides, floods, subsidence, impacts with outer space objects etc.

Atmospheric Disasters : Hurricanes, Tornadoes, Droughts, severe Thunderstorms, Lightening etc. are major atmospheric disasters.

Other Natural Disasters : Insect infestations, Disease, Wildfires are other natural disasters.

Natural hazards can also be divided into 'catastrophic disaster', which have devastating consequences to huge numbers of people, or have a worldwide effect, such as impacts with large space objects, huge volcanic eruptions, world-wide disease epidemics and world-wide droughts. Such catastrophic hazards only have a small chance of occurring, but can have devastating results if they do occur.

Natural disaster can also be divided into 'rapid onset Disaster', such as Volcanic Eruptions, Earthquakes, Floods, Landslides, severe Thunderstorms, Lightening and Wildfires, which develop with little warning and strike rapidly. Slow onset disaster like drought, insect infestations, and disease epidemics take years to develop.

2. Anthropogenic Disaster

These are disasters which occur as a result of human interaction with the environment. They include technological disasters as well. These disaster often aggrevate the impact of natural disasters.

Technological Disaster

It occurs due to exposure to hazardous substances such as radium, mercury, asbestos fibbers, and coal dust. They also include other disaster that have formed only through human interaction, such as acid rain and contamination of the atmosphere or surface waters with harmful substances as well as the potential for human destruction of the ozone layer and potential global warming.

Floods

Floods mean the overwhelming of usually dry land by a large amount of water that comes from an overflowing river or lake, exceptionally high tide, melting snow or sudden excessive rain. The floods are natural disaster which is a response to rain fall but it becomes hazards when it causes colossal loss to human lives and property.

Causes of floods

The floods of the river are caused by both natural and man made factors. Among the natural factors river floods are mainly due to prolonged high intensity rainfall, meandering courses of river, extensive flood plains break in slope in long profile, blocking of free flow of rivers due to enormous debris by landslide, volcanic eruptions, earthquake etc. Also due to cloud burst, cyclones, storms, hurricanes, typhoons and high tides. Along with these man made factors such as urbanisation, channel manipulation and diversion, construction of bridges, barrages and reservoirs, large scale deforestation, land use changes, erosion and encroachments along the banks etc. are mainly responsible for flooding of rivers.

In India heavy rain fall and snow melting in Himalayan region causes floods in plains of North India such as Ganga and Yamuna river basins in the north east. The heavy rain fall and cyclones in the lower catchment area of West Bengal and Orissa results devastating floods. Frequent rain fall in the hilly regions of Assam causes frequent floods of high magnitude through the Brahmaputra river almost every year.

Flood control measures

Flood control measures include various steps to tame the menacing rivers such as to delay the return of runoff resulting from torrential rainfall to the rivers, to hasten the discharge of water, to reduce the volume of water, to divert the flow of water,

to reduce the impact of floods by reforestation, construction of artificial levees, flood wall and storage reservoirs, canalizations widening and deepening of river streams, removing of bends of river, steps to control the soil erosion to avoid siltation, proper flood plain managements etc.

In India such flood control measurement is taken along the rivers Kosi (Bihar), Mahananda, Brahmaputra, Ganga and Yamuna by constructing flood walls. In certain river basins flood control storage reservoir has been constructed such as Damodar Valley Corporation, Ukai dam along the Tapi river etc. Diversion of stream along the Ghaggar river in Rajasthan, construction of embankments and flood wall along the Ganga river near few cities in north such as Delhi, Allahabad, Lucknow etc. On Kosi river flood embankment is running for 246 km in Bihar. The Bagmati flood control embankment running for a distance of 241 km along the Mahananda river.

Consequences of floods

Disaster associated with flooding can be divided into primary hazards that occur due to contact with water, secondary effects that occur because of the flooding such as disruption of services such as break down of communication, disruption of rail and road traffic, health impacts such as famine and disease, and tertiary effects such as changes in the position of river channels, forest and wild life loss and ecological loss. In India Bihar, Uttar Pradesh, Orissa, Assam, West Bengal are few states which are most influenced by floods in various rivers.

Flood Management

The management of floods implies not letting the excess runoff water suddenly and intensely in the drainage network. The various ways in which this can be done by reduction in runoff, reduction of water volume and flood peak and by

reduction of flood level. The most effective way of flood management is the reduction of runoff by inducing and increasing infiltration into the ground in the river catchment area by increasing the forest canopy, which will also help reduction of soil erosion and siltation.

The volume of water can be controlled by construction of resorting storage reservoir and dams along the river course. Also the construction of small dams on the tributary streams which check floods in the sub stream and it will minimize flood disaster. The flood level in a region can also be reduced by stream channelisation i.e. construction of canal network. The level can also be controlled by widening and deepening and straightening of river course. The excess water of flood can also be controlled by diversion of water to lakes to other basin of river, or to artificial channels etc.

In India such flood management is carried out in Godavari, Krishna, Cauvery river deltas and in Indo-Gangetic plains. In India 15764 km of embankment and 31838 km. drainage channels have been is constructed. Nearly more than 900 towns and 4750 villages have been protected from floods. About 14.08 million hect. area has been benefited by flood management. However, this management does not always prove adequate.

In case of the recent floods in the Western Maharashtra, there was huge damage to property and life. The experts attribute man made situation to aggravate the damage caused by the heavy precipitation. In Mumbai the flooding of the suburbs was mainly due to choking of the Mithi river course due to encroachments, construction, reclamation etc. In the rural areas, the flood situation was worsen due to deforestation in the catchment, landslides, agriculture expansion along river banks and construction and settlement in the flood plains of the rivers. Much of the damage could have been avoided and

there been a good implementable flood disaster management plan.

Earthquake

Earth is a planet of continuous changes that started billions of years ago and that will continue for billions of years to come. Most of the great changes on earth take place along the interfaces between the lithosphere, hydrosphere and atmosphere. These changes are more or less continuous and catastrophic. Earthquake is one of such forces, which is continuously changing the earth surface.

Earthquakes are inevitable and unpredictable forces of nature, which mark a continuous adjustment of the thin and unstable crust of the earth. Earthquake is a form of energy in wave motion transmitted through the surface layers of the earth. These waves (seismic waves) move outward in widening circles from a point of sudden energy release called the focus. These seismic waves gradually lose energy as they travel outward in all directions and passage of these waves create trembling or shaking of ground.

The point where the shock waves reach the surface is termed as epicentre, around which lines of equal seismic intensity can be drawn, called as isoseismic lines. The waves generated by an earthquake are recorded by an instrument called seismograph or seismometer. The science of earthquake study is known as Seismology. The measurement of earthquake is done by Richter scale, devised by Charles F. Richter in 1935, it describes the quantity of energy released by a single earthquake and the scale number range from 0 to 9. It is open ended and logarithmic scale, which increases 10 fold. The earthquake magnitude of 2 is the smallest normally detected by human senses.

Distribution of earthquake

Most of the Earth's great earthquakes occur along the boundaries of oceanic and continental crusts. The downward deflection of the oceanic crust along boundaries of great crustal plates are called subduction zones and are the regions of extremely destructive earthquakes. These sudden tectonic movements can produce large earthquakes which can be very violent and can cause enormous destruction, particularly if they occur in heavily populated areas.

In India the earthquakes are occurring along the Himalayas foothill zones, where the Asiatic Plate is moving southward and Indian plate is moving northward. Along with this in North Eastern States and on the Deccan traps too the earthquake occur more frequently. In the last few years earthquakes in Maharashtra have shown that it is no longer a earthquake free zone.

Causes of earthquake

Earthquakes are caused basically due to 'disequilibrium' in any part of the crust of the earth. There are various causes for disequilibrium of earth crust such as volcanic eruptions, faulting and folding, upwarping and downwarping, hydrostatic pressure of man-made water bodies like reservoirs and lakes and of late the plate movements. Recently the plate tectonic theory has been accepted as the most plausible explanation of earthquakes.

As per the theory of plate tectonics, the crust of the earth is composed of solid and moving plates having either continental crust or oceanic crust or even both continental oceanic crust. The earth's crust consist of six major plates and 20 minor plates. These plates are constantly moving in relation to each other due to thermal convective currents originating deep within the earth. Normally the moderate earthquake are caused along the constructive or divergent plate margins and high magnitudes

and deep focus earthquake are caused along the convergent or destructive plate margins because of collision of two convergent plates and consequent subduction of one plate margin along the benioff zone. Some anthropogenic factors may also result in earthquake such as quarrying, mining, blasts, explosions, dams or construction activities etc.

Consequences of earthquake

The impact of the earthquake is not determined by the magnitude of seismic intensity but are decided on the basic of quantum of damages done by specific earthquake to human lives and property. The few visible impacts of the earthquake are deformation of earth surface, slope instability, land slides, rise and subsidence of ground, changes in drainage pattern, occurrences of floods due to damages to water reservoirs, changes in ground water levels, generation of tsunamis waves and damages to coastal area, loss of human life, structures and property, damages to towns and cities, loss of cattle life, occurrences of forest fires etc.

Earthquake warning

There is no organised operational earthquake warning systems present anywhere in the world. Earthquake prediction is still in the research stage. Furthermore, the only valid earthquake prediction may be the short-term prediction based on precursor events that occur in months, weeks, days, or hours before the earthquake strikes. These are not sufficiently developed to be of value for warning purposes. There is a good probability of occurance of large destructive earthquakes throughout the globe.

On the basis of research and on statistical probabilities, it is difficult to determine which of these expected earthquakes will be the greatest and which one may occur first. But if past seismic history can serve as a guide by studying past seismic

activity, geologists can often speculate on what controls the dynamics of earthquakes and make predictions.

Cyclone

The term cyclones is taken from Greek word 'kuklos' meaning circle. A cyclone is a atmospheric disturbances, which involves a closed circulation about a low pressure centre, anticlockwise in the northern hemisphere and clockwise in the southern hemisphere. The cyclones are mainly of two types i) temperate cyclones and ii) tropical cyclones.

i) Temperate cyclones

The low pressure system of temperate latitudes is known as temperate cyclone. This cyclone system is also called as depression, wave depression or low, because these cyclones are basically developed due to polar and tropical air masses, which meet and form what is known as the Polar Fronts. In size these cyclones are 150 to 3000 km in diameter and move at a rate of 500 to 2000 km per day. These develops between 30^{o} and 65^{o} north and south latitudes in both hemispheres. The main regions where these cyclones are developed are east Nevada, Colorado, Great Lakes in USA, in Europe around Baltic sea, Mediterranean basin etc. and in south hemisphere Antarctic frontal zones. In this cyclone the rainfall is light to moderate, which occurs in the form of light showers, but in this cyclone fogginess and poor visibility are common in the precipitation areas.

ii) Tropical cyclones

The tropical cyclone is a system of low pressure occurring in tropical latitudes. These cyclones originate in the ocean where warm tropical currents supply an abundance of water vapour, especially in the waters studded with islands. The differential heating over land and sea probably causes a small area of low atmospheric pressure to develop. Most of the

tropical cyclone originates in the equatorial belts. These cyclone are most frequent in late summer and autumn (August-October) in North Hemisphere and in spring (March-April) in South Hemisphere.

These cyclone have a diameter of about 150 to 300 km. The tropical cyclones originates in western margin of oceans with well defined track moving at a average speed of 15 to 25 km per hour accompanied with towering cumulonimbus clouds, torrential rainfall, violent winds, thunder and lighting. These cyclone are known by various names in different regions of the world such as 'Hurricane' in North Atlantic, 'Typhoons' in Western North pacific, 'Willy-Willy' in Australia, 'Cyclone' in Indian ocean, 'Baguio' in Philippine Islands etc.

Consequences of cyclone

The cyclones are one of the most destructive and violent of natural forces. Their effects are limited to the coastal regions and the islands in the ocean. The high velocity winds, storms, heavy rainfall and flooding causes severe damages to life and property. The strong winds uproots the vegetation and destruction to man made structures. The heavy rain fall results in landslides and often in high tides formation. The cyclones in ocean causes navigation problems and ship wreck due to low visibility. In coastal region during cyclone period 12 meters high sea swell occurs, which causes damage to coastal property, loss of standing crops and life. Damages to fishing ground, fishing boats and harbours are also massive.

Control of cyclone

Cyclone is one of the natural phenomena and it is developed by various complex climatic changes in land and over ocean in combination. Controlling cyclone is difficult, but one can minimise the effects of cyclone by adopting suitable measures. These include forestation along the coastal belt to

control the damage due to wind velocity, construction of artificial embankment to stop water surge and tidal waves, reliable advance forecasting of cyclone using satellite system, well established early warning and communication system, rescue shelters, etc. This will considerably reduce the impact of cyclone and loss of property and life. In some of the western countries cloud seeding is undertaken in order to reduce the wind speed and rainfall and as a result the rainfall occurs before it reaches the land area. At present scientists are developing technique to divert the path of cyclone and control its speed.

Landslides

Landslide is the down slope gravitational movement of a body of earth or rock as a unit, owing to failure of the material to withhold. It may be induced by natural agencies or caused by human interference with slope stability. It is a serious geological hazard common to almost every part of world. Globally, landslides cause billions of dollars in damage and thousands of deaths and injuries each year. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. There are various type of landslides according movement and material such as, slump, debris slide, debris fall, rock slide, rock fall, mudflows etc.

Landslides are usually associate with heavy precipitation, wind action, and human activities. Gravity is the prime driving force for the landslide movement or down slope movement of material. Factors that allow the force of gravity to overcome the resistance of earth material to landslide movement include: saturation by water by heavy rainfall, deforestation loosing soil binding, steepening of slopes by erosion or construction, alternate freezing or thawing of surface, earthquake vibrations, volcanic eruptions, glacier movement, down slope agricultural

practices and terracing of slope, road construction in hills etc. Usually landslides are associated with periods of heavy rainfall or rapid snow melting and tend to worsen the effects of flooding. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides.

In India, landslides are common in mountainous areas during monsoon season. The Nashri area between Batote and Ramban on the National Highway 1 in Jammu is a unique example of seasonal landslides. Similarly landslides are frequent after winter rains and snowing in Himalayas. In Maharashtra along the Western Ghats on hill passes and on Konkan railway track landslides are frequently observed during rainy season.

Consequences of landslides

Landslides are occasional and a local catastrophic phenomenon. They have limited and site specific environmental influence as occur sporadically and in thinly populated mountainous regions. However, in these region too the landslides block road and railway traffic, damages bridges, houses, and other man made structures, blocks the river flow and pollutes the river water.

Landslides control measures

To control the landslides along the fragile hill slopes, reforestation and plantation of trees and grasses is to be carried out to control and reduce the erosion and loosening of top soil and rocks. Proper drainage of rain water is to be carried out in order to avoid water logging. On the steep slopes of hills concrete walls are to be constructed or wire nets are laid on the slope to avoid the downward movement of rocks and debris.

Tsunami

Tsunami is a series of extra large waves of extremely long wavelength, usually generated by a violent, impulsive under sea disturbance or activity near the coast or in the ocean. When a sudden displacement of a large volume of water occurs or if the sea floor is suddenly raised or dropped by an earthquake, big tsunami waves are formed by the forces of gravity. The waves travel out of the area of origin and can be extremely dangerous and damaging when they reach the shore.

The word 'tsunami' (pronounced tsoo-nah'-mee) is composed of the Japanese words "tsu" (means harbor) and "nami" (means wave). Often the term, "seismic or tidal sea wave" is used to describe the same phenomenon, however, the terms are misleading, because tsunami waves can be generated by other, non seismic disturbances such as volcanic eruptions or underwater landslides, and have physical characteristics different of tidal waves.

The most destructive tsunamis are generated from large, shallow earthquakes with an epicentre or fault line near or on the ocean floor. It in the regions where the earth is characterised by tectonic subduction along tectonic plate boundaries. The high seismicity in the regions is caused by the collision of tectonic plates. It causes large earthquakes, and it tilt, offset, or displace large areas of the ocean floor from a few kilometres to as much as a 1,000 km or more. The sudden vertical displacements over such large areas, disturb the ocean's surface, displace water, and generate destructive tsunami waves. The waves travel great distances from the source region and destruction along their path. For example, in 1960 the Great Chilean tsunami was generated with a magnitude of 9.5 earthquake. Its waves were destructive not only in Chile, but also as far away as Hawaii, Japan and other parts of Pacific. It should be noted that not all earthquakes generate tsunamis. Usually, it takes an earthquake with a

Richter magnitude exceeding 7.5 to produce a destructive tsunami.

The violent volcanic eruptions also cause impulsive disturbances, which also displace a great volume of water and generate extremely destructive tsunami waves in the immediate source area. When the tsunami is generated, its energy is distributed throughout the water column, regardless of the ocean's depth. A tsunami is made up of a series of very long waves. The waves will travel outward on the surface of the ocean in all directions away from the source area, much like the ripples caused by throwing a rock into a pond. The period of the tsunami waves may range from 5 to 90 minutes. The wave crests of a tsunami can be a thousand km long, and from a few to a hundred kilometres or more apart as they travel across the ocean. On the open ocean, the wavelength of a tsunami may be as much as two hundred kilometres, many times greater than the ocean depth, which is on the order of a few kilometres.

Tsunami waves in the deep ocean can travel at high speeds for long periods of time for distances of thousands of kilometres and lose very little energy in the process. The deeper the water, the greater the speed of tsunami waves will be. For example, at the deepest ocean depths the tsunami wave speed will be as much as 800 km/h, about the same as that of a jet aircraft. As the average depth of the Pacific ocean is 4000 m, tsunami wave speed will average about over 700 km/h. In 1960, great tsunami waves generated in Chile reached Japan, more than 16,800 km away in less than 24 hours, killing hundreds of people.

On December 26, 2004 Sumatra earthquake occurred with a magnitude of 9.0 Richter scale along a subduction zone in which the India and Australia plates met.This generated

great tsunami along the Sumatra, Nicobar, and Andaman Islands, Sri Lanka extending upto Myanmar and Java.

Within hours killer tsunami waves radiating from the earthquake's epicenter slammed into the coastline of 12 Indian Ocean countries. The tsunami waves had heights reaching up to 15 meters (50 feet) which snatched people out to sea, drowning them in their homes or on beaches, and demolishing an immense amount of property along the coast. The tsunamis generated by the earthquake have killed over the 150,000 people in twelve countries namely Indonesia, India, Sri Lanka, Thailand, Malaysia, Maldives, Myanmar, Bangladesh, the Andaman and Nicobar Islands, the Maldives, Seychelles, Somalia, Tanzania, and Kenya.

The tsunami caused water level rise all over the eastern Indian coast but destruction of a serious nature with loss of lives took place in Andamans and Nicobar Islands, The worst affected area were along the Andaman islands, districts of Nagapattinam, Cuddalore and Kanyakumari. The Southern Gulf of Mannar and districts of Tirunelveli and Tuticorin.

In terms of the death toll, India had the third highest total following Indonesia and Sri Lanka. On the Indian mainland, more than 8,800 people are confirmed dead with thousands more missing. Of this total, almost 8,000 of the deaths were from Tamilnadu and 600 were from Pondicherry. At least 1,316 of the Andaman and Nicobar islands. A total of 40,000 people are confirmed dead and 5,542 were missing - 4,500 from Katchall island alone. At least 140,000 Indians from fishing families, were sheltered in relief centers.

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Chapter : 6

Social Issues and the Environment

6.1 Introduction :

To live a happy and prosperous life, man needs appropriate natural and social health. Technological progress, has led to degradation of almost all natural resources. Consumption of natural resources by few groups of people is completely against the principle of sustainable development which includes equality to all and purity of resources. Development means not only economic growth, but it should be sustainable. To meet the aim of sustainable development, the development should be such that it meets the needs of the present generation without compromising the ability of future generations to meet their own needs. By using the principles of optimum use, recycle and reuse, use of resources within their carrying capacity is the only solution for this.

With the increasing degradation of water as a resource, there would rise critical condition in the future. Therefore water conservation is the need of time. For this purpose projects such as rainwater harvesting or watershed management should be encouraged. Also appropriate government policies and response of peoples is important.

Due to the wrong concept of development, today the whole world is facing the problems such as ozone layer depletion, global warming etc. To solve such problems everyone should have the knowledge of environment and environmental ethics.

