LIST OF COURSES

THE STANDARD FIREWORKS RAJARATNAM COLLEGE FOR WOMEN (AUTONOMOUS), SIVAKASI – 626 123.

(Affiliated to Madurai Kamaraj University, Re-accredited with A Grade by NAAC,
College with Potential for Excellence by UGC and Mentor Institution under UGC PARAMARSH)

COURSES RELATED TO GENDER, ENVIRONMENT AND SUSTAINABILITY, HUMAN VALUES AND PROFESSIONAL ETHICS

The following courses are mandatory for UG Programmes

S. No.	Courses Related To Gender, Environment And Sustainability, Human Values	Description
1.	Environmental Studies	Create awareness on environmental issues and inculcate environmental ethics.
2.	Peace Education	Promote them to learn about Non-violence and Peace, global harmony, role-models and human rights.
3.	Value Education and Gender Studies	The course mandatory for all first UG students in the curriculum tells about the societal values, family values, professional ethics, and morality as a part of Gender studies, sex and gender, adolescence period, gender equality, women employment and women health is focused. As a whole the course hub on peaceful contentment of women. It enables the students to maintain peace and harmony with in our own self and to maintain a universal human goodness.
4.	Women Studies	Create awareness on gender equality, relationship with family and environment, breast feeding and child care and nutrient requirements.

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COURSES RELATED TO GENDER, ENVIRONMENT AND SUSTAINABILITY, HUMAN VALUES AND PROFESSIONAL ETHICS

THE STANDARD FIREWORKS RAJARATNAM COLLEGE FOR WOMEN (AUTONOMOUS), SIVAKASI
DEPARTMENT OF PHYSICS
B.Sc. PHYSICS PROGRAMME
(For those who have joined in 2017and later)
CHOICE BASED CREDIT SYSTEM
PROGRAMME CODE – GLPH
PROGRAMME SCHEME

Component	Course Code	Course Title	Teaching Hours Per Week	Credits	Duration of Exam. (Hrs.)	Marks Allotted		
						Internal	External	Total
Semester I								
Part I	GLGT11/ GLGH11/ GLGF11	தமிழ் இலக்கியமும் உரைநடையும்/ Hindi Language Course – I/ French Language Course - I	6	3	3	25	75	100
Part II	GLGE11	Communicative English-I	6	3	3	25	75	100
Part III	GLPH11	Mechanics and Properties of Matter	4	4	3	25	75	100
	GLPH12	Physics applications in Everyday life	3	3	3	25	75	100
	GLPH1A	Fundamental Physics (Maths& Chemistry)	4	4	3	25	75	100
Part IV	GLPE11	Peace Education	2	2	2	25	75	100
		Total	**25**	**19**				**600**
Semester II								
Part I	GLGT21/ GLGH21/ GLGF21	தாய்மை இலக்கியமும் பதிவும்/ Hindi Language Course -II / French Language Course - II	6	3	3	25	75	100
Part II	GLGE21	Communicative English-II	6	3	3	25	75	100
Part III	GLPH21	Optics	5	5	3	25	75	100
	GLPH2L	Lab I	6	4	3	40	60	100
	GLPH2A1	Digital Electronics (Maths)	4	4	3	25	75	100
	GLPH2A2	Solid State Physics and Digital Electronics(Chemistry)	4	4	3	25	75	100
Part IV	GLES21	**Value Added Course** Environmental studies	2	2	2	25	75	100
	GLCL23	**Value Added Course** Introduction to Computers and MS office	2	2	2	25	75	100
Part V	-	Extension Activities – Physical Education and Social Awareness Programme		1				100
		Total	**35**	**28**				**900**
Semester III								
Part I	GLGT31/ GLGH31/ GLGF31	சமய இலக்கியமும் நாடகமும்/ Hindi Language Course –III / French Language Course - III	6	3	3	25	75	100
Part II	GLGE31	Communicative English-III	6	3	3	25	75	100
Part III	GLPH31	Electricity	4	4	3	25	75	100
	GLPH32	Electromagnetism	3	3	3	25	75	100
Part IV	GLPH3N	Physics for the new world	2	2	2	25	75	100
		Total	**32**	**21**				**700**
Semester IV								
Part I	GLGT41/ GLGH41/ GLGF41	கவிதை இலக்கியமும் சிறுகதையும்/ Hindi Language Course -IV/ French Language Course - IV	6	3	3	25	75	100
Part II	GLGE41	Communicative English-IV	6	3	3	25	75	100

Dr.(Mrs) S.SIVA DEVI
HOD of Physics
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Dr. T. Palaneeswari
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COURSES RELATED TO GENDER, ENVIRONMENT AND SUSTAINABILITY, HUMAN VALUES AND PROFESSIONAL ETHICS

Part III	GLPH41	Basic Electronics	5	5	3	25	75	100
	GLPH4L	Lab II	6	4	3	40	60	100
Part IV	GLPH4N	Solar Energy and its Applications	2	2	2	25	75	100
	GLPH4DSL	**Skill Based Course** **Discipline Specific Course** Scientific Skill Development	2	2	2	40	60	100
		Total	**27**	**19**				**600**
Semester V								
Part III	GLPH51	Classical Mechanics	6	5	3	25	75	100
	GLPH5E1	Digital Electronics	5	5	3	25	75	100
	GLPH5E2	Atomic and Nuclear Physics	5	5	3	25	75	100
	GLPH5E3	Fiber optics	5	5	3	25	75	100
	GLPH5E4	Energy physics	5	5	3	25	75	100
Part IV	GLGV51	**Value Added Course** Career Guidance and Subject Viva	2	2	2	25	75	100
	GLWS51	**Value Added Course** Women Studies	2	2	2	25	75	100
		Total	**30**	**29**				**700**
Semester VI								
Part III	GLPH61	Solid State Physics	6	5	3	25	75	100
	GLPH62	Wave mechanics	5	5	3	25	75	100
	GLPH6L	Lab IV	6	5	3	40	60	100
	GLPH6E1	Thermodynamics	5	5	3	25	75	100
	GLPH6E2	Bio physics	5	5	3	25	75	100
Part IV	GLSE66	**Skill Based Courses (Open to all)** Self-Employment courses Domestic Electrical Appliances Servicing	2	2	2	25	75	100
	GLSE66L	**Self-Employment courses** Domestic Electrical Appliances Servicing – Lab	2	2	3	40	60	100
		Total	**31**	**29**				**700**

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ENVIRONMENTAL STUDIES

Published by

Curriculum Design and Development Cell

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Sivakasi-626 123.

Environmental studies

Authors

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Sivakasi – 626 123.

Dr. (Mrs.) D. Sasireka, M.Sc., M.Phil., Ph.D.,

Principal

SFR College for Women

Sivakasi

FOREWORD

SFRC one of the premier Institutions of higher education, has mainstreamed and mandated environmental studies at under graduate level as they are the critical stakeholders and who would translate knowledge into wise application for solutions pertaining to environmental issues. Existence of life depends on the most abundant resources of the planet—land, air, and water. At present the world is faced with one of the most paradoxical situations in its history—feeding the burgeoning population while conserving the resources for consumption by the present population has been predicted to be unsustainable. Environment is not a single subject, it is an integration of several subjects that include both science and social studies. It is essentially a multidisciplinary approach and its components include Biology, Geology, Chemistry, Physics, Engineering, Sociology, Health Sciences, Anthropology, Economics, Statistics and Philosophy. Thus, the scope of environmental studies extremely wide and covers some aspects of nearly every major discipline. The need for sustainable development is a key to the future of mankind. Continuing problems of pollution, solid waste disposal, degradation of environment, issues like economic productivity and national security, Global warming, the depletion of ozone layer and loss of biodiversity have made everyone aware of environmental issues. In this situation the authors have brought out this edition with amazing consistency to enrich the social standards of life of stakeholders. Their credential efforts are duly acknowledged.

It is my privilege to acknowledge the Dynamic Diplomats of the members of Management Committee as the academic success of our institution is mainly due to their healthy concoction of innovation, planning and perseverance with farsightedness to visualize and anticipate changes to the tune of the present globalized academic sector.

D.Sasireka

Dr. (Mrs.) T. Palaneeswari, M.Com., M.Phil., Ph.D.,

Principal,

The Standard Fireworks Rajaratnam College for Women

Sivakasi

FOREWORD

SFRC stands as a dynamic testimony for its devoted service towards the cause of higher education. It has mandated environmental studies into under graduate curriculum. In the era of advance living standard of the human being, our environment is getting affected to a great extent by the means of air pollution, noise pollution, deforestation, water pollution, soil pollution, acid rain and other dangerous disasters created by the human beings through technological advancement. Other issues threatening mankind are overpopulation, Climate change, Urban sprawl, Global warming, Hazardous waste, Biomedical wastes, e-waste and loss of biodiversity that have made everyone aware of environmental issues. The degradation of the environment has become a serious problem for the existence of human beings. Everyone must know how to protect our environment to keep it safe forever as well as ensure the nature's balance on this planet to continue the existence of life. There is a need for information that clarifies modern environmental concepts such as the need to conserve biodiversity, the need to lead more sustainable lifestyles and the need to use resources more equitably. Environmental studies take a multidisciplinary approach to the study of human interactions with the natural environment. It integrates different approaches of the humanities, social sciences, biological sciences and physical sciences and applies these approaches to investigate environmental concerns. At this juncture, the efforts put forth by the authors to enable the students to understand the complexities of the environment and to adapt appropriate activities and pursue sustainable development which are harmonious with the environment, should be highly acknowledged. It is my honour to acknowledge the magnanimous members of the Management Committee for their untiring support in all means to bring innovation in curriculum.

T.Palaneeswari

PREFACE

Environmental studies is a multidisciplinary field which relates human interaction with the environment. It incorporates the study of the physical, chemical and biological processes that take place on the Earth. Study of environment is an integral part of education which must be updated constantly by changing with the changing time. Sustainable development is the only key to unlock the environmental issues. Depletion of ozone layer and loss of biodiversity has rung the bell and now people have started to focus on minimization of pollution, disposal of solid waste. This textbook is written to convey about the ecosystem, biodiversity, causes, effects and methods adopted to minimize pollution and also about natural disasters. The Authors are obliged to the Management and Principal for their unvarying encouragement and support.

Authors

THE STANDARD FIREWORKS RAJARATNAM COLLEGE FOR WOMEN (AUTONOMOUS), SIVAKASI.

PART IV – ABILITY ENHANCEMENT COURSES

VALUE ADDED COURSES

BDES11 - ENVIRONMENTAL STUDIES

SEMESTER I

(For those who have joined in June 2020 and later)

Contact hours per week : 02
Total number of hours per semester : 30
Number of credits : 02

Course Outcomes (CO):

On successful completion of the course, the learners should be able to

CO1[K2]: recognize the importance of environment and role of individual in its protection.
CO2 [K2]: represent the primary environmental problems and its potential solutions.
CO3 [K3]: utilize the methods for the sustainable use of natural resources.
CO4 [K4]: organize an action plan for sustainable alternatives that integrate science, humanist and social perspectives.
CO5 [K4]: compare the structure and functions of ecosystems in the context of human- environmental interactions.

CO-PO Mapping table (Course Articulation Matrix)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	1	-	-	-	1
CO2	3	3	1	-	-	-	-
CO3	3	3	1	1	-	1	1
CO4	3	3	1	3	-	3	1
CO5	3	3	3		-	-	-
Weightage of the course	**15**	**13**	**7**	**4**	**-**	**4**	**3**

Based on the level of contribution (9-High, 3-Medium, 1-Low)

UNIT I (10 hrs)

Environmental studies: Introduction – uses of environment – importance of environmental studies – scope of environmental studies – environmental studies as a multidisciplinary subject – need for public awareness. Natural resources: types - renewable resources - non –renewable resources – forest resources – water resources – mineral resources – food resources – energy resources – land resources.

Ecosystem: Concept of ecosystem – functions of ecosystem – components of ecosystem – biogeochemical cycles – Biodiversity – *In situ* and *ex situ* conservation of biodiversity – conservation of wild life.

UNIT II **(10 hrs)**

Environmental Pollution: Introduction –pollutants – causes of pollution – types of pollution – effects of pollution – air pollution - water pollution – marine pollution – soil pollution – noise pollution – thermal pollution – radioactive pollution.

Role of IT in environment, sustainable development, Environmental legislations and acts.

Unit III **(10 hrs)**

Solid waste and Disaster management

Solid waste management: Solid waste – types, causes and impact of solid waste – solid waste management – Landfill – Composting – incineration – Recycling – Pyrolysis – Reduction in use – Hazardous waste management – Hazardous waste – impact and strategies.

Disaster management: Disaster and its types – Disaster management – causes, impact, protective steps and case study: Flood, Earthquake, Cyclone, Landslides and Tsunami.

(Study Material will be provided)

Reference Books

1. Arumugam. A., Kumaresan. V (2015), **Environmental Studies**, Saras Publications, Nagercoil, Tamilnadu, India.
2. Eracha Bharucha, (2008), **Text Book of Environmental Studies,** University Press, Hyderabad.
3. Agarwal, S.P (2006), **Environmental Studies**, Narosha Publishing House, Kolkatta.
4. Manoharachary, C. and Jyarama Reddy, P (2006), **Environmental Studies,** B.S. Publication, Hyderabad.

CONTENTS

UNIT 1: INTRODUCTION TO ENVIRONMENTAL STUDIES

Dr. S. Subha Ranjani

INTRODUCTION

The science of Environment studies is a multi-disciplinary science because it comprisesvarious branches of studies like chemistry, physics, medical science, life science, agriculture,public health, sanitary engineering etc. It is the science of physical phenomena inthe environment. It studies of the sources, reactions, transport, effect and fate of physicaland biological species in the air, water and soil and the effect of from human activity uponthese.

DEFINITION

The word environment isderived from the French word ***'environ'*** meaning surroundings. **Environment** is the complex of physical, chemical, and biotic factors that act upon an organism or an ecological community and ultimately determine its form and survival.

USES OF ENVIRONMENT

Environment plays an important role in the healthy living of human beings. The only home that humans have is environment, and it provides air, food, and other needs. Humanity's entire life support system depends on the well-being of all the environmental factors.

IMPORTANCE OF ENVIRONMENTAL STUDIES

The environment studies make us aware about the importance of protection and conservation of our mother earth and about the destruction due to the release of pollution into the environment. The increase in human and animal population, industries and other issues make the survival cumbersome. A great number of environment issues have grown in size and make the system more complex day by day, threatening the survival of humankind on earth. Environment studies have become significant for the following reasons:

1. Environment Issues are being of Global:

It has been well recognised that environment issues like global warming and ozone depletion, acid rain, marine pollution and biodiversity are not merely national issues but are global issues and hence require international efforts and cooperation to solve them.

2. Development and Environment:

Development leads to Urbanization, Industrial Growth, Telecommunication and Transportation Systems, Hi-tech Agriculture and Housing etc. However, it has become

phased out in the developed world. The North intentionally moves their dirty factories to South to cleanse their own environment. When the West developed, it did so perhaps in ignorance of the environmental impact of its activities. Development of the rich countries of the world has undesirable effects on the environment of the entire world.

3. Explosive Increase in Pollution:

World census reflects that one in every seven persons in this planet lives in India. Evidently, with 16 per cent of the world's population and only 2.4 per cent of its land area, there is a heavy pressure on the natural resources including land. Agricultural experts have recognized soil health problems like deficiency of micronutrients and organic matter, soil salinity and damage of soil structure.

4. Need for an Alternative Solution:

It is essential, especially for developing countries to find alternative paths to an alternative goal. We need a goal as under:

- A true goal of development with an environmentally sound and sustainable development.
- A goal common to all citizens of our planet earth.
- A goal distant from the developing world in the manner it is from the over-consuming wasteful societies of the “developed” world.
- It is utmost important for us to save the humanity from extinction because of our activities constricting the environment and depleting the biosphere, in the name of development.

5. Need for Wise Planning of Development

Our survival and sustenance depend on resources availability. Hence, Resources withdraw, processing and use of the products have all to be synchronised with the ecological cycle. In any plan of development, our actions should be planned ecologically for the sustenance of the environment and development.

SCOPE OF ENVIRONMENTAL STUDIES

Environmental studies discipline has multiple and multilevel scopes. This study is important and necessary for everyone. The scopes are summarized as follows:

1. The study creates awareness among the people to know about various renewable and nonrenewable resources of the region. The endowment or potential, patterns of utilization and the balance of various resources available for future use in the state of a country are analyzed in the study.

2. It provides the knowledge about ecological systems cause and effect relationships.

3. It provides necessary information about biodiversity richness and the potential dangers to the species of plants, animals and microorganisms in the environment.

4. The study enables one to understand the causes and consequences due to natural and main induced disasters (flood, earthquake, landslide, cyclones etc.,) and pollutions and measures to minimize the effects.

5. It enables one to evaluate alternative responses to environmental issues before deciding an alternative course of action.

6. The study enables environmentally literate citizens (by knowing the environmental acts, rights, rules, legislations, etc.) to make appropriate judgments and decisions for the protection and improvement of the earth.

7. The study exposes the problems of over population, health, hygiene, etc. and the role of arts, science and technology in eliminating/ minimizing the evils from the society.

8. The study tries to identify and develop appropriate and indigenous eco-friendly skills and technologies to various environmental issues.

9. It teaches the citizens about the need for sustainable utilization of resources as these resources are inherited from our ancestors to the younger, generating without deteriorating their quality.

10. The study enables theoretical knowledge into practice and the multiple uses of environment.

ENVIRONMENTAL STUDIES AS A MULTIDISCIPLINARY SUBJECT

The science of Environment studies is a multidisciplinary science because it depends on various disciplines like Chemistry, Physics, Engineering, Sociology, Health Sciences, Anthropology, Economics, Statistics, Geology and Philosophy,Medical science, etc. It is the science of physical phenomena in the environment. It is inherently a multidisciplinary field that draws upon not only its core scientific areas, but also applies knowledge from other non-scientific studies such as economic, law and social science.

1. Physics:

- To understand the flux of material and energy interaction.

2. Chemistry:

- To understand the molecular interactions in the system.

3. Biology:

- To describe the effects within the plant and animal kingdom and their diversity.

4. Atmospheric Science:

- To examine the phenomenology of the Earth's gaseous outer layer with emphasis upon interrelation to other systems.
- Itcomprises meteorological studies, greenhouse gas phenomena, airborne contaminants, sound propagation phenomena related to noise pollution, and even light pollution.

5. Ecology:

- To analyse the dynamics among an interrelated set of populations, or a population and some aspects of its environment.
- The ecological studies deals with endangered species, predator interactions, and effects upon populations by environmental contaminants, or impact analysis of proposed land development upon species viability.

6. Environmental Chemistry:

- To study the chemical alterations in the environment.
- Principal areas of study include soil contamination and water pollution.
- The topics of analysis involve chemical degradation in the environment, multi-phase transport of chemicals and chemical effects upon biota.

7. Geo-science:

- It includes environmental geology, environmental soil science, volcanic phenomena and evolution of the earth's crust.
- In some classification systems, it can also embrace hydrology including oceanography.

8. Mathematics and Computer Science:

- It will help in environmental modelling and analysis of environment related data.

9. Economics:

- It deals with economical aspects of various components of environment.

10. Law:

- It helps in framing of environment related laws, Acts, rules and their monitoring.

11. Social Science:

- It helps in dealing with population and health related issues.

An understanding of the working of the environment requires the knowledge from wide ranging fields. The Table 1 below shows a list of topics dealt commonly in air pollution and the related traditional fields of knowledge illustrating the interdisciplinary nature of the subject.