6.2 From unsustainable to sustainable development

Human society, in its endeavour to survive and acquire better living conditions, has been using the natural resources since the time immemorial. In the process of development man has been able to alter the natural conditions to a great extent and has lived in reasonably secured and comfortable life as compared to his ancestors. However, the modern society now is largely dependent on industrialisation and technological innovations based on overuse of the limiting natural resources.

The past experience suggests that this so called development has been at the cost of exploitation of resources resulting into qualitative and quantitative degradation of the environment. Considering the current rate of misuse or abuse of these natural resources like water, oceans, air, land etc. it is clear that developmental model of most the countries is not sustainable. In the rush to develop the environmental concerns are grossly ignored or neglected. (This have now emerged as the main constrains for sustained existence and future survival, if not for development, within nature's limits.) It is now an established fact that positive and sustainable development is possible only with healthy environment.

This unsustainable model of development in most developing countries is based on the developed countries, where $1/5^{th}$ of the people overuse almost 80% of the world resources, leaving 80% of the global population, mainly from the developing countries, with only 20% of the degraded resources. This problem is likely to worsen in the next 60 years when world population will double but not the earth and its resources. They will be further degraded if the present unsustainable developmental progress continues.

The sustainable development is defined as "the development that meets the needs of the present generations

without compromising the ability of future generations to meet their own needs". Other simpler definition of the term is "Sustainable development improves the quality of human life while living within the carrying capacity of nature's life support systems". It is evident from these definitions that, today's development in true sense is not sustainable development but it is a mere unhealthy growth. This development is largely beyond nature's carrying capacity, locally as well as globally by eroding the vial and basic natural resource base. Therefore, this development is short term and unsustainable.

Unless we consciously change from the present unsustainable developmental pattern to more eco-friendly and sustainable life styles most of the present day developmental problems will not be solved satisfactorily. Limited natural resources with increasing demand to meet growing population's needs and consumerist life styles are the root cause of social, economical and political stress seen today.

A new strategy is therefore necessary to be evolved which will involve concept of caring for nature and for the people. This new ethics will have to be based on just, equitable and sustainable living today and for better tomorrow. The strategy should be based on mutually reinforcing conservation actions at the individual, national and international level. The basic principles in the strategy for sustainable development would be to live within the carrying capacity of the earth, while respecting and caring for community of whole life and not man alone. It will support to minimise the depletion of non-renewable resources and conservation of earth's vitality and diversity.

This strategy will further be based on maintaining the natural resource base by adopting and thorough improvement in knowledge, organisation, technical efficiency and wisdom. The thrust will have to be on integrating nature conservation

and environmental protection as an essential part of all developmental planning and implementation. Since the present human attitude is the root cause of environmental degradation, we must acknowledge that if we are the cause of the environmental problem then we alone are the solution to the same. We must try to change personal attitudes and practices and involve more and more people in environmental protection and sustainable development initiatives.

6.3 Urban problems related to energy

Energy is one of the main components of development of human society. Every country need energy to maintain physical comfort in much of the world to win and manufacture useful materials and artifacts, for transport, for communications, for agriculture and for industry in general. In the earlier stages of the industrial revolution, fuel sources were local and widely distributed. Industrial activity tended to grow in areas were local sources of coal were available. A problem related to energy in the present form of industrialization is the centralized nature of fuel production and distribution. No comfortable living can be achieved in life without the use of adequate energy.

The harnessing and utilization of energy is associated with worrying problems, namely, depletion and environmental damage. Energy resources all over the world are getting depleted. Over 90 percent of all the energy used in the entire world come from fossil fuels (coal, oil and gas) that are exhaustible. Currently, the world uses in one year an amount of fossil fuels that took nature roughly one million years to produce. At our present rate of consumption and assuming no population increase, all the known oil reserves could be exhausted by the middle of this century and natural gas by 2070. Coal supplies will last roughly for 200 years at current consumption rates.

High energy consumption

Urban areas are responsible for the bulk of household energy consumption. The fuel which families use in urban areas is dependent largely on income level and the ways they use energy are also very different. When charcoal is the main source of energy, the problem is observed to be worse because of the low efficiency in both the charcoal-making processes in the rural areas and in extracting energy from charcoal, mainly for cooking. Biomass fuel not only provides energy for poor rural populations, but also to people with higher incomes. The energy demand of the individuals and community in urban area is very high especially for food and lightening due to the different life patterns. The energy is also required in high quantity to support the needs of high density population such as water storage, street lightening, lifts, shops, holdings and many other community places.

For any kind of energy intensive preparations or processes at domestic level, either LPG or electricity based appliances are used. However due to limited use of LPG in the households, use of electricity has become indispensable in the urban areas. The power failure or frequent interruptions in supply are not affordable to the businesses, many make provisions for stand by generators run on petrol, kerosene or LPG. Commercial establishments respond to power cuts by using generators, which not only increases costs but also contributes significantly to air and noise pollution. In fact, air pollution caused by diesel powered generators, is a major concern today. Use of power generator sets is also highly fuel consuming, costly and not a permanent solution. The alternative sources of energy like solar are not still affordable due to their high costs.

Currently and in future, there are no sustainable and affordable options to charcoal consumption for most of the people living in urban areas. Among the various forms of energy consumed by the urban population, the major proportion is in the form of electricity. With increase in income, the demand for energy evolves from basic energy end uses, such as cooking and lighting, communication, space conditioning and entertainment, all of which need larger quantities and different forms of energy.

Many industries still use high energy consuming equipment mainly because of the non-availability of capital to replace them with energy efficient equipment. With the failure of the public distribution system, the urban poor are forced to buy either low efficiency fuels such as kerosene or low quality coal from the market. Legal supply of electricity is still a distant dream for many urban poor families. Citizens have reacted violently on several occasions in all parts of the country on interrupted supply and continuous power cuts. It is common to see lights switched 'ON' in public or government institutions during the day.

The energy conservation measures can be applied in following ways.

- Promotion of new techniques to reduce energy consumption especially high energy demanding consumers.
- Legal requirement of energy audits to be carried out by major energy consumers.
- Reducing the demand for stolen electricity with strict rules and monitoring.
- Promoting community participation for energy conservation.

- Actively promoting the use of energy efficient appliances.
- Encouraging the purchase of energy efficient equipment.
- Promoting the construction of energy efficient buildings.

6.4 Water conservation, Watershed management, Rain Water Harvesting

Fresh water is one of precious natural resources. However this vital resource is given less importance due to its easy, free availability and most of the people believe that it is infinite. There is contrasting picture in the country at the same time when in some regions there is problem of floods due to heavy rains and acute water shortage in the other parts of country. This picture is seen almost every year.

World Health organisation estimates that 8% of diseases in third world countries are caused by lack of hygienic conditions, lack of clean drinking water and improper sewage disposal. Hence clean drinking water supply is of the highest priorities in many developing countries.

Water shortages are getting worse as surface water sources are not utilised carefully and as aquifers are depleted. Water conservation is the most effective means of increasing fresh water supply in many areas. Rational use of water resource by reduced use, recycling, reuse in the activities like irrigation, industrial processes and domestic use can easily be implimented.

Water Conservation Measures

Number of water conservation measures are practiced in different places depending on availability of water, local requirements and traditions. Some of the measures are as follows -

Retention of rainwater from surface through construction of reserviors, tanks.

For ground water recharge, construction of check dams, percolation tank etc.

For agriculture water management use of lift irrigation, drip and sprinklers for irrigation.

Other water conservation measures include recycling of waste water after proper treatment, reduced use of water, rain water harvesting, conservation of natural wetlands, recharging ground water, watershed management, awareness among the people from local to global level, reducing water pollution and enforcement of law etc.

Catchment Area

'It is the surface area from which run off rainwater is collected. It can be roof top area of terraces or buldings or designated ground area. The catchment area of housing or society can be increased by connecting the water collection network by pipeline. The various factors affecting run-off are as follows -

1. Intensity of rainfall, duration of rainfall, timing of rain i.e. first rainfall (water used for wetting), during next rainfall (water used for percolation)
2. Surface characters such as smooth surface (fast water run off), rough surface (less water runoff)

Watershed Management

When the rain, sleet, snow and other forms of precipitation falls on land some water soaks into the ground and becomes part of ground water. The remaining surface water runs down the mountains, hills and across the plains as small streams. These small streams come together and form a large stream and eventually join to form a river. Thus watershed is the total area of land developed by a drainage network of the stream.

Definitions of watershed - (1) conservation or collection of water at a common point. (2) Watershed is also called as the area of land that is drained by river, stream or lake.

The watershed management is based on - basin morphology, drainage pattern, size. shape, slope of watershed, vegetation cover, climatic conditions, characteristics, etc.

Watershed management is a co-ordinated analysis conducted by team of experts from various disciplines like hydrology, geology, engineering, agriculture, economics, soil sciences, etc. Water shed

management also includes soil conservation measures, terracing, contouring, tree plantation, nalha bunding, gully pluging etc.

Rainwater Harvesting -

Rainwater harvesting methods are used almost about 4000 years in drier regions. These methods are practiced, evolved and perfected in the regions with less annual rainfall. Only after the piped water was made available to the towns and cities these practices were neglected along with the age-old. But many of these are now being used in many parts of country like Rajasthan, Gujarat and Tamilnadu.

Though India has enough surface runoff and ground water as fresh water resources, it is limited, site specific, also there is a problem of water pollution. It is documented that water scarcity makes women and children spend more time and labour for water collection from far away. It leads to health problems. Also the children suffer their studies. Hence for clean fresh water rainwater harvesting is essential.

Definition -

Rain water harvesting means 'catch water where it falls'. "Collection of precipitation water during Monsoon and other rains and storing it for use during the rest of the year is known as rain water harvesting.

The rain water harvesting is possible from any surface which is from pollution like roof top of house, agricultural field or surface of ground.

There are chances of contamination of surface water due to pollutants which affects the water quality. Therefore there are two rainwater harvesting systems -

1. Rain water harvesting from rooftops into tanks.
2. Rain water harvesting from surface of ground in underground tank.

Rooftop rainwater is stored in tanks and used for day to day purpose, where rain water is collected from house or building roof tops in storage tank. It is called as roof top harvesting.

If surface run off water is collected in under ground tank, it can be used for domestic, agricultural and other purposes.

Community rooftop harvesting, storage and recharging

Amount of rainfall x rooftop area = volume of water harvested

(Meter^2) (meter^3)

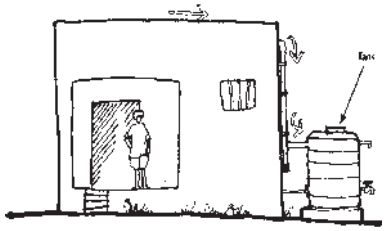

Fig. 6.1 : Roof top water harvesting

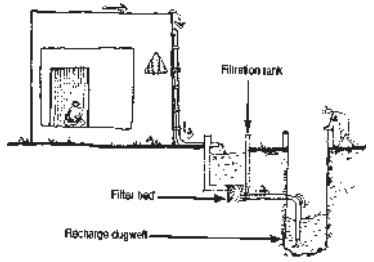

Fig. 6.2 : Ground water recharging

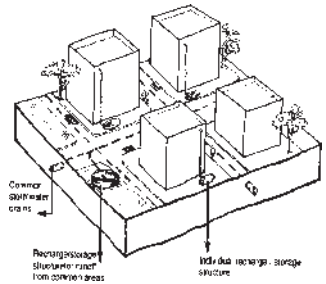

Fig. 6.3 : Community roof top harvesting, storage and recharging.

Collection System -

It is a system where collection and storage of rain water is done with minimum quantitative losses. It includes collection channels, pipes, tanks, pits or natural depression. Collected water can be used for various purposes by means of channel, pipes, perforated pipes or drip irrigation.

Benefits of rainwater harvesting

- Provides pure and clean quality of water if it is collected from clean surface at low cost
- Reduce dependance on water from dams, reservoirs and other systems due to direct capturing of rainwater.
- Less pressure or reduces pressure on natural water storage capacity.
- Reduce soil erosion and flooding.
- Increase ground water recharge.
- Women and children save their time spent on water collection and reduces health problems.
- Less / No charges of electricity for distribution system as water can be stored near individual houses and housing complexes.

6.5 Resettlement and rehabilitation of people, its problems and concerns

Millions of people have been displaced by development projects in India since the year 1950. However, less than 25% of them have been resettled and rehabilitated satisfactorily. Regardless of the magnitude of the population displaced and absence of rehabilitation measures, neither the central government nor the state governments have enacted effective legislations to amend the situation. Inherent social and

economic inequalities embedded in Indian society, along with the type of laws for land acquisition and compensation payment have curtailed the capacity of the displaced to organize themselves and demand better rehabilitation provisions. It is evident from the agitations of the displaced people all over the country, under various developmental projects such as dams, roads, sancturies etc., that their issues have not been handled effectively by the concerned governmental agencies. The people who have sacrificed land and livelihood for the country are still struggling for rehabilitation.

However, of late, people affected by the Sardar Sarovar Project (SSP) and the activists spearheading the Narmada movement seem to have sown the seeds of protest and have thus challenged the government effectively. The movement has brought the issue of the rights of displaced people to the forefront, generating a national debate. The Resettlement and Rehabilitation (RandR) policy provisions now available for SSP- displaced people are considered to be a package that carry the promise of development opportunities to the dispossessed, for the first time in the country.

Government approach to R and R in irrigation projects

All irrigation projects in India have typically followed the incremental approach to the resettlement of displaced people. In that people were shifted and resettled according to the construction and submergence schedule. In this approach, a clear demarcation of the level and area of submergence, the identification and enumeration of affected households, a survey and acquisition of land in the submergence area were undertaken in phases, in accordance with the tentative submergence schedule.

The government defended the incremental approach by stating that in large irrigation projects, the R and R process that continues over a long period of time has to be carried out

in steps and not in one go. Lands under submergence cannot be kept frozen for the purposes of acquisition over years, to the detriment of the displaced. The entire process is a time stream of actions and has to be judged from how far the scheduled RandR targets are in keeping with the main physical works of the projects and how best they have been met with. This argument reinforces the belief that the RandR approach is solely dictated by the progress of the main project work. It considers the displacement of people and environmental destruction induced by the projects as residual elements and deals with them as and when they become problematic in the project cycle.

Further, the government's argument for delaying land acquisition for the benefit of the displaced does not have much meaning because, once an area has been identified for submergence, its value as property for sale and collateral for loan drops and, in effect, the incentive for improvement vanishes automatically. In many projects where the waiting time for the acquisition of land was prolonged due to project delays, farmers witnessed greater difficulties in getting credit and access to agricultural improvement programmes. In the Indian context, the moment the government identifies an area for submergence, the provision of all forms of developmental assistance to that area comes to a halt.

Rehabilitation Dimensions, Government Policy and Community Response

The Magnitude of the Problem

The magnitude of the rehabilitation problem can be understood against the background of development of irrigation projects in terms of number of projects, the extent of the added irrigated area, the number of villages and the people affected by dam construction. Rehabilitation is basically a

human rights issue. Government's concern is always more for the command area of the dam rather than catchment area, as it provides added revenue to government.

In India, the following specific examples give an idea of displaced villages, with affected population due to irrigation project. Hirakud dam on Mahanadi (Orissa State) affected over 249 villages and 20,000 population. The Government of Orissa resettled these by providing maximum facilities only to 33 villages out of 249. In Madhya Pradesh, under the Rehand project 105 villages were submerged. Under the Chambal Project (in Gandhi Sagar Dam) 228 villages were affected by losing their land under the dam. The "Srisailam Project", in Andhra Pradesh, 100 villages were submerged and over one lakh people displaced who owned 1,06,925 acres of land and 20,728 households, In Maharshtra, for Koyna Project, a total of about 100 villages were affected involving a population of about 30,000. 15 dam affected villages were resettled in four districts. Under the Warna Dam Project in Sangli district, there are 25 affected villages (16 fully and 9 partly) yet to be properly rehabilitated within the command area. The involved population under the Warna project is 4,730. In western Maharashtra there are several dam projects under different stages of completion and most face the rehabilitation problem.

Benefits

The economic benefits added by irrigation projects are too well known to stand a detailed discussion. Land productivity in the command area is raised. There are many studies of cost-benefit type by economists, there are some studies analysing the social aspects of the change as well. Now-a-days, attention is also being given to the problem of ecological change and conservation of natural resources. It is not clear who are the major beneficiaries of an irrigation project ? The affected community or the unaffected and possibly better off

sections of the society in the command area. It is most likely that the latter are the main beneficiaries.

Rehabilitation process

The villages which come under submergence of any irrigation project are affected villages. From such affected villages, the agricultural and settlement area is acquired by the government. Earlier some of the resettled villages were resettled in the catchment area, which displaced in ecological damage in the catchment areas. These days all the affected villages are shifted and resettled in a new location of command area. For such affected villages, it becomes necessary again to acquire the agricultural land within the command area. Resettled villages are to be provided with all the necessary facilities within their new settlement locations.

As per Land Acquisition Act, the Government is acquiring the land by fixing a ratio within the command and catchment area. The rules have been framed by giving compensation of land or alternative land for residential and for agricultural purposes to the affected landholders, considering the number of family members as a base for distribution of land. On the basis of total population of the new village, the amenities like school building, playground, roads, provision of drinking water, and many other such facilities are provided by the government.

For obtaining compensation and other personal benefits to the affected families and to the village, it is essential to contact the concerned government offices related to rehabilitation and irrigation work. Finally, no irrigation project work is complete without judging it in relation to the opportunities of employment of capital and layout resources and rehabilitation work completed in the command area.

Government Policy Objectives

The responsibility of the government as it is often stated

is that “the problem to be solved is primarily that of rehabilitation and not one of general betterment of the community as a whole. The general socio-economic betterment of people is a nation-wide problem and cannot be linked with the problem of rehabilitation. In rehabilitation, an attempt is made, as far as possible and practicable, to give the affected people some facilities and means of livelihood approximating to those they had in their original villages, but of course, with suitable improvement in hygienic and other living conditions in keeping with the present rate of advancement”. Though these are good thoughts, at times one does not see them translated into action.

Response of the Community

It is necessary to identify the response of both the affected and the non- affected sections because, though the responses are different they need to be complementary and mutually supporting. The responses of the affected community can be understood and sympathised. The change means, as stated earlier, a shift from an area and site to which they are traditionally and emotionally attached. Further, settling down in a new place is to them a leap in the unknown ! Lack of education, poverty, inadequate skills and ignorance regarding what the shift implies, all these compound these difficulties. Hence their response to take the change is conditioned by indecision and anxiety. They literally drag their feet and are, therefore, out to shift to the new sites. It is important, therefore, that any such rehabilitation programme must be preceded by educating the community so that they may willingly accept the change and actively participate in it for their own benefit.

The response of the non-affected section is more relevant in the case of those who belong to the command area, because they receive the benefit of the project through increased productivity free from drought hazards. The interface in co-

operation between the affected and the non-affected through government agencies, and secondly building up a new social homogeneity in the village which enfolds the new settlers. Experience shows that a non-affected person very unwillingly surrenders a part of his holdings which is least fertile. Again there are instances which new settlers are regarded with aversion. This shows that it is also necessary to educate the non-affected persons, many of them better off due to irrigation availability, towards cultivating the right social attitudes for absorbing the new comers in their environment.

Thus each project has its affected villages and affected population, its non-affected economically better off villages and non-affected population which has a stable traditional background and prospects of seeing better times. The real prospect lies in mutual understanding and co-operation, aided by government policies and measures.

The displaced villagers, despite their sacrifice of traditional home and stable livelihood, take to uncertain, tragic and unstable life, which is called in Marathi as “Upra”. Dam affected villagers have to restart their life in the shadow of uncertainty and anxiety, while many, if not all, benefited villages in the command area continue to live with stable, prosperous and productive irrigated agriculture. With a successful implementation and a plan for rehabilitation and with irrigation projects promoting irrigated farming on a large scale, the shortage of today, may turn tomorrow’s surplus.

In this context it must be ensured that resettlement is done speedily, with adequate compensation, of cash or land or both as the case may be, and even before completion of the dam project. This will demonstrate the will of the government, develop confidence in the displaced people and give them opportunities to start new life at par with the people in the command area.

Drawbacks of Resettlement

The resettlement approach pursued demands no time and resources for planning of some aspects which are fundamental to the satisfactory execution of R and R, especially a detail survey of the submergence area, the identification and enumeration of the people affected directly and indirectly, an estimate of the number of people affected by reservoirs, canals, and other irrigation structures and an assessment of the nature and extent of resources and institutional mechanisms required for resettlement.

It is often experienced that people are normally shifted to resettlement sites at the last minute. The people and the R and R staff are subjected to immense pressure to shift within a period of six months prior to the expected submergence. This creates a situation wherein people do not have any other alternative but to shift. Shifting has to be done irrespective of whether they have received compensation, land, and other benefits, or whether the R and R sites have been prepared with all provisions in place. Thus, once people have shifted, they automatically loose their bargaining power.

Resettlement and rehabilitation is a protracted process. Successful rehabilitation demands the involvement of project personnel for a long period. In the current practice the involvement of people is always brief and ends immediately after shifting, while the resettled require a considerable amount of time to establish a decent livelihood and restructure their social organization in the new setting. Today’s resettlement strategy emphasis is on relocation and not rehabilitation, which requires considerably longer periods of involvement of R and R machinery. According to this strategy, agricultural land, resettlement sites, and manpower for R and R work also has to be located in the same way.

6.6 Environmental Ethics, issues and possible solution

In the oriental culture environmental ethics was always given prominence in daily life from the early times. Although nature was the focus of much nineteenth and twentieth century philosophy, contemporary environmental ethics only emerged as an academic discipline in the 1970s. The questioning and the re–thinking of the relationship of human beings with the natural environment over the last thirty years. This reflected an already widespread perception in the 1960s that the late twentieth century faced a population time bomb and a serious environmental crisis.

Ethics refers to moral principles. An ethic is more than the presence of a basic value. It is also an injunction to action. Environmental ethics inculcates a precious code in the individuals and society. Therefore environmental ethics ought to be developed in each person. Ethics commands an individual from within to make decisions and take actions on the different aspects of Environment, which are not harmful to any community. It also sharpens the judgement of a person not to threaten the health and security of other fellow beings for the sake of material and political gains.

Human beings are competent in science and technology and not as competent in ethics and politics. This incompetence leads to environmental pollution as well as pollution of the mind. Presently there is an environmental debate, conservationist against industrialist and developers, there is no logical consequences of ideas therefore misguided passion, which clouds the conceptual, scientific and ethical issues. As a result it does not contribute either to the human nor environmental well being.

Ethics in the west are individualistic and have brought an

end to human suffering e.g. blacks, women and children and have won equality. Economic prosperity is a result of individualistic ethics whether good or bad. Today the supercilious altitude of acquitance and ruthless behaviours in the name of progress has resulted into domination over and exploitation of the environment. Complication with economics, ethics and science has given emergence to technocratic individualism. Technocratic individualist know the price of everything and the value of nothing, they thus dominate environment and other humans as well, ignoring distributive inequalities. Technocratic individualist also encourage rapid use of environmental resources, therefore today there is lack of sustainability and no permanence.

People forget environmental well being due to greed, selfishness, and insecurity. Thus the best solution is to remember the priorities in life and come down the consumer ladder. The theory of priority is built around 3 classes of goods necessity, enhancement and luxury. Environmental ethics should recognise this and the four senses 1) Among persons (interpersonal equity), 2) Among generations (intergenerational equity) 3) within nations (inter national / regional equity) 4) among nations (international equity).

The famous thinker Schumacher has very well put the idea in few words “If developed nations non-ethically deplete non-renewable resources and distribute them inequitably we are headed for economic and environmental destruction.”

It is very true that one cannot go on living as parasites on future capital which we are in no position to repay, this is violence against nature and will finally lead to violence against human beings. Konrad Lorenz has put it in a different way he says, “No one has the right to overturn an ecological balance which belongs to everyone.”

If today man devastates nature with blind vandalism he is threatening the children with ecological collapse. Although the rhythm of human ecology is determined by technology, technology is no solution, since it is dictated by profit and ignores loss of nature, it does not give time to reflect back on aims. e.g. building of large dams has not solved the problem of water scarcity nor electricity shortage. The root cause being changing attitudes and lifestyles.

Human beings are blind towards what they destroy, what is lacking today is sensitivity and emotionality, the only ray of hope is increased awareness, awareness that leads to ethical actions. Today there is a need for internal revolution of concepts, mentality and relations i.e. "Be more and Not Have more". Be more tolerant, non-violent, conservative, sensitive, optimistic, simplistic etc.

Technocratic Individualism has led to the Tragedy of the commons, which maximises own welfare at the cost of others. There is thus a need for 'Anthropocentric Ethics', which says all human beings, and non- human beings deserve equal respect as equal members of the biotic community.

There is a need for 'Environmental Holism' which rejects over consumption, neo- classical economic values and human centred focus, it challenges the greed, callousness and ignorance which is the basis of human attitudes to nature.

Without ethical moralities environmental ethics are likely to be unworkable due to the multiplicity of problems. Ethical priorities can be classified as duty to recognise strong human rights, duty to protect environmental interest and duty to recognise weak human right.

6.7 Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust

Climate Change

The Earth's Climate is vastly different now from what it was 100 million years ago. Although the changes in Earth's climate in the distiant past were driven by natural causes, such as variations in CO_2 content of the atmosphere and other natural consequences.

Present as well as future climatic changes will probably have another source i.e. human activities. Human can directly or indirectly alter the natural flows of energy enough to create significant climatic changes. The best-known way people could modify climate is by enhancing the natural capacity of atmosphere to trap radiant heat near the Earth's surface i.e. greenhouse effect. This natural phenomenon allows solar energy to reach the Earth's surface and warm the climate. Gases such as water vapour CO_2 trap large fraction of long wavelength radiant energy called terrestrial infrared radiation near Earth's Surface.

This green house effect is responsible for 33^0C of surface warming. Thus, seemingly small human induced changes to the natural greenhouse effect are typically projected to result in a global warming of 1^0C to 5^0C in the next century. This could result in an ecologically significant change.

10 warmest years of this century have all occured in the last 15 years of the 20th Century, of this 1998 was the warmest year on the record.

Dry weather has aggravated forest fires causing huge damage of property and wildlife in France, Spain, Protugal. The snow cover in the Northen Hemisphere and floating ice in the Arctic Ocean have discreased. Globally sea level has risen. Worldwide frequency of extreme rainfall events has increased.

Global warming

Atmospheric concentration of carbon dioxide and other greenhouse gases released by human activities, such as, burning of fossil fuel and deforestation are increasing the Earth's temperature. The mechanism commonly known as the green house effect is what makes the Earth habitable. These gases in the atmosphere act like the glass of green house, letting sunlight in and preventing heat from escaping. But human activities have increased the concentration of green house gases like Carbondioxide, methane, nitrous oxide which also have alterted the chemical composition of atmosphere. The heat-trapping property of these gases is undisputed although how exactly earth's climate will respond to then is not cleared.

Changing Atmosphere

Energy from sun and it's intensity drives the Earth's weather and climate, also heats up the Earth's surface; in turn, the Earth radiates energy back into space. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy.

Whithout this natural 'greenhouse effect' temperatures would be much lower than they are now, and life as known today would not be possible. These greenhouse gases keeps earth's average temperature more hospitable at 30-35^{0}C. But the problem may rise when the atmosperic concentration of greenhouse gases increases.

Along with the industrial revolution, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat trapping capability of earth's

atmosphere. According to scientist the greenhouse gas concentrations are increasing, due to combustion of fossil fuels and other human activities. Plant respiration and the decomposition of organic matter release more than 10 times the CO_2 released by human activities, but these releases have generally been in balance during the centuries leading up to the industrial revolution with carbon dioxide absorbed by terrestrial vegetation and oceans.

In last few hundred years there is additional release of carbon dioxide by human activities. Fossil fuels burned to run cars and trucks, heat homes and businesses and power factories are responsible for about 98% of carbon dioxide emissions, 24% of methane emissions and 18% of nitrous oxide emissions. Increased agriculture, deforestation landfills, industrial production and mining also contribute a significant shore of commissions, decreasing forest and natural vegetation.

Greenhouse Gases -

Greenhouse gases occur naturally in the atmosphere and others result from human activities. Naturally occuring greenhouse gases are water vapor, carbondioxide, methane, nitrous oxide, and ozone. Certain human activities results to add the levels of most of these naturally occuring gases.

Carbon dioxide - is released to atmosphere when solid waste, fossil fuels, coal, natural gas, wood and wood products are burned.

Methane - is from the production and transport of coal, natural gas and oil. It is also emited from the decomposition of organic waste in agriculture, in municipal solid waste, landfills and raising of livestock.

Nitrous oxide - is released during agricultural and industrial activities as well as during combustion of solid waste and fossil fuels. Some are not naturally occuring but very

powerful greenhouse gases are hydro flurocarbons (HFCs), perfluro-carbons (PFCs) and sulfur hexafluroide (SF_6) which are generated from various industrial processes.

The ability of green house gases to absorb heat in the atmosphere differs. Methane traps more than 21 times heat per molecule than carbon dioxide, Nitrous oxide absorbs 270 times more heat per molecule than carbon dioxide. Often estimates of greenhouse gas emissions are presented in units of millions of metric tons of carbon equivalents (MMTCE), which weights each gas by it's GWP value (Global Warming Potential)

Increasing concentrations of greenhouse gases are likely to accelerate the rate of climate change. Experts expect that the average global surface temperature could rise 0.6-2.5^{0}C in the next fifty years, and 1.4-5.8^{0}C in the next century, which will give rise to significant regional variation. Rate of evaporation increases with rise in temperature, which will increase average global precipitation. Soil moisture is likely to decline in many regions and intense rainstorms are likely to become more frequent. Sea level is likely to rise two feet along most of the coasts. Calculations of climate change for specific areas are much less reliable than global ones and it is unclear whether regional climate will become more variable.

The changes in global temperature could introduce new infectious diseases. The crop yield could be affected, the ground water balance may be changed, indirectly effecting the quality of human life; ecosystems.

Acid Rain

Acid Rain includes various ways of acid fall from the atmosphere. In precise term it is known as acid deposition, which is of two forms wet and dry. The wet deposition is acidic rain, fog and snow. This acidic water flows over and

through the ground and it affects on variety of plants and animals life. The strength of effects depend on various factors such as acidity of water, chemistry and buffering capacity of the soils, types and sensitivity of fish, trees and other living things present in the water.

The dry deposition means 'spread of acidic gases and particles. Nearly half of the acidity in the atmosphere falls back to earth through dry diposition. As wind blows these acidic particles and gases deposit onto buildings, cars, homes and trees. These dry deposited gases and particles get washed away from trees and other surfaces by rainstorms, and runoff water adds these acids to the acid rain, making the combination more acidic. Winds blow the compounds that cause both wet and dry acid deposition over hundreds of kilometers. Scientists have discovered that Sulphur dioxide and nitrogen dioxides are primary causes of acid rain. When these gases react with water vapor, oxygen and other chemicals to form various acidic compounds like mild solutions of sulphuric acid and nitric acid.

Effects of acid rain

Acid rain and deposition have many and long lasting effects. It damages the forest, soil, fish and other living organisms in the food chain, materials and human health. Acid rain causes acidification of lakes and streams and causes damage to trees at high elevations and other sensitive forest soils. Acid rain decays paints and material of historical buildings, statues and sculptures that are, part of national cultural heritage.

The effects of acid rain are seen on aquatic environment such as, streams, lakes and marshes. Acid rain flows to streams, lakes, marshes after falling on forests, fields, buildings and roads. It also directly falls on aquatic habitat. Most lakes and streams have a pH between 6 and 8. Acid rain primarily

affect the watershed of lakes. In areas where buffering capacity is low, acid rain also releases aluminium, from soils into lakes and streams which is highly toxic to many species of aquatic organisms.

Acid rain does not directly kill the trees. It weeken the trees by damaging their leaves, limiting nutrients available to them or exposing them to toxic substances slowly released from the soil. As a result of this trees are injured or they are dead. e.g. In Industrialized area of Europe forest and plantation covering large areas have been destroyed.

Dry deposition of acidic particles contribute to corrosion of metals (such as bronze) and the deterioration of paint and stone, such as marble and limestone This reduce the value of buildings, bridges, cultural objects such as statues, monuments, tombstones and cors. The pollutants such as sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) interact in atmosphere to form fine sulphate and nitrate particles. These particles can be easily transported long distance by wind and get inhaled deep into lungs.

The 'Black Triangle' covering area Poland, the Czech Republic and South East Germany is one of the worst acid rain affected areas in the world. If pollution control technologies are used damage from acid rain may be minimised on avaided. e.g. Substitution of low sulfuric fuel. Use of alternative fuel for power plants e.g. burning of natural gas emits less SO_2 than coal burning. Use of catalytic converters to reduce NOx emissions like natural gas powered vehicles, battery powered cars, fuel cells and combinations of alternative fuel for various purposes according to need and can contribute to solve the problem and become part of solution.

Ozone layer depletion

The presence of ozone in the stratosphere is a function of altitude, latitude and season. It is located in between 10 to 50 km above the Earth's surface and contains 90% of all stratospheric ozone. Under normal condition stratospheric ozone is formed by a photochemical reaction between oxygen molecules, oxygen atoms and solar radiation.

Ozone molecule contains three oxygen atoms. It is blue in colour and has strong odour. Normal Oxygen, which we breathe, has two oxygen atoms and is colourless and odorless. Out of each 10 million air molecules, about 2 millions are normal oxygen but only 3 are of ozone. But a small amount of ozone plays a key role in the atmosphere. The ozone layer absorbs the portion of ultraviolet light called UVB. UVB has been linked to many harmful effects, including various types of skin cancer, cataracts and harm to crop and some forms of marine life.

Naturally ozone molecules are constantly formed and destroyed in the stratosphere and total amount remains relatively stable. The ozone concentration vary naturally with sunspot, seasons and latitude. Scientists have established records studying several decades that detail normal ozone level during these natural cycles.

The ozone layer is essential to life on earth. In recent years the thickness of this layer is decreasing. Measurements carried out at Antarctic have shown that at certain times. More than 95% of the ozone concentrations found at altitude between 15 to 20 kms and more than 50% of total ozone are destroyed. This reduction is seen during the winter and early springs. More than 1-2% of ozone levels are decreased by natural phenomenon like sun-spot and stratospheric winds.

Over the past 10-15 years, there has been a large and

unexpected loss of ozone in stratosphere each spring above Antarctica. The ozone concentration has dropped from 320 Dobson units to 200 Dobson units in period 1957-64. Ozone layer is also decreasing from other parts of northen and southern hemisphere along with Antarctica. The rate of degradation of ozone layer is estimated to be around 1% per 10 years. Above northen Europe the decrease is estimated to be about 3.5% per 10 years during winter.

The main cause of ozone layer depletion is the increase stratospheric concentration of chlorine from industrially produced CFCs, halogns . Every chlorine atom destroy upto 100000 ozone molecules. The amount of damage that an agent can do to the ozone layer is expressed relative to that of CFC-11 and is called the Ozone Depletion Potential (ODP), ODP of CFC-11 is 1. The life time of these ozone depleting substances is very long and hence continues to deplete ozone layer.

Aircraft emissions of nitrogen oxide and water vapour add to depletion. Along with this the large volcanic eruptions can have an indirect effect on ozone levels.

Consequences of ozone depletion -

Earth's ozone layer protects all life forms from the sun's harmful radiation. But the degradation of ozone layer due to human induced activities are likely to make following damage -

1. 1% loss of ozone layer tends to 2% increase in UV radiation. Continuous exposure to UV radiation affects humans, animals, plants and can lead to skin problems, depression of immune systems, corneal cataracts.
2. Increased UV radiation may also lead to massive die-off of phytoplanktons and therefore to increase global warming.
3. Ozone is considered as a green house gas. So, reduction

of ozone will reduce green house effect upto some extent. Hence, efforts to tackle ozone depletion may result in increased global warming.

Global Reaction

In 1985, the Vienna Convention was adopted to formalize international co-operation on this issue. Additional efforts resulted in signing of Montreal Protocol in 1987 to reduce the production of CFCs.

Nuclear Accidents and Holocoust

When nuclear accident's occur, radiations spread in the environment and people are injured. In the world already accidents have occured and out of these the two most ill famous nuclear accidents are the Three Mile Island reactor 2 in the United states and Chernobyl reactor 4 in former Soviet Union.

The nuclear holocaust causes mass human mortality. The atom bomb used in the second world war by US on the cities of Hiroshima and Nagasaki killed several thousands of innocent people and completely destroyed the cities. Nuclear holocousts are thousand times more powerful than that 2 bombs. Therefore the potential threat of nuclear holocaust is more than ever.

Nuclear Accidents in the World

Some of the recorded nuclear accidents in the world are given below. However most of the accident cases are not reported due to security reasons or are under reported.

1. 1952 Dec. 12 - Chalk River, nr. Ottawa, Canada - A partial meltdown of reactor's uranium fuel core resulted after the accidental removal of four control rods. Millions of gallons

of radiactive water accumulated inside the reactor. No injuries were reported.

2. 1957 Oct. 7, Windscale Pile No. 1 north of Liverpool, England - fire in graphite - cooled reactor spewed radiation over the countryside, contaminating a 200 squaremile area.

3. 1979, March 28, The three mile nuclear plant, USA - on an island 10 miles away from Harrisburg Pennsylwania the Three mile Island Nuclear Power station.

   Two main reasons are simple human error and the failure of a rather minor value in the reactor. Some radioactive gas and water was released into the river which was drinking water source.

4. South Ural Mountains - explosion of radioactive waste at soviet nuclear weapons factory 12 miles from city of Kyshlym forced the evacuation of over 10,000 people from a contaminated area. No casualities were reported.

5. 1986 April 26, Chernobyl, nr. Kiev, Ukraine - Explosion and fire in the graphite core of one of four reactors released readiooctive material that spread over part of soviet Union. Eastern Europe, Scandinavia and later Western Europe. Total casualties are unknown worst such accident to date.

6. 1999 Sept. 30, Tokaimura, Japan. Uncontrolled chain reaction in uranium - processing nuclear fuel plant spewed high levels of radioactive gas into the air, killing two workers and seriously injuring one other.

World Health organisation has found that the radiation released from Chernobyl accident was 200 times than that of the Hiroshima and Nagasaki nuclear bombs combined. According to Ukrainian Radiological Institute, over 2500 deaths

resulted from the Chernobyl incident. WHO has found a significant increase in Cancer. The rate of thyroid cancer is particularly high. One of the greatest tragedies of accidents was that Soviet Union tried to keep the incidents overlooked.

Usually there are strict precautionary measures in nuclear plants but some times normal safty guidelines are overlooked and accident occur. Most accidents of this type are result of many small mistakes adding upto create a catastrophe.

6.8 Wasteland reclamation

According to land utilization pattern in India, 47 percent of the total land area is under agriculture, 22.8 per cent under forest cover and 11.6 per cent and 11.6 per cent is barren and uncultivable. But, of this total land of 320.7 million hectares, at least half is degraded. Productivity of this land is far below its production potential. Also some of the forest land is also being degraded and now can be added into the category of early wasteland.

A total of about 145 million hectares of the total uncultivated land account for degraded land. Out of this, 40 million hectares is forest lands and 95 million hectares is pasture, grazing lands and other uncultivated lands. Approximately, 73.6 million hectares land has become wasteland due to water erosion. On the other hand, the country is deficit in fuelwood and fodder. The total fuelwood requirement is of about 133 million tonnes and the recorded production of fuelwood from the forests is about only 39 million tonnes. Besides, fodder demand is around 700 million tonnes and the supply is of 540 million tonnes. This gap needs to be and can be filled by developing the wastelands for both, raising the fuelwood and producing the fodder. In this view, the wastelands offer greater scope for development in the country.

Concept of wasteland

Wasteland is defined as the land which is degraded and is presently lying unutilised except as current fallows due to different natural or human dominated constraints. In simple terms, the barren land or the land which has become unproductive is referred as wasteland.

Wastelands could be considered as those lands which are unutilised, partially utilised or mismanaged for any productive purposes. With increase in total wasteland, the environment becomes unstable and the natural balance gets disturbed. Therefore there is an urgent need to ensure environmental stability and ecological balance. Both these factors are vital for security and human survival along with the survival of all other life forms.