Table 1.1 Interdisciplinary Nature of Environmental Science:

Air Pollution	**Major subject/ Topic knowledge required**
Nature and reaction of air pollutants	Chemistry and Chemical engineering
Effects of air pollutants on human beings, animal and plants	Physics, Chemistry, Zoology, Botany and various branches of life science.
Effect of air pollutants on materials	Meteorology, Thermodynamics, Geography
Effect of climate on air pollution	Mathematical modeling.
Air pollution control devices	Physics, chemistry and various branches of Engineering
History of air pollution and air pollution episodes	History
Economic impacts of air pollution	Economics and Demography
Sociological impacts of air pollution	Sociology
Alternative fuels	Various branches of Physical sciences
Conservation of resources and pollution control	Various branches of physical and political sciences
Ozone hole and global warming	Almost all fields under the sun has got something to contribute to the understanding and prevention of these phenomenon

NEED FOR PUBLIC AWARENESS:

Since our environment is being degraded due to human activities, It is essential to make the public aware of the formidable consequences of the Environmental Degradation. If these are not addresses and reformative measures undertaken, the extinction of life is inevitable. We are facing various environmental challenges as discussed below:

Growing Population

A population of over thousands of millions is growing. Over 17 million people are added each year. It puts considerable pressure on its natural resources and reduces the gains of development. Hence, the greatest challenge before us is to limit the population growth. Although population control does automatically lead to development, yet the development leads to a decrease in population growth rates.

Poverty

- India has often been described a rich land with poor people. Poverty and environmental degradation have a nexus between them. The vast majority of our people are directly dependent on the natural resources of the country for their basic needs of food, fuel, shelter and fodder.
- Environment degradation has adversely affected the poor who depend upon the resources of their immediate surroundings. Thus, the challenge of poverty and the challenge of environment degradation are two facets of the same challenge.
- Population growth is essentially a function of poverty. Because, to the very poor, every child is an earner and helper and global concerns have little relevance for him.

Agricultural Growth

People must be acquainted with the methods to sustain and increase agricultural growth without damaging the environment. High yielding varieties have cause soil salinity and damage to physical structure of soil.

Need for Ground water

It is essential to rationalize the use of groundwater. Factors like community wastes, industrial effluents and chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater. It is essential to restore the water quality of our rivers and other water bodies as lakes. Deciding on suitable technologies for restoring the quality of groundwater aquifers is essential.

Development and Forests

- Forests serve catchments for the rivers. The increasing demand of water, led to using rivers for irrigation projects. These caused forests to submerge and displacement of local people apart from damaging the local flora and fauna.
- Forests in India have been shrinking for several centuries owing to pressures of agriculture and other uses. Vast areas that were once green, stand today as wastelands. These areas are to be brought back under vegetative cover. The tribal communities inhabiting forests respects the trees and birds and animal that gives them sustenance. We must recognize the role of these people in restoring and conserving forests.
- The modern knowledge and skills of the forest department should be integrated with the traditional knowledge and experience of the local communities. The strategies for the joint management of forests should be evolved in a well planned way.

Degradation of land

A small portion of land possesses potential for production. Agricultural land suffers from varying degrees of soil degradation. Land degradation mainly occurs due to overgrazing and soil erosion due to wind and water.

Reduction of Genetic Diversity

Proper measures to conserve genetic diversity need to be taken. At present, most wild genetic stocks have been disappearing from nature. Wild animals including the Asiatic Lion are facing problem of loss of genetic diversity. The protected areas network like sanctuaries, national parks and biosphere reserves are isolating populations. So, they are decreasing chances of one group breeding with another. Remedial steps are to be taken to check decreasing genetic diversity.

Evil Consequences of Urbanisation

Nearly 27 per cent Indians live in urban areas. Urbanisation and industrialisation has given birth to a great number of environmental problem that need urgent attention. Over 30 percent of urban Indians live in slums. Out of India's 3,245 towns and cities, only 21 have partial or full sewerage and treatment facilities. Hence, coping with rapid urbanization is a major challenge.

Air and water Pollution

Majority of our industrial plants are using outdated and population technologies and makeshift facilities devoid of any provision of treating their wastes. A great number of cities and industrial areas that have been identified as the worst in terms of air and water pollution. Acts are enforced in the country, but their implementation is not easy. The reason is their implementation needs great resources, technical expertise, political and social will. Again the people are to be made aware of these rules. Their support is indispensable to implement these rules.

NATURAL RESOURCES

Natural resources are naturally occurring substances that are considered valuable in their relatively unmodified (natural) form. A natural resource's value rests in the amount of the material available and the demand for it. The latter is determined by its usefulness to production. Mining, petroleum extraction, fishing, hunting, and forestry are generally considered natural-resource industries, while agriculture is not. The term was introduced to a broad audience by E.F. Schumacher in his 1970s book *Small is Beautiful*.

CLASSIFICATION OF NATURAL RESOURCES

Natural resources are mostly classified into renewable and non-renewable resources.

RENEWABLE RESOURCES

Renewable resources are generally living resources (fish, reindeer, and forests, for example), which can restock (renew) themselves if they are not over-harvested but used sustainably. Once renewable resources are consumed at a rate that exceeds their natural rate of replacement, the standing stock will diminish and eventually run out. The rate of sustainable use of a renewable resource is determined by the replacement rate and amount of standing stock of that particular resource. Non-living renewable natural resources include soil and water.

Flow renewable resources are very much like renewable resources, only they do not need regeneration, unlike renewable resources. Flow renewable resources include renewable energy sources such as the following renewable power sources: solar, geothermal, biomass, landfill gas, tides and wind.

Resources can also be classified on the basis of their origin as biotic and abiotic.

Biotic resources are derived from living organisms. Abiotic resources are derived from the non-living world (e.g., land, water, and air). Mineral and power resources are also abiotic resources some of which are derived from nature.

NON-RENEWABLE RESOURCES

A non-renewable resource is a natural resource that exists in a fixed amount that cannot be re-made, re-grown or regenerated as fast as it is consumed and used up.

Some non-renewable resources can be renewable but take an extremely long time to renew. Fossil fuels, for example, take millions of years to form and so are not practically considered ‘renewable’. Many environmentalists proposed to tax on consumption of non renewable resources.

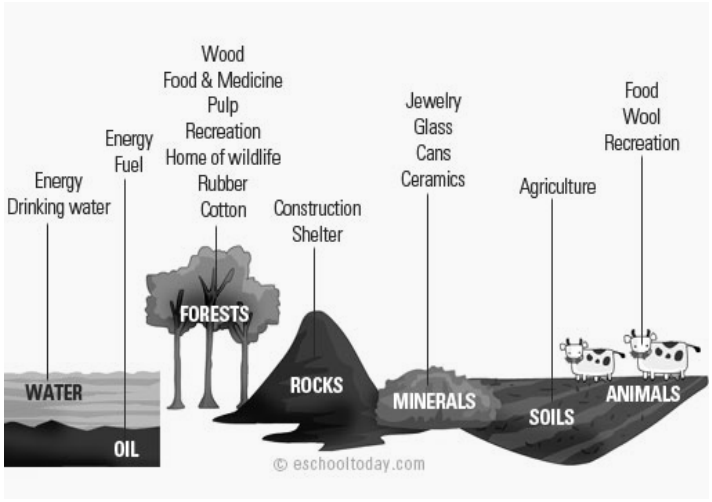

Figure 1.1: Natural resources

Problems associated with natural resources

1. The unequal consumption of natural resources

A major part of natural resources today are consumed in the technologically advanced or 'developed' world, usually termed 'the west'. The 'developing nations' of 'the east', including India and China, also over use many resources because of their greater human population. However, the consumption of resources per capita (per individual) of the developed countries is up to 50 times greater than in most developing countries. Advanced countries produce over 75% of global industrial waste and greenhouse gases.

2. Planning land use

Land is a major resource, needed for not only for food production and animal husbandry, but also for industry and growing human settlements. These forms of intensive land use are frequently extended at the cost of wild lands, our remaining forests, grasslands, wetlands and deserts. This demands for a practical policy that analyses the land allocation for different uses.

3. The need for sustainable lifestyles

Human standard of living and the health of the ecosystem are indicators of sustainable use of resources in any country or region. Ironically, both are not in concurrence with each other. Increasing the level of one, usually leads to degradation of other. Development policies should be formulated to strike a balance between the two.

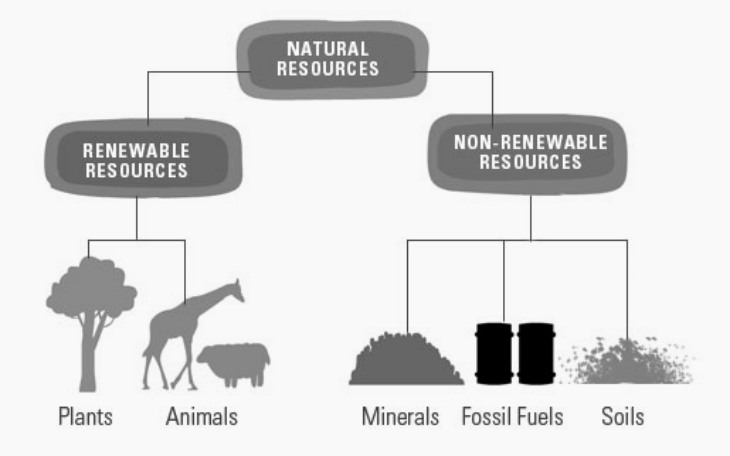

Figure 1.2: Types of Natural resources

FOREST RESOURCES

The word ‘forest’ is derived from the Latin word ‘foris’ means ‘outside’. A forest is a natural, self-sustaining community characterized by vertical structure created by presence of trees. Trees are large, generally single-stemmed, woody plants. Forest can exist in many different regions under a wide range of conditions, but all true forests share these physical characteristics. Many animals need forests to live and survive. Forests are very important and grow in many places around the world. They are an ecosystem which includes many plants and animals.

Forest is important renewable resources. Forest vary in composition and diversity and can contribute substantially to the economic development of any country.It is estimated that about 30% of world area is covered by forest whereas 26% by pastures (Pastures- Land covered with grass and other low plants suitable for grazing animals, especially cattle or sheep).Among all continents, Africa has largest forested area (33%) followed by Latin America (25%), whereas in North America forest cover is only 11%. Asia and former USSR has 14% area under forest. European countries have only 3% area under forest cover. According to the 2019 report, the total forest cover of our country is 712,249 square kilometres (21.67% of India's total geographical area).

Types of Forests

Forests can be classified according to a wide number of characteristics, with distinct forest types occurring within each broad category. However, by latitude, the three main types of forests are tropical, temperate, and boreal.

Tropical

Most tropical forests receive large amounts of rain annually (up to 100 inches), which is spread evenly throughout the year. However, there are some tropical forests that receive seasonal rainfall and experience both a wet and dry season. While tropical forests have many layers, most of the nutrients are held in the vegetation within the canopy; therefore, the soils are typically low in both mineral and nutrient content. Shallow roots allow for 'catching' any nutrients released by decaying leaves and ground litter.

Tropical forests are particularly important since they are unusually rich in biological diversity, especially insects and flowering plants. This incredible amount of biodiversity—accounting for 50 to 80 percent of the world's plant and animal species, with a potential for millions still undiscovered—is what defines these forests and makes them most unique. In just a few square kilometers, hundreds—even thousands—of tree and plant species can be found.

Deforestation is one of the greatest concerns in tropical areas, especially within rainforests which cover only a small area (approximately 7 percent) of the Earth's surface. Aside from their vast biodiversity, tropical forests provide homes to a large number of indigenous people and, in looking beyond the typical forest offerings, tropical forests supply both local and global markets with a variety of ingredients for medicines; nearly half of all medicines used today are linked to discoveries within these forests.

Temperate

Temperate forests—common throughout North America, Eurasia, and Japan—are primarily deciduous, characterized by tall, broad-leafed, hardwood trees that shed brilliantly colored leaves each fall. These forests experience varied temperatures and 4 seasons, with winter often bringing below freezing temperatures and summer bringing higher heat and humidity. Rainfall also varies, averaging 30 to 60 inches annually, allowing for soils that are well developed and rich in organic matter. They also provide habitat for a wide variety of smaller mammal species, including squirrels, raccoons, deer, coyotes and black bear and many bird species, including warblers, woodpeckers, owls, and hawks.

Temperate forests are often most affected by human activity since they are located in or near the most inhabitable areas. The land in these areas has long been used for agriculture and grazing, although great expanses of forest regeneration and small areas of pristine forest exist. The hardwoods are valuable for making furniture and other commodities, and many remaining forests have been modified to accommodate recreation and tourism.

Boreal

Boreal forests (also known as taiga) are located just south of the tundra and stretch across large areas of North America and Eurasia. They are one of the world's largest biomes, encompassing about 11 percent of Earth's land area, but have very short growing seasons with little precipitation and represent relatively few tree species. The forest is dominated by coniferous trees, which have needle-shaped leaves with minimal surface area to prevent excessive water loss. These forests provide habitat for a few large mammal species, such as moose, wolves, caribou, and bears, and numerous smaller species, including rodents, rabbits, lynx, and mink.

Despite the remote locations and often inhospitable environment, boreal forests have long been a source of valuable resources. Fur trading began in the 1600s and continued well into this century. Boreal forests are also rich in metal ores—including iron—and coal, oil, and natural gas. Most importantly, the forest serves as a major source of industrial wood and wood fiber, including softwood timber and pulpwood. However, the low productivity rate in these forests leads to a slow rate of forest regeneration.

Benefits of Forests

A forest is a biotic community predominantly of trees, shrubs and other woody vegetation, usually with a closed canopy. This invaluable renewable natural resource is beneficial to man in many ways.

The direct benefits from forests are:

(a) Fuel Wood: Wood is used as a source of energy for cooking purpose and for keeping warm.

(b) Timber: Wood is used for making furniture, tool-handles, railway sleepers, matches, ploughs, bridges, boats etc.

c) Bamboos: These are used for matting, flooring, baskets, ropes, rafts, cots etc.

(d) Food: Fruits, leaves, roots and tubers of plants and meat of forest animals form the food of forest tribes.

(e) Shelter: Mosses, ferns, insects, birds, reptiles, mammals and micro-organisms are provided shelter by forests.

(f) Paper: Wood and Bamboo pulp are used for manufacturing paper (Newsprint, stationery, packing paper, sanitary paper)

(g) Rayon: Bamboo and wood are used in the manufacture of rayon (yarns, artificial silk-fibres)

(h) Forest Products: Tannins, gums, drugs, spices, insecticides, waxes, honey, horns, musk, ivory, hides etc. are all provided by the flora and fauna of forests.

The indirect benefits from forests are:

(a) Conservation of Soil:

Forests prevent soil erosion by binding the soil with the network of roots of the different plants and reduce the velocity of wind and rain — which are the chief agents causing erosion.

(b) Soil-improvement:

The fertility of the soil increases due to the humus which is formed by the decay of forest litter.

(c) Reduction of Atmospheric Pollution:

By using up carbon dioxide and giving off oxygen during the process of photosynthesis, forests reduce pollution and purify the environment.

(d) Control of Climate:

Transpiration of plants increases the atmospheric humidity which affects rainfall and cools the atmosphere.

(e) Control of Water flow:

In the forests, the thick layer of humus acts like a big sponge and soaks rain water preventing run-off, thereby preventing flash-floods. Humus prevents quick evaporation of water, thereby ensuring a perennial supply of water to streams, springs and wells.

Conservation of forests

Forests are most affected through human activities. Forests are destroyed by civilization, urbanization, agriculture, fire, felling of trees, grazing, plant diseases, etc. Deforestation leads to serious ecological imbalance. Hence it is inevitable to take necessary steps to conserve forests. Some of the steps we can take to conserve our forest resources are as follows:

1. Regulated and Planned Cutting of Trees:

One of the main reasons of deforestation is commercial felling of trees. According to an estimate, about 1,600 million cubic metres of wood have been used for various purposes in the world. Although trees are considered as perennial resource, when exploited on a very large scale, their revival cannot be possible.

Therefore, cutting should be regulated by adopting methods like:

(i) Clear cutting- useful for those areas where the same types of trees are available over a large area.

(ii) Selective cutting-mature trees are selected for cutting.

(iii) Shelter wood cutting-useless trees are cut down followed by medium and best quality timber trees.

The time gap between these cuttings is helpful in re-growth of trees.

2. Control over Forest Fire:

Destruction or loss of forest by fire is fairly common.It starts by natural process, i.e., by lightning or by friction between trees during speedy winds, while in most cases it is also by man either intentionally or unintentionally.In order to save forests from fire, it is necessary to adopt latest techniques of fire fighting and fire suppression techniques are to develop three metre wide fire lanes around the periphery of the fire, back fires, arrangement of water spray, fire retardant chemicals should be sprayed from back tank and if possible by helicopters. There must be trained staff of fire fighters to control the fire.

3. Reforestation and Afforestation:

The sustained yield concept dictates that whenever timber is removed, either by block cutting or by selective cutting, the denuded area must be reforested. This may be done by natural or artificial methods. Similarly, any forested land which has been destroyed by fire or mining activities should be reforested. In rugged terrain, aerial seeding is the method of choice.

Besides all this, fresh afforestation programmes should be started. New plantations will not only increase the forest cover but also help in making up the eco-balance. For afforestation, selection of trees should be done according to local geographical conditions and care must be taken during initial growth of the trees.

Forest Management:

Management of forest resources is the key to all conservation efforts. In forest management, the following aspects should be taken into consideration:

(i) Survey of forest,

(ii) Categorisation of forest.

(iii) Economic use of forest,

(iv) Administrative setting for forest management,

(v) Training programmes for persons engaged in forest conservation activities,

(vi) Use of forest land as tourist centers,

(vii) Social and agro-forestry,

(viii) Development of new techniques for the conservation of forests,

(ix) Research for efficient use and conservation of forest, and

(x) Policy decisions and their proper implementation.

In brief, conservation of forest resources can be done by cooperative efforts of the government, non-government organisations and the public through a proper management system.

WATER RESOURCES

Water is an indispensable resource for life on earth. Approximately 70.8 % surface of earth is covered with water in the form of oceans. Out of this, about 97% is not fit for human consumption, about 2% is locked as a glacier and only less than 1% available as fresh water that can be used for human consumption and other uses.

Water is a very important source and essential for life because it has very unique characteristic such as

1. Water exists as liquid over a wide range of temperature 0-100^{o}C with highest specific heat and latent heat of vaporization.
2. Water is excellent solvent and act as carrier of nutrient and helps to distribute them to the cells in the body, regulates the body temperature and support structure and can dissolve various pollutant and can act as carrier of large number of microorganisms
3. It is responsible for hydrological cycle which acts as resource of water to the earth. It is estimated that about 1.4 inch thick layer of water evaporates and majority of water returns to earth through hydrological cycle.

Sources of Water:

The important sources of water can be classified into two groups:

Surface Water:

Surface water is found in rivers, lakes, or other surface impoundments. Surface water is naturally replenished by precipitation and naturally lost through discharge to evaporation and sub-surface seepage into the ground. Surface water is exposed to many different contaminants, such as animal wastes, pesticides, insecticides, industrial wastes, algae and many other organic materials.

Ground Water:

Ground water is the water trapped beneath the ground. Rain that soaks into the ground, rivers that disappear beneath the earth and melting snow are but a few of the sources that recharge the supply of underground water. Ground water may contain any or all of the contaminants found in surface water as well as the dissolved minerals it picks up during its long stay underground. Other sources of water, which have not yet been tapped but represent a potential source, are saline lakes, saline springs, snow and ice fields.

Use of Water Resources

Water resources are used for agricultural, industrial, domestic, recreational, and environmental activities. Majority of the uses require fresh water.However, about 97 percent of water found on the earth is salt water and only three percent is fresh water. A little over two-thirds of the available fresh water is frozen in glaciers and polar ice caps. The remaining freshwater is found mainly as groundwater and a negligible portion of it is present on the ground or in the air.

Following is a brief account of how water is used in different sectors.

Agricultural Use

Agriculture accounts for 69 percent of all water consumption in agricultural economies like India. Agriculture, therefore, is the largest consumer of the Earth's available freshwater.By 2050, the global water demand of agriculture is estimated to increase by a further 19% due to irrigational needs. Expanding irrigation needs are likely to put undue pressure on water storage. It is still inconclusive whether further expansion of irrigation, as well as additional water withdrawals from rivers and groundwater, will be possible in future.