Classification of Wasteland

All the areas or lands that are degraded and presently lying unutilised except as current fallows due to different constraints are considered as wastelands. These wastelands are classified into two classes as culturables wastelands and non-culturables wastelands. In India, out of total 54.771 Million hectares of wasteland, 32.842 Million hectares is cultivable and 21.929 Million hectares is non-cultivable.

Wasteland could be either state or under private occupation or notified forest area that is not yielding the desired production.In the country, a large area is not yielding the desired rate of production due to different factors like soil erosion, salinity, water logging, shifting cultivation, etc. Such damage to the land caused is of permanent nature at many places. The pressure of increasing population on limited productive lands is ever increasing. The consequent reduction of land-man ratio is making it imperative to launch a developmental programme

for these lands to meet the end objectives of self-sufficiency in food, fodder, timber and ecological balance by undertaking different initiatives.

Cultivable Wastelands

All the lands available for cultivation whether not taken up for cultivation or taken up for cultivation once but not cultivated during the current year and for last five years or more in succession are included in this class. These lands are either fallow or covered with shrubs, herbs or woodland, but are not put to any use. These shrubs, herbs or other vegetation in culturable wasteland depends on relief, depth of soil, physio-chemical characters of soil, soil qualities, rainfall, average humidity, supply of nutrient and the climate etc.

a) **Gullied land:-** This land is formed due to localised surface run-off, resulting in percepitible channels with the formation of undulating terrain.

b) **Ravinous land:-** It is a network of gullies formed in deep alluvium entering a nearby river, flowing much lower than the surrounding table lands. Ravinous land is classified for operational purpose into three categories as shallow (3-6 mts.), medium (6-9 mts.) and deep (more than 9 mts.) ravinous land.

(c) **Undulating upland with or without scrub:-** The land prone to degradation and may or may not have shrub cover is referred as Undulating upland with or without scrub. Generally, this land topographically occupies high location and excludes hilly and mountainous terrain.

(d) **Surface water-logged land and marsh:-** If on a region the water is near the surface and it stands for most of the year, such land is referred as surface water-logged land and marsh. It excludes the land with water bodies having open surface like lakes, ponds and tanks.

The land which is permanently or periodically inundated by water and is characterised by specific vegetation which include grasses and reeds is called as marsh. Such lands are classified into salt, brackish and fresh water categories, depending upon salinity of water.

(e) **Salt affected land** *:* The lands are characterised by excess presence of soluble or exchangeable salts like sodium salts, calcium salts, magnesium salts or potassium salts which have adverse effects on the growth of plants. These salts largely contribute soil salinity.

(f) **Shifting cultivation area** *:* The land in the mountain regions formed due to felling of trees and burning of forest areas for growing crops on the slopes and such activity is shifted year to year is referred as shifting cultivation. Shifting cultivation leads to extensive soil losses resulting in degraded land or wasteland.

(g) **Degraded forest land** *:* The land with various types of destructed forest covers or having reduced vegetation cover of less than 20 per cent of canopy cover is referred as degraded forest land.

(h) **Degraded grazing land** *:* The cattle or any domesticated animal grazing lands that have become degraded due to lack of proper soil conservation and drainage measures or the areas in practice as grazing grounds are included under this category.

(i) **Degraded non-forest plantation land***:* The lands which have not been utilised up to their maximum capacity for any purposes are referred as degraded non-forest plantation lands.

(j) **Strip lands***:* These are narrow strips of land on either side of transportation networks and canal bunds which

are hospitable for growth of vegetative cover and are referred as strip lands.

(k) **Sands***:* These areas that have been stabilised by the accumulation of sand in coastal or inland areas are referred as sands.

(l) **Mined and industrial wastelands** *:* The large-scale mining operations bring about degradation of land and result in mine dumps or overburdens. Such lands are mining wastelands. The lands where large-scale degradation is caused by large-scale industrial effluent discharges is called as industrial wastelands.

Unculturable wastelands :

Lands, which have no capacity to develop natural vegetative cover, are defined as unculturable wastelands. Most of these are difficult to bring under cultivation. There are three types of unculturable wastelands. i.e. barren, rocky or stony wasteland or sheet rock area; steep sloping area; and snow covered or glacial area.

Major causes leading to wasteland :

The lands are converted into the wastelands due to various reasons. Following are some of the main reasons.

- Due to increasing population pressure agricultural expansions is taking place. It is leads to deforestation for additional agriculture land. As a result, soil erosion is increasing and the quality of soil is decreasing.
- The cattle grazing is unplanned and ever increasing in the country. The uncontrolled grazing by less productive livestock is leading to increased total wasteland area.
- There is growing demand for fuel wood in the country. The large scale cutting of trees for fuel wood purpose has increased the rate of deforestation and tremendous

increase in wastelands.

- Shifting cultivation is another major reason for increasing wastelands in the hilly regions. Shifting cultivation does not only lead to the destruction of trees, but causes serious soil erosion and degradation of natural ecosystems.
- Various developmental activities like mining and road development are also leading to the wastelands due to disposal of tailing and other activities like excavation works.
- Pattern of monoculture in agricultural practices many times makes the land deficient in nutrients and the land becomes a wasteland.
- Excess use of fertilizers and excess irrigation also has resulted into the saline lands and finally, into the agricultural wastelands.

Methods of wasteland reclamation:

The wastelands, if not totally damaged, can be reclaimed by number of ways. The root causes of wasteland formation need to be understood before initiating reclamation work. There are several mechanical, biological and chemical treatment methods of soil reclamation. The wastelands can be reclaimed by breaking the surface cover of the wasteland and aerating it to support the flora. Some times, the chemicals like calcium sulphate is used to reclaim the wasteland. If available, the carbonaceous matter is used to reduce the salinity of the soil to reclaim it. Various programmes like social forestry can help to protect the land from further erosion and help to reclaim the soil. Finally, if protected, different natural ecosystems develop on their own and help in the development of wastelands into usable fertile lands.

The unculturable or culturable wastelands can be brought under tree cover, provided they are properly treated with the

help of appropriate technology. The suitable vegetation may be selected to adopt the local conditions like local soil, moisture, local needs and climatic conditions. Such efforts can help to cure the wastelands. In selecting these species, one should take extra care that the species planted will not cause further ecological damage. Local people's initiative must be considered to find out the most appropriate form of vegetation as per their needs and experience.

The concept of social forestry has emerged to protect further degradation of wastelands and to improve their conditions. The main purpose of social forestry is for the production of fuelwood and timber besides provision of grazing, supply of grasses and fodder, thorns for fencing, protection of agricultural lands against erosive action of wind and water etc. Under this concept, various programs are included. These are raising of trees on bunds; wind breaks; preventing wind erosion; increasing leaf fodder; and releasing cow-dung as manure.

Such artificially developed, properly conserved and managed areas or plantations, not forests, can be an asset to our agricultural production. Shelter belts can effectively reduce the adverse effects of wind erosion, hot and cold waves, snowdrifts, frosts, etc. They are effective measures to reduce evaporation, increase carbon assimilation, help plant growth, raise water-table, improve soil moisture and rainfall. The trees grown are useful for sericulture, paper-making, sports goods and basket making. Also dense trees and fruit cum-timber trees like mango, jackfruit are preferably planted near wells, tanks, and other residential areas. Social forestry can be practised along the banks of canals, railway lines, school yards, community grounds, and roadside. The state forest department and agricultural universities can provide institutional help and infrastructure for undertaking the

programs for raising such plantations with the help of students and local youth at the grass root level.

Action plan and efforts by government :

The local governing bodies like Panchayat, and for wasteland development at different levels, the Central and State Governments can provide technical guidance and financial assistance. Different government, semi-government and self-government agencies and institutions like schools, colleges, agricultural universities, forest research institutes, etc. can play a vital role in the initiative. The NSS, NCC, NGOs, ex servicemen etc. can play a crucial role in the wasteland development programmes on a campaign basis. The target of the programme should be time bound, intensive and result oriented. Local people's participation at every stage and every level be consciously encouraged in promoting reclamation of the wastelands.

Voluntary action

National Wasteland Development Board has a scheme of grant-in-aid to enlist the help of non-governmental organizations (NGOs). With the help of NGOs, the wasteland development and reclamation programme can be launched and successfully implemented in a decentralized manner. Most of these organisations work at grass root level in the society and have detailed knowledge of local conditions. The social workers, working with such organisations, can play key role and have close relationship with faith and regional affection for development.The voluntary action by these non-government organisations can be a successful experiment in wasteland development programme. Some local and regional NGOs in Maharashtra have done exemplary work in the field of water conservation, wasteland development, forest protection and nature conservation. However, this work should be replicated to achieve multiplier effect.

6.9 Consumerism and waste products

Consumerism

Today it is often true that increase in effluence is directly proportionate with the increase in the waste generation. The life styles of the present generation have been influenced to a great extent by consumerist attitudes, where every one wants the best of everything at any cost. This self-centred attitude is the root cause of the environmental problems and social unrest in the society. As we adopt the use and throw culture it is bound to affect the social fabric of the society as very few can actually sustained these life styles.

Waste products

In nature there is nothing like wastage. Every material is recycled naturally and reused by organisms at different trophic levels. The concept of waste is in human culture. product but in human society the things which are not of direct or indirect use are considered wastes or by products.

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Chapter : 7

Environmental Protection

7.1 Introduction

Environment and development are inter-related and interdependent to each other. But the fact is that for any developmental activity, there is always loss valuable natural resources. At the same time, the problems like pollution and population growth are increasing the seriousness, of the issue.

In recent time, awareness about environmental protection is increasing day by day. Environmental Legislation has attained great importance for solving many environmental problems. At the international level, many conferences, workshops are being held for these purposes. Stockholm conference in 1972, Earth summit in 1992, Johanesburg conference in 2002 are some of the steps taken by the world towards sustainable development. In India also many legislative measures are taken for environmental conservation. According to section 48A, every state must protect and conserve their environment Under section 51 A(g), many fundamental duties are provided for Indian citizen. Many important legislative provisions for environmental conservation are as follows :

1. Environmental (Protection) Act, 1986.
2. Air (Prevention and Control of pollution) Act, 1981
3. Water (Prevention and Control of pollution) Act, 1974
4. Wildlife (Protection) Act, 1972.
5. Forest (Conservation) Act, 1980.

7.2 Environment Protection Act, 1986

'Environmental studies' is of vital concern in recent times. Right from mothers womb, one needs unpolluted air to breath, uncontaminated water to drink, nutritious food to eat and hygienic condition to live in. These elements are very essential for the sound development of human personality. On the contrary, in the name of development and progress through industrial, scientific, technological and agricultural resolution, environment is being affected day by day. As a result of this, we are facing various problems like global warming, acid rain, increasing air and water pollution, degradation of natural resources etc.

In recent time, with the increasing concern for the protection of environment, the subject of 'Environmental Legislation' has attained great importance all over the world. Many international organisations, NGOs, institutions are working with the same objectives at international level. UNO is carrying out various discussions, conferences to bring the attention of the world on vital issues of environment protection. From Stockholm Conference in 1972, Earth Summit in 1992, Johanhesburg Conference in 2002, all the developed, developing and underdeveloped countries are involved in evolving a global environmental governance to control, resolve and monitor the environmental problems.

In our country, the Government of India has made number of efforts for protection of environment through govt. policies and legal enactments. The Indian Parliament has enacted many acts for protecting its natural resources, air, water and soil, wildlife, biodiversity, mineral resources etc.

1. Environment Protection Act, 1986

Environment protection Act was enacted for the protection and improvement of environment and for matters connected there with. Prevention of hazards to human beings, other living creatures, plants and property was the basic idea for the protection and improvement of environment.

As per the declaration at the United Nations Conference on the Human Environment held at Stockholm is June 1972, India being a participant, Indian Parliament took a vital step by enacting Environment Protection Act, 1986. The Act received on 23 May, 1986 and it was published in the Gazette of India on 26 May, 1986. This Act become effective from 19th Nov. 1986. This Act is superior to earlier legislations especially Water (Prevention and Control of Pollution) Act, 1974 and Air (Prevention and Control of Pollution) Act, 1981, with respect to overcome the drawbacks in tackling environmental problems.

As per the amendment of Environment (Protection) Rules 1986 vide G.S.R. 1063 (E), on 26th Dec. 1989, a new schedule for ambient air quality standards in respect of noise pollution was inserted.

The Environment Protection Act has 4 Chapters containing 26 Sections.

- Section 1 and 2 include preliminary information
- Section 3 to 6 deal with general powers of Central Govt.
- Section 7 to 17 deal with the prevention, control and abatement of pollution.
- Section 18 to 26 deal with miscellaneous provision.

2. Definitions :

■ Preliminary information :

The Environment (Protection) Act, 1986 extends to the whole of India Section 1 of this Act deals with its short title,

extent and commencement. Section 2 deals with various definitions under the Act. Following are the major terms defined in the Act.

a) 'Environment' - includes water, air and land and the interrelationships which exists among and between water, air and land and human beings, other living creatures, plants microorganism and property.

b) 'Environmental pollutant - means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be injurious to environment.

c) 'Environmental pollution' - means the presence in the environment of any environmental pollutant.

d) 'Handling' in relation to any substance, means the manufacture, processing, treatment, package, storage, transportation, use, collection, destruction, conversion, offering for sale, transfer or the like of such substance.

e) 'Hazardous substance' means any substance or preparation which by reason of its chemical or physico chemical properties or handling is liable to cause harm to human being, other living creatures, plant, micro-organisms, property or the environment.

f) 'Occupier' is relation to any factory or premises, means a person who has control over the affairs of the factory or the premises and includes in relation to any substance the person is possession of the substance.

3. General powers of the Central Government

Section 3 to 6 of chapter two of this Act deal with general powers of the Central Government in matters relating to protection and improvement of environment and prevention, control and abatement of environment pollution. As per Section 3 (2), powers are given to the Central Government to take

necessary measures with respect to all or any of the following matters namely.

- To plan and execute a nation-wide programme for the prevention, control and abatement of environment pollution.
- To lay down standards for the quality of environment in its various aspects.
- To lay down standards for emission or discharge of environment pollutants from various sources.
- To restrict any industries, their operations or processes if these are polluting the environment and secure that these operations and processes shall not be carried out or shall be carried out subject to certain safeguards.
- To lay down procedures and safeguards for the prevention of accidents which can cause environment pollution and remedial measures for such accidents.
- To lay down procedures and safeguards for the handling of hazardous substances.
- To examine manufacturing processes, materials and substances which are likely to cause environmental pollution.
- To carry out and sponsor investigations and research relating to problems of environmental pollution.
- To inspect any premises, plant, equipment, machinery manufacturing or other processes, materials or substances.
- To establish or to give recognition to environmental laboratories and institutes.
- To collect and disseminate information in respect of

matters relating to environmental pollution.

- To prepare manuals, codes or guides relating to the prevention, control and abatement of environmental pollution.

Section 4 of this Act deals with appointment of officers and their powers and functions. Section 5 of this Act deals with power to give directions to any person, officer or any authority. These directions include the power to direct for (a) the closure, prohibition or regulation of any industry, operation or process or (b) stoppage or regulation of the supply of electricity or water or any other service.

As per section 6, the Central Government can make rules related to standards of quality of air, water or soil, maximum allowable limits of concentration of various environmental polluttants for different areas, handling of hazardous substances, location of industries and prevention of accidents, for the regulation of environmental pollution and can make applicable by publication of requistite notification in the Official Gazette.

4. Prevention, Control and Abatement of Environmental Pollution :

Chapter III of this Act is its section 7 to 17 deals with prevention, control and abatement of environmental pollution. Following are the major legal provisions under this chapter.

- As per section 7, persons carrying on industry, operation etc. are not allowed to emit or discharge environmental pollutants in excess of the standards.
- Section 8 lays down that persons handling hazardous substances are required to comply with procedural safeguards.

- Section 9 lays down that if any industry discharges excess environmental pollutant then it is the duty of the person having control over the affairs of the industry to furnish information to authorities or agencies.
- Section 10 lays down that subject to the provisions of this Act, any person empowered by the Central Government to enter into any premises for the purpose of performing any of the functions of the Central Government entrusted to him or for the purpose of examining and testing any equipment, plant, records registers, document etc.
- As per section 11, the authority competent under this Act or any officer empowered by the Act shall have power to take samples in a prescribed manner.
- As per section 12, these samples need to be send to the environmental laboratories established or recognised by the Board for analysis.
- As per Section 13, this analysis is to be carried out by the government analyst who is appointed by the Central Government.
- As per section 14, any report signed by a Government analyst may be used as evidence of facts in any proceeding under this Act.

5. Punishment Provisions

As per sections 15 to 17, there are several stringent punishment provisions in the Act. According to section 15 (1), whoever fails to comply with any of the provisions of this Act, he is liable for the punishment with imprisonment extendable to five years or with a fine maximum up to Rs. 1,00,000/- or with both. In case the failure or contravention continues with additional fine with may extend to Rs. 5,000/- for every day during such failure or contravention continues after the

conviction for the first such failure or contravention. According to section 15 (2), if the failure or contravention continues beyond a period of one year after the date of conviction, the offendes shall be punishable with imprisonment for a term which may entend to seven years.

According to section 16, if any offence under this Act has been committed by a company, every person, who at the time the offence was committed, was directly incharge of and was responsible to the company for the conduct of the business of the company, as well as the company, shall be deemed to be guilty of the offence and liable to be proceeded against and punished accordingly. However, if a person proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence, then he is not to be held liable to any punishment.

According to section 17 (1), if any offence under this Act has been committed by any Government Department, then the Head of the Department is to be held guilty of the offence and liable to be proceeded against and punished accordingly. But if the concerned Head proves that the offence was committed without his knowledge or that he has exercised all due diligence to prevent the commission of such offence, then he is not held liable for any such punishment.

But as per section 17 (2), if the offence has been committed by a Department and it is proved that the offence has been committed with the consent of or is attributable to any neglect on the part of any officer other than Head of Department, such officer will be guilty of offence and liable to be proceeded and punished accordingly.

6. Miscellaneous provisions :

Chapter IV of the Act including sections 18 to 26 lay down miscellaneous provisions of this Act. According to section

18, no suit, prosection or other legal proceeding would lie against the Government or any officer or other employee of the Government, in respect of anything which is done in good faith in pursuance of the Act or the rules made or orders or directions issued there under.

According to section 19, the court is not empowered to take cognizance of any offence under the Act except on a complaint made by the competent authority of the Government or by a person who has served a notice of 60 days to file the complaint against the polluter.

According to section 20, the Central Government is empowered to obtain any information, reports or returns etc from any competent/prescribed authority for performing its functions.

As per section 21, all members, officers and employees appointed under the Act are deemed to be public servant within the meaning of section 21 of the Indian Penal Code, 1860.

According to section 22, no civil court is empowered to entertain any suit or proceeding in respect of anything done under this Act. As per section 23, Central Government is empowered to delegate its powers to the competent authority. As per section 25, Central Govt is empowered to make rules for carrying out the purposes of this Act. As per section 26, these rules are required to be laid before parliament for approval before making them applicable.

7.3 The Air (Prevention and Control of Pollution) Act, 1981

The day by day increasing 'Air Pollution' is indeed very complicated problem before man. Especially, in most of the Indian cities air pollution is a major problem. Air pollution is injurious to human beings or other living creatures a plants or property or environment.

With this background, India participated at United Nations conference on Human Environment held at Stockholm (Sweden) in June 1972, India being a signatory to this conference, Indian Government is bound to keep control on air pollution. As agreed in the conference, the Indian Government is not only bound to take appropriate steps for the presentation of the natural resources of the Earth but also for the preservation of the quality of air and control of air pollution.

With this object, the Parliament of India enacted the Air (Prevention and control of Pollution) Act, 1981 for the prevention, control and abatement of air pollution. This Act came into force on 30th March 1981.

1. The Air (Prevention and Control of Pollution) Act, 1981

The main objective of this Act is prevention, control and abatement of air pollution and to take appropriate steps for the prevention and control of pollution.