Industrial Use

Water is the lifeblood of the industry. It is used as a raw material coolant, a solvent, a transport agent, and as a source of energy. Manufacturing industries account for a considerable share in the total industrial water consumption. Besides, paper and allied products, chemicals and primary metals are major industrial users of water.

Worldwide, the industry accounts for 19 percent of total consumption. In industrialized countries, however, industries use more than half of the water available for human use.

Domestic Use

It includes drinking, cleaning, personal hygiene, garden care, cooking, washing of clothes, dishes, vehicles, etc. Since the end of World War II there has been a trend of people moving out of the countryside to the ever-expanding cities. This trend has important implications on our water resources.

Government and communities have had to start building large water-supply systems to deliver water to new populations and industries. Of all water consumption in the world, domestic use accounts for about 12 percent.

Use for Hydropower Generation

Electricity produced from water is hydropower. Hydropower is the leading renewable source of electricity in the world. It accounts for about 16 percent of total electricity

generation globally. There are many opportunities for hydropower development throughout the world.

Today, the leading hydropower generating countries are China, the US, Brazil, Canada, India, and Russia.

Use for Navigation and Recreation

Navigable waterways are defined as watercourses that have been or may be used for transport of interstate or foreign commerce. Agricultural and commercial goods are moved on water on a large scale in a number of regions in the world.

Water is also used for recreational purposes such as boating, swimming, and sporting activities. These uses affect the quality of water and pollute it. Highest priority should be given to public health and drinking water quality while permitting such activities in reservoirs, lakes, and rivers.

Overutilization of Surface and Ground Water

Water scarcity has become a burning global issue. The UN has held several conventions on water in recent decades. Continuous overutilization of surface and ground water has led to virtual water scarcity in the world today.

The depleting sources for high growth in human population over the centuries and increased man-induced water pollution across the world have created unforeseen water scarcity around the globe. As a result, there has been continuous overutilization of the existing water sources due to mammoth growth in world population.

Groundwater is the major source of water in many parts of the world. However, there has been continuous depletion of this source due to its overexploitation by rising human population and the rapid rise in industrialization and urbanization in modern times.

Consequences of Overutilization

Water scarcity now becomes an important topic in international diplomacy. Nearly three billion people in the world suffer from water scarcity. International, intrastate and regional rivalries on water are not new to world. The ongoing Jordan River conflict, Nile River conflict, and Aral Sea conflict are cases in point. The intra-state issues such as Cauvery Water dispute in South India, 2000 Cochabamba protests in Bolivia is still a simmering cauldron causing periodic tension at the national and regional levels.

According to World Health Organization (WHO) sources, a combination of rising global population, economic growth and climate change means that by 2050 five billion (52%) of the world's projected 9.7 billion people will live in areas where fresh water supply

is under pressure. Researchers expect about 1 billion more people to be living in areas where water demand exceeds surface-water supply.

Climate Change

Climate change can have an impact on the drainage pattern and hydrological cycle on the earth thereby severely affecting the surface and groundwater availability.Climate change is believed to rise the global temperature at an increasing pace. Temperature increase affects the hydrological cycle by directly increasing evaporation of available surface water and vegetation transpiration.As a result, precipitation amount, timing and intensity rates are largely affected. It impacts the flux and storage of water in surface and subsurface reservoirs.

Floods & Draughts

Floods and droughts are two well-known natural hazards in the world. The former is due to excess in water flow and the latter is due to scarcity of water.The amount of rainfall received by an area varies from one place to another depending on the location of the place. India records most of its rainfall in the monsoon season.Heavy rains lead to rise in the water level of rivers, seas, and oceans. Water gets accumulated in the coastal areas, which results in floods. Floods bring in extensive damage to crops, domestic animals, property and human life.

On the other hand, droughts set in when a particular region goes without rain for a long period of time. In the meantime, the soil will continuously lose groundwater by the process of evaporation and transpiration. Ground water becomes scarce and this leads to droughts. In drought conditions, it is very difficult to get food and fodder for the survival. Life gets difficult and many animals perish in such conditions.

MINERAL RESOURCES

Minerals are naturally occurring elements or compounds that have been formed through slow inorganic processes. Modern civilization is based on the use and exploitation of mineral resources. Minerals can be metallic and non-metallic.Minerals are not evenly distributed in the Earth. Some countries are rich in mineral deposits whereas others are devoid of it.

Extraction of minerals is carried out through mining. Minerals are extracted from beneath the surface, processed, and used for different purposes.Mineral resources, however, are exhaustible and finite, which means excessive use may affect their availability in the future.

Distribution of Minerals in India

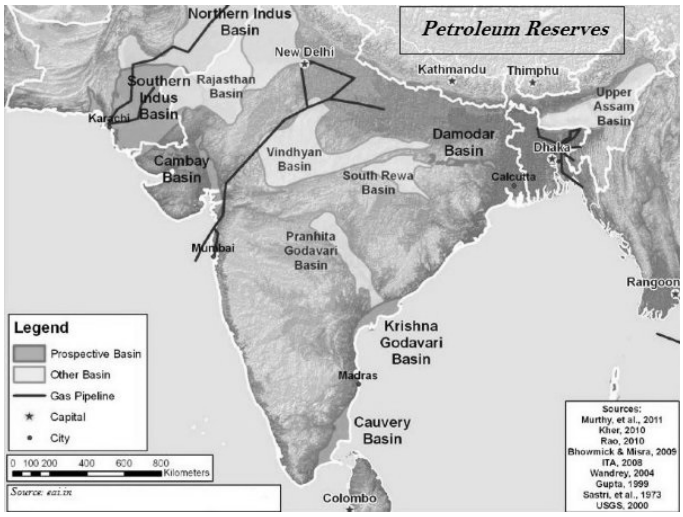

Figure 1.3: Mineral distribution of India

- More than 97% of **coal** reserves occur in the valleys of Damodar, Sone, Mahanadi, and Godavari rivers.
- **Petroleum** reserves in India are located in the sedimentary basins of Assam, Gujarat, and Mumbai High (i.e. off-shore region in the Arabian Sea).
- Some new petroleum reserves are also found in the Krishna-Godavari and Kaveri basins

Environmental Impacts of Mineral Extraction

Extracting and use of mineral resources can affect the environment adversely. Environmental affect may depend on factors such as mining procedures, ore quality, climate, size of operation, topography, etc. Some of major environmental impacts of mining and processing operations are as under

1. Degradation of land.
2. Pollution of surfaces and ground water resources.
3. Effect on growth of vegetation due to leaching out effect of minerals.
4. Surface water pollution and groundwater contamination lead to occupational health hazards etc.
5. Air pollution due to emission of gases.
6. Deforestation affects flora and fauna.
7. Rehabilitation of affected population.

Conservation of Minerals

Conservation of minerals can be done in number of ways and these are as follows,

- Industries can reduce waste by using more efficient mining and processing methods.
- In some cases, industries can substitute plentiful materials for scarce ones.

- Some mineral products can be recycled. Aluminum cans are commonly recycled. Although bauxite is plentiful, it can be expensive to refine. Recycling aluminum products does not require the large amounts of electric power needed to refine bauxite.
- Products made from many other minerals, such as nickel, chromium, lead, copper, and zinc, can also be recycled.
- Strict laws should be made and enforced to ensure efficient management of mining resources.

Case Study

- Ara villi mountains which covers about 10% of geographical area is rich source of minerals wealth .This mountain range play important role in control of climate and act as mini water shed. On the request of environmentalist, Honourable Supreme Court has passed the order to stop these mines in Rajasthan.
- Marble mining near Rajsamant Lake has lead to drying up of lake. Marble mining was stopped on December 2002.
- Mining in Goa has attained the attention of the press and media and ultimately government has to take the decision to stop this mining.

FOOD RESOURCES

Food is essential for growth and development of living organisms. These essential materials are called nutrients and these nutrients are available from variety of animals and plants. There are thousands of edible plants and animals over the world, out of which only about three dozen types constitute major food of humans.

Types of Food Resources

In the food resources, there are 2 kinds of food production are as follows: -

1. The industrialized agriculture.
2. The traditional agriculture.

Industrialized Agriculture

The industrialized agriculture is called high input agriculture since it uses large amounts commercial fertilizers for field, the pesticides, fossil fuels and water. The large fields of monoculture (single crops) are planted and the plants are selectively covered to produce high productions. Most of the food made by industrialized processes is traded by

farmers for profit and this kind of food production is most common in modernized nations because of the involvement of high expenses and technology.

Traditional Agriculture

The traditional agriculture is the most widely used form of production of food, happening mostly in developing nations. This can be classified later as either traditional intensive agriculture or traditional subsistence and the differences between the 2 involve the relational amounts of food produced and resources input. The subsistence agriculture practices only animal and human labor and only produces enough food for the families of farmer's.

The traditional, intensive agriculture uses more labor of animal and human, irrigated water and fertilizers. This may as well involve growing processes such as intercropping designed to maintain soil fertility rate.

Types of nutrition:

1. Nutritious nutrition:

To maintain good health and disease resistant, we need large amount of carbohydrate, proteins, fats and smaller amount of micronutrients such as vitamins and minerals such as Fe, Ca and iodine. Food and agricultural organisation (FAO) of United Nations estimated that on an average, the minimum calorie intake on a global state is 2500 calories/day.

2. Under nutrition

People who cannot buy enough food to meet their basic energy needs suffer from under nutrition. They receive less than 90% of this minimum dietary calorie. Effect of under nutrition: Suffer from mental retardation and infectious diseases.

3. Mal nutrition

Besides minimum calorie intake we also need proteins, minerals, vitamins, iron and iodine. Deficiency leads to malnutrition resulting in several diseases.

Table 1.2: Effect of Malnutrition

S.No	Deficiency of Nutrients	Effects
1.	Protein	Growth
2.	Iron	Anemia
3.	Iodine	Goiter
4.	Vitamin A	Blindness

Case studies

A study on birth defects in water birds, in Kesterson wildlife refuge in California, indicated that these defects where due to high concentration of selenium.

Recent reports from cotton growing belt of Punjab which covers Abohar, Fazalka and part of Bathinda indicates that over use of pesticides for control of insect pest in cotton to enhance productivity has not only affected soil health, but also caused cancer in human being.

Diclofenac is the drug for veterinary use to treat the livestocks which have strong residual nature, which leads to high persistence throughout the foodchain .Due to biomagnification it becomes more dangerous to the vultures as they are consumers of diclofenac treated cattle. Diclofenac is responsible for bringing three South Asian species

ENERGY RESOURCES

Energy consumption of a nation is usually considered as an index of its development, because almost all the development activities are directly or indirectly dependent upon energy. Power generation and energy consumption are crucial to economic development as economy of any nation depends upon availability of energy resources. There are wide disparities in per capita energy use of developed and the developing nations. With increased speed of development in the developing nations energy needs are also increasing.

- Major sources of energy in India are classified as −
    - Conventional sources (e.g. coal, petroleum, and nuclear power).
    - Non-conventional sources (e.g. solar energy, hydro energy, geo-thermal energy, etc.)
- Fossil fuel or conventional sources of energy are found exhaustible in nature and also not environmental friendly; on the other hand, the non-conventional sources of energy such as solar energy, wind energy, geo-thermal energy, tidal energy, etc. are renewable sources of energy and they are also environmental friendly (as they do not pollute environment).

Energy Scenario

In India, energy is consumed in a variety of forms such as fuel wood; animal waste and agricultural residues are the traditional sources of energy. These non-commercial fuels are gradually getting replaced by commercial fuels i.e. coal, petroleum products, natural gas and electricity.Out of total energy, commercial fuels account for 60% where as the balance

40% is coming from non-commercial fuels. Of the total commercial energy produced in the form of power or electricity,

69% is from coal (thermal power),

25% is from hydel power,

4% is from diesel and gas,

2% is from nuclear power, and

Less than 1% from non- conventional sources like solar, wind, ocean, biomass, etc.

Petroleum and its products are the other large sources of energy. In a developing country like India, in spite of enhanced energy production, there is still shortage due to increased demand of energy. In spite of the fact that there is a phenomenal increase in power generating capacity, still there is 30% deficit of about 2,000 million units.

As we have already seen about the renewable and non-renewable resources previously, these Non-renewable resources can further be divided into two categories, viz. Recyclable and non-recyclable.

Recyclable resources

These are non-renewable resources, which can be collected after they are used and can be recycled. These are mainly the non-energy mineral resources, which occur in the earth's crust (e.g. ores of aluminium, copper, mercury etc.) and deposits of fertilizer nutrients (e.g. phosphate sock and potassium and minerals used in their natural state (asbestos, clay, mica etc.).

Non-recyclable resources

These are non-renewable resources, which cannot be recycled in any way. Examples of these are fossil fuels and nuclear energy sources (e.g. uranium, etc) which provide 90 per cent of our energy requirements.

Use of Alternate Energy Sources

There is a need to develop renewable energy sources which are available and could be utilized (solar or wind) or the sources which could be created and utilized (bio-mass). The main renewable energy sources for India are solar, wind, hydel, waste and bio-mass. Bio-mass are resources which are agriculture related like wood, bagasse, cow dung, seeds, etc.

Hydel energy

India has a total hydro energy potential of about 1.5 lakh MW, of which only about 20% is installed. Small hydro plant potential is about 15000 MW and most of it is in the northern and eastern hilly regions.

Wind energy

The wind power potential of India is about 45,000 MW out of which capacity of 8748 MW has been installed in India till 2008. India is one of the leading countries in generating the power through wind energy.

Gujarat, AP, Karnataka, MP and Rajasthan are states having more than 5000 MW potential each. These potentials could be improved if the technology of putting turbines in sea is embraced. There are wind farms on sea generating as high as 160 MW of power.

Geothermal energy

Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. Earth's geothermal energy originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%). Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels.

Ocean thermal energy conversion (OTEC)

Ocean Thermal Energy Conversion (OTEC) uses the difference between cooler deep and warmer shallow or surface ocean waters to run a heat engine and produce useful work, usually in the form of electricity. A heat engine gives greater efficiency and power when run with a large temperature difference. In the oceans the temperature difference between surface and deep water is greatest in the tropics, although still a modest 20 to 25°C. It is therefore in the tropics that OTEC offers the greatest possibilities. OTEC has the potential to offer global amounts of energy that are 10 to 100 times greater than other ocean energy options such as wave power

Biomass energy

Biomass is the oldest means of energy used by humans along with solar energy. Fire was generated using wood or leaves, which is basically a biomass. The biomass could be used to generate steam or power or used as a fuel. Power is generated using rice husk in Andhra Pradesh, while several bagasse based plants are there. India has a potential of 3500 MW from bagasse.

Organic waste such as dead plant and animal material, animal dung, and kitchen waste can be converted by the anaerobic digestion or fermentation into a gaseous fuel called biogas. Biogas is a mixture of 65% methane (CH_4) and of 35% CO_2 and may have small

amounts of hydrogen sulphide (H_2S), moisture and siloxanes. It is a renewable energy resulting from biomass.

Bio-fuels

India has more than 50 million hectare of wasteland, which could be utilized for cultivating fuel plants. Jatropha is one of the options which can be planted on arid lands and be used for production of bio fuels.

Solar energy

India being a tropical country has potential to use solar energy on commercial bases. According to estimates, 35 MW of power could be generated from one sq km. With such potential, solar energy has bright future as energy source for the development of the country. Initial cost is the biggest limitation, which has led to the low realization of its potential. For solar energy to become one of the front-runners, it will require lot of research, cheap technology and low capital.

Problems Relate To the Use of Energy Resources

- Fossil fuel
- Global warming
- Acid rains
- Dangers posed by leaded fuels ,Oil spills
- Water pollution caused by poorly managed coal mines
- Air pollution.

Alternate energy resources

- The initial cost of establishment of alternate energy generation is costlier than conventional resources.
- Maintenance of these structures is difficult.
- It requires more space.
- Energy supply is unpredictable during natural calamities.

Significant progress in sustainable development

India is an active player at international fora in the fight against climate change.India has taken significant steps to improve energy efficiency, which have avoided an additional 15% of annual energy demand and 300 million tonnes of CO_2 emissions over the period 2000-18, according to IEA (International energy agency) analysis. The major programmes target industry and business, relying on large-scale public procurement of efficient products such as LEDs(Light-Emitting Diodes lights)and the use of tradable energy efficiency

certificates. The government's LED programme has radically pushed down the price of the products in the global market and helped create local manufacturing jobs to meet the demand for energy-efficient lighting.

Recent IEA analysis shows that in 2018, India's investment in solar PV was greater than in all fossil fuel sources of electricity generation together. Large-scale auctions have contributed to swift renewable energy development at rapidly decreasing prices. By December 2019, India had deployed a total of 84 GW (GigaWatt) of grid-connected renewable electricity capacity. By comparison, India's total generating capacity reached 366 GW in 2019. India is making progress towards its target of 175 GW of renewables by 2022.

Case Study

Importance of the energy resources in present economy and as a base for our future can be underlined by the fact that recent confrontations between some powerful nations of the world have primarily been attributed driven by objective to secure their energy supplies. Examples of this have been the two gulf wars. It was the hunger for energy resources that drove Iraq to lead an offensive over Kuwait and also reason for second Gulf war has been attributed to energy security by defence experts. In recent times, world has witnessed a confrontation at South China Sea between India, Vietnam and China over the issue of exploring natural gas and

LAND RESOURCES

Resources which are available on land are called land resources. Land resources includes natural vegetation, wild life, human life, economic activities, transport and communication. Moreover, most of our basic needs like food clothing and shelter comes from land. Therefore, careful use of land is necessary.

Land Resources in India

In India, Land resources includes 43% of plains, 30 % of mountains and 27% of plateaus. Most of plains consist of agricultural land and industries, Mountains provides spot for tourism and perennial flow of rivers. Plateaus are rich source of minerals, fuels and forests.

Utilisation of Land Resources in India

Land resource in India is classified into forests, lands not available for cultivation, fallow land, agricultural lands, etc.

Forests: In India around 22.8 % of land is covered with forests.

Land not available for cultivation: Barren and wasteland for example, rocky, arid, deserts, etc covers 8.61 % of land. Moreover, land for non-agriculture uses like, building, roads, factories and settlements, etc takes upto 5.57%. Also, the, other uncultivated lands mainly consist of Permanent pastures and grazing land which takes up 3.38%; Land under miscellaneous tree crops groves which is 1.11% and culturable waste land which is 4.17%.

Fallow land: Total fallow land in land resources contains 8.13% out of which 4.76% covers the current fallow. Current fallow is land not cultivated from less than one agricultural year. Lands left uncultivated for one to five years contains 3.37%. If fallow lands are cultivated once or twice in 2 to 3 years, and if these are included in NSA then the percentage of NSA in India will be around 54% for that particular area.

Net Sown Area (NSA): Area sown more than once in an agricultural year in addition to net sown area or gross cropped area is called net sown area or NSA. Net sown area is available in 46.24% in total land resources in India. States of India like Punjab and Haryana have 80% of net sown area from total area. Whereas, Arunachal Pradesh, Mizoram, Manipur and Andaman Nicobar Islands have less than 10% of net sown area from total area.

Degradation of land resources

In India 130 million hectares of land is degraded. Out of this 56% is water eroded area, 28% is forest-degraded area, 6% saline and alkaline deposits and 10% is wind-eroded area. States like Jharkhand, Chattisgarh, Madhya Pradesh, Odisha major cause of land degradation is mining. In Gujarat, Rajasthan, Madhya Pradesh and Maharashtra overgrazing is the reason for degradation of land resources. In Punjab Haryana, Western Uttar Pradesh, over irrigation is the responsible for land degradation. Out of 17 million hectare canal irrigated area, 3.4 million hectare is suffering from water logging and salinity. Soil erosion, water logging, salinization and contamination of the soil with industrial wastes like fly-ash, press mud or heavy metals all cause degradation of land.

Some other causes of degradation of land resources includes- Continuous use of land for long period without taking appropriate measures to conserve it. Processing of minerals like limestone in industries produces dust, which slows down process of infiltration of water in soil, thereby, degrading the land. Waste materials from industries causes land as well as water pollution.

Soil Erosion

Soil erosion refers to loss or removal of superficial layer of soil due to the action of wind, water and human factors. In other words, it can be defined as the movement of soil components, especially surface-litter and top soil from one place to another. It has been

estimated that more than 5000 million tonnes topsoil is being eroded annually and 30% of total eroded mass is getting loosed to the sea.It results in the loss of fertility. It basically is of two types, viz. geologic erosion and accelerated erosion.

Salinization

It refers to accumulation of soluble salts in the soil. Concentration of soluble salts increases due to poor drainage facilities. In dry land areas, salt concentration increases where poor drainage is accompanied by high temperature. High concentration of salts affects the process of water absorption hence affects the productivity.

Water Logging

Excessive utilization of irrigation may disturb the water balance which can lead to water logging due to rise of water table .Anaerobic condition due to poor availability of oxygen in water logged soils may affect respiration process in plants which will ultimately affect the productivity of water logged soil.

Desertification

Desertification is a process whereby the productive potential of arid or semiarid lands falls by ten percent or more. Desertification is characterized by devegetation and depletion of groundwater, salinization and severe soil erosion.

Preventive Measures

1. Afforestation
2. Proper management of grazing or Control on over-grazing
3. Planting of shelterbelts of plants
4. Stabilisation of sand dunes by growing thorny bushes
5. Proper management of waste lands
6. Control of mining activities
7. Proper discharge and disposal of industrial effluents and wastes after treatment

ECO SYSTEM

CONCEPT OF ECOSYSTEM

The ecosystem is the structural and functional unit of ecology where the living organisms interact with each other and the surrounding environment. In other words, an ecosystem is a chain of interaction between organisms and their environment. The term “Ecosystem” was first coined by A.G.Tansley, an English botanist, in the year 1935.

FUNCTIONS OF ECOSYSTEM

The functions of the ecosystem are as follows:

1. It regulates the essential ecological processes, supports life systems and renders stability.
2. It is also responsible for the cycling of nutrients between biotic and abiotic components.
3. It maintains a balance among the various trophic levels in the ecosystem.
4. It cycles the minerals through the biosphere.
5. The abiotic components help in the synthesis of organic components that involves the exchange of energy.

COMPONENTS OF ECOSYSTEM

According to this discipline, an ecosystem is a physically defined environment, made up of two inseparable components:

The biocenosis (biotic): a set of living organisms such as animals, plants or micro-organisms, that are in constant interaction and are, therefore, in a situation of interdependence.

The biotope (abiotic): a particular physical environment with specific physical characteristics such as the climate, temperature, humidity, concentration of nutrients or pH.

Biotic components of ecosystem

Biotic components are the living things that have a direct or indirect influence on other organisms in an environment. Some of these factors include plants, animals, as well as fungi and bacteria. These biotic components can be further classified, based on the energy requirement source. Producers, consumers, and decomposers are the three broad categories of biotic components.

Producers

Producers are the plants, green algae, etc in the ecosystem include all the autotrophs. They generate their own energy requirement through photosynthesis, in the presence of sunlight and chlorophyll. All other living beings are dependent on plants for their energy requirement of food as well as oxygen.

Consumers

These include all the heterotrophs that directly or indirectly depend on producers for their food. Consumers are further categorized as herbivores, carnivores, omnivores. The herbivores are the living organisms that feed on plants. Carnivores eat other living organisms. Omnivores are animals that can eat both plant and animal tissue.

Decomposers

Fungi and certain bacteria are the prime representatives of this category, which are the saprophytes. They feed on the decaying organic matter and convert this matter into nitrogen and carbon dioxide. The saprophytes play a vital role in recycling the nutrients so that the producers i.e. plants can use them once again.

Abiotic components

The abiotic elements of an ecosystem include all the non-living things in an environment. They include the water, the air, the temperature and the rocks and minerals that make up the soil. Abiotic components of an ecosystem might include how much rain falls on it, whether it is fresh water or salt water, how much sun it gets or how often it freezes and thaws. The biotic components of the ecosystem both live on and interact with the abiotic components.

There are two kind of abiotic compounds: organic and inorganic. *The organic components* of an ecosystem are proteins, carbohydrates, lipids and amino acids, all of which are synthesized by the biota (flora and fauna) of an ecosystem and are reached to ecosystem as their wastes, dead remains, etc, The climate, temperature, light, soil, etc., are other abiotic components of the ecosystem. *The inorganic components* of an ecosystem are carbon dioxide, water, nitrogen, calcium, phosphate, all of which are involved in matter cycles.

BIOGEOCHEMICAL CYCLES

A biogeochemical cycle or an inorganic-organic cycle is a circulating or repeatable pathway by which either a chemical element or a molecule moves through both biotic (biosphere) and abiotic (lithosphere, atmosphere and hydrosphere) components of an ecosystem.

Biogeochemical cycles connect living things to the earth.

The four chemicals that make up 95% of living things are:

Carbon,

Hydrogen,

Oxygen and

Nitrogen.

These elements are constantly being cycled through living and non-living organic matter.

In an Ecosystem the Three Primary Nutrient Cycles:

A. The Water Cycle

B. The Carbon Cycle

C. The Nitrogen Cycle

The Water (Hydrologic) Cycle: The movement of water between different reservoirs on the earth, under ground and in the atmosphere is known as the water cycle.

1. To a large degree, availability of water determines the diversity of organisms in an ecosystem. Water is crucial to Life. Cells contain 70 - 90 % water, and water provides the aqueous environment in which most of life's reactions occur.

2. The availability of water is one of the key factors that regulates the productivity of terrestrial (land) ecosystems.

3. Bodies of water such as lakes, rivers, streams, and the oceans contain a substantial percentage of the Earths water. The atmosphere also contains water in the form of:water vapor

some water found below ground known as ground water.

Processes of the Water Cycle:

A. Evaporation: Evaporation is the process by which water changes from a liquid to a gas or vapor. It is the primary pathway that water moves from lakes, rivers, and oceans back into the water cycle as atmospheric water vapour

B. Transpiration: Transpiration is the process of water movement through a plant and its evaporation from aerial parts, such as leaves, stems and flowers.

C. Condensation(Cloud Formation): Condensation is the process where water vapor becomes liquid. It is the reverse of evaporation

D. Precipitation: precipitation is any product of the condensation of atmospheric water vapor that falls under gravity from clouds. The main forms of precipitation include drizzle, rain, sleet, snow, ice pellets, graupel and hail.

E. RUN OFF, or returned back into the Cycle.

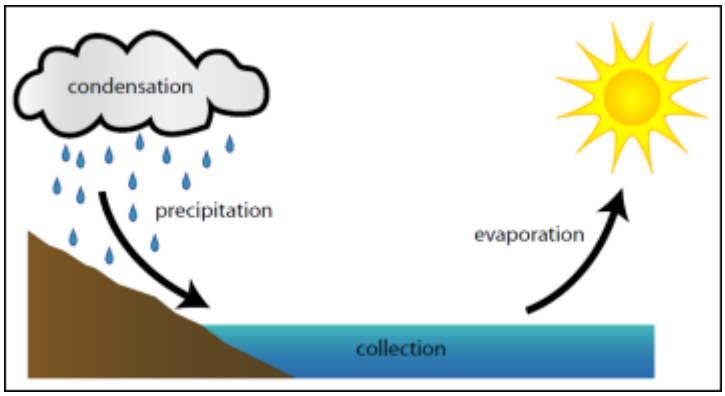

Figure 1.4: Water cycle

The Carbon cycle

1. Together, photosynthesis and cellular respiration form the basis of the carbon cycle. Carbon is found in all of the major macromolecules (carbohydrates, nucleic acids, proteins and lipids) which are necessary for all living systems.

2. The Earth's atmosphere contains carbon in the form of carbon dioxide (CO_2). There are five major reservoirs of carbon:

- Atmosphere
- Terrestrial biosphere
- Oceans
- Ocean sediments and
- Earth's interior.

3. Processes of the carbon Cycle:

Photosynthesis: During photosynthesis, plants and other autotrophs use CO_2 along with water and solar energy, to build organic molecules (carbohydrates), thus storing the carbon for themselves and other organisms.

Cellular Respiration: Both autotrophs and heterotrophs use oxygen to break down carbohydrates during cellular respiration. Consumers obtain energy-rich molecules that contain carbon by eating plants and animals.

Volcanic Eruptions and geothermal vents: carbon from deep within the earth's interior is brought back to the surface during eruptions of steam, gasses and lava.

Decomposition: Carbon is returned to the environment through decomposers and cellular respiration (breathing releases CO_2 back to the atmosphere).

Combustion: When wood or fossil fuels are burned, the chemical reaction releases carbon dioxide back into the atmosphere

Deposition: Coal, petroleum, and calcium carbonate rock are deposited in sediment and underground. Calcium carbonate deposits are eroded by water to form carbon dioxide. Large amounts of carbon are tied up in wood, only returning to the atmosphere when wood is burned.

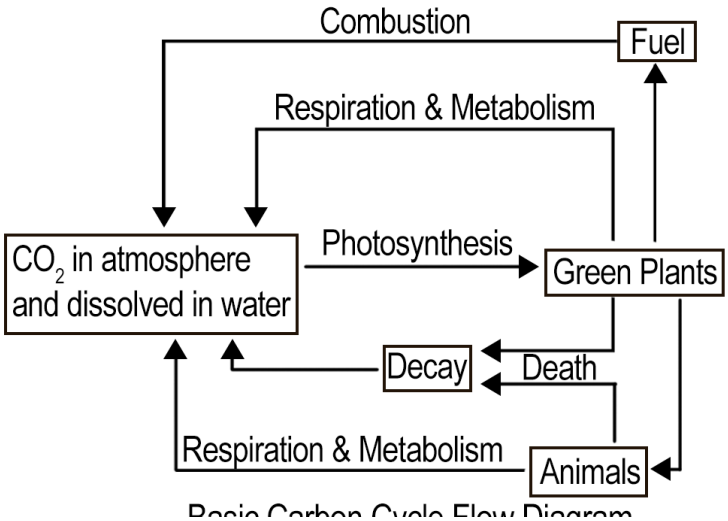

Figure: 1.5: Carbon cycle

The Nitrogen cycle:

All organisms need nitrogen, an important nutrient, to make proteins and nucleic acids.

Most nitrogen is found in the atmosphere (80%) as N_2, and most living things cannot use it. All organisms rely on the actions of bacteria that are able to transform nitrogen gas into a usable form.

Nitrogen-fixing bacteria (Cyanobacteria and Rhizobium) play a key role in the nitrogen cycle. They live in the soil and in the roots of some kinds of plants, such as beans, peas, clover, and alfalfa. These bacteria have enzymes that can break the atmospheric N_2 bonds. Nitrogen atoms are then free to bond with hydrogen atoms to form Ammonia (NH_3).

Processes of the Nitrogen Cycle:

Nitrogen fixation is the conversion of nitrogen gas to ammonia; Ammonia can be absorbed by plants from the soil, and used to make proteins, and enter the food web for consumers.

Assimilation:

Consumers obtain nitrogen from the plants and animals they eat by digesting the food's proteins and using it to make their own proteins.

Ammonification:

Decomposers return the nitrogen from the remains of dead plants and animals back to the soil.

Nitrogen is also returned from animal and plant waste by decomposers (dung, urine, leaves and bark).

Through ammonification, nitrogen that would be lost, is recycled back into the ecosystem.

Denitrification

Denitrification occurs when anaerobic bacteria (chemoautotrophs) break down nitrates and release nitrogen gas back into the atmosphere.

Nitrification

Bacteria convert ammonia into nitrogen compounds that plants can utilize more easily.

Autotrophs (plants) are therefore dependent on nitrogen-fixing bacteria, and all other organisms are dependent on autotrophs.

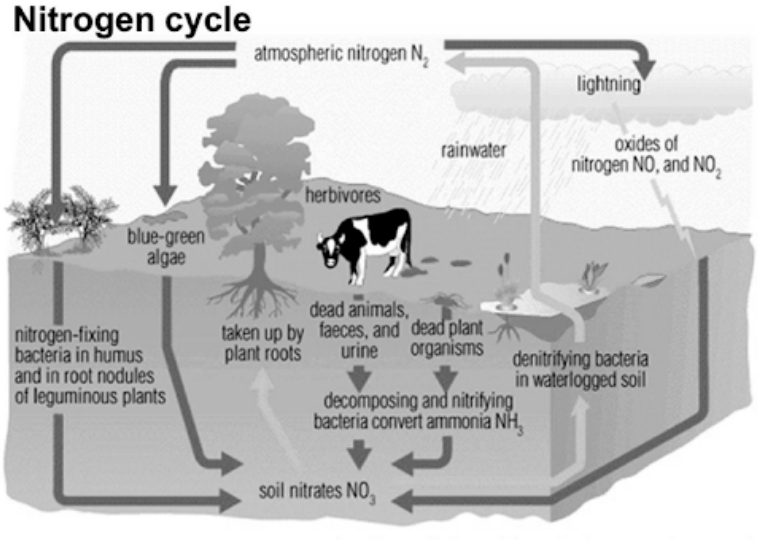

Figure 1.6: Nitrogen cycle

BIODIVERSITY

Biodiversity describes the variety of life on Earth, including the 8 million plant and animal species on the planet, the ecosystems that house them, and the genetic diversity among them.

Biodiversity is a complex, interdependent web, in which each member plays an important role, drawing and contributing in ways that may not even be visible to the eye. The abundant foods we eat, the air we breathe, the water we drink and the weather that makes our planet habitable all come from nature.

Types of Biodiversity

There are the following three different types of biodiversity:

1. Genetic Biodiversity
2. Species Biodiversity

3. Ecological Biodiversity

Species diversity

Species diversity refers to the variety of different types of species found in a particular area. It is the biodiversity at the most basic level. It includes all the species ranging from plants to different microorganism.

No two individuals of the same species are exactly similar. For example, humans show a lot of diversity among themselves.

Genetic diversity

It refers to the variations among the genetic resources of the organisms. Every individual of a particular species differs from each other in their genetic constitution. That is why every human looks different from each other. Similarly, there are different varieties in the same species of rice, wheat, maize, barley, etc.

Ecological diversity

An ecosystem is a collection of living and non-living organisms and their interaction with each other. Ecological biodiversity refers to the variations in the plant and animal species living together and connected by food chains and food webs.

It is the diversity observed among the different ecosystems in a region. Diversity in different ecosystems like deserts, rainforests, mangroves, etc., include ecological diversity.

Biodiversity in India

- India is the only country in the world with native populations of both tigers and lions.
- India is just 2% of the world's land mass, but is home to 8% of the world's biodiversity.
- Among plants, 33% of the world's species are endemic to India, which means they are found nowhere else in the world.
- Mangroves in India account for about 3% of the world's entire mangrove vegetation.
- India is one of the 17-megadiverse countries in the world. Out of 35 biodiversity hotspots in the world, India has 4 biodiversity hotspots.
- India is home to 12% of the world's bird species.
- In terms of endemism, India's position is tenth in birds with 69 species, fifth in reptiles with 156 species and seventh in amphibians with 110 species.
- India ranks 10th among the plant rich countries of the world. India is home to more than 50,000 species of plants, including a variety of endemics.

- India is home to nearly half of the world's aquatic plants. The fact that India has a coastline of about 8,000 km makes our country quite rich in its floral and faunal diversity.
- The Kharai, a unique breed of camels that can swim are found only in Kutch, Gujarat. Kharai camels have a special ability to swim in seawater and feed on saline plants and mangroves. They have been provided special protection by the government.

Importance of Biodiversity

Biodiversity and its maintenance are very important for sustaining life on earth. Few of the reasons explaining the importance of biodiversity are:

Ecological Stability

Every species has a specific role in an ecosystem. They capture and store energy and also produce and decompose organic matter. The ecosystem supports the services without which humans cannot survive. A diverse ecosystem is more productive and can withstand environmental stress.

Economic Importance

- Biodiversity is a reservoir of resources for the manufacture of food, cosmetic products and pharmaceuticals.
- Crops livestock, fishery, and forests are a rich source of food.
- Wild plants such as Cinchona and Foxglove plant are used for medicinal purposes.
- Wood, fibres, perfumes, lubricants, rubber, resins, poison and cork are all derived from different plant species.
- The national parks and sanctuaries are a source of tourism. They are a source of beauty and joy for many people.

Ethical Importance

All the species have a right to exist. Humans should not cause their voluntary extinction. Biodiversity preserves different cultures and spiritual heritage. Therefore, it is very important to conserve biodiversity.

***IN SITU* AND *EX SITU* CONSERVATION OF BIODIVERSITY**

In situ

In situ Conservation is one of the methods of the conservation of genetic resources in natural populations of plant or animal species. In other words, it is a set of conservation techniques involving the designation, management and monitoring of biodiversity in the same

area where it is encountered.It is applied to conservation of agricultural biodiversity in agro forestry by farmers, especially those using unconventional farming practices.

Ex situ

Ex situ Conservation is one of the methods of the conservation of living organism outside their natural habitat through genetic conservation.

It includes

- Gene banks, e.g. seed banks, sperm and ova banks, field banks;
- In vitro plant tissue and microbial culture collections;
- Captive breeding of animals and artificial propagation of plants, with possible reintroduction into the wild; and
- Collecting living organisms for zoos, aquaria, and botanic gardens for research and public awareness.

CONSERVATION OF WILD LIFE

Wildlife conservation is the practice of protecting plant and animal species and their habitats. As part of the world's ecosystems, wildlife provides balance and stability to nature's processes. The goal of wildlife conservation is to ensure the survival of these species, and to educate people on living sustainably with other species.

National and international organizations like the World Wildlife Fund, Conservation International, the Wildlife Conservation Society, and the United Nations work to support global animal and habitat conservation efforts on many different fronts. They work with the government to establish and protect public lands, like national parks and wildlife refuges. They help write legislation, such as the Endangered Species Act (ESA) of 1973 in the United States, to protect various species. They work with law enforcement to prosecute wildlife crimes, like wildlife trafficking and illegal hunting (poaching). They also promote biodiversity to support the growing human population while preserving existing species and habitats.

Conservation of wild life in India

Wildlife is defined under Section 2(37) of the Wildlife Protection Act, 1972 to include any animal, either aquatic or terrestrial and vegetation that forms a part of any habitat. In India, there are various laws for the protection and conservation of wildlife, as well as overall biodiversity. The Wildlife Protection Act, 1972 is legislation that has been implemented for the protection of wild animals, birds, and plants with a view of ensuring the ecological and

environmental security of India. In addition, a Wildlife Crime Control Bureau has also been established to curb the illegal trade of wildlife, including endangered species.

The Government of India came up with various Wildlife Conservation Projects and Programs to promote wildlife awareness amongst the people. Project Tiger, Jungle Lodges and Nature Camps are the few names that not only aid in protecting the natural heritage, but encourage eco-tourism as well. Some of the conservation programs are as follows:

Project Tiger– Aiming at ensuring a viable population of Bengal tigers in their natural habitat, this tiger conservation programme was launched in 1973. The project is remarkably successful not only in conservation of tigers but also of the entire ecosystem. Nearly 47 tiger reserves are nestled in more than 17 regions including Ranthambore National Park and Jim Corbett National Park.

Project Elephant– Project Elephant was started in 1992 by Indian Government to ensure conservation of elephants and their habitat of migratory routes. The project also strives to protect elephant against unnatural death and poachers.

Gir National Park– Considered as one of the most important protected areas in Asia, Gir National Park is the only dwelling place of the Asiatic lions. Reckoned as one of the popular wildlife sanctuaries in India, Gir is home to 2,375 distinct species of fauna.