This Act covers all the major industries which are likely to pollute the air. The industries covered under Air (Prevention and Control of Pollution) Act, 1981 are mainly, asbestos and asbestos product industries, cement and cement products industries, ceramic and ceramic product industries, chemical and allied industries, coal and lignite based chemical industries, engineering industries, ferrous, metallurgical industries, fertilizers industries, foundries, food and agricultural products industries, mining industry, nonferrous metallurgical industries, ores/mineral processing industries, power (coal, petroleum and their products) generating plants and boiler plants, paper and pulp (including paper products) industries, textile processing industries, petroleum refineries, petroleum products and disposal of wastes, plants for recovery from petrochemical industries and incinerators etc.

As per the amendment in 1987, this Air (Prevention and control of Pollution) Act, 1981 includes following provisions.

This Act includes 54 sections divided into seven chapters.

- Section 1 and 2 include preliminary infermation.
- Section 3 to 15 deal with matters of Central and State Boards
- Section 16 to 18 deal with powers and functions of Boards.
- Section 19 to 31 deal with prevention and control of air pollution.
- Section 32 to 36 deal with Funds, Accounts and Audit.
- Section 37 to 46 deal with penalties and procedure
- Section 47 to 58 deal with miscellaneous provisions.

2. Definitions

Preliminary - The Air (Prevention and control of Pollution) Act, 1981 extends to whole of India.

Section 1 deals with the extent and commencement. Section 2 includes various definitions the terms like air pollutant, air pollution, approved appliances, automobile, Board, chimney, emission, control equipment, industrial plant, member, occupier, etc are defined. Following are the major terms defined in the Act.

(Section 2a) - "Air pollutant" means any solid, liquid or gaseons substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.

(Section 2b) - "Air Pollution" means the presence in the atmosphere of any air pollutant.

(Section 2d) - "Approved fuel" means any fuel approved by the State Board for the purpose of this Act.

(Section 2f) -"Board" means the Central Board or State Board.

3. Provisions relating to the prevention and control of air pollution.

Chapter 2, section 3 to 15 deal with matter related to Central and state Boards for prevention and control of pollution. The Central Board for the Prevention of Water Pollution constituted under Section 3 of the Water (Prevention and control of Pollution) Act, 1974 has been also considered competent to perform the functions and exercise the powers of Central Board for the Prevention and control of Air Pollution, as per Section 3 of this Act.

Similarly, as per section 4 of the Act, the State Boards constituted under the said Water Act have been authorised to preform the functions of state Boards in respect of prevention control of air pollution. As per section 5, the State Board to be constituted under the Act is same as mentioned in Water Act, section 3. As per section 6, no State Board is constituted for a Union territory separately. The Central Board is empowered to exercise the powers and perform the functions of a State Board under this Act for the Union territory.

Section 7 to 15 of this Act deals with, the terms and conditions of service of State Board members, disqualification for appointment as member of the state Board, vacany, meetings of Board, constitution of committees by the Board, temporary association of persons with Board, Member-secretary and officers and other employees of state Board and delegation of powers etc. Maharashtra Pollution Control Board (MPCB) is constituted under this Act and is working for the prevention, control and abatement of pollution in the state.

4. Powers and functions of Pollution Boards (Secs. 16 to 18)

The Chapter III, Sections 16 to 17 deals with powers and functions of the Boards. Section 18 deals with the power of the Central Govt. and Central Board to give directions. The Central and State Boards have to perform the following functions as specified in Sections 16 and 17.

Advisory and scientific functions : To advice, plan and execute nation-wide programme, provide technical assistace and guidance, carryout investigation and research, plan and organise the training of persons, organise through mass media comprehensive programmes.

Administrative functions : To collect, compile, and publish technical and statistical data prepare manuals, codes or guides regarding prevention, control and abatement of air pollution.

Technical and Executive functions : To lay down standards for quality of air and to establish or recognise laboratories for aforesaid purposes.

5. Prevention and Control of Air Pollution

Chapter IV of this Act, in sections 19 to 31 deals with Prevention and control of Air Pollution, Section 19 gives power to the State Government for the prevention and control of Air pollution by empowering for declaring any areas within the State as air pollution Control areas for the purpose of this act. As per section 20, the state government is also empowered to give instruction to the authority concerned with vehicular pollution control for ensuring standards for emission of air pollutants from automobiles.

As per Section 21, restrictions are imposed on the use of certain industrial plants in an air pollution control area. Section

22 prohibits any discharge of air pollutants in excees of the standards specified by the state Board. As per section 22-A, the Board may make an application to a court for restraining any person from causing air pollution in any air pollution control area. As per section 23, if there is excess release of pollutants in pollution control area, the concerned person will have to furnish such information to the State Board and other agencies in certain cases as a part of his duty.

As per section 24, the State Board is empowered with to confer upon any person a right to enter into any place of industry of or other places for the purpose of performing any of the functions of the Board assigned to him. As per section 25, state board or any officer empowered by it may obtain information and asper section 26, can take samples of air or emission etc. As per section 28, such samples are then to be sent to the State Air laboratory for analysis. As per section 29, the reports of this analysis is to be signed by authorised analyst. As per section 30, these reports may be used as authentic evidence under this Act.

As per section 31, any person by an order made by State Board may make an appeal to the Appellate Authority within a period of 30 days from the date of such order. As per the provisions of Section 31-A, as a part of immediate measure, the Act empowers the Central Government to direct for the closure, prohibition or regulation of any industry, operation or stoppage or regulation of supply of electricity, water or any other service.

Chapter V containing sections 32 to 36 are related with Funds, Accounts and Audit. Section 32 deals with contribution by Central Government, section 33 deals with fund of Board, Section 33A, deals with borrowing powers of Board, Section 34 deals with budget, section 35 deals with annual report section 36 deals with accounts and audit of Boards etc.

6. Penalties and procedure

Chapter VI of the Act in sections 37 to 46 deals with the provisions of penalties and procedure. As per section 37, any person failing to comply with the provisions of section 21 or section 22 or with orders of directions issued under section 31-A, is liable for the punishment with imprisonment for a term not less than one year and six months which may extend to six years and with fine. As per section 37 (1), in case such failure continues, the punishment of an additional fine can be imposed. Such fine can be extended to Rs. 5,000/- for everyday, during the period such failure continues after conviction for the first such failure. As per section 37 (2), the offenders may be punished with the imprisonment for a term not less than 2 years which may extend to 7 years and with fine if such failure continues beyond a period of one year after the date of conviction.

Section 38 provides for the punishment with imprisonment for a term which may extend to three months or with fine which may extend to Rs. 10,000/- or with both to any person, if he destroys, pulls down, removes, injures or defaces any pillar, post or stake fixed in the ground or any notice or obstructs any person or damages any works or property belonging to the Board. As per section 39, if a person contravenes any of the provisions of this Act, for which no penalty has been provided in this Act, then such person is to be punished with imprisonment for a term which may extend to three months or with a fine which may extend to Rs. 10,000/- or with both. In case of continuing contravention, the punishment with an additional sum which may extend to Rs. 5,000/- for everyday during such contravention if continues after conviction for the first such contravention.

As per section 40, if an offence is committed by any company under this Act, then every person who is incharge of

the company at the time and the company itself, is deemed to be guilty of the offence and liable to be proceeded against and punished accordingly.

As per section 41, if any Department of Government Committe such offence then, the Head of that Department is liable for punishment. As per section 42, if any act is done in good-faith or intended to be done in good faith under this Act then no suit, prosecution or other legal proceeding shall lie against these authorities. As per section 43, the court is competent to take cognizance of any offence under the Act, only on a complant made by or with the Previous sanction is writing of the State Board. As per section 44, all the members, officers and employees of the Board are treated as public servants within the meaning of section 21 of Indian Penal Code, 1860.

As per section 45, Central and state Boards are to furnish reports and returns accounts, to the Central and State Govt. respectively. As per Section 46, no suit or proceedings can be initiated in any civil courts in respect of any matter for which the Appellate authority empowered to determine any dispute is constituted under this act.

7. Miscellaneous provisions

Chapter VII including sections 47 to 54 contains miscellaneous provisions. Sec. 47 is related to power of Central Govt. to supersede State Board. Sec. 48 deals with special provisions in case of supersession of Central Board or the State Board. Sec. 49 deals with dissolution of State Boards. Sec. 51 deals with maintenance of Register, sec 52 deals with effect of other laws and section 53, 54 deals with powers of Central and State Govt. respectively to make rules. These powers are effective in controlling the air pollution to the great extent.

7.3.3 The Water (Prevention and Control of Pollution) Act, 1974

The problem of water pollution has special significance in Indian context. There were various acts passed in past in concerned with the prevention of water pollution in the different states. The shore nuisance (Bombay and Kulaba) Act of 1853, The Serais Act of 1867, The Indian Fisheries Act of 1897, The Orisa River Pollution Act of 1953 and The Maharashtra (Prevention and Control of Pollution) Act of 1967 are a few of them. The special Act to deal with the problems of water pollution was enacted by the Indian parliament in year 1974. The Act came into force on 13 March, 1974. The short title of the Act is The Water (Prevention and Control of Pollution) Act, 1974.

Objectives of the Act: The Act has been passed to achieve the following objectives

- To prevent and control the water pollution and maintain or restore the wholesomeness of water.
- To establish Central and State Boards for the prevention and control of water pollution.
- To confer on and assign powers and functions to such Boards on the matters of water pollution and to provide penalties for the contravention of the provisions of the Act.
- To establish Central and State water testing laboratories to enable the board to assess the extent of pollution and lay down standards and establish defaults.

Applicability of the Act

The Act is applicable to all the states who adopted it under 252(1) of the constitution. Many states passed resolution under Art. 252(1) and requested the Parliament to enact a law for prevention and control of water pollution as the subject of water pertain to State list. Consequently, the Indian

parliament enacted the Water Act as The Water (Prevention and Control of Pollution) Act, 1974.

There are 64 sections in the Act. These are divided in 8 chapters. The first chapter of the act contains preliminary information on the application and commencement of the Act. Section 2 of this Act defines the major terms like occupier, pollution, State Board, Central Board, Sewage effluent which are likely to be frequently used with reference to the subject matter.

Constitution of Central Board

Chapter II of the act in its 3 to 12 deals with the constitution of Central and State Boards, the terms and conditions of the services of the members, disqualification, holding of board meetings and constitution of other committees. Constitution of Central Pollution Control Board has been described in Section 3. According to Subsection 2 of Section 3 the Central Board shall consist of the following members.

a. A full-time Chairperson who is having special knowledge or experience in environmental protection.

b. The officials not exceeding five, to be nominated by the Central Government as representatives.

c. The persons not exceeding five from amongst the members of the State Boards, nominated by Central Government.

d. The representatives not exceeding three from agriculture, fishery, trade or industry to represent the interest of these fields.

e. The persons not exceeding two to represent companies or corporations owned, controlled or managed by Central Government.

f. A full-time member secretary having special knowledge, qualification and experience of scientific, engineering or management aspects of pollution control to be appointed by Central Government.

Constitution of State Boards

Constitution of State Pollution Control Board has been described in Section 4. It has been cleared that the Central Board shall exercise the powers and functions as state board for Union Territory. According to Subsection 1 of Section 4 the State Board for each state shall consist of the following members.

a. A full-time Chairperson who is having special knowledge or experience in environmental protection or in administering institutions dealing with this matter.

b. The officials not exceeding five, to be nominated by the State Government as representatives.

c. The persons not exceeding five from amongst the members of the local authorities functioning within the State nominated by State Government.

d. The representatives not exceeding three from agriculture, fishery, trade or industry to represent the interest of these fields.

e. The persons not exceeding two to represent companies or corporations owned, controlled or managed by State Government.

f. A full-time member secretary having special knowledge, qualification and experience of scientific, engineering or management aspects of pollution control to be appointed by State Government.

Constitution of Joint Boards

Section 13 of this act provides for the constitution of Joint Boards. According to Section 13, two or more states or Union Territory or Union Territories can constitute a Joint Board with an agreement for a specific period.

Composition of Central Pollution Control Board has been described in Section 14. Each participating State Government nominates their officials and the Central Government nominates its officials on behalf of the participating Union Territories. According to the provisions in Section 14 the Joint Board shall consist of the following members.

a. A full-time Chairman who is having special knowledge or experience in environmental protection, to be nominated by Central Government.

b. The officials not exceeding two from each participating states, to be nominated by the respective State Governments to represent those governments.

c. One person from amongst the members of the local authorities functioning within each of these states, nominated by participating Government.

d. One representative to represent the interest of agriculture, fishery, trade or industry as non-official member from each participating State.

e. Two persons to represent companies or corporations owned, controlled or managed by participating State Governments.

f. A full-time member secretary having special knowledge, qualification and experience of scientific, engineering or management aspects of pollution control to be appointed by Central Government.

Powers and Functions of Central Board

The functions of the Central Board are embodied in Chapter IV of this act. The main function of the Central Board is to promote the cleanliness of streams and wells. According to Section 16(1) of this act, Central Board may perform the following functions:

a. Give advice to the Central Government on any matter concerning the prevention and control of water pollution.

b. Co-ordinate the activities of the State Boards and resolve the disputes among the states.

c. Provide technical assistance and guidance to the State Boards and sponsor investigations and research for the prevention, control or abatement of water pollution.

d. Plan and organise the training of persons engaged in prevention, control or abatement of water pollution.

e. Organise through mass media a comprehensive programme for the prevention, control and abatement of water pollution.

f. Perform the functions of State Boards where as specified in the directions passed under 18(2).

g. Collect, compile and publish technical and statistical data relating to water pollution.

h. Lay down the standards for a stream or well.

i. Plan and organise nation-wide programme for the prevention and control of water pollution.

j. Establish the laboratories or give recognition to the existing laboratories for the purposes of Board.

Functions of State Board

The functions of the Central Board are embodied in Chapter IV of this act. According to Section 17(1) of this act, State Board shall perform the following functions:

a. Plan a comprehensive programme for the prevention, control or abatement of water pollution of streams and wells in the state.

b. Give advice to the State Government on any matter concerning the prevention and control of water pollution.

c. Collect and disseminate information relating to water pollution and prevention, control or abatement of water pollution.

d. Encourage, conduct and participate in investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution.

e. Collaborate with the Central Board in organising the training of persons engaged or to be engaged in programmes relating to prevention, control or abatement of water pollution and to organise mass education programmes.

f. Inspect sewage or trade effluents, works and plants for the treatment of sewage and trade effluents and to review plans, specifications or other data relating to plants set up for the treatment of water, works for the purification of thereof and the system for the disposal of sewage or trade effluents or in connection with the grant of any consent as required by this act.

g. Lay down, modify or annual effluent standards for the sewage and trade effluents and for the quality or receiving waters resulting from the discharge of effluents and to classify waters of the state.

h. Evolve economical and reliable methods of treatment of sewage and trade effluents, as per local conditions.

i. Evolve methods of utilisation of sewage and suitable trade effluents in agriculture.

j. Evolve efficient methods of disposal of sewage and trade effluents on land and in streams with minimum degree of dilution.

k. Lay down standards of treatment of sewage and trade effluents to be discharged into any particular stream with minimum dilution as per local conditions.

l. Make, vary or revoke any order

   (i) For the prevention, control or abatement of discharge of waste into streams or wells.

   (ii) Requiring any person concerned to construct new systems for the disposal of sewage and trade effluents or to modify, alter or extend any such existing system or to adopt such remedial measures as are necessary to prevent, control or abate water pollution.

m. Lay down effluent standards to be complied with by persons while causing discharge of sewage or sludge or both and to lay down, modify or annual effluent standards for the sewage and trade effluent.

n. Give advice to the State government with respect to the location of any industry which is likely to pollute a stream or well.

o. Perform such other functions as may be prescribed or as may be entrusted to it by Central Board or State Government.

Prevention and control of water pollution

Chapter V deals with different powers provided in the Act for the prevention and control of water pollution. The state Government can restrict to apply the Act to a specific area

(Sec. 19). Section 20 of the Act provides for the power to obtain any information required by the Board to perform its functions. By following the standard procedure, any person authorised by the Board can take samples of effluents (Sec. 21). These samples are sent to the authorised laboratory for the analysis, analysed by Government recognised analyst (Sec. 22) and the reports are prepared in triplicate. Any person authorised by the Board can enter and inspect any part or process of any premises (Sec. 23) for the purpose of performing any functions of the Board.

The use of stream or well for the disposal of any polluting matter has been prohibited under Section 24 and use of new outlets for the discharge of effluents has been restricted by Section 25. The matter related to the grant or refusal of consent to operate the process, plant or industry has been dealt with in Section 27, 28 and 29. In case of accidents in industrial area, the information should be furnished to the state Board (Sec.31). The Board can take certain measures under emergency (Sec.32) or can make application to Courts for restraining pollution of water (Sec. 33). As provided in Section 33-A of this Act, the central Government also can direct through its Officers to close, prohibit or regulate any industrial operation or to stop or to regulate the supply of electricity, water or any other services.

Penalties and Procedures

Seventh chapter of this Act deals with different penalties and legal procedure of imposing penalties. The person is held guilty, if he doesn't give required information as under Sec. 20(2) and (3) and is punishable with imprisonment which may extend to three months or with fine up to Rs. 10,000/- or with both. The continuation of such failures is again punishable. Failure to comply with the provisions of Section 32 (c) (1), Section 33(2) or Section 33-A is punishable with imprisonment

not less than one year and six months which is extendable to six years and with fine. The continuation of such failure is again punishable. If anybody destroys the matter put up by the Board or restricts anybody from performing any work as a part of function of the Board or distracts any property belonging to the Board, then he is punishable with imprisonment up to three months or with fine up to Rs. 10,000/- or with both.

If any person disposes any polluting matter into any stream or well then he is punishable with imprisonment up to six years and with fine. The use of new outlet for the effluent discharge without the permission of the board is punishable with imprisonment not less than one year and six months, extendable up to six years and with fine. The Court takes cognizance of any offence only on the complaint made by the Board or otherwise by any person who has served a notice of not less than sixty days. The courts of JMFC and higher ranks are only competent to try such suit.

Miscellaneous provisions

The provisions related to establishment of water testing laboratories, matter related to appointment of analysts, rule making powers of Central and State Governments are included in Chapter VIII. These provisions are equally important in the implementation of this Act.

7.3 Wildlife (Protection) Act, 1972 (Act No. 53 of 1972)

Wildlife is an essential biotic component of nature. It constitutes national heritage and wealth. Wildlife destruction leads to nature imbalance with several adverse impacts on different ecosystems. Wildlife is a great asset for any healthy and prosperous human society. Considering the urgent need of protecting the wildlife in the country, the Wildlife (Protection) Act was passed by Indian Parliament on 9th of September, 1972.

The passing of the Act constitutes an important landmark in the history of wildlife legislation in India. The forest and wildlife were directly or indirectly the State subjects. Parliament had no power to make law on the same, except as provided in Articles 249, 250 and 252 of the constitution till 1976. In 1976, entries related to wildlife along with forest were transferred from State List to Concurrent List to empower Central Government to enact legislation on these issues with 42nd constitutional Amendment.

The Wildlife (Protection) Act of 1972 is made applicable throughout the country. The Act is adopted by all the States except that of Jammu and Kashmir. The State of Jammu and Kashmir has its own Act for the purpose of its wildlife protection. The main objective of passing this Act was to protect the wildlife including all flora and fauna. The first comprehensive list of endangered wildlife species was complied in the Act. This provided for the protection of threatened faunal species from indiscriminate destruction and hunting. The Act empowered the Central Government to declare certain areas as National Parks to achieve the purpose of wildlife protection.

There are 66 Sections in Wildlife (Protection) Act, 1972. These have been divided in seven chapter and six Schedules. The lists of wildlife prohibited from hunting have been included in Schedules I to V. Schedule I contains the list of identified list of rare or endangered animal species. These are totally protected throughout India with the provisions of this Act.

The Act contains provisions, which prohibit trade in rare and endangered species. The act supports for conservation and management of wildlife of the country. The Central Government it to provide financial assistance to State for strengthening management and protection of infrastructures of National Parks and Wildlife Sanctuaries for protection of wildlife. For the control of poaching and illegal trade in wildlife

products, captive-breeding programmes for endangered species of wildlife, development of selected zoos and wildlife education are the other activities under the provisions of this Act.

The Major Provisions in the Act

The Wildlife (Protection) Act, 1972 has been amended in 1982, in 1986 and in 1991 for different purposes. Chapters III A and IV A were inserted by the amendment of 1991 and the Chapter V A was inserted by the amendment of 1986. With these amendments the powers of the State Government to declare any wild animal a vermin have withdrawn and immunisation of livestock within a radius of five km from a national park or wildlife sanctuary, has been made compulsory to control the spread of animal diseases.