Dachigam National Park-Dachigam National Park boasts of preserving the Hangul. Also known as Kashmir stag, it is the most famous subspecies of elk native to India. Initially, the park was established to ensure supply of clean drinking water to the city of Srinagar.

Kaziranga Wildlife Sanctuary– Tucked beautifully in Assam, Kaziranga National Park is famed for housing two-third population of the world's great one-horned rhinoceroses. The sanctuary is also titled as the World Heritage Site.

The NGOs– Various NGOs endeavor to protect Indian wildlife. Some of them are Wildlife Society of Orissa (Orissa), Rhino Foundation for Nature (Assam), Friends of Forests (Maharashtra), North Eastern Society for Preservation of Nature and Wildlife (West Bengal), Nature's Beckon (Assam), Nature Conservation Society Amravati (Maharashtra), The Friends of the Doon (Uttaranchal) and Bali Nature and Wild Life Conservation Society (West Bengal).

Wildlife Sanctuaries in India

Various wildlife sanctuaries in India lure wildlife lovers and avid holidaymakers not only from India but from abroad as well. With 17 biosphere reserves and more than 500 wildlife sanctuaries in India to explore, one can rest assure of enthralling experiences.

Popular Wildlife Sanctuaries and National Park in India

- Bandhavgarh National Park, Madhya Pradesh
- Corbett National Park, Uttar Pradesh
- Gir National Park & Sanctuary, Gujarat
- Kanha National Park, Madhya Pradesh
- Kaziranga National Park, Assam
- Periyar Wildlife Sanctuary, Kerala
- Sunderbans National Park, West Bengal

UNIT 2 : ENVIRONMENTAL POLLUTION

Dr. S. Shailaja

INTRODUCTION

All living organisms require a balanced environment for growth, development and reproduction. All the components required by the organisms are present in the environment. When the balance of the environment gets disturbed the survival of living organisms becomes difficult.

Pollution is defined as an undesirable change in the physical, chemical or biological characteristics of our environment which is harmful to the man directly or indirectly. Pollution is the contamination of the environment with waste that damages either the natural resources or health of man. The word pollution is derived from the Latin word '*pollutus*' which means '*to make unclean'*.

Environmental pollution can be caused by chemical substances, physical factors or development of undesirable living organisms.

POLLUTANTS

Pollutants are substances introduced into the biosphere as a result of human activity that affect the normal human life and domesticated species. The nature and concentration of the pollutants determine the severity of the pollution.

TYPES OF POLLUTANTS

Ecologically pollutants can be classified into three types.

- Non-degradable pollutants
- Degradable (or) non-persistent pollutants
- Slowly degradable or persistent pollutants

Non-degradable pollutants

Pollutants that cannot be decomposed by natural processes are called non-degradable pollutants. Once they fall in the environment they remain as such without any change. Continuous use of the substance leads to accumulation of the pollutant both in the environment and in the organisms through food chain or biogeochemical cycles. The accumulation of pollutants in the organisms is called *biological magnification*.

Examples: plastics, polythene bags, heavy metals like mercury, lead, arsenic, synthetic fibres, silver foils, nuclear wastes.

Degradable or non-persistent pollutants:

The pollutants that can be rapidly decomposed by natural processes are called degradable or non-persistent pollutants.

Examples: Domestic waste, heat, noise, sewage, paper products, vegetables, juice, seeds, leaves, human sewage, animal and crop waste etc.

Slowly degradable or persistent pollutants:

Some pollutants remain in environment for longer time because they decompose very slowly by the natural processes.

*Examples: P*lastics, pesticides, DDT, insecticides

TYPES OF POLLUTION

Pollution is either caused by natural events (like forest fires) or by man-made activities (like cars, factories, nuclear wastes, etc.). Pollution is classified into the following types:

- Air pollution
- Water pollution
- Soil pollution
- Marine pollution
- Noise pollution
- Thermal pollution
- Nuclear hazards

AIR POLLUTION

Air pollution refers to the release of contaminants into the atmosphere that are detrimental to human health and the planet as a whole. Air pollution is most crucial from the public health point of view because every individual person breathes 22,000 times a day and inhales about 15-22 kg of air per day. Polluted air causes physical ill effects to the life existing on earth and also have a great impact on environment by serving as a major cause for green house effect, global warming, ozone layer depletion and acid rain.

Figure 2.1: Air pollution

Air Pollutants

Air pollutants are substances in the air that can cause harm to humans and the environment. Pollutants can be natural or man-made in the form of solid particles, liquid droplets, or gases.

Types of Air Pollutants:

Air pollutants are of two types. They are

- primary air pollutants
- secondary air pollutants.

Primary air pollutants:

Primary air pollutants are substances emitted into the air directly from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulphur dioxide released from factories.

Examples: hydrocarbons, chromium, lead, carbon monoxide, aerosol, nitrogen oxides, sulphur dioxide, suspended particulate matters etc .

Secondary air pollutants:

Secondary pollutants are not emitted directly rather, they form in the air when primary pollutants react or interact. An important example of a secondary pollutant is ground level ozone, that causes photochemical smog.

Examples: ozone (O_3), peroxy acetyl nitrate (PAN), aldehydes, sulphuric acid, peroxides etc.

Causes of Air pollution:

1. Burning of fossil fuels in industries and automobiles

Fossil fuels are derived from the organic remains of plants and animals. The principal fossil fuels are coal, petroleum (oil), natural gas. Sulphur dioxide (SO_2) emitted from the combustion of fossil fuels like coal, petroleum is one the major causes of air pollution.

$$S + O_2 \rightarrow SO_2$$

Pollutants emitted from vehicles including trucks, jeeps, cars, trains, airplanes cause an immense amount of pollution. Carbon Monoxide (CO) is another major pollutant emitted from vehicles due to improper or incomplete combustion of carbon.

$$2C + O_2 \rightarrow 2CO$$

$$C + O_2 \rightarrow CO_2$$

Internal combustion engine is an engine in which combustion of a fossil fuel occurs with an oxidiser (air) in a combustion chamber. The air drawn from the atmosphere for this purpose contains 80% nitrogen and forms nitric oxide (NO).

$$N_2 + O_2 \rightarrow 2NO$$

Petroleum refineries and electric power stations burn coal (fossil fuel) for power generation. It also releases hydrocarbons and various other chemicals that pollute the air.

2. Agricultural activities

Use of insecticides, pesticides, and fertilizers in agricultural activities emit harmful chemicals into the air. Ammonia is a very common by product from agriculture-related activities and is one of the most hazardous gases in the atmosphere.

3. **Dust and Mining operation**:

Dust in the air is increased by dust storms, wind, volcanoes, automobiles etc. Mining is a process wherein minerals below the earth are extracted using large equipment. During the process dust and chemicals are released in the air causing massive air pollution.

4. Ionizing radiations

Ionizing radiations include alpha particles, beta particles and gamma rays. Environmental radioactive pollution has resulted from past nuclear weapons testing, nuclear waste disposal, accidents at nuclear power plants, as well as from transportation, storage, loss, and misuse of radioactive sources.

5. Indoor air pollution

Burning of fuels (LPG), wood for cooking also causes air pollution. Household cleaning products, painting supplies emit toxic chemicals in the air and cause air pollution.

6. Chloro fluoro carbons (CFC's)

Freons and other chloro-fluoro –carbons used in the refrigerators as coolants, aerosol sprays, dry cleaning fluids, cleansing agents for cleaning electronic components act as filling agents in aerosol packages.

7. SPM (Suspended Particulate Matter)

Suspended particulate matters are solid component present in air in the form of smoke, fly ash, pieces of asbestos, dust and vapours. They can remain suspended in air for extended periods. It serves as a major source of haze which reduces the visibility. These particulates are characterized as follows:

Aerosol	-	Particles suspended in air
Mist	-	Aerosol with liquid droplets
Dust	-	Aerosol with solid particles
Smoke	-	collection of tiny solid, liquid and gas particles
Plume	-	geometrical form of smoke coming out of chimney
Fog	-	aerosol of water droplets
Smog	-	mixture of smoke and fog

SPM acts as respiratory irritants. They aggravate heart or respiratory diseases.

8. Black carbon

Black carbons (BC) are tiny particles of carbon released as a result of the incomplete combustion of fossil fuels, biofuels and biomass. These particles are extremely small, ranging from 10 µm (micrometers), the size of a single bacterium to less than 2.5 µm, one thirtieth the width of a human hair and small enough to pass through the walls of the human lung and into the bloodstream.

While black carbon is suspended in the air, it absorbs the sun's heat millions of times more effectively than CO_2. When wind carries black carbon over snow, glaciers or ice caps where it falls out onto the white, normally reflective surface, it is particularly damaging because it contributes directly to melting. Overall, black carbon is considered the second biggest contributor to global warming after CO_2.

Disastrous Effects of Air pollution

1. Respiratory and heart problems

Breathing and long exposure to polluted air can create several respiratory and heart problems along with cancer. People in areas containing polluted air suffer commonly from pneumonia and asthma.

2. Green house effect and Global warming

Those gases that contribute effectively in retaining heat in the atmosphere are called green house gases. Carbon dioxide, methane, water vapour, oxides of nitrogen, chlorofluorocarbons are some of the major green house gases.

In the absence of greenhouse gases, the solar radiation emitted as heat radiation passes through the clear atmosphere and reaches the earth's surface where it is absorbed and retained. Some of the absorbed heat radiation is reflected back into the atmosphere and a balance is maintained between the heat energy absorbed by the earth and radiated from the earth as reflected solar radiation and emitted thermal Infra red radiation.

In the presence of greenhouse gases, the solar rays (UV rays) pass through the layer of green house gases in the atmosphere. The heat radiation which is reflected back from the earth into the atmosphere is retained due to the blanketing effect of green house gases. These results in a rise in global temperature named as global warming.

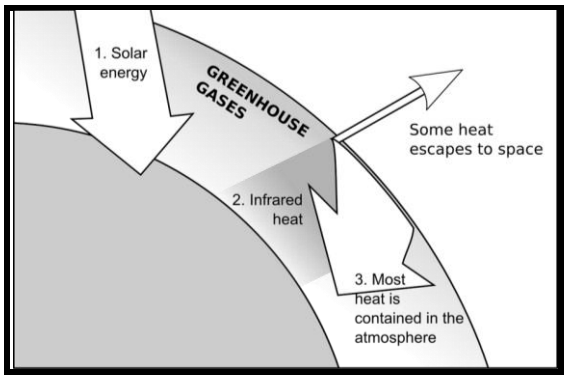

Figure 2.2: Green house effect

Greenhouse gases come from all sorts of everyday activities, such as using electricity, heating at our homes, and driving around the town.

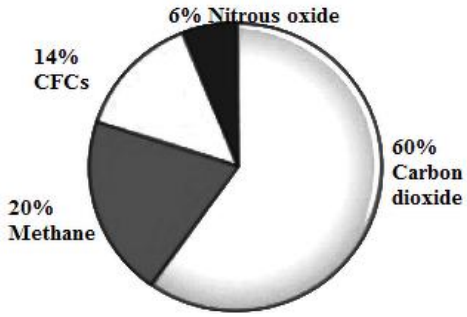

Figure 2.3: Green house emission

Effects of Global warming:

- Melting glaciers, early snowmelt, and severe droughts will cause more dramatic water shortages and increase the risk of wildfires.
- Rising sea levels will lead to coastal flooding.
- Forests, farms, and cities will face troublesome new pests, heat waves, heavy downpours, and increased flooding. All those factors will damage or destroy agriculture and fisheries.
- Disruption of habitats such as coral reefs and Alpine meadows could drive many plant and animal species to extinction.

- Allergies, asthma, and infectious disease outbreaks will become more common due to increased growth of pollen-producing weeds, higher levels of air pollution, and the spread of conditions favourable to pathogens and mosquitoes.

3. Acid rain

Harmful gases like nitrogen oxides and sulphur oxides are released into the atmosphere during the burning of fossil fuels in automobiles, factories and industries. The water droplets combine with these air pollutants, becomes acidic and then falls on the ground in the form of acid rain.

4. Depletion of the ozone layer

Ozone present in stratosphere prevents the harmful UV radiations from the sun reaching the earth. In unpolluted air containing minimum chemical compounds 'ozone oxygen cycle' is maintained and the total concentration of ozone remains the same. The balance is disturbed by release of chemicals like chlorofluoro carbons containing free radical which breaks the ozone molecules causing ozone depletion.

Control of Air Pollution

Air pollution should be confined at the source itself. This can be achieved by adopting any of the strategies mentioned below**:**

- Modifying the processes in such a way that the pollutants are not formed beyond the permissible limits. The emission of exhaust can be reduced by catalytic converter.
- Reducing the concentration or dilution of pollutants before getting released into the environment. Electrostatic precipitators can reduce smoke and dust from industries.
- Adopting Green Chemistry technology where the substances which would produce more toxic elements are replaced with less toxic substances. Gaseous pollutants arising from industries can be removed by differential solubility of gases in water.
- Level of pollution can be controlled by framing legislations by the Government.
- Car-pooling can be insisted.

CASE STUDIES

1. **Bhopal Tragedy:**

   The **Bhopal disaster**, also referred to as the **Bhopal gas tragedy**, was a gas leak incident on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh, India. It killed more than 16,000 human beings. The cause of the tragedy is the release of methyl isocyanate.

2. **Stone leprosy in Taj Mahal**

   Stone leprosy is the corrosion of stone by acid rain. Taj Mahal is one of the Monuments (Wonders of the world) constructed out of white marble by Shajahan in memory of his loving wife Mumtaj during 1632-1643. The Mathura Oil Refinery situated 50 Km away from Taj Mahal releases pollutants like sulphur dioxide, nitrogen oxide and sulphur trioxide which corrodes the monument.

Regulations/Standard

There are two types of standards:

- Emission standard
- Air quality standard

Emission standard:

Sources cannot emit more than a specified mass of pollutant over a period of time. This is based on technology, economics, and relation to airborne concentration. The objective is to control pollutant sources so that ambient pollutant concentrations are reduced to levels considered safe from public health point of view.

Air Quality Standards:

Airborne concentration of a pollutant cannot exceed a specified value over a certain "averaging period". Air quality standards are based only on effects. A pollutant at a certain concentration may be harmful over longer exposure time, but relatively harmless over shorter exposure time.

Air Quality Index (AQI)

The AQI is a tool that simplifies reporting air quality to the general public. It has been adopted by the USEPA (United States Environmental Protection Agency) and is used by

many cities to report to the public an overall assessment of a given day's air quality. The AQI converts concentration of 5 criteria pollutants (PM, O_3 , CO, SO_2 , NO_2) into a single index (number) between 0 and 500 and assigns a descriptive term (e.g. good, moderate) to that value.

Table 2.1: Air Quality index

S.No	AQI	Level of Health Concern	Colour
1	0 to 50	Good	Green
2	51 to 100	Moderate	Yellow
3	101 to 150	Unhealthy for sensitive groups	Orange
4	151 to 200	Unhealthy	Red

WATER POLLUTION

Water is the most important source of the planet and two third of our earth is covered by water. Water cycle is a process occurring naturally in which the water from oceans, seas and other water bodies gets evaporated and finally falls back to the earth as rain or snow by the process of condensation. The economic growth of several countries among the world is being determined also by water as it is essential for drinking, irrigation, industrial purposes etc.

Water pollution is the contamination of the water bodies by any change in physical, chemical or biological properties of water usually caused by human activities and that have detrimental effect on living organisms.

Water Pollutants

As water is a universal solvent, various elements are found dissolved in it. The substances which pollute the water are called water pollutants.

The common water pollutants are: Domestic sewage, industrial effluents, pesticides, herbicides, fertilizers, bacteria and viruses, plankton blooms, heavy metals like mercury, temperature, silt, radioactive substances, oils etc.

Sources of water pollution:

The source of water pollution can be classified as

- Point sources
- Non-point sources

Point sources of water pollution:

When a source of pollution is readily identified with its entry point it is known as point source of pollution. Eg.: Municipal and industrial discharges.

Non-Point sources of water pollution:

When the source of pollution cannot be identified, it is said to be non-point source of pollution. Pollution does not originate from a single source. Pollution is often the cumulative effect of small amounts of contaminants gathered from a large area. Eg.: Acid rain, agricultural runoff, etc.

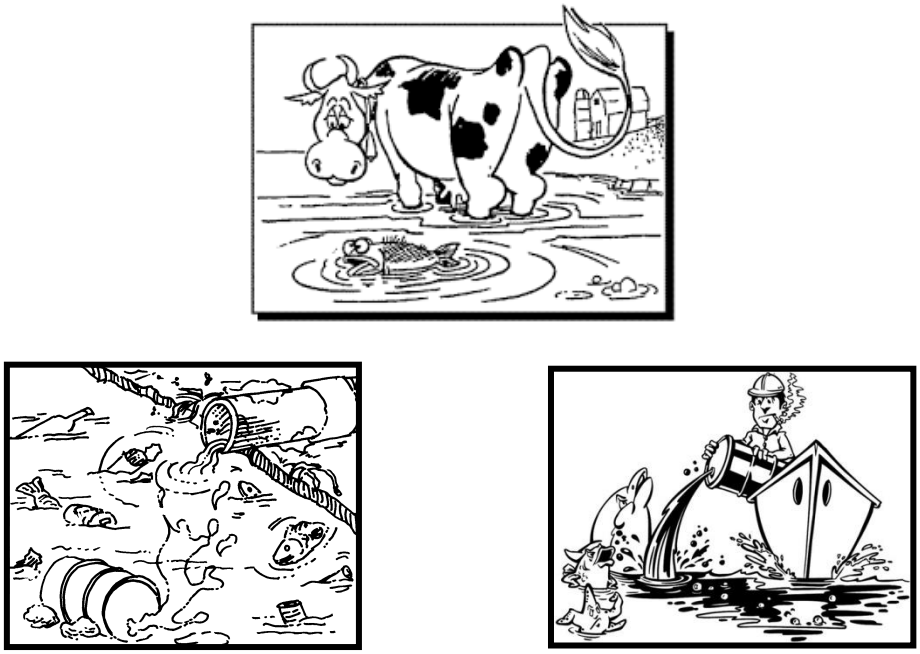

Figure 2.4: Causes of water pollution

Causes of water pollution:

- ***Organic wastes / O_2 Depleting Wastes:***

The organic wastes are decomposed by aerobic (oxygen demanding) bacteria. To degrade the organic wastes, aerobic bacteria utilize O_2 present in water. The amount of oxygen required to break down the organic wastes is known as Biological Oxygen Demand (BOD). When water is highly polluted, the oxygen available in water would be completely utilized by the aerobic bacteria. This leads to an increase in BOD level in water. The aquatic life is not possible when BOD of water is 4 ppm (parts per million) and above. BOD of pure water is 1ppm.

- ***Pathogens:***

The pathogens are disease causing agents which include bacteria, virus etc., They may cause some water borne diseases such as cholera, typhoid, fever, dysentery, etc,.

Table 2.2: Diseases and pathogens

Disease	Pathogen	Symptoms
Typhoid Fever	Salmonella typhi bacteria	• A fever that increases gradually • Muscle aches • Fatigue • Sweating • Diarrhoea or constipation
Cholera	Vibrio cholerae bacteria	• Nausea • Vomiting • Diarrhoea • Muscle cramps
Giardiasis	Giardia parasite	• Abdominal pain • Cramps and bloating • Diarrhoea • Nausea • Weight loss
Bacillary dysentery - shigellosis.	bacteria – Shigella	• Stomach cramps and pain • Diarrhoea • Fever • Nausea • Vomiting • Dehydration
Amoebic dysentery	Entamoeba histolytica	
Hepatitis A	Hepatitis A virus	• Fatigue • Clay-colored bowel movements • Jaundice • Nausea and vomiting • Abdominal pain near liver • Loss of appetite • Sudden fever
Salmonellosis	Salmonella bacteria	• Diarrhoea • Fever • Abdominal cramps

- ***Inorganic Pollutants***

These are water soluble phosphates and nitrates. The major source of these inorganic pollutants is agricultural runoff which contains fertilizers, pesticides, etc. The excessive addition of these nutrients to water is known as ***eutrophication***. This condition would promote the growth of algae to form an algal bloom.