The chapter-I contains short title and definitions of some important terms used in the Act. These definitions include some technical terms like animal, animal article, captive animal, closed area, habitat, hunting, National park, sanctuary, taxonomy, trophy, vermin, wild life, etc.

The Second Chapter deals with the authorities to be appointed for the purpose of wildlife protection in the country. There are provisions for the appointment of Director, Assistant Director, Chief Wildlife Warden and other officers. The higher authorities can delegate their powers to their sub-ordinate officers. Special wildlife Advisory board can be constituted in each State or Union Territory under Section 6 of this Act. It is to advise the concerned Government on the matters of wildlife protection and conservation. The composition of Wild Life Advisory Board is as follows.

1. The Minister in charge of Forest as Chairman or Chief Secretary, in case if no minister.
2. Two members of the State Legislator.

3. The Secretary in charge of forests.
4. Chief Conservator of Forests as ex officio or Chief Wild Life Warden as ex officio.
5. One officer to be nominated by the Director.
6. The officials or non-official members upto fifteen in number who have interest in wild life protection.

Procedure to be followed by the Board and its duties have been provided in Section 7 and 8 respectively.

Chapter III of the Act deals with the provisions related to wild animal hunting. Hunting of wild animals specified in the Schedule has been prohibited except certain exceptions like self-defence. Any such animal killed is the property of the Government. The Government can grant permission to kill these animals for academic purposes. These provisions have been embodied in Sections 9 to 13. Chapter III-A is a new insertion by amendment (in 1991) in the Act with Sections 17A to 17H to deal with the protection of specified plants as mentioned in schedule VI., These plants include Beddomes cycad, Blue vanda, Kuth, Ladies slipper orchid, Pitcher plant, and Red vanda.

Legal provisions for the declaration of wildlife sanctuaries, national parks and closed areas have been made in Chapter IV of the Act. By notification in official gazette, the State Government can declare any area fit for the protection and conservation of wildlife as a wildlife sanctuary by following the legal procedure under the provision of Section 8 to 26. Restriction on entry of any person other than legally permitted has been explained in Section 27 and 28.

Hunting of wildlife in the area of wildlife sanctuary without permission has been strictly prohibited. The activities casing fire are also restricted in this area. There is restriction on the

use of injurious substances like chemicals or explosives in the area of wildlife sanctuaries. Similar provisions have been made in respect of declaration of national parks, game reserves and closed area. The central Government has the power to declare any area as wildlife sanctuary or national park.

Chapter IV-A containing 38 A to 38 J Sections has been inserted with the amendment in the original Act. It deals with the matter of the constitution and functioning of central zoo authority for the purpose of wildlife protection in zoos. The harmful activities like teasing the animals in zoos have been restricted.

The legal matter related to wild animal trade has been explained in Section 39 to 49 in Chapter V. The possession, sell and transfer of wild animals, uncured trophy or meat, salted or dried skin without legal permission and license is restricted. No person is entitled for hunting of wildlife, control or possession of any articles, trophies or goods made up of wild animals in any form without license. The conditions and procedure for issue of license are explained in this chapter. Sections 49A to 49C have been newly inserted in the Act by amendment Act of 1986 with addition of new chapter as Chapter V-A. These sections deal with the prohibition on trade and commerce in and other animal articles. It has been made compulsory to the traders to keep entire record of the all stock of trophies, animal articles and captive animals.

The power of entry, search, arrest and detention of offender under this Act has been explained in Chapter VI in its Section 50 to 58 with legal procedure. The person authorized under this Act has been given power to enter in any area including private premises for conducting investigations of the offences related to the wildlife. Such person is also permitted to conduct search, seize any captive animal, animal article, any specified plant or any derivatives.

He can detain any premises or even arrest any person with due procedure, if required.

Any person guilty of any offence under this act has been held punishable with imprisonment for a term, which may extend to three years or with fine extendable up to Rs. 25,000/- or with both. The person who contravenes the provisions related to the provisions of trade and commerce in trophies, animal articles etc. made from wild animals can be punished with imprisonment extendable to seven years and also with fine not less than Rs. 5,000/-. According to Section 55(c), the Court can take cognizance of any offence on a complaint filed by any person, if has served a notice of 60 days with clear intention and allegations in respect of any offences related to wildlife. The wildlife authorities are authorized to compound the offences under certain circumstances.

The other matter related to service conditions of the officers serving for the wildlife protection and other miscellaneous provisions have been provided in Sections 59 to 66 under Chapter VII. Under these provisions, the Central Government and State Governments are empowered to make rules for the purpose of execution of this Act. If any officer or any person while taking any action in good faith commits any offence, then he is not be punished under this Act.

7.6 Forest (Conservation) Act, 1980

The forest is an important traditional resources for the people to satisfy their needs. There was no Act to regulate the use of forest prior to British rule. Prior to independence, the Indian Forest Act, 1927 was a comprehensive Act for regulating the Forests in India. But, there was a need to pass a special Act to provide for the conservation of Forests. Therefore, the Forest (Conservation) Act was passed in 1980 to provide for the conservation of forest and for matters

connected therewith. The Act was published in the Official Gazette on 27th December, 1980. It applies to the cases of mining and similar leases granted for non-forest purposes. The Act was subsequently amended in 1988.

The Act extends to whole of India except the State of Jammu and Kashmir. It has the following five sections:

1) Short title, extent and commencement (Sec.1).
2) Restriction on the de-reservation of forest or use of forest land for non-forest purpose (Sec.2).
3) Constitution of advisory committee (Sec.3).
4) Power to make rules (Sec.4).
5) Repeal and saving (Sec.5).

Section 3-A (penalty for contravention of the provisions of the Act) and Section 3-B (offences by authorities and Government Department) were further added through amendments in1988.

The Forest (Conservation) Act was primarily passed to check deforestation caused due to non-forest activities, which result in nature disturbances and ecological imbalances. The provisions made in this Act apply to all forests irrespective of the forest classes. The word "forest" covers all statutorily recognized forests, including reserved, protected or any other forests. Section 2 (i) of the Act gives the meaning of the term 'reserved forest'. The term "forest land" includes any forest area as on Government record irrespective of its ownership.

Major provisions in the Act

The main objective of this Act is to provide for the conservation of forests and for the other matters connected thereto. The major provisions in the Act are as follows

The act puts restrictions on the power of the State

Government in respect of preservation of forests or use of forest land for non-forest purposes like cultivation of tea, coffee, spices, rubber, palms, oil-bearing plants, horticulture crops or medicinal crops. It does not include use of forest for the work related to forest conservation, development and management of forests and wildlife. The activities like establishment of check-post, fire lines, wireless communications and constructions of fencing bridges and culverts, dams, waterholes, trench marks, boundary or pipeline work are excluded.

According to Section 2 of the Act the State Government can not make any order without prior approval of the Central Government in respect of de-reservation of forests or use of forestland for any non-forest purpose. Such orders include the orders directing

(i) that any reserved forest or any portion thereof, shall cease to be reserved;
(ii) that any forest land or any portion thereof may be used for any non-forest purpose.
(iii) that any forest land or portion thereof may be assigned by way of lease or otherwise to any private person or non-Government body, and
(iv) that any forest land or any portion thereof may be cleared of trees which have grown naturally in that land for the purpose of using it for reforestation.

2) Section 3 of the Act empowers the Central Government for the constitution of advisory committee to advise the Government in respect of the grant of approval under Section 2 by the Central Government, or any other matter connected with conservation of forests which may be referred to it by the Central Government.

3) The violation of the provision in Section 2 has been made punishable with imprisonment for a period extending to 15 days (Sec. 3-A). Any government department or any authority can be held liable to proceed against and punished accordingly (Sec. 3-B) for any such contravention.

4) The Act was amended in 1988. This amendment shattered all the expectations of tribal communities and many voluntary agencies. It brought all the forest land under the jurisdiction of the forest department.

Section 4 of the Act gives power to the central Government to make rules for carrying out the provisions of the Act and get them approved by the house of parliament and notify in Official Gazette.

In brief, forest can not be looked upon as mere a source of revenue generation, but as the wealth of nation. These are vital renewable natural resources. The forests can not be overlooked for any other developmental activities by converting the forest land into the non-forest purpose. They should be protected and conserved for well being of the people today and in the future Nation.

7.3.6 Population growth and human health, human rights

From the demographic point of view, over population of any country whether it be under developed, developing or advanced can become a problem under certain circumstances.

A nation may have over population or under population depending on the population density, space and natural resources. Population problem can be examined from either

the quality or qualitative point of view or both. However, at present the sheer quantity, ie. number of people, is the major problem for all under developed and developing countries. The greatest obstacle in development in India is the population growth.

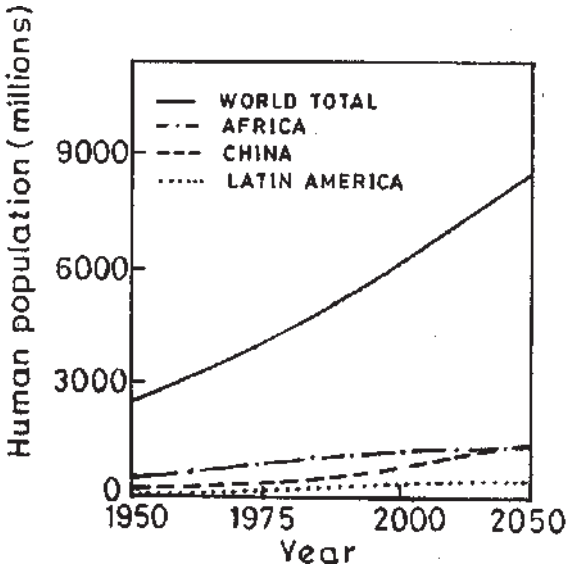

Fig. 7.1 : Population growth trend

As for quantity the most desirable population number is the one that permits the maximum production, the highest standard of living, political stability and economic security and adequate freedom and leisure for the pursuit of cultural values. It is fundamental that the health of human is determined by their genetic heritage and how they interact with the environments in which they live. These environments provide sustenance and protection, but also present hazards to health and ultimately to life.

Even in primitive communities, human environments were complex, being always made up of many interrelated physical and social elements. Social elements impact heavily on the physical environment, as human activities continuously alter natural conditions. Among these social elements, demographic factors are powerful determinants of the state of the environment and, thereby, the state of human health. Both the environment health and human health are now endangered on a global scale, and demographic factors are crucial in this crisis.

The concept of health is defined in the constitution of the World Health Organization (WHO) as a "Complete state of physical, mental and social well being, and not merely the absence of diseases". In practice, health measures are usually aimed at averting, preventing, and curing, diseases and impairments mainly those of the human body. To varying degrees, communities are also concerned with mental diseases, and most seek to control the social diseases, crime, violence, destitution and alienation.

Population levels and their geographical distribution are key consideration in any development. Population, environmental variables economic well being and human health are closely interwoven. It has been estimated that for at least another half-century, the world will have major population problems to deal with. The figure 7.1 predicts the probable population growth trend in the world. The German Advisory Council on global change has also predicted that the expected population growth, which will mainly occur in Asia, Africa and Latin America, will aggravate both environmental and developmental problems. The only solution to this is reduction of population growth.

There is a debate on our ability to provide for, and the Earth's capacity to support, this number of human beings. It

has focused on whether or not world food production will be able to increase by as much as will be necessary to maintain sufficient good supplies for the growing population. Ever-increasing food supplies will be needed to meet the demand created by a growing population if not problems of hunger, malnutrition, poverty, inadequate access to food by all individuals and underdevelopment will be the final result.

This growing population has affected the carrying capacity of the planet eventually resulting into number of problems e.g. inadequate resources, living conditions, unhygienic, improper sanitation facilities, enormous waste generation, malnutrition, poverty, pollution, inadequate, facilities etc. It is time to ponder over our old saying "Health is wealth" and how it can be achieved. Today due to population pressures and human impact the natural elements like air, water and soil have be polluted to a great extent. It is necessary to take proper precautions and measures for improving the condition before the situation reaches irreparable stage. It should be remembered that in unplanned development there is inevitable competition making people overuse resources and this exploitation increases as population grows.

Table 7.1 Indian Population Stratification

Total Pop. Millions	Births 1000	Deaths 1000	Rate of natural increase	Projected Population		Projected Population changed bet 2025-50	Infant Mortality Rate	Total Fetidly Rate
				Year 2025 Millions	Year 2050 Millions			
1,086.6	25	8	1.7	1,363	1,628.	50%	64	3.1

Percentage of Popular of age		Life expectancy at birth in years.		Urban Population %	% of pop between 15-49 with HIV Aids by end 2003	Area of country	Pop per sq mile
215	65	Total	62	28	0.9%	1,269.34	856
		Male	61				
36	4	Female	63				

Source – World Population Data sheet 2004 of the population reference bureau WWW. Prb. Org – Webster.

Human Rights

The concept of human rights has been evolved from the concept of natural rights which in turn were derived from natural law. The development of human rights and their recognition and protection on international level can be divided into different periods.

Historically the idea of Natural Rights is very old. In the classical literature of Ancient Greece from the 5th century B.C. we come across a striking expression of the beliefs in the power exercised by the gods in a human society based on law. According to Ancient Greek writers the god establishes a law which stands above the obligations and interdictions imposed by the rulers of the community. Jus Naturale was a Roman Law which was regarded as established by nature herself.

According to Marcus Tullius Cicero the Great Roman Jurist there is one eternal and immutable law, which will apply to all people at all times and which emerges from the God. At the turn of the century after the French Revolution the doctrine of natural law was a doctrine of abstract and immutable Principles and of eternal and inviolable human rights. From the beginning of the 19th century, attention was directed more to the rights of the individual than to the objective norms.

Historically the recognition, protection and implementation of human rights in the constitution of India has its genesis in the forces that operated in the national struggle for independence during the British rule. After witnessing the colonial rule, every Indian was of the firm opinion that these rights are not only basic but also inalienable for them for leading a civilised life. In fact Indians wanted the same rights and privileges that their British masters were enjoying in India. It was implicit in the birth and formation of the Indian National Congress in 1885.

By the mid twenties of the 20th century various developments and the consciousness among Indian leaders and congress put forward demands for the acceptance of civil rights for the Indian people. The drafting of Mrs. Beasant's commonwealth of India Bill of 1925 Article 4 of this bill contained a list of 7 Fundamental Rights as follows.

- Liberty of person and security of his dwelling and property.
- Freedom of conscience and the free profession and practice of religion.
- Free expression of opinion and the right of assembly peaceably and without arms and of forming associations or unions.
- Free elementary education.
- Use of roads, public places, courts festive and the like.
- Equality before the law, irrespective of considerations of nationality and
- Equality of the sexes.

The supreme court of India for the first time in Maneka Gandhi V. Union of India, pressed Article 14 and 19 into the service of Article 21 of the constitution in order to evolve the principle that the procedure for the deprivation of personal liberty had to be fair, just and reasonable. Therefore the Supreme Court has expanded the scope of Art 21 to include certain rights which though are not specifically incorporated in the constitution of India. These rights are impliedly quarantined rights and now available to the persons of India. They are as follows :

- Right to lively hood.
- Right against Inhuman, cruel and degrading treatment.
- Right to speedy trial.

- Right to provide legal assistance.
- Right to life and capital punishment.
- Right against environmental pollution.
- Right to privacy.
- Liberty to travel abroad.
- Right of not to be imprisoned for Inability to fulfil a contractual obligation.
- Right of prisoner to be treated with humanity.
- Right of compensation in case of violation of right to life and personal liberty.

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Chapter : 8

Field Project Work

8.1 Introduction

The youth are an important asset to the society whose energies, if harnessed properly by giving opportunity and proper direction can help in improving the environmental conditions for the better future.

Students are our future generation and therefore the attitudes to safeguard the environment, built during this course particularly with field experience, will remain with them for life time. With their participation in environment study and conservation projects, students will realise the impact of human actions on the immediate environment and the linkages with the larger issues. Understanding of the complexity in environmental protection and nature conservation will lead to the youth indulging in undertaking conservation activities and adopting eco-friendly life styles and motivate others to do so. Therefore, the present curriculum designed by the UGC and directed by the Hon. Supreme Court has given enough weightage to the fieldwork as an essential part of this environmental study course.

8.2 Environmental action

Unless environmental awareness leads to environmental protection action it does not serve any purpose. Environment education is the key to the future and its ultimate goal is appropriate action.This is to understand the existing environmental conditions in the field by observing natural

processes and studying human actions at the grass root level. It is assumed that the personal field experience gained by the students through the need based, action oriented field projects will make them realise that their actions too can make a difference. This will foster a sense of responsibility for their environment.

The concerned teachers are expected to encourage the students to undertake meaningful projects under the field work in the region around colleges and surrounding villages. The emphasis needs to be on the work which will show tangible results in a fairly short time. The sense of involvement and achievement which will result from undertaking these projects will excite and motivate students and lay a foundation for a lasting commitment to the environment. Students need to realise through these action projects that, irrespective of whether they live in cities, towns or villages, there is something that they themselves can do, directly or indirectly, to improve the environment.

8.3 Scope of the field project

The field projects, for which there are 30 marks assigned, are to be carried out during the period of the course. Though it is expected that as far as possible these field projects should be individual assignments, considering the nature of the project, more than one student can be assigned the same project. This will also be useful for a class with large number of students. However, there should not be more than five students for one specific field project and specific task be assigned to each of the students in the team. The team projects are expected to cover more and interrelated parameters in wider area. It is also expected that duplication of the projects is avoided.

While assigning the field projects it has to be remembered that there is paucity of the basic data about various

environmental parameters at the local level. This lacuna can be overcomed through these projects over a period of years. This data is not only necessary to generate awareness among students and locals, but also is crucial for local policy makers and concerned agencies to take appropriate actions for development and to safeguard environmental concerns.

College can plan its activities, by involving these students through their need based field projects, as per the priorities of the region, in the vicinity of the college or in its catchment area. This will provide a good opportunity to the college of interaction with the society.

The data thus systematically generated and analysed on identified issues related to the environment and sustainable development, for a period of around five years, can prove to be extremely useful for the concerned. Therefore, the whole activity of students field projects need to be planned by the concerned teaching faculty with care and precaution.

8.4 Methodology

The projects are expected to generate data through student's personal observations, monitoring of some crucial parameters, individual or collective surveys by administering interview schedule or questionnaire etc. The scope of the problem should be equivalent to 10 lectures by the teachers. However, the student can spend more time on the project during weekends, holidays or at spare time as per the need of the project. The project report is to be submitted at the end of the course.

It must be ensured that the project activity should not be in the form of a picnic, leisure field visit, annual trip , excursion etc. However, common field visits of the students to local areas of environmental interest can be arranged to expose them to the issues. All the projects should have clear

and over riding relevance to the environmental issues and problems, preferably local or regional. Wherever possible local success stories of environmental mitigation measures should be highlighted in the field study for multiplier effect. Projects leading to resource conservation be preferred.

Distance/External students

For the external students in lieu of the field projects of 30 marks, two separate assignments of 3000 words and 15 marks each are compulsory. These assignments in the form of articles are to be based on any major topic related to contemporary environment issues and are to be submitted before final written examination to the Centre for Distance Education.

8.5 Suggested list of field project themes

Though a large number of field projects can be undertaken in the course, depending on the available resources, laboratory facilities, local conditions and priorities, the concerned teacher should chose the appropriate themes for this purpose. A few themes as a guideline are suggested below for individual and group projects.

1) Status of environmental parameters in the villages and towns i.e. water supply, sanitation, sewage disposal, solid waste, health care and hygiene etc.
2) Periodic monitoring of pollution parameters in surface and ground water, air, noise, solid waste etc.
3) Survey of traffic and transportation, vehicles, garages and servicing centres in the towns and city.
4) Study on local areas for biodiversity: plants and animal species diversity, migration, predation, man and wildlife conflict etc.