As a result, the quality, taste and smell of water would change. Besides, the oxygen level would also be depleted and water becomes unsuitable for the fishes and other aquatic animals. There is also another possibility of these pollutants getting accumulated into the biological systems (bioaccumulation) and also, they reach human through food chain as mentioned below.

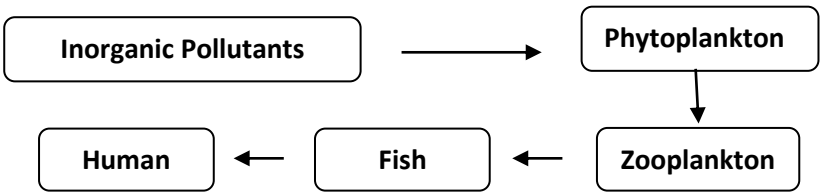

Figure 2.5: Food Chain

At each level of food chain, these pollutants are increasingly concentrated in biological systems. This process is known as biomagnifications. Thus, pollutants are becoming major threat to life. Acids, salts and compounds of toxic metals like Mercury, Lead, Copper etc., discharged by the industries may cause the diseases/disorders as listed below:

Table 2.3: Diseases and Metals

S.No	Metals	Name of Disease
1	Mercury (Hg)	MinaMata
2	Cadmium (Cd)	Itai Itai
3	Aluminium (Al)	Aluminosis
4	Zinc (Zn) & Copper (Cu)	Hyperkeratosis
5	Tin (Sn)	Stanosis
6	Lead (Pb)	Plumbism

- ***Oil***

Leakage or spilling of either crude petroleum or refined petroleum (fuel oil, gasoline and other b products) primarily destroys aquatic life as it forms a thin layer which prevents the interaction of oxygen with water. However, some toxic chemicals would be evaporated. Nevertheless, the heavy oil components like naphtha and asphalt which sink into ocean floor is believed to cause greatest long-term effect on aquatic life.

- ***Suspended Matters:***

The suspended matters would interfere with the penetration of sunlight in water. Thereby the productivity of aquatic plants would be greatly reduced. This condition would warrant ecological imbalance.

- ***Thermal pollutants:***

In a thermal power station, approximately 700 million gallons water is being used by a plant per day which is then discharged into the nearby water body. This would cause a rise in temperature by 15°C than the normal level. This condition would decrease the solubility of

oxygen. Further, the rise in temperature affects the breeding (reproduction) cycle of aquatic life and also making them susceptible to diseases.

- ***Ground water pollution:***

Ground water is a vital source of drinking water. EPA (Environmental Protection Agency) estimates that 2% of a country's usable ground water is moderately or severely polluted. The two major sources of ground water pollution are leaks of hazardous organic chemical from underground storage tanks and seepage of toxic heavy metal pollutants from landfills, dumps and lagoons.

Effects of water pollution:

Eutrophication

Due to over nutrients (nitrogen) in the water bodies, algae grow well and oxygen will be depleted from the water which adversely affect the fish, plants and animals species living in t he water. This condition is called ***eutrophication***. The cause of eutrophication is the use of fertilizer in the fields and discharge of waste in the water bodies.

Biochemical oxygen demand (**BOD**)

BOD is the amount of dissolved oxygen needed by to break down organic material by microorganisms aerobically present in the given water sample at a specific temperature and time period. It is measured in mg/l or ppm. It has become a practise to measure the BOD over a period of 5 days.

Chemical Oxygen Demand (COD)

The amount of oxygen required for chemical oxidation of organic materials present in water is called COD. It is expressed in mg/l. COD is usually measured 2 hours.

Prevention of water pollution

The best way to prevent/reduce water pollution is to minimize its harmful effects. Few methods are suggested below to prevent water pollution:

1. ***Saving water*:** Water conservation is the universal responsibility of every citizen. The usage of water for daily use for various activities like bathing, laundry, watering plants etc can be minimized. Small changes we make domestically will make a huge difference. Rain water harvesting must be done.
2. ***Sewage treatment*:** Treating waste products before disposing of it in a water body helps reduce water pollution on a large scale. Agriculture or other industries can reuse this wastewater by reducing its toxic contents.

3. ***Use environmentally friendly products***: By using soluble products that do not go on to become pollutants, we can reduce the amount of water pollution caused by a household. Replacement of chemical fertilizers with biofertilizer (Rhizobium, Azotobacter, Asospirllium etc) and pesticides with bio pesticides (Bacillus Sp.).

Drinking Water Qualities:

Drinking water is also known as potable water. This water is safe to drink or to use for preparation of food. The amount of drinking water required to maintain good health varies, and depends on physical activity level, age, health-related issues, and environmental conditions. In a temperate climate under normal conditions, adequate water intake is about 2.7 litres for adult men. Physical exercise and heat exposure cause loss of water and therefore may induce thirst and greater water intake. Drinking water quality standards describes the quality parameters set for drinking water.

Table 2.4: Indian Standard for Drinking Water – Specification IS 10500: 2012

Physical parameters

S.No	Parameter	Acceptable limit	Permissible limit
1	Colour	5Hz	15Hz
2	Odour	Agreeable	--
3	pH	6.6- 8.5	No relaxation
4	Total Dissolved solids	500 mg/L	2000 mg/L
5	Turbidity	1 NTU	5NTU
6	Aluminium	0.03 mg/l	0.2 mg/l
7	Ammonia	0.5 mg/l	No relaxation
8	Barium	0.7 mg/l	No relaxation
9	Iron	0.3 mg/l	No relaxation
10	Manganese	0.1 mg/l	0.3 mg/l
11	Sulphate	200 mg/l	400 mg/l
12	Nitrate	45 mg/l	No relaxation
13	Chloride	250 mg/l	1000 mg/l
14	Fluoride	1 mg/l	1.5 mg/l
15	Arsenic	0.01 mg/l	0.05 mg/l

CASE STUDIES

1. **Minimata disease:**

   Minimata disease is caused by mercury poisoning and affects the nervous system. This pollution was caused by a plastic industry managed by the Chisso Chemical Company, in Minamata, Japan in 1953. The effluent (liquid waste) discharged into the Minamata river containing mercury ions reached the sea. The mercury ions are insoluble and non-toxic. The micro organism living in the mud converted the mercury ions into soluble toxic methyl mercury. Through water the methyl mercury entered the food chain. Due to this there was a mass death of fishes, sea birds, cats, dogs and human beings.

2. **Pollution in River Ganga**

   River Ganga is a sacred and holy river of length 2,570km. River Ganga is formed by the union of two large rivers, namely, Ramaganga and Yamuna. Ganga is polluted due to domestic sewage, industrial effluents, tannery effluents, pesticide and fertilizer pollution, cremation pollution etc. BOD

SOIL POLLUTION

Soil pollution is defined as the undesirable change in the land due to the presence of toxic chemicals in high concentration that affect the normal human activities. Soil pollution affects plants, animals and humans equally. Effects of soil pollution may vary based on age, general health status and other factors, such as the type of pollutant or contaminant inhaled or ingested.

Types of soil pollution:

Soil pollution can be broadly classified into two categories:

- Naturally caused soil pollution
- Anthropogenic soil pollution (caused by human activity)

Natural Pollution of Soil

Some pollutants are naturally accumulated in soils. This may be due to differential deposition of soil by atmosphere or by water. Some contaminants can be produced in the soil

due to some environmental conditions. For example, per chlorates (ClO_4^-) can be formed in soils containing chlorine and certain metals during a thunderstorm.

Anthropogenic Soil Pollution

Soil pollution caused by man is called anthropogenic soil pollution. A variety of human activities like demolition of old buildings, usage of lead-based paints, spillage of petrol or diesel from vehicles, improper disposal of effluents from factories, usage of pesticides and fertilizers for agricultural purposes etc can lead to the contamination of soil.

Soil pollution is a global threat that is particularly serious in regions like Europe, Eurasia, Asia and North Africa, as indicated by the Food and Agricultural Organization of the United Nations (FAO). Moreover, the FAO distinguishes the soil pollution into two types.

- **Specific pollution:** Soil pollution can be caused by a specific event or a series of events within a particular area in which contaminants are released to the soil, and the source and identity of the pollution is easily identified. This land pollution is normally found in cities, old factory sites, around roadways, illegal dumps and sewage treatment stations.
- **Widespread pollution:** covers extensive areas and has several causes the reasons for which are difficult to identify. Cases such as these involve the spreading of pollutants by air-ground-water systems and seriously affect human health and the environment.

Soil Pollutants:

Most of the hazardous soil pollutants are xenobiotics (substances that are not naturally found in nature and are synthesized by human beings). The term 'xenobiotic' is derived from Greek words – 'Xenos' (foreigner), and 'Bios' (life). Several xenobiotics are known to be carcinogens. The soil pollutants may be ***biodegradable*** or ***non-biodegradable***. The ***biodegradable*** pollutants are decomposed by microorganism. *Examples*: crop wastes, dead bodies of animals, paper boards, wooden logs etc. The ***non-biodegradable*** pollutants are not decomposed by microorganisms. *Examples:* Plastic bags, metals, etc.

The soil pollutants may be solid wastes or liquid wastes. The solid waste comes from kitchen, industries, hospitals, agriculture etc. The solid waste coming from municipality is called Municipal Solid Wastes (MSW).

Causes and effects of soil pollution:

- **Pesticides /Weedicides**

The wide range of various pesticides, insecticides, fungicides, herbicides and weedicide such Aldrin, endrin, malathion, etc., are employed in intensified agricultural practices. As these toxic chemicals are fat soluble hydrocarbons, they tend to accumulate in the living organisms and get concentrated at each trophic level. Hazards of these pollutants are listed below:

- ❖ Affect not only the target organisms but also the other beneficial microorganisms.
- ❖ Interfere with the photosynthesis and metabolic activities of plants.
- ❖ Damage the central nervous system and cause cerebral haemorrhage.

- **Chemicals**

The toxic metallic pollutants, salts, acids and alkalis of industrial discharges and the precipitates of acid rains pollute the soil. An example for the chemical pollutant is fluoride which inhibits photosynthesis in plants and also causes abscission of leaves and fruits. In human beings the fluorides cause mottling of teeth, weak bones, and knocking of knees etc.,

- **Fertilizers**

The chemical fertilizers added to soil would interfere with soil microbial communities and thus affect the soil quality. Further, they would also deteriorate the soil quality by enhancing the salt content.

- **Human and Animal Wastes**

In both under developed and developing countries these wastes would create unhygienic conditions. The pathogenic organisms found in these wastes would ultimately cause health hazards like amoebiasis (dysentery) cholera etc., in domesticated animals and human beings.

- **Discarded Materials**

Man discards materials like rugs, leather, plastics, glass, paper, concrete materials, e-waste, components of machineries etc., on land. This would make land barren.

- **Hazardous wastes**

Vast amounts of hazardous electronic wastes, plastics and metal scrap wastes are being burned or discarded in the fields, irrigation canals and waterways across developing countries in Asia. This practice would pollute the natural environment. It is noteworthy that millions of kilogram of electronic wastes of computers and televisions are being generated in developed countries every year. Of which, 50-80% is being shipped for recycling in countries like India, China and Pakistan. On recycling process, the heavy metals like lead, mercury, cadmium etc., are being released into soil which in turn would pose health hazards.

- **Plastics**

With the revolution in modern life, plastic consumption triples every decade. The throw away culture of these non-biodegradable petrochemical-based plastics causes serious environmental problems. On accumulation of these wastes, the aesthetic qualities of cities and forest are greatly affected. It prevents the percolation of rain water. On burning, these wastes release dioxin which is highly carcinogenic.

- **Nuclear / Radioactive wastes**

Radioactive elements from nuclear power plants and mining units reach through water.

- **Salination of Soil**

The increase in the concentration of soluble salts in soil is known as salination. The salinity would reduce the fertility of the soil. About 6000-8000 hectares of farm land turns saline every year in Punjab alone. The major causes of soil salinity are:

- ❖ Agricultural practices like prawn culture
- ❖ Inflow of water from sea at coastal regions
- ❖ Excessive use of alkaline fertilizers
- ❖ Improper drainages

Control of soil pollution:

Land surface is covered with soil. We come in close contact with soil and rely on it for each and every activity. So, soil pollution has to treated seriously. Soil pollution can be controlled by the following methods:

- The 3 R principle of pollution control must be followed (R-Reduce, R- **Reuse, R-Recycle)**

- Kitchen wastes can be segregated as biodegradable and non-biodegradable wastes and dumped into appropriate municipal waste container.
- Minimize the usage of chemical fertilizers and pesticides. Organic manures and biological pesticides can be used.
- Industrial effluents can be treated at the source point itself. Zero waste technology can be adopted in factories and industries.

- Plan wind shields by planting vegetation in 7 to 9 rows in a zig-zag pattern with 5 meters space between each row and each tree.

Several technologies have been developed to tackle soil remediation. Soil remediation is a process used to treat soils contaminated by heavy metals or other pollutants by removing and converting them into less harmful products. Some important strategies followed for the decontamination of polluted soil are listed below.

- Excavation and subsequent transportation of polluted soils to remote, uninhabited locations.
- Extraction of pollutants via thermal remediation – the temperature is raised in order to force the contaminants into the vapor phase, after which they can be collected through vapor extraction.
- Bioremediation or phytoremediation involves the use of microorganisms and plants for the decontamination of soil.
- Mycoremediation involves the use of fungi for the accumulation of heavy metal contaminants.

MARINE POLLUTION

Human population is growing in coastal areas globally. Human rely more on coastal resources for fishing, desalination for drinking water, use of beaches and coastal areas. The main reason for marine pollution is water pollution. Many of our waste products which include visible litter and invisible waste like chemicals end up in the sea.

The 1982 United Nations Convention on the Law of the Sea defined marine pollution as "The introduction by man, directly, or indirectly, of substances or energy to the marine environment resulting in deleterious effects such as: hazards to human health, hindrance to marine activities, impairment of the quality of seawater for various uses and reduction of amenities."

Causes and effects of marine pollution:

More than 80% of marine pollution comes from the land. Air also carries pesticides and dust from farms into sea. Marine pollution is caused by the following factors:

(i) Direct discharge:

Industrial effluents are poured into the sea. Municipal wastes and garbage's are dumped into the ocean. The sewage contains rich amount of nutrients. The nutrients facilitate

the thick growth of phytoplankton and algae by the process called eutrophication. Plankton bloom is caused by bioluminescent dinoflagellates. They emit red light in the tides and it is called red tide. They kill fishes.

The fertilizers and pesticides applied on agricultural fields are washed into the sea by surface run off. Heavy amount of nutrients brings about the thick growth of bioluminescent dinoflagellates causing plankton bloom. The fishing boats and ships discard old and useless fishing nets into the sea. Seals and sea lions starve after being entangled by nets or muzzled by six-pack rings.

(ii) Ship pollution: Oil spilling, due to leaks in the oil tanker ships, cause marine pollution. Discharge of cargo residues from bulk carriers can pollute ports, waterways, and oceans. The passengers of the ships and the fish farmers throw the plastics into the sea. Sea turtles mistake plastic bags for jellyfish and die from internal blockages. Plastic debris kills 100,000 marine mammals and 2 million sea birds die annually. Thin film of oil on the surface of water is called oil slick. Mangrove plants are affected more by oil slick.

(iii) Atmospheric pollution: Another pathway of pollution occurs through the atmosphere. Wind-blown dust and debris, including plastic bags, entering the sea from landfills and other areas cause marine pollution.

(iv) Climate change: Ocean temperature is also rising with climate change. Increasing Carbon dioxide level, the atmosphere is acidifying the oceans. This is altering the aquatic ecosystems by modifying fish distribution and the livelihoods that depend on them.

(v) Deep sea mining: Mining occurs in the ocean floor. Removal of parts of the sea floor will result in disturbances to the benthic layer and organisms. Greatest impact of deep-sea mining is the sediment plumes. Two types of plumes are possible. They are near-bottom plumes and surface plumes. Near-bottom plumes occur when the tailings are pumped back down to the mining site. Turbidity of water is increased by the floating particles. Surface plumes will spread over vast areas depending on the size of the particles and water currents. Light penetration is affected which in turn will affect food web to a greater extent.

Control measures for marine pollution:

A ban should be implemented on the dumping of industrial, residential and agricultural wastes and chemicals into water sources. All that flows to the water sources in then eventually taken to the ocean.

The industries must contain sewage treatment plants. The sewage treatment includes screening, sedimentation, decomposition. Large materials in sewage can be removed by ***screening***. Dissolved particles can be removed by ***sedimentation***. The BOD can be reduced by treating the water in ***oxidation ponds***. Oxidation pond is a large pond with 1 to 2 m depth. The sewage is allowed to decompose by microorganisms.

Oil from surface waters and contaminated beaches can be removed through the use of chemical dispersants which can be sprayed on the oil. The oil spill is removed by a process of emulsification. The oil slick can be removed by ***slick lickers*** which absorb oil from the surface of waters. Volatile part of oil is removed by evaporation. The oil deposited on the rocks and harbour walls can be cleaned with high pressure. The bacterium ***Pseudomonas putida*** prepared by genetic engineering eats away the oil slick. This bacterium is called a ***super bug***.

The Government should take up steps to educate people about the causes, effects and the remedies to prevent the causes of marine pollution. Awareness programs gives us a basic idea about how much we are actually harming or affecting the environment since almost every activity we do has a negative effect on our environment.

CASE STUDIES

1. On January 28, two vessels, the M.T. *BW Maple* and M.T. *Dawn Kanchipuram* collided with each other outside Kamarajar harbor at Ennore, causing a huge quantity of furnace oil to spill into the sea. By the end of its first week, the leak had polluted over 35 kilometers of the city's shoreline, engulfing most Chennai beaches.The oil spill caused havoc in the lives of fisher communities in Chennai, Kancheepuram and Tiruvallur.

2. Two cargo ships collided off the Mumbai coast on August 17, 2015 causing an oil spill that spread quickly through Maharashtra's coastline. MSC Chitra ruptured its tank when it hit incoming MV Khalijia and ran aground at Colaba, near Prongs Reef Lighthouse. The vessel contained about 1,200 tonnes of fuel oil in its tanks of which 800 tonnes spilled into the Arabian Sea before the leaks could be plugged two days later. "Entire mangroves in our area turned black. It was a scary sight," said Dipesh Khattu, a teenager from Pirwadi village in Uran taluka of Raigad, one of the affected districts about 100 km from Mumbai.

NOISE POLLUTION

The word noise is derived from the Latin word '*Nausea'* which means '*a feeling of sickness at the stomach with an urge to vomit'*. All sound is not noise. Noise is defined as 'unwanted or offensive sound that unreasonable intrudes into our daily activities'.

Sound waves cause eardrums to vibrate, activating middle and inner organs and sending bioelectrical signals to the brain. The human ear can detect sounds in the frequency range of about 20 to 20,000 Hz. Sound is measured in *decibel*(dB). The permissible noise level of human ear is 125 decibels as per Environmental Protection Rules 1999.

Noise pollution is the dumping of unwanted sound into the environment. Noise pollution is believed to be a silent pollution because nothing is deposited after the noise is over. Any sound above 85dB can cause hearing impairment. Normal conversation is 65dB.

The Union Environment Ministry has prescribed noise standards for different vehicles. The vehicle manufacturers are instructed to follow these standards.

Table 2.5: Permissible limit of noise in vehicles

S.No	Name of Vehicle	Permissible limit of noise
1	Two wheelers	80dB
2	Cars	82dB
3	Buses and trucks	85dB
4	Heavy vehicles	89 t0 91 dB
5	Jet air craft	100 dB

Sources of noise pollution:

Noise pollution may be due to indoor or outdoor sources. The sources of noise pollution may be classified into three types.