5) Study of resources such as wetlands, grasslands, forest habitats, energy etc. in the vicinity.
6) Survey of bio-gas plants, ETP, CETP, windmills, etc.
7) Energy budgeting of factory, office premises, domestic units, etc.
8) Environmental impact of brick kilns, Gurhal, cottage or small scale industries etc.
9) Traditional and modern agriculture practices, such as shifting cultivation (Kumri), 'Raab', burning of agriculture wastes, composting, vermi- culture etc.
10) Review of social forestry, afforestation projects, energy plantations, mono-culture, etc.
11) Mining, quarrying, dam and construction activity etc.
12) Urbanisation and its environmental impact.
13) Quantification of solid and liquid waste.
14) Disposal and management of wastes i.e. recycling, reuse etc.
15) Changing agriculture: use of fertilisers, pesticides, over irrigation, exotic species, soil salinity, poly houses etc.
16) Population profile, sex ratio, age distribution, occupation and resources.
17) Literacy and environmental awareness, Environmental impact of pilgrims, festivals, etc.
18) Public health and hygiene, epidemics etc.
19) Impact of natural disasters and man made hazards.
20) Environmental awareness among people and community action, environmental movement, campaigns etc.
21) Alternative technologies for better environment, e.g. solar, vermi-composting, water harvesting, bio-fuel etc.

22) Traditional methods of nature conservation and sacred practices.

23) Study of local Heritage sites, sacred grooves, sacred tanks.

24) Case study on prevention of cruelty to animals.i.e. animal races, fights etc.

8.6 Field studies under biodiversity

(such as Recording of local wildlife and other animal activities)

1) Habitat wise seasonal animal counts such as birds.

2) Observation of lifecycles of moths, butterflies, grains flour weevils, frogs, toads, etc.

3) Composition of different species of flora and fauna in an identified habitat

4) Investing Pest Control and Pesticides – Household, agricultural, bio-fertilizers, biological pest control.

5) Creating Habitats for birds and small animals and observing and maintaining records of the different life stages and activities.

The brief example of the social survey are given below:

8.3.6 Social survey

(This basic sample interview schedule is designed for rapid survey on water for neighbourhood)

1) Name Address of respondent

2) Position in the family (Head, wife, grand parent, child,)

3) Education status -illiterate, upto SSC, Graduate, Post Graduate,

4) Income group – up to 5000, 5001 – 10,000/- 10,001 – 20,000, above 20,000.

5) Occupation of the head of family – agriculture, service, self employed, other

6) Type of House (roofed house, flat, bungalow, chawl, row house, any other)

7) Number of persons in the house- adults, children (below 15)

8) Source of Water e.g. stream, river, tank, well, pipeline, borewell etc.

9) Time consumed in collecting the daily requirement, 30 m, 1hr, 1.5hr etc.

Duration of Water if from tap

Storage facility (Type) -

Storage Capacity in lits.

10) Do you Purify water for drinking Yes / No

11) If yes in which way Alum, tap filter, cloth filter, water filter, Aqua-guard

12) Details of water usage in (buckets) 10 lit, 15 lit, 20 lit per person/day

13) Quantity of water used in lits (buckets)

- Cleaning
- Cooking and Drinking
- Washing (Clothes, Utensils, House)
- Bathing and Brushing after meals
- Sanitation
- Gardening
- Vehicle Wash
- Any other

Total liters.

14) Quantity of water used by family /day

Are there any measures for water conservation/ management?

How much water is wasted ?

How much water can be saved ? how ? recycle, reuse etc.

17) General Remarks.

Sample size of the respondents should depend on the nature of the study problem and the target group. However, the study should represent a sizable population of respondents to avoid biased associated with a small sample size.

8.7 Implementation of the project

Implementation of any project involves specific basic stages as given below

(1) Review of literature.

(2) Formulation of the study problem and, deciding on the topic.

(3) Deciding the area, target group, sample size and time period of work.

(4) Formulation of objectives and hypothesis, preparation of work schedule.

(5) Adopting and finalising the methodology of work – library, empirical, laboratory, documentation.

(6) Collection, Compilation and analysis of data.

(7) Writing of the final technical report with the help of necessary maps, diagrams, tables, graphs, photographs, wherever necessary.

(8) Binding and submission of the final report .

The final project report is expected to be minimum ten pages, on A 4 size, typed or properly hand written on one side of the page. The written matter must be not less than six pages.

8.9 Field Work Reporting

A format of field project report shall be of the following nature

Cover Page :-

Title of the project

Name of the student

Name of the supervisor

Name of the college and the department

Year of submission

Second page: Declaration of the student

Third page : Certificate of the Supervisor,
(countersigned by the Teacher and the Head or Principal)

content page Contents, list of tables, diagrams, figers, maps, photographs etc.

Chapter I : Introduction

Chapter II : Methodology

Chapter III : Observations

Chapter IV : Discussion

Chapter V : Summary and conclusions,
Bibliography
Appendix
Annexures

Project reporting will be exclusive work of the students to be submitted under the supervision of the concerned

department faculty. The reports will be assessed by the panel of examiners in the respective subjects prepared by the University. The final project report is to be submitted, in the above prescribed format. to the college before commencement of the written examination at the end of the course. Distance learning and external students shall submit their assignments to the Centre for Distance Education.

Through the above mentioned projects the final aim is to improve knowledge, skills and attitudes of the students for improving the local environmental conditions while focusing on larger issues to make them think globally and act locally.

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सर्वसामान्य पर्यावरण संज्ञांची सूची (इंग्रजी/मराठी)

Ecosystem	परिसंस्था
Non-living	निर्जिव
Organism	जीव
Interrelated	परस्पर संबंधीत
Ecology	परिस्थितीकीशास्त्र
Environmental	पर्यावरणीय
Engineering	अभियांत्रीकी
Autotrophic	स्वयंमपोषी
Heterotrophic	परपोषी
Biomass	जैव वस्तुमान
Abiotic	अजैविक
Biotic	जैविक
Population	लोकसंख्या
Evolution	उत्क्रांती
Carnivorous	मांसभक्षी
Herbivorous	तृणभक्षी
Ecotone	अेतव्याप्तस्थान
Biosphere	जीवावरण
Atmosphere	वातावरण
Structure	संरचना
Concept	संकल्पना
Producer	उत्पादक
Consumer	उपभोक्ता
Decomposer	विघटक
Energy Flow	ऊर्जावहन
Solar Radiation	सौर किरण
Co-ordination	समन्वय

Biological	जैविक
Algae	शैवाल
Invasion	आक्रमण
Grassland	गवताळ प्रदेश
Food chain	अन्नसाखळी
Food web	अन्न जाळी
Ecological	परिस्थितीकीय
Pyramids	मनोरा/शंखू
Phytoplankton	वनस्पती प्लवक
Zooplankton	प्राणी प्लवक
Impact	प्रभाव
Trophic levels	ऊर्जाविनिमय स्तर
Trophic	ऊर्जाविनिमय स्तर
Structure	संरचना
Troposphere	तपांबर
Reproduction	प्रजनन
Resistance	रोध
Reuse	पूर्णवापर
Recycle	पूर्णचक्रीकरण
Residue	अंश
Biomes	जीवसंहती
Evergreen	सदाहरित
Estuary	नदीमुख खाडी
Environmental Science	पर्यावरणशास्त्र
Exploitation	अयोग्य वापर
Explosion	विस्फोट
Marsh	दलदल
Action Plan	कृतीयोजना

Eutrophication	पोषणातिरेक
Fungus	बुरशी
Bacteria	जीवाणू
Biotic Community	जैविक समुह
Model	प्रारूप
Ecological Succession	परिस्थितिकीय उन्नती क्रम/अनुक्रम
Climax	उच्च उन्नत स्थिती
Stablization	स्थिरीकरण
Diversity	विविधता
Non-Biodegradable	अविघटनशील
Bio-degradable	जैव-विघटनशील
Pollution	प्रदुषण
Pollutant	प्रदुषक
Radioactive	किरणोत्सर्गी
Air Pollution	हवाप्रदुषण
Ionosphere	दलांबर
Inorganic	असेंद्रिय
Organic	सेंद्रिय
Deforestation	जंगलतोड
Desertification	वाळवंटीकरण
Soil Pollution	माती प्रदुषण
Water Pollution	जल प्रदुषण
Noise Pollution	ध्वनी प्रदुषण
Virus	विषाणू
Chlorophyll	हरितद्रव्य
Effluent	सांडपाणी
Reclamation	पुनर्भरण
Mining	खाणकाम
Ambient	सभोवताली

Barren	पडीक
Catastrophe	प्रलय
Urbanisation	शहरीकरण
Unicellular	एक पेशीय
Micro-nutrient	सुक्ष्म पोषके
Micro-Waves	सूक्ष्मलहरी, सूक्ष्मतरंग
Sludge	गाळ
Sancturies	अभयारण्ये
National Park	राष्ट्रीय उद्याने
Biological Reserves	जैविक संरक्षित क्षेत्र
Advisory Committee	सल्लागार समिती
Acid Rain	आम्ल वर्षा
Act	कायदा
Coral Reef	प्रवाळ बेटे
Decentralization	विकेंन्द्रीकरण
Extinction	नामशेषत्व/विनाश / नामशेष
Endangered	आस्तित्व धोक्यात असलेले
Exotic	परस्थ
Limiting Factor	नियंत्रक घटक
Earthquake	भूकंप
Environmental	पर्यावरणीय
Impact	प्रभाव/परिणाम
Erosion	धूप
Resources	संसाधने
Exhaustible	विनाशी
Renewable	पुननिर्मितीक्षम
Non-Renewable	अ-पुननिर्मितीक्षम
Treatment	प्रक्रिया
Terrestrial	भूतल

Ultra-Violet	अतिनील
Species	प्रजाती
Solar Ponds	सौरतळी
Overgrazing	अतिचराई
Nuclear hazards	आण्विक धोके
Per capita income	दरडोई उत्पन्न
Ozone layer Depletion	ओझोन थराचा क्षय
Photosynthesis	प्रकाशसंश्लेषण
pH	सामू
Minerals	खनिज
Physical Factors	प्राकृतिक घटक
Salinity	क्षारपड
Land erosion	जमिनीची धूप
Land	जमिन
Degradation	ऱ्हास
Land Slides	भूस्खलन
Solid Waste	घनकचरा
Management	व्यवस्थापन
Sustainable	शाश्वत/निरंतर
Section	भाग/अनुच्छेद
Wildlife	वन्यजीव
Biodiversity	जैवविविधता
Hot Spots	संवेदनशील प्रदेश
Bio-geographical	जैवभौगोलिक
Mega Bio-diversity	समृद्ध जैव विविधता
Geothermal	भूऔष्णिक
Green House Effect	हरितगृह परिणाम
Ground water	भूजल
Drought	अवर्षण

Famines	दुष्काळ
Inexhaustible	अविनाशी
Insecticides	कीटकनाशके
Manmade	मानव निर्मित
Natural Reserves	नैसर्गिक संरक्षित क्षेत्र
Tiger Project	व्याघ्र प्रकल्प
Fossils	अवशेष/जीवाश्म
Standards	मानके, मानदंड
Space	अवकाश
Stratosphere	स्थितांबर
Prevention	नियंत्रण
Disaster	आपत्ती
River linking Project	नद्या जोड प्रकल्प
Volcano	ज्वालामुखी
Cyclone	चक्रीवादळ
Social Issues	सामाजिक समस्या
Non-Conventional	अपारंपारिक
Conventional	पारंपारिक
Watershed	जलसंधारण क्षेत्र
Management	व्यवस्थापन
Resettlement	पूनर्वसन
Rehabilitation	पूर्नअधिवास
Ethics	नीती
Flora	वनस्पतीसंपदा
Fauna	प्राणीसंपदा
Genetic	अनुवंशिकता
Development	विकास
Conservation	संवर्धन
Protection	संरक्षण

In-situ	मूळस्थानी
Ex-situ	परिस्थानी
Reserved	आरक्षित
Thermal Pollution	औष्णिक प्रदुषण
Chapter	प्रकरण/परिच्छेद
Provision	तरतूद
Carrying Capacity	धारणक्षमता
Global Warming	जागतिक तापमान वाढ
Waste land	पडीक जमीन
Field Project	क्षेत्रीय प्रकल्प
Eutrophic	पोषणातिरेक
Solar radiation	सौर प्रारणे
Hazardous Waste	घातक कचरा
Sub-Article	उपकलम
Anthropogenic	मानव निर्मित
Constitution	राज्यघटना
Article	कलम
Subsection	उप-अनुच्छेद
Bioremediation	जैवउपचार
Technique	तंत्रज्ञान

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Days observed related to environment

Sr.No.	Date and Month	Days celeberated
1.	15th January	Animal welfare
2.	2nd February	World Wetland Day
3.	3rd February	Godess Narmata Jayanti
4.	14th March	World Anti Dam day
5.	21st March	World Forest Day
6.	22nd March	World Water Day
7.	22nd April	World Earth Day
8.	31st May	World Anti Tobacco Day
9.	5th June	World Environment Day
10.	17th June	World Desertification Day
11.	6th July	Forest Week
12.	11th July	World Population Day
13.	23rd July	Forest Conservation Day
14.	26th August	Nature Club Day
15.	16th September	Ozone Layer Protection Day
16.	21st September	World Biosphere Day
17.	1st October	Wild Life Week starts
18.	2nd October	World Reaved Animal Day
19.	8th October	Natural disaster Protection Day
20.	14th October	World Animal Right Day
21.	16th October	World Food Day
22.	24th October	World Development and Information Day
23.	1st November	World Ecosystem Day
24.	14th November	National Childrens Day
25.	25th November	No Non veg Day
26.	29th November	International Biodiversity Day
27.	1st December	Ocean Protection Day
28.	Full December month	Biodiversity month.

Ecological foot prints, carbon foot prints and carbon credits

1.1 Ecological foot prints:

The simplest way to define ecological footprint is the impact of human activities measured in terms of the area of biologically productive land and water required to produce the goods consumed and to assimilate the wastes generated. More simply, it is the amount of the environment necessary to produce the goods and services necessary to support a particular lifestyle. The ecological footprint is also defined as the biologically productive area needed to provide for everything people use such as fruits and vegetables, fish, wood, fibers, absorption of carbon dioxide from fossil fuel use, and space for buildings and roads.

The **Ecological footprint** is a method promoted by the Global footprint network to measure human demand on natural capital i.e. the quantity of nature it takes to support people or an economy. It tracks this demand through an ecological accounting system.

The Ecological Footprint can be calculated for a single individual, city, region, country and the entire planet. The units for ecological footprint are **global hectares (gha)**, which measure the amount of biologically productive land with productivity equal to the world average.

1.2 Carbon footprint:

A carbon footprint is the amount of greenhouse gases primarily Carbon dioxide released into the atmosphere by a particular human activity. A carbon footprint can be a broad measure or be applied to the actions of an individual, a family, an event, an organization, or even an entire nation. It is usually measured as tons of CO_2 emitted per year, a number that can be supplemented by tons of CO_2-equivalent gases, including methane, nitrous oxide, and other greenhouse gases.

1.3 Ecological Footprint vs Carbon Footprint

Ecological footprints and carbon footprints are both ways of measuring something's impact on environment on the other hand, a carbon footprint measures the total amount of greenhouse gas emissions caused by an individual, organization, or activity. A carbon foot print is measured in units of carbon dioxide which quantifies how much a certain amount of a greenhouse gas would impact global warming in respect to carbon dioxide.

Thus the carbon footprint is concentrates on activities that likely related to greenhouse gas emissions, instead of considering an entire lifestyle as it may consider for calculating an ecological footprint. A carbon footprint to be expected to used, for example, to determine the impact that burning fossil fuels or consuming electricity would have on the environment.

1.4 Carbon credits

A carbon credit is a tradable permit or certificate that gives the holder the right to emit over a certain period a one tone of carbon dioxide or an equivalent of another greenhouse gas such as methane, nitrous oxide or hydro fluorocarbons

The main goal for the creation of carbon credits is the reduction of emissions of carbon dioxide and other greenhouse gases from industrial activities such as power, steel, textile, fertilizer, etc. using all fossil fuels – such as coal, oil and natural gas to reduce the effects of global warming.

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Equitable use of resources for sustainable lifestyles

The consumption of resource in the society has increase many fold from last five years. There is a large gap in the consumers lifestyle between developed and developing countries. It has been approximately estimated that More Developed Countries (MDC) of the world constitute only 22% of world's population but instead of that they use 88% of natural resources. They use 73% of energy resources and have 85% global income and inturn they contribute very huge quantity of pollution. On the other hand less developed countries (LDCs) have moderate industrial growth and comprise 78% of world's population and use only 12% of natural resources, 27% of energy and have only 15% of natural resources, 27% of energy and have only 15% of global income. There is a huge gap between rich and poor. In this age of growth and development the rich have became more rich and the poor is becoming more poorer. This result into unsustainable growth. There is an growing global concern about the management of natural resources. The explanation to this problem is to have equitable distribution of resource and income.

Two major causes of unsustainability are over population in poor countries and over consumption of resources by rich countries. For equitable use of natural resources more developed countries have to lower down their level of consumption so that these resources can be shared by poor people to satisfy their needs. There are several principles that each of us can adopt to bring about sustainable lifestyles :

- Reduction of the unsustainable and unequal use of resources and control of population growth.
- Expand green grassland.
- Sustainable Growth, development and Consumption is neccesary.

- Use of appropriate technology which consume less electricitiy.
- Reduce, Recycle and Reuse approach.
- Promoting environmental awareness approach
- Resources utilization as per carrying capacity.
- Ensure that any utilisation of the ecosystem is sustainable.
- Preserve biodiversity and maintain essential ecological processes.

Solid waste management control rules

The Union Ministry of Environment, Forests and Climate Change (MoEF & CC) recently notified the new Solid Waste Management Rules (SWM), 2016. This rule replaces the Municipal Solid Waste (Management and Handling) Rules, 2000, which have been in place for the past 16 years.

These rules are the sixth category of waste management rules brought out by the ministry, as it has earlier notified plastic, e-waste, biomedical, hazardous and construction and demolition waste management rules.

According to Union Minister of State for Environment, Forests and Climate change 62 million tonnes of waste is generated annually in the country at present, out of which 5.6 million tonnes is plastic waste, 0.17 million tonnes is biomedical waste, hazardous waste generation is 7.90 million tonnes per annum and 15 lakh tonnes is e-waste. Out of which only about 75-80 % of the municipal waste gets collected and only 22-28 % of this waste is processed and treated.

In the new rules of waste management along with municipal areas different areas like urban agglomerations, census towns, notified industrial townships, areas under the control of Indian railways, airports, places of pilgrimage, special economic zones, religious and historical importance, and State and Central Government organisation taken in their extent.

Most important highlights of the new SWM rules , 2016

- The solid waste management rules are now applicable beyond Municipal areas as explained above.
- The source segregation of waste has been mandated to channelize the waste to wealth by recovery, reuse and recycle.
- Responsibilities of generators have been introduced to segregate waste in to three categories i.e Wet waste , dry waste and domestic hazardous wastes such as diapers, napkins, empty containers, mosquito repellents etc. and this segregated waste should be handover to authorized rag- pickers or waste collectors and local bodies.
- No person should throw, burn or bury the solid waste generated by them on streets, open public spaces outside his premises or in the drain or water bodies.
- Generator will have to pay ‘User fee’ to waste collector and for ‘Spot fine’ for littering and Non- segregation.
- Sanitary waste like baby’s diapers, sanitary pads must be wrapped securely in pouches provided by manufacturers or brand owners of the products or suitable wrapping material should be placed in the bins meant for dry/non-biodegraded waste.
- The concept of partnership in Swachh Bharat has been introduced. The big organizations like industry, malls or hotels should segregate the waste and sorting the waste and manage it with partnership with local bodies.
- All hotels and restaurants should segregate biodegradable waste and set up a system for proper collection or otherwise follow the rules of local body to ensure that such food waste is utilized for composting or bio-methanation.
- For bio-degradation waste new townships and group Housing societies have been made responsible to develop in-house waste handling and processing unit.
- Every street vendor should keep suitable containers for storage of waste as notified by the local bodies.
- All Special Economic zone should leave 5% total area or sheds for recovery and recycling facility.
- All manufacturers should provide necessary financial support to local body for establishment of waste management system.