1. Automobile noise
2. Industrial noise
3. Domestic noise

Automobile noise:

Main source of noise pollution is automobile noise. The noise arising from the automobiles is called automobile noise. This include road traffic, rail traffic and air craft noise. Road traffic includes scooters, bikes, autos, cars, trucks, buses, tractors, JCB's, etc. Heavy vehicles produce more noise than light vehicles. Diesel vehicles produce more noise than petrol vehicles.

The invention of supersonic aircrafts has added more noise for the persons who live near aerodromes. The higher the speed of an aircrafts the greater the noise pollution. Birds are scared by the noise of aeroplanes. Satellites are projected into space with the help of high explosive rockets which also contribute more to noise pollution. The noise from locomotive engines, horns and whistles, and switching and shunting operation in rail yards can create annoyance neighbouring communities and railroad workers.

Ships also create noise pollution that disturbs natural wildlife. Animals such as whales use water to communicate with one another over great distances. Human-generated noises in the ocean, such as engine noises by boats, may interfere with animal communication.

Industrial noise:

Industrial noise is caused by machines of numerous factories, industries and mills used for the technological advancement. The ambient air standards of noise for industrial area is 75dB during day time and 70 dB during night time.

Domestic noise:

Noise produced in human dwelling places constitute domestic noise. It includes disturbance form household gadgets and community. Certain household equipment, such as vacuum cleaners, some kitchen appliances and movement of utensils, cutting and peeling of fruits/vegetables etc. have been and continue to be noisemakers, although their contribution to the daily noise dose is usually not very large.

Effects of Noise pollution:

The effect of noise pollution is multifaceted & inter related. The effects of Noise Pollution on Human Being, Animal and property are as follows:

(i) Decreases of efficiency & concentration:

Noise pollution can cause emotional or psychological effects like irritability, anxiety and stress. Lack of concentration and mental fatigue are significant health effects of noise. It has been observed that the performance of school children is poor in comprehension tasks when schools are situated in busy areas of the city. Industrial workers are affected by sleeping disorders and behavioural changes. Sometimes they are irritated and annoyed and fail to interact with a person around them and this leads them to become **"loners"** and in extreme circumstances might have **"tremors",** speech problems and many other behavioural problems.

(ii) **Hearing Problems:**

Noise pollution can cause temporary or permanent deafness. Temporary hearing loss is often called a Temporary threshold shift (TTS). People suffering from this condition will be unable to detect weak sounds. However, hearing ability is usually recovered within a month. Permanent loss, usually called Noise Induced Permanent Threshold Shift (NIPTS) represents a loss of hearing ability. A sound level of 150dB or more can physically rupture the human eardrum and >180dB can kill a person.

(iii) Blood Pressure: The noises are recognized as major contributing factors in accelerating the already existing blood pressure and altering pulse rates.

(iv)Effect on Vegetation: Plants are similar to human beings as they are sensitive like man. They require a cool & peaceful environment for better growth. Noise pollution causes poor quality of crops in a pleasant atmosphere.

(v) Effect on Animal: Man-made noise pollution has made the earth an uncomfortable place to live for animals. Noise pollution damage the nervous system of animal. Animal loses the control of its mind. They become dangerous. Intolerable noise levels can decrease a cow's capacity of milk production. Birds in urban areas use their sharp hearing abilities to hunt prey. High noise level has a negative impact on their living. Sonar navy tests can hurt the whale's ear and reduce its ability to breed and feed.

(vi)Effect on Property: Loud noise is very dangerous to buildings, bridges and monuments. It creates waves which struck the walls and put the building in danger condition. It weakens the edifice of buildings.

Control of Noise Pollution:

Noise pollution must be controlled as it produce serious adverse effect on human health. There are four fundamentals ways in which noise can be controlled:

(i) Reduce noise at the source

(ii) Block the path of the noise

(iii) Increase the path length of noise and

(iv) Protect the recipient.

Domestic noise can be reduced by operating the electronic gadgets like radios, tape recorders, television sets, mixers, washing machines in 'low volume'. Carpets can be used at home to reduce noise. The usage of loudspeakers in residential zones must be restricted.

Automobile noise pollution can be reduced by lubricating the machines, tightening the loose nuts and preventing vibration of machines by rubber padding. Noisy automobile should be

condemned. Selection of machinery or equipment's which generate less noise is an important strategy in noise minimisation. Establishing lower speed limits for highways that pass through residential areas, limiting traffic volume and providing alternative routes for trucks are effective noise control measures. Vehicles plying without silencers must be stopped immediately.

Industrial noises can be reduced by constructing the residential houses far away from industries and factories. Noise reduction can be done by using rigid sealed enclosures around machinery lined with acoustic absorbing material. The latest technology for overcoming the effects of noise is using white noise machine. It is a device which converts unbearable noise into pleasant sound.

Green Belt Development is growing trees or green plants for reduction or attenuation of sound. The degree of attenuation varies with species of green belt. Plants absorb and dissipate sound energy and thus act as Buffer Zone. Trees should be planted along highways, schools and other places.

Zoning urban areas to maintain a separation between residential areas and zones of excessive noise.

THERMAL POLLUITON

Thermal pollution is the degradation of water quality by any process that changes ambient water temperature. Fish and other organisms adapted to particular temperature range will be disturbed by the temperature change. Rapid increase or decrease of temperature is called 'Thermal Shock'.

When one think of environmental pollution, thermal pollution does not come into their mind at all. Thermal pollution is a real and persistent problem in our modern society. Even a small increase of temperature (only one or two degrees Celsius) can adversely affect the abilities of the organisms found in water to digest, properly metabolize and reproduce.

Causes of thermal pollution:

(i) Water as cooling agent:

Biggest source of thermal pollution is production and manufacturing plants. These plants use the water from the nearby source to cool their machines and the used water with high temperature is released into the water bodies such as a river, lake, or ocean back. When the hot water returns to the river or ocean, the water temperature rises sharply. This will affect the quality and longevity of wildlife that live in shallow and deep waters. Water is commonly used in power generating station.The streamside vegetation is wiped away.

(ii) **Nuclear power plants:**

Nuclear power plants emit a large amount of unutilized heat and traces of toxic radio nuclear into nearby water streams.

(iii) **Soil Erosion:**

Constant soil erosion causes water bodies to rise by depositing soil inside the water. As the level of water is raised, the water will be more exposed to sunlight which will result in the increase of temperature. The high temperature could prove fatal for aquatic biomes as it may give rise to anaerobic conditions.

(iv) **Deforestation:**

Trees and plants prevent sunlight from falling directly on lakes, ponds or rivers. These water bodies are directly exposed to the sunlight when deforestation takes place. As a result, temperature of the water is increased.

(v) **Runoff from Paved Surfaces:**

Runoff from paved surfaces like roads and parking lots can make water warmer. During summer seasons, the pavement gets quite hot, which creates warm runoff that gets into the sewer systems and water bodies.

(vi) **Natural Causes:**

Natural causes like volcanoes and geothermal activity under the oceans and seas can trigger warm lava to raise the temperature of water bodies. Lightening can also introduce massive amount of heat into the oceans. This will increase the overall temperature of the water bodies and have significant impact on the ecological balance.

Effects of thermal pollution:

(i) **Decrease in Dissolved Oxygen Levels:** The warm water holds relatively less oxygen than cold water. Dissolved oxygen will be less in the water. Blue green algae flourish in the surface of water bodies thus decreasing oxygen level. Young fishes may be killed by warm water.

(ii) **Increase in Toxins:** The pollutant from various industrial plants are heated and cause rise in the temperature of water which increases the toxicity of the poison present in water. The death rate of aquatic life increase with toxicity.

(iii) **Change in water properties:** The decrease in density, viscosity and solubility of gases in water increases the setting speed of suspended particles which seriously affect the food supplies of aquatic organism.

(iv) **Loss of Biodiversity:** Sponges, molluscs and crustaceans are eliminated at temperatures above 37°C. Aquatic organisms like juvenile fish, plankton, fish, eggs, larva, algae and protozoa which pass through screens and condenser cooling system are extremely sensitive to abrupt temperature changes.

(v) **Affecting Reproductive Systems:** A significant halt in the reproduction of marine wildlife can happen due to increasing temperatures as reproduction can happen only within certain range of temperature. Spawning of animals in water is disturbed. Excessive temperature can cause the release of immature eggs or can prevent normal development of certain eggs.

(vi) **Increases Metabolic Rate:** Thermal pollution increases the metabolic rate of organisms as increasing enzyme activity occurs that causes organisms to consume more food than what is normally required, if their environment were not changed. It disrupts the stability of food chain and alter the balance of species composition.

(vii) **Migration:** Changes in temperature of the environment may cause certain species of organisms to shift their habitat to some other place. This can result in loss for those species that depend on them for their daily food as their food chain is interrupted.

Control measures of prevent thermal pollution:

- **Cooling ponds:** The hot water from the industries are stored in ponds. The water cools naturally by evaporation. The cooled water is then discharged into the water bodies.
- **Cooling Towers:** The hot water is passed through a system of coiled pipes kept in a tower. Cool air is passed over the pipes upwards from the bottom of the tower. The hot water is allowed to flow downwards from the top of the tower.
- **Spray Ponds:** The hot water is sprayed through nozzles into fine water droplets. The cooled water is collected in spray ponds after the heat is dissipated form the droplets.
- **Cogeneration**: Cogeneration or combined heat and power (CHP) is the use of a heat engine or power station to generate electricity and useful heat at the same time. The heat is recycled into useful heat for domestic and/or industrial heating purposes.
- **Trigeneration**: Trigeneration or combined cooling, heat and power (CCHP) refers to the simultaneous generation of electricity and useful heating and cooling from the combustion of a fuel or a solar heat collector.
- **Green infrastructure or blue-green infrastructure**: Green infrastructure or blue-green infrastructure is a network providing the “ingredients” for solving urban and climatic challenges by building with nature.

RADIOACTIVE POLLUTON

Radiation is the process by which radiant energy is transferred from one place to another in the form of electro-magnetic waves. Radioactivity is produced by the spontaneous decay of the isotopes of some elements, whose nuclei are unstable. Emission of alpha particle, beta particles, neutrons, gamma rays and x-rays are the five types of radiation that generally occurs. The various types of radiation differ from one another by their frequency or wavelength. Higher the frequency or lower the wavelength of a radiation, higher will be its energy. Again, higher the energy of the radiation, it will cause higher damage to the living organisms.

Non-ionising Radiations:

These are the radiations which induce the ionisation of atoms and molecules. An atom is ionised when energy supplied to it separates one or more of its electrons. Ionisation of a molecule produces two fragments. The radiation pollution is mainly caused by non-ionising radiation. Alpha (α), beta (β), and gamma (γ) radiations are mainly responsible for radiation pollution. Alpha radiation contains energetic -alpha particles. Each alpha particle carries two units of positive charges and interacts strongly with living tissues.

Beta radiation is made up of energetic electrons. Each beta particle carries one unit of negative charge and interacts strongly with matter. Gamma radiations are made up of high energy photons. Photons bring about strong electro-magnetic interactions with matter.

Sources of Radiation Pollution:

Radiation sources are mainly natural but partly manmade.

Natural sources

The natural sources of radiations are:

1. Radioactive minerals;
2. Cosmic rays;
3. Radio nuclides.

Radioactive Minerals:

The minerals containing Uranium- 235 (U^{235}), Uranium-238 (U^{238}), Thorium-232 (Th^{232}), Plutonium- 239 (Pu^{239}) etc. are capable of emitting energetic radiations causing pollution.

Cosmic Rays:

The cosmic rays containing highly energetic particles reach the surface of the earth causing pollution. The intensity of cosmic rays depends on latitudes and altitude of the place. The intensity is maximum at the poles and minimum at the equator

Radio nuclides:

The unstable radio-nuclides in the atmosphere can be split up into smaller parts emitting energetic radiation. The smaller radio-nuclides enter into the body of organism along with air during respiration.

Manmade radiation

The various sources of manmade radiation are:

1. Nuclear power plants;
2. Radio-active wastes;
3. Nuclear explosions; and
4. Radio-isotopes
5. Electronic gadgets

1. Nuclear Power Plants:

Nuclear power plants emit radiation to a very smaller extent except accidental leaks.

2. Radio-active Wastes:

The nuclear power plants produce a lot of nuclear radio-active wastes. The disposal of these wastes has become a global problem. Some countries producing large quantity of nuclear wastes dump them in ocean near other countries.

3. Nuclear Explosion:

During nuclear explosion, a large number of radio-nuclides are generated in the atmosphere. The radio nuclides settle down with rain contaminating the soil and water bodies. Finally, these enter into food chain causing serious problem to the living organisms.

4. Radio-isotopes:

Radio-isotopes are also prepared artificially either by nuclear fusion or by nuclear fission. If these radio-isotopes are not properly handled, these emit radiations causing pollution.

5. Electronic gadgets:

Television sets produce radiations which can also cause cancer. All the mobile phones, microwave ovens and other gadgets used also produce harmful radiations.

Effect of Radiation Pollution:

When radiation passes through different living organisms the following dis-orderness takes place:

1. Radiation splits the molecules of the tissues into ions and free radicals and causes mutation by breaking DNA (Deoxy ribonucleic acid) molecules in the nucleus.

2. Radiation in bone marrow may cause leukemia.

3. Radiation may cause skin burns which may lead to skin cancer.

4. Radiation at pelvic regions of pregnant ladies, cause damage to the foetus.

Control of Radiation Pollution:

Radiation pollution can be controlled in the following ways:

1. Care should be taken to check manmade radiation pollution at source.

2. Nuclear reactor should be perfectly maintained to avoid accidental leakage.

3. Nuclear tests should be banned.

CASE STUDIES

1. The **Chernobyl disaster** was caused by a nuclear accident that occurred on Saturday 26 April 1986, at the No. 4 reactor in the Chernobyl Nuclear Power Plant, near the city of Pripyat in the north of the Ukrainian SSR. The accident was the result of a flawed reactor design that was operated with inadequately trained personnel. The resulting steam explosion and fires released at least 5% of the radioactive reactor core into the environment, with the deposition of radioactive materials in many parts of Europe. Two Chernobyl plant workers died due to the explosion on the night of the accident, and a further 28 people died within a few weeks as a result of acute radiation syndrome.

2. The **Fukushima Daiichi nuclear disaster** was a nuclear accident at the Fukushima Daiichi Nuclear Power Plant in Ōkuma, Fukushima Prefecture, Japan. It was the most severe nuclear accident and the only other disaster to receive the Level 7 event classification of the International Nuclear Event Scale. The accident was started by the Tōhoku earthquake and tsunami on Friday, 11 March 2011.

Role of IT in Environment

The emerging growth of the internet services and facilities, geographic information system or GIS, and the data that gets transmitted through satellites, etc. have generated a higher affluence of the updated information on several aspects of the environment as well as health.

Database on the Environment System:

Database is a collection of connected data in a computerized form on some subjects. The data can be retrieved at any hour of the day whenever needed. The comprehensive databases include wildlife database, forest cover database etc,. The EAZA (European Association of Zoo and Aquaria) conservation database is an online tool to facilitate and coordinate cooperation and communication of the conservation efforts within as well as outside the zoo community. The databases are also available for some diseases which include malaria, fluorosis, HIV/AIDS, etc. Some of the databases available in general are listed below:

- National Management Information System (NMIS)
- Environmental information System (ENVIS)
- Remote Sensing and Geographical Information System (GIS)
- Geographical Information System (GIS)
- World Wide Web (WWW)

National Management Information System (NMIS)

NMIS of Department of Science and Technology has a database compilation of research and projects as well as information related to research scientist and personals.

Environmental information System (ENVIS)

According to the ministry of environment and forests, the government of India has developed an information system known as ecological information system or ENVIS. It has its headquarters in Delhi and has its branches all over India. ENVIS aims at providing environmental information to all the decision makers, engineers, scientist, and policy planners of all over the Country. The centres of ENVIS implement the work hours in generating a new network for databases in areas such as clean technologies, pollution control, biodiversity, wildlife, environmental management, remote sensing and renewable energy.

Remote Sensing and Geographical Information System (GIS)

Remote sensing is the science of collecting data regarding an object or a phenomenon without any physical contact with the object. Remote sensing technology is designed to collect and retrieve large amounts of data regarding an object or a phenomenon in a short period of time. The data could be about various aspects of the object including its position on the earth's surface. Remote sensing technology relies upon technical instruments to collect data over large areas which reduce the manual work that could otherwise have required a lot of people to do.

The process of remote sensing that accesses through satellites can be used to get through the ongoing alterations in the environment as well as to predict the natural hazards before time such as floods, droughts, volcanic eruptions, starvation, etc. It is one of the most useful techniques in exploring the availability of mineral deposits, crude oil, and locating other geothermal powerhouses.

Geographical Information System (GIS):

GIS or geographic information system is considered as one of the most effective tools in the entire environmental management topic. It is a process of superimposing different thematic maps with the help of digital data on a large scale of interconnected aspects. The different thematic maps that contain digital information and database on various elements, such as forestland, water resources, soil type, cropland, industrial growth, human settlement, and industrial growth, etc. are placed in a layered prospectus in the computer with the help of software.

GIS also helps in identifying some deadly and chronic diseases that come from the infested areas which are very much prone to vector-borne diseases such as malaria, COVID-19, based on the geographical map of that area. There are some distribution information centres (DICs) in India that are interrelated with each other and with the central information network getting its access to the international database. GIS play a significant role in resource mapping, management, planning, environmental conservation, and environmental impact assessment as well.

The World Wide Web (WWW):

With the availability of resources on every aspect, things like classroom activities, digital files of photos, web-exercises, animations, power point lecture presentations, and quiz competitions have proved to be more helpful for both the students as well as teachers who pursue environmental studies.

Sustainable Development

Sustainable development is the need of the present time not only for the survival of mankind but also for its future protection. Unlike the other great revolutions in human history the Green Revolution and the Industrial Revolution the ‘sustainable revolution’ will have to take place rapidly, consciously and on many different levels and in many different spheres, simultaneously. Sustainability can be defined as the practice of maintaining world processes of productivity indefinitely—natural or human-made—by replacing resources used with resources of equal or greater value without degrading or endangering natural biotic systems.

Environmental Legislations and Acts

Environmental legislation is a collection of many laws and regulations aimed at protecting the environment from harmful actions. Some of the laws related to environmental protection and wildlife are:

- The Environment (Protection) Act, 1986
- The Forest (Conservation) Act, 1980
- The Wildlife Protection Act, 1972
- Water (Prevention and Control of Pollution) Act, 1974
- Air (Prevention and Control of Pollution) Act, 1981
- The Indian Forest Act, 1927.

The Environment (Protection) Act, 1986:

Environment Protection Act, 1986 is an Act of the Parliament of India. In the wake of the Bhopal gas Tragedy or Bhopal Disaster, the Government of India enacted the Environment Protection Act of 1986 under Article 253 of the Constitution. Passed in March 1986, it came into force on 19 November 1986. It has 26 sections and 4 chapters. The purpose of the Act is to implement the decisions of the United Nations Conference on the Human Environment. They relate to the protection and improvement of the human environment and the prevention of hazards to human beings, other living creatures, plants and property.

The Forest (Conservation) Act, 1980:

The Forest (Conservation) Act, 1980 an Act of the Parliament of India to provide for the conservation of forests and for matters connected therewith or ancillary or incidental thereto. It was further amended in 1988. This law extends to the whole of India. It was enacted by Parliament of India to control further deforestation of Forest Areas in India. The act came into force on 25 October 1980. It has five sections.

The Wildlife Protection Act, 1972

The Wild Life Protection Act, 1972 is an Act of the Parliament of India enacted for protection of plants and animal species. Before 1972, India had only five designated national parks. Among other reforms, the Act established schedules of protected plant and animal species; hunting or harvesting these species was largely outlawed. The Act provides for the protection of wild animals, birds and plants; and for matters connected there with or ancillary or incidental thereto. It extends to the whole of India.