- Non –recyclable material having calorific value more than 1500K/cal/kg should not be a disposed of on landfills and should only ustilized for preparing refused derived fuel and shall be used for in cement production or thermal power plants.
- As per the Construction and Demolition waste Management Rules, 2016 the Construction and Demolition waste should be stored and disposed off separately.
- An event or gathering organiser of more than 100 persons at any licensed/ unlicensed place should ensure segregation of waste at source and segregated waste should be handover to authorized rag- pickers or waste collectors and local bodies.
- The SWM Rules would be challenging to see how segregation at source will work on the ground level. An enormous awareness campaign in association with communities, NGOs, students and other stakeholders needs to be planned to push for better implementation of these rules.

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Human Health and welfare

"Health" is a common aspect to be considered in most cultures and communities. In some cultures health and harmony are considered equivalent and define as " being at peace with the self, community, god and cosmos (the world or universe regarded as an orderly, harmonious system)

In Human health and welfare the health is classified as Public health and Social Health.

Public Health:

The term came into general use around "1840". It arose from the need to protect the public from the spread of communicable diseases. It is defined as "The organized application of local, state, national and international resources to achieve "Health for all" i.e. attainment by all people of world a level of health that will permit them to lead a socially and economically productive life."

Public health is a combination of scientific disciplines (e.g. epidemiology, biostatistics, lab sciences, social sciences, demography) and skills and strategies' (e.g. epidemiological investigations, planning and management, interventions, surveillance, evaluation) that are directed to the maintenance and improvement of the health of people.

Public health shapes the context within which people and community where they live, learn, work and play. Public health promotes and protect the health of people and community where they live, learn, work and play. Public health promote wellness by encouraging healthy behavior.

Social Health:

Social well being implies harmony and integration within the individuals, between each individual and other member of society and between individuals and the world in which they live. It is defined as "Quality and Quantity of an individual's interpersonal ties and extent of involvement with the community."

Welfare is a type of government support intended to ensure that members of a society can meet basic human needs such as food and shelter. The Ministry of Health and Family Welfare is an Indian Government ministry charged with health policy in India. It is also responsible for all government programs relating to Family planning in India.

The ministry is composed of two departments: Department of Health and Family welfare and the Department of Health and Research. The Department of Health deals with health care, including awareness campaigns, immunization campaigns, preventive medicine and public health etc.

Convention on Biological Diversity (CBD)

The convention on biological diversity is international legal instrument for the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources that has been ratified by 196 countries. Convention on biological diversity covers biodiversity at all levels; ecosystem, spicies and genetic resources. The convention was opened for signature on 5th June, 1992 in the the United Nations Conference on Environment and Development (Rio Earth summit).

Conventions and protocols on environment:

International environmental conventions and protocols are important because they enable countries to work together to address vital environmental issues that are transboundary or global in nature, such as air pollution, climate change, protection of the ozone layer, and ocean pollution. Some important environmental conventions and agreements which are as follows:

The Ramsar Convention

The Ramsar Convention is an international treaty for the conservation and sustainable and wise use of wetlands. It is also known as convention on wetlands. It is named after the city of Ramsar in Iran, where the convention was signed. Marking the date of the adoption of the convention of wetlands on 2nd February, 1971, it is celebrated as World Wetland Day. The convention entered into on force in India on 1st February 1982. India currently has 42 sites designated as wetlands of international importance called as Ramsar Sites.

The Montreal Protocol

The Montreal Protocol on Substances that deplete the Ozone Layer is an international agreement made in 1987. It is one of the world's most successful environmental treaties and since its adoption, it has encouraged countries to commit to phasing out the production and consumption of ozone-depleting substances. The Protocol now has 197 countries participating and resulted in the phase-out of 99 percent of nearly 100 ozone-depleting chemicals.This helped to protect the Ozone layer.

As a result of Chloroflurocarbons (CFC) phase-out, recent years have seen a growth of hydrofluorocarbons (HFCs) in air conditioning and refrigeration systems. While HFCs do not deplete the ozone layer, they are powerful greenhouse gases (GHGs) that contribute to climate change. Following seven years of negotiations, parties to the Montreal Protocol came together, on 15 October 2016, in Kigali, Rwanda, to

agree a new amendment to the protocol to reduce these "super GHGs" by more than 80% in the next 30 years. known as the Kigali amendment. The new agreement establishes three different timetables for all developed and developing countries to freeze and then reduce their production and use of HFCs, with the first cuts expected from developed countries by 2019.

Kyoto Protocol

The Kyoto Protocol was the first agreement between nations to mandate country-by-country reductions in greenhouse-gas emissions. Kyoto emerged from the United Nations Framework Convention on Climate Change (UNFCCC). The framework pledges to stabilize greenhouse-gas concentrations "at a level that would prevent dangerous anthropogenic interference with the climate system.This treaty was finalized in Kyoto, Japan, in 1997, and it went into force in 2005. Nearly all nations have now ratified the treaty, with the notable exception of the United States. The Kyoto Protocol implemented the objective of the UNFCCC to reduce the onset of global warming by reducing greenhouse gases which are Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur hexafluoride (SF6).

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Degradation of ecosystem and its impact on Environment

Degradation means loss of quality. It is well known now that degrading ecosystems like land, water, air cannot support growing population. It results in the disturbance of ecosystem services such as resources availability and their quality i.e. soil, water, air.

Ecosystems are working in co-ordination with each other that means they are dependent on each other. Hence human interference in one ecosystem leads to loss of other ecosystem functions. This can be explained with example of soil erosion in forest (i.e. land) degradation due to forest cutting. Similarly cutting of forest leads to loss of quality of air. As air is one of the ecosystem service provided by forests.

Types of ecosystem degradation :

a) Land (Soil) - Loss of soil quality leads to loss of agricultural productivity. Causes of land or soil ecosystem degradation are poor farming practices, industrial water pollution, and improper waste disposal on land. Also deforestation leads to desertification causing loss of land ecosystem like agricultural, forest, grassland. It leads to change in local climate making ecosystem alteration. In India there is rise of 0.57% of desertification of land in 2013 since earlier 29.3% in 2003. It is 1.87 million hector's (ISRO).

Effects of land degradation –

- ❒ Soil erosion
- ❒ Loss of agricultural land
- ❒ Loss of natural vegetation
- ❒ Change in local climate

b) Water quality deterioration – Ecosystem such as river, streams, wells, ponds are affected by manmade pollution. Major cause of loss of quality of water is mixing of industrial wastewater into fresh water bodies. Eutrophication is also main cause of death of rivers

worldwide. For example- Eichornia is aquatic weed causing rivers and lakes to convert into land.

Effect of water quality deterioration-

- ❒ Loss of drinking water quality
- ❒ Ground water pollution
- ❒ Surface water pollution
- ❒ Spread of water born diseases

c) Deterioration of Air Quality – Deterioration of air quality is result of industrial pollution and transport. Forest ecosystem purifies air quality which available on earth. Worldwide 18% of oxygen is generated by Amazon rain forest. Change in forest cover leads to loss of air quality globally.

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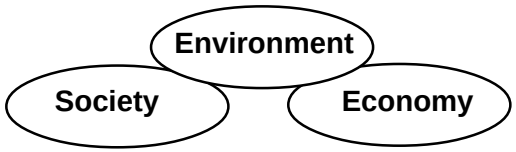
Environmental Sustainability

Environmental sustainability is one of the basic need of today's era. It means meeting our own needs without compromising the ability of future generations to meet their own needs. Environmental sustainability, is responsible interaction of human society with the nature to prevent depletion of natural resources and permit for long term environment quality. The sustainability depends on the community's sensible and ecofriendly actions towards planned economic development.

The concept of Sustainable Development was first put forward in 1987 report 'Our Common Future' prepared for the World Commission on Environment and Development. The links between inequality, poverty and environmental degradation were identified in this report and it was clearly stated that the world needed to find a way to harmonize ecological balance with economic prosperity. The report emphasized the reality that sustainable development is the key solution for better future.

Sustainability is a holistic approach that includes ecological, social, and economic dimensions, recognizing that all must be considered together for environmental conversation. The concept of sustainability stands on three pillars which are Environment, Economy and Society. These pillars in many national standards and certification schemes form the backbone of tackling the core environmental problem.



First pillar includes the earths 'Environment' which indicates that it is necessary to keep balance of natural resources. The usage of such resources should be within limit considering its renewability. The second pillar related to 'Economy' implies an approach to economic growth while

preserving the environmental quality. The economic growth against nature's resilience capacity elaborates the environmental problems like pollution, degradation of natural resources, loss of biodiversity including social imbalance. The third pillar includes the 'Society'. The universal human rights and basic necessities of the society can be achieved through appropriate use and distribution of natural resources. It is necessary to make the society environmentally aware. The people should learn to value resources and allow nature to replenish. Therefore, for a better future of society, the sustainable development is essential which mixture of economic, social and environmental policies is for today and for tomorrow.

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Environmental communication and public awareness

Environmental communication is the distribution of information and the implementation of communication practices that are related to the environment. It is the planned and strategic use of communication processes and media products to support effective policy making, public participation and project implementation geared towards environmental sustainability. Environmental communication also includes human interactions with the environment. This includes a wide range of possible interactions, from interpersonal communication and virtual communities to participatory decision-making and environmental media coverage. Environmental Communication is a two-way social interaction process enabling the people concerned to understand key environmental factors and their interdependencies and to respond to problems in a competent way. Environmental communication proves important as it fosters a sense of connection to the natural world, promotes sustainable development and encourages conservation of natural resources and vulnerable plant and animal species.

There are different communication tools useful for the community interaction:

Communication and Public Awareness tools

Print / radio

- ❒ Media press release
- ❒ Radio programme
- ❒ Feature articles

TV

- ❒ News
- ❒ Biodiversity Agriculture, Science programmes
- ❒ Videos/CDs/DVDs of interesting activities and outcomes

Advertising and feature stories

- ❒ Print
- ❒ Radio
- ❒ Television

Publishing

- ❒ Brochures
- ❒ Posters
- ❒ Bill Boards
- ❒ Letters
- ❒ Leaflets/flyers
- ❒ Technical Reports
- ❒ Websites
- ❒ Blogging, Listserves, Wikis

Public Relations

- ❒ Biodiversity, Science and Agriculture shows
- ❒ T-shirts, Bags, Stickers
- ❒ Telephone calls
- ❒ Side events
- ❒ Conference

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Environmental Movements:

Environmental movements have played very essential role in environmental conservation in Indian history. Some of them are as follows:

- **The Chipko Movement**:

The Chipko Movement is non- violent, social or ecological and environmental movement by rural villagers for the conservation of forest in India. The word 'Chipko' means 'to hug or stick' as in this movement villagers hugged the trees and encircled them to prevent felling of trees. This movement originated in the Himalayan region of Uttar Pradesh (later Uttarakhand) in 1973. In this movement both female and male activist played vital role including Gaura Devi, Sudesha Devi, Bachni Devi, Chandi Prasad Bhatt and many other. Women's active participation was the most novel aspect of this movement.

Chipko protests in Uttarakhand achieved a major victory in 1980 with a 15 years ban on green felling in the Himalayan forest of the state by order of Hon Mrs. Indira Gandhi Prime Minister of India. In addition to the 15 years ban in Uttarakhand, felling of trees in Western Ghats and Vindhyas also stopped. It has also generated pressure for a natural resource policy that is more sensitive to people need and ecological requirements. This movement has become a relaying point for many other environmental movements. Sunderlal Bahuguna was one of the leaders who gave notable contributions to the Chipko movement. in general, was his creation of the Chipko's slogan "Ecology is permanent economy".

- **The Appiko movement:**

In the early 1980's, the Karnataka department of forestry opened for logging the forests of Western Ghats, which spread across the state of Karnataka. The government proposed the construction of pulp and paper mill and a chain of hydroelectric dams to control the river in Western Ghats.

Thus, to prevent clear cutting of trees in that area, this movement was started by embraced trees which were to be cut by contractors of the forest department. The Appiko movement similar to Chipko movement for the conservation of forest in India was non violent movement launched in September 1983. It was started in the Salkani village of Kannada district in Karnataka. It is also known as southern version of Chipko movement as local people of Salkani village including men, women and children hugged the trees in 'Kalase' forest to prevent felling of trees. The Appiko movement used various techniques to raise awareness such as slide show, Folk Dances, Street plays, etc. This movement was led by Shri. Pandurang Hegade.

The protest within the forest continued for 38 days and finally the felling order were withdrawn and the state government has banned felling of green trees in some forest areas, only dead and dry trees are felled to meet local requirement.

- **Save Silent Valley Movement:**

Save silent valley was an environmental movement intended to protect Silent Valley, an evergreen tropical forest in the Palakkad district of Kerala. This tropical rainforest in Western Ghat is precious reservoir of biodiversity where many plants and animal species have survived for centuries. The save silent valley movement is a source of inspiration for many later anti-dam movements in India. The silent valley movement was related with the proposed construction of river valley project to fetch electricity and irrigation to the people of an area. This battle was started and it goes on for ten years.

Several NGO's, KSSP (Kerala Shatra Sahitya Parishad) opposed the project. The KSSP had published a campaign booklet with titled 'The silent valley hydroelectric project : A techno-economic and socio-political assessment'. Many environmentalists of the India including the noted ornithologist Salim Ali has raised their voice in assembly of the legislative

and has given their objection. The IUCN also registered disapproval. A nationwide campaign was launched to save Silent Valley. Save Silent Valley Movement started in various states and several NGO's within state joined hands. By using any possible material to inform at that time like letters to the editor of newspaper, seminars, widespread awareness program, by using this all the public sustained pressure exerted on the government by citizens, in the last finally petition, appeals in the court proved ultimately successful.

- **Ralegan Siddhi movement by Anna Hajare**

Social activist Shri. Anna Hazare is well-known for his village Ralegan Siddhi, which has been named as a model for its novel experiments in water conservation, use of non-conventional energy methods were used for social transformation. Ralegan Siddhi is in a drought-prone and rain-shadowed area of Maharashtra. In 1975, due to water scarcity problem and soil degradation 2,500 people, mostly farmers, were un-farmable. Wells ran dry which made it difficult for people to find drinking water during part of the year. As a result of which people started leaving Ralegan Siddhi in search for work.

Anna Hazare knew that the only way that the village could be revived was with the participation of the entire community, especially the youth. Anna started a youth society and village assembly to spread ideas and organize the village and a livelihood elsewhere. He was able to identify water development as the primary need of the village. His intervention to manage rain-water runoff through watershed development was cheap with maximized use of local resources. He went on to include community work to prevent erosion and to promote widespread afforestation. The holistic impact of these measures began to be felt within a decade. Presently, the total productivity has increased manifold. There is a sense of community and sharing among all the people, and complete self-sufficiency in food grains. Hazare has helped farmers of

more than 70 villages in drought-prone regions in the state of Maharashtra since 1975.

Alwar District movement by Rajendra Singh Rana :

Water is the elixir of life. It sustains the growth and development of various organisms. If we continue to exploit our water resources, then a time will come when we will face a major global water scarcity and water wars will follow it. Dr. Rajendra Singh of Alwar district of Rajasthan understood it very well. His attempts at water management and conservation are a testimony to this fact. He won the Magsaysay Award in 2001 and Stockholm water prize in 2015 for his water conservation activities. He bagged the title of 'Waterman of India' for his inspirational efforts. He solved the problem of water scarcity in Rajasthan by disseminating information on traditional water conservation technologies. 'Johads' can be described as small earthen check dams that capture and conserve rainwater and help in meeting our water needs in dry seasons. It also improves percolation and helps in recharge of groundwater table.

Rajendra Singh was able to revive 3000 Johads spread across more than 650 villages in Alwar district, Rajasthan, starting from 1984. It has resulted in a steady rise of the groundwater table by almost 6 meters and a 33% increase in the forest cover in the area that was destroyed by deforestration and mining activities. Five seasonal rivers are now perennial in nature due to his continuous efforts.

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Human population growth and impact on environment:

Human population is growing with alarming rate. There were 1 billion people in 1800. Today in 200 years it is 7.6 billion. This exceptional rise of population has put large pressure on resources and natural state of environment.

According to researchers population size is important factor in measuring environmental impact. Rising number of mouths needs what not? Land, food, water and other life support system is required by people.

a) Effects of population on physical environment-

Physical environment means non living things around human. These are required for survival of man and other living creatures in nature. These include land, air, water and soil. Soil is also considered as living resource as it has microorganisms for its completeness. This soil has pressure of agriculture over production with chemical supplements. Similarly, production of goods to meet demand of people leads to air, water pollution.

b) Effects of population on forests -

It is clear that growing organization leads to cutting of forests. This causes loss of green cover which is important source of air for life. Not only air but other resources such as biodiversity, fresh water are also reduced due to pressure of human settlements.

Recently in year March 2018 Cape Town in Africa declared first 'Waterless City' of world. This is alarming and is repeatedly told by environmental scientists.

c) Land, soil degradation-

Land is required for both residential and agriculture purpose. Good soil is need of food production. Loss of productive land is due to extreme agriculture with less organic matter over irrigation. Loss of agriculture land due to townships and roads is also effect of population rise. It takes 50 years to form one inch of productive soil but destruction of top soil needs only few weeks of human activities.

d) Effects of population on atmosphere -

Recent years are witnessing rise in temperature of earth atmosphere due industrialization and transport emission. 1990's were hottest decade in last 1000 years. Intergovernmental Panel on Climate Change (IPCC) predicts rise of 1 to 2°C in earth' s average temperature by year 2030. This has effect on human life and earth's atmospheric cycles.

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Indian Culture and Environmental Protection

Nature and natural resources are always given vital importance in Indian culture. It is always reflected through traditional practices, religious beliefs, rituals, folklore, and arts and crafts and in the daily lives of the Indian people. The culture also tells us how our ancestors lived in harmony with nature and with a tradition to respect each component in ecosystems. Drawing up the natural resources for mere sustenance and at the same time protecting the same was part of life. Now days, the sophisticated human civilisation tends to look the indigenous people as primitive, poor, illiterate, backward and superstitious which seems to be wrong in today's situation.

In fact, these people were having incredible understanding of nature and natural systems. For these people, the earth was not an object to be used and also, not a possession. For them, earth was a living entity to be given due respect and the relationship was one of sacred trust and loving relationship. Worshiping Mother Earth is part of Indian rituals. There are innumerable examples of festivals, rituals, songs, and myths that celebrate the gifts of nature, enlightening the close sense of togetherness. Respect for nature is inherent in many religious faiths. Many Hindu gods and goddesses are shown to use animals as mount. Sacred groves or sacred forests preserved with admiration have been part of Hindu and Buddhist culture.

One of the finest examples of traditional practices in India based on religious faith which has made a profound contribution to nature conservation has been the maintenance of certain patches of land or forests as "sacred groves'. These forest patches are dedicated to a deity or a village God, protected, and worshipped. These are found all over India, and abundantly along the Western Ghats, the west coast, and in several parts of Kerala, Karnataka, Tamil Nadu and Maharashtra. In Jainism, Christianity as well as in Islam, conservation of the environment is based on the principle that

nature and its components are created by God and humans are entrusted with the responsibility of protecting it. Today, when people throughout the world are anxious by the degradation of natural resources and facing disastrous consequences, long-established ethics of nature conservation could be looked upon as a source of motivation and guidance for the future. Perhaps no other culture can provide such a profound variety of cultural practices and ecologically sound relationship with nature as the Indian.

Sustainable Development and its goal in Indian context

The Sustainable Development Goals (SDGs) are the plan to attain a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate change, environmental degradation, peace and justice. The SDGs and targets will stimulate action in the following critically important areas: poverty, hunger, education, health and well-being, gender equality, water and sanitation, energy, economic growth, infrastructure, industry and innovation, reducing inequalities, sustainable cities, consumption and production, climate action, ecosystems, peace and justice, and partnership.

The Sustainable Development Goals were adopted in September 2015 as a part of the resolution, 'Transforming our world: the 2030 Agenda for Sustainable Development'. India is committed to achieve the 17 SDGs and the 169 associated targets, which comprehensively cover social, economic and environmental dimensions of development and focus on ending poverty in all its forms and dimensions. This comprehensive agenda recognises that it is no longer sufficient just to focus on economic growth, but on fairer and more equal societies, and a safer and more prosperous planet. It recognises, above all, that global and interconnected challenges can only be fought with global and interconnected solutions. It is an ambitious plan that will require a renewed global partnership between governments, businesses, the civil society, and individuals. As we make progress towards achieving the 169 targets, we will reorient national and global development on a more sustainable, more resilient path.

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