Water (Prevention and Control of Pollution) Act, 1974

The Water (Prevention & Control of Pollution) Act, 1974 was adopted by the Indian parliament with the aim of prevention and control of Water Pollution in India. Depending on the pollution of the water, water is demarked under various water classes in accordance with the Water (Prevention & Control of Pollution) Act, 1974. Drinking water at source found without conventional treatment but after disinfection is designated as Class A while water designated for outdoor bathing comes under Class B. Any drinking water source which has been conventionally treated comes under Class C while water used for propagation of wildlife and fisheries is demarked as Class D. Water under Class E is used for irrigation and industrial cooling along with waste disposal.

Air (Prevention and Control of Pollution) Act, 1981:

Industrialization and urbanization have resulted in a profound deterioration of India's air quality. Out of the 3 million premature deaths in the world that occur each year due to outdoor and indoor air pollution, the highest numbers are assessed to occur in India. According to the World Health Organization, the capital city of New Delhi is one of the top ten most polluted cities in the world. Surveys indicate that in New Delhi the incidence of respiratory diseases due to air pollution is about 12 times the national average.

The Act provides for the prevention, control and abatement of air pollution. It also provides for the establishment of Boards with a view to carrying out the aforesaid purposes. Decisions were taken at the United Nations Conference on the Human Environment held in Stockholm in June, 1972, in which India participated, to take appropriate steps for the preservation of the natural resources of the earth which, among other things, include the preservation of the quality of air and control of air pollution.

The Indian Forest Act, 1927:

The Indian Forest Act, 1927 was largely based on previous Indian Forest Acts implemented under the British. The most famous one was the Indian Forest Act of 1878. Both the 1878 act and the 1927 act sought to consolidate and reserve the areas having forest cover, or significant wildlife, to regulate movement and transit of forest produce, and duty leviable on timber and other forest produce. It also defines the procedure to be followed for declaring an area to be a Reserved Forest, a Protected Forest or a Village Forest. It defines what is a forest offence, what are the acts prohibited inside a Reserved Forest, and penalties leviable on violation of the provisions of the Act.

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UNIT III :SOLID WASTE MANAGEMENT

Mrs. J. Porkodi

Introduction

Solid Waste Management (SWM) is an essential service in any society. This generally refers to the collecting, treating and disposing of solid material that is discarded because it has served its purpose or it is no longer useful. The primary goal of SWM is reducing and eliminating adverse impacts of waste materials on human health and the environment to support economic development and superior quality of life. This is done in the most efficient manner ie., at low cost and also to prevent the upsurge of wastes.

SOLID WASTE

Solid waste is a heterogeneous mass of waste materials thrown-away from residential, commercial, agricultural and industrial activities. Eg. Municipal wastes, hotel wastes, packing materials, building wastes, broken glasses, bottles, plastics, etc.

Pollution due to unwanted deposition of solid wastes on land and water is called **solid waste pollution.** It causes pollution on land, water and air. Solid waste is a health hazard.

TYPES OF SOLID WASTES

The solid wastes may be

1. Biodegradable
2. Non-bio degradable.

1. The biodegradable wastes are readily decomposed by the activity of microorganism.

Eg. Slaughter house waste, card board box etc.

2. The non-biodegradable wastes are not decomposed by the microorganism.

Eg. Broken glasses, metals, concrete wastes, etc.

The solid wastes may also be classified based on the action of heat on it

1. Combustible
2. Non-combustible.

1. The combustible wastes can be easily destroyed by heat.

Eg. Paper, card board, plastics, wood, rubber, etc.

2. The non-combustible wastes are not destroyed by heat.

Eg. Ceramics, metals, glasses, etc.

The solid wastes may be

Domestic wastes

Municipal wastes

Commercial wastes

Clinical wastes

Industrial wastes

Agriculture wastes

E-wastes, etc.

Figure 3.1: Solid wastes

1. The domestic wastes include all residential wastes. ***Eg***. Kitchen waste.
2. Commercial wastes are produced as a result of consumerism. ***Eg.*** Plastics, packing materials.
3. Industrial wastes are discarded from industries. ***Eg***. Iron scraps from laths, broken titles from titles-factories, etc.
4. Agricultural wastes are formed as a result of agriculture. ***Eg***. Cattle dung, straw, crop wastes, etc.
5. Municipal wastes are collected from towns and cities. ***Eg***. Hotel wastes.
6. Clinical wastes are discarded materials of hospitals and clinical laboratories.
   Eg. Syringes, needles, bottles, operated tissues, bandage materials, etc.
7. E-wastes are the used and old electronic goods. ***Eg***. TV, computer, printer, ribbons, etc.
8. The solid waste may also be garbage, rubbish, ashes, etc.
9. Garbage is the waste resulting from handling, preparation, cooking and serving of food.
   Eg. Kitchen waste, hotel waste, etc.
10. Rubbish includes all wastes except ash.
    Eg. Paper, plastic, card board, wood, metals, packing materials, etc.
11. Ashes are residues from fire.

COMMON SOLID WASTE

The common solid wastes are the following:

Paper	Boards	Packing materials
Carry bags	Plastic toys	Mug
Buckets	Fuel wood	Rubber
Vegetable wastes	Peels of fruits	Broken glasses
Bottles Bulls	Used clothes	Dust Stone
Concrete wastes	Bricks	Plaster
Sweepings	Ashes	Food waste
Tin cans	Branches of trees	Garden trimmings
Gunny bags	Food serving materials, *etc.*	

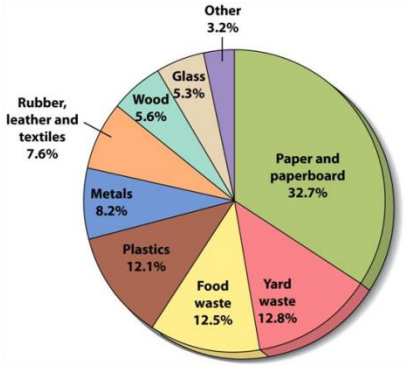


Figure 3.2: Percentage of various solid wastes in world

CAUSES OF SOLID WASTE

The solid wastes are created by the various sectors in the world. They are

Factories	Building construction
Industries	Municipality
Agriculture	Mining
Hotels	Consumerism
Quarries	Hospitals
Domestic activities	Electronic goods

SOLID WASTE MANAGEMENT

The disposal of solid wastes from the environment is called **Solid Waste Management**. The solid waste includes garbage, rubbish, agricultural wastes, industrial wastes, etc.

Solid wastes seem to be pollutants when they are thrown elsewhere around us. If they are properly recycled, several useful materials can be made from them. Hence, it is said that waste is wealth.

They are managed by the following methods:

Landfill
Composting
Incineration
Recycling
Pyrolysis
Reduction in use
Reuse

I. LANDFILL

Landfill is carefully designed structure built into or on top of the ground in which trash is isolated from the surrounding environment (groundwater, air, rain). This isolation is accomplished with a bottom liner and daily covering of soil. A sanitary landfill uses a clay liner to isolate the trash from the environment

1. Landfill is a solid waste disposal site where solid wastes are allowed to decompose in a safe way.
2. Municipal solid wastes, hospital wastes, camp wastes, animal wastes, plant wastes, sludges, soils, slurries, powders, dusts, etc. can be disposed off in landfills.
3. The landfill may be made **above ground** or **below ground** or **above-below ground**.
4. Before filling, the site is lined with **liners** to prevent seepage and **contamination of ground water.**
5. When the filling reaches a thickness of 1.5m, it is covered with earth of 6 inches.
6. Like this many layers are dumped one above the other.
7. The wastes are **decomposed** by bacteria in 2 to 4 months.

8. The decomposed waste is reduced by 20 to 40% of its height.
9. **Biogas** (methane) produced during decomposition can be used for the generation of electricity.
10. The landfill area can be used as lawns, gardens, play grounds, etc.

Advantages of landfill

1. Economical
2. No need for the segregation of the components of wastes.
3. There no residue and hence needs to further treatment.
4. Low lying land, quarrying pits etc. can be used.
5. The biogas released can be collected and used for other purposes.
6. Landfill areas can be used for other purposes.

Disadvantages of landfill

1. Bad odour
2. Mosquitoes and flies breed.
3. Large area is required.
4. Chances for fire.

Case study - Converting wastes into biogas

The BordoPoniente dump, just outside Mexico City, used to be one of the world's largest landfill sites, covering 370 hectares and containing 70 million tons of garbage. It was closed in 2011 and the city committed to a full, environmentally-appropriate landfill site closure process. In the years leading up to its closure, the city implemented comprehensive collection programs for recycling and organic waste in order to drastically reduce the need for new landfill space. Since being shut down, the BordoPoniente landfill has been putting the off-gassing from that 70 million tons of garbage to good use, by building a biogas electricity plant. Experts estimate that the city will be able to reduce greenhouse gas emissions by 1.4 to 2 million tonnes during

II COMPOSTING

Composting is an aerobic method (meaning that it requires the presence of air) of decomposing organic solid wastes. It can therefore be used to recycle organic material. The process involves decomposition of organic material into a humus-like material, known as compost, which is a good fertilizer for plants

1. Composting degrades organic matter into manure called **compost**.
2. Composting generates manure from organic wastes.
3. The compost contains nutrients and micronutrients.
4. It disposes solid wastes.
5. It is a biodegradable process.
6. There are 4 methods of composting.

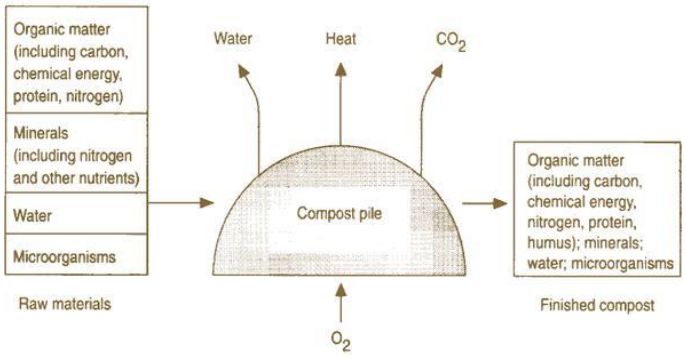


Figure 3.3: Composting

They are:

Window composting

Aerated static pile composting

Mechanical composting

Vermicomposting

a) In **window composting**, the solid wastes are placed in long rows of almost triangular cross sections in open air (windows).
b) In **aerated static pile composting**, the wastes are laid on the floor of ventilating pipe system.
c) **Mechanical composting** is done in vessels.

Vermicomposting is the degradation of waste by earthworms. It is required air and moisture.

III INCINERATION

Incineration is a waste treatment process that involves the combustion of organic substances contained in waste materials. described as "thermal treatment". Incineration of waste materials converts the waste into ash, flue gas and heat. The ash is mostly formed by the inorganic constituents of the waste and may take the form of solid lumps or particulates carried by the flue gas. The flue gases must be cleaned of gaseous and particulate pollutants before they are dispersed into the atmosphere. In some cases, the heat generated by incineration can be used to generate electric power

1. Incineration is the burning or combustion of wastes. The plant used for the incineration is called incinerated.
2. Incineration is an **oxidation** process.
3. It is a method for disposing **solid wastes**.
4. Enormous amount of **heat** is produced during incineration. This heat is used to produce **steam** from water. The steam is used to generate **electricity**

IV RECYCLING

Recycling can prevent the waste of potentially useful materials and reduce the consumption of fresh raw materials, thereby reducing: energy usage, air pollution (from incineration), and water pollution (from landfilling). Recycling of wastes saves energyand it also reduces greenhouse gas emissions, which helps to tackle climate change.

1. Waste papers are ground into pulp and again used for the manufacture of **paper**.
2. Cow dung is used in gobar gas plant to produce **biogas** for cooking and lighting.
3. Garbage is decomposed to **manure**.
4. Solid wastes are incinerated to release **heat**. This heat is used to produce steam from water. The steam is allowed to rotate turbines to generate **electricity**.
5. Slaughter house wastes and fish wastes are used to prepare **feed** for cattle.
6. **Wood chips** and **saw dust** are made into fuel.
7. Glass pieces are melted and remade into bottles.
8. Aluminium, tin, iron scraps, etc. can be reused.

9. The thermal power plants flyash by burning coal. The flyash is used for making bricks, concrete and as manure.

Plastic waste – a substitute for road construction

In India, engineers are adopting a method of taking plastic garbage — the kind that litters the country, chip bags, chocolate bar wrappers, plastic bags, bottles, lids, etc. — and shredding them to be added as a substitute for bitumen in road construction. This method takes a waste product (of which there seems to be a never-ending supply) and reinvents it as a useful substitute in construction. And, it is simple and cost-effective to boot!

V PYROLYSIS

Pyrolysis is the breakdown of solid wastes by heat in the absence of oxygen. It also represents a process of thermal degradation of the waste in the total absence of air that produces recyclable products, including char, oil/wax and combustible gases.

1. Pyrolysis is a Greek term meaning **fire** and **breakdown**.
2. It is an endothermic process.
3. It produces three components from solid wastes. They are gas, liquid and char.
4. The gas includes methane, hydrocarbons, carbon dioxide, etc.
5. Liquid includes tar, acetic acid, acetone, methanol, etc.
6. The char includes carbon.
7. The gas, liquid and char have high calorific value.
8. It is released by combustion.

VI REDUCTION IN USE

Less use of raw materials will decrease the production of waste.

VII Reuse

1. Certain wastes can be reused.
2. Newspaper can be reused for packing.
3. Cycle tubes are used for making rubber bands.

CONCLUSION

The solid waste management stresses '**three R s**'. They are:

Reduction in use

Reuse

Recycling

This will reduce pollution.

HAZARDOUS WASTE MANAGEMENT

Hazardous wastes are harmful wastes causing ill effects now or in future and they cannot be disposed by ordinary methods. Hazardous waste management involves reducing the amount of hazardous substances produced, treating the hazardous wastes to reduce their toxicity and applying sound control measures to reduce or eliminate exposures to these wastes. It involves the collection, treatment and disposal of waste material that is improperly handled which causes substantial harm to human health and environmental safety.

Radioactive wastes`

Pesticides

Oils

Bottles

Paint

Thinner

Acids

Alkalies

Biomedical wastes

Surgical dressing

Biological tissues

Culture wastes

Needles

Syringer

IMPACT OF HAZARDOUS WASTES

1. Radioactive hazardous cause

Deaths

Gene mutations

Still births

Destruction of plants and animals

Cataracts in the eye

Cancer

Vomiting

2. Pesticides cause

Biomagnification

Cancer

Hazardous waste management strategies

Reduction in use

Reuse

Recycle

Detoxification

Incineration

Solvent extraction

Deep well injection

DISASTER MANAGEMENT

Disaster is a sudden and great accident due to flood, earthquake, etc. It leads to heavy loss of money, property and life.Disaster management refers to the conservation of lives and property during natural or man-made disasters. Disaster management plans are multi-layered and are planned to address issues such as floods, hurricanes, fires, mass failure of utilities, rapid spread of disease and droughts.

Disaster is a natural phenomenon.It is a natural hazard or natural calamity.

The disaster is of two types, namely

1. Natural disasters
2. Manmade disasters

Natural disasters occur naturally. **Eg**. Flood, Earth quake, Tsunami, etc.

Manmade disasters are caused by man. **Eg**. Accidents, Fire, etc.

The following are the natural disasters:

Floods	Landslide
Drought	Tsunami
Earthquakes	Volcanoes.
Cyclones	

Disaster management is the handling of the impacts of the natural disaster. It includes:

1. Prediction of the occurrence of natural disasters
2. Prevention
3. Protection
4. Resettlement
5. Rehabilitation, etc.

FLOODS

A flood is an overflow of water on normally dry ground. This is most commonly due to an overflowing river, a dam break, snowmelt, or heavy rainfall.Floods are an area of study of the discipline hydrology and are of significant concern in agriculture, civil engineering and public health.

1. Flood is a natural disaster or natural calamity.
2. It is caused by intense and continuous rains, cyclones, failing of dams, melting of ice, high tides, etc.
3. The magnitude of a flood is called recurrence interval.
4. The area that is covered in water, is called flood plain.
   Buildings or other structures of flood plains can be damaged by floods.

Types of flood

Flood is of the following 4 types:

River flood	Urban flood
Coastal flood	Ice.

1. River flood is caused by the overflowing of rivers. It is brought out by continuous and intense rains, hurricanes, etc.
2. Coastal flood is the intrusion of seawater. It is caused by storms and hurricanes in the sea and also by tidal waves caused by earthquakes and volcanoes.
3. Urban flood is due to urbanization. Fields and wood lands are converted into dwelling places, factories, roads, etc. This prevents the normal absorbance of rain water. Hence streets and roads become swift moving rivers.
4. Ice blocks, prevent the natural running water causing flood.

Figure 3.4: Intense rain causes flood

Causes of flood

Flood is caused by the following factors:

1. Continuous rain
2. Intense rain
3. Ice or debris jam in the river
4. Melting snow
5. Thunder storm
6. Cyclones
7. Landslide
8. Levee failure (embankment failure)
9. Urbanization- conversion of fields and woodlands into dwelling places, factories, roads, etc.
10. Dam failure
11. Earthquake
12. Volcanoes

Impacts of floods

1. Death of human beings by drowning.
2. Death of domestic and pet animals.
3. Collapse of buildings
4. Road transport is disrupted
5. Rails are dislodge
6. Electric supply become cut off
7. Telecommunication goes off
8. Soil erosion

9. Landslides
10. Drainage system fails
11. Croplands are damaged
12. Certificates, documents, books, etc. are damaged.
13. Food items, grains, etc. are washed off.
14. Drinking water becomes contaminated

Protective steps

1. When there is flood across your way, stop, turn around and go another way.
2. Stay away from flooded areas.
3. Move to high grounds
4. Never try to walk, swim, drive or play in flood water.
5. If you are in a vehicle and become surrounded by water, get out safely and immediately.
6. Beware of snakes, as flood waters wash out snakes from their homes.
7. Stay away from creek and stream banks.
8. Throw away all food that has come into contact with flood water as it contains germs, bacteria, etc.
9. Everyone in your family should know where to go if there is flood.
10. Discuss floods with your family members.
11. Keep certificates, insurance policies, ID cards, documents, etc. in safe- deposit box.
12. Avoid construction of buildings in low lying lands.
13. If your area is flood-borne, raise your furnace, water heater, electric panel to higher floor.
14. Construct levees to stop water entering the buildings.
15. Listen to weather in Radio or TV news during flood times.
16. Store clean water in bottles.
17. Bring necessary outdoor belongings into the house.
18. Switch off the electric lines.

What to do after a flood

1. Seek necessary medical care at the nearest hospital.
2. Help neighbours who may require special assistance.
3. Avoid disaster areas.
4. Continue to listen to weather in radio.
5. Stay out of flooded buildings.
6. Avoid smoking inside the buildings.
7. Wear shoes.
8. Carefully watch electric lines.
9. Check drainage.
10. Check water lines.
11. Watch for snakes that may enter houses.

Organizations involved in flood relief

1. National Disaster Management(NDM) of Ministry of Home Affairs.
2. Indian Army
3. Indian Air Force
4. Indian Red Cross Society (IRCS)
5. Oxfam
6. Action Aid
7. NGO
8. United Nations Disaster Management Team(UNDMT)

Major flood records

1. **Huang He River Flood**

   Huang He is the muddiest river in the World. It is in China. It means Yellow River. In 1931, more than 35,00,000 people were killed due to flood in this river.

2. **Bristol Channel Flood (Seven Estuary Flood)**

   In 1607, about 3000 people were drowned in Seven Estuary Floods in Britain.

EARTHQUAKE

An earthquake (also known as a quake, tremor or temblor) is the shaking of the surface of the earth resulting from a sudden release of energy in the Earth's lithosphere that creates seismic waves. Earthquakes can range in size from those that are so weak that they cannot be felt to those violent enough to propel objects and people into the air, and wreak destruction across entire cities. At the Earth's surface, earthquakes manifest themselves by shaking and displacing or disrupting the ground. When the epicenter of a large earthquake is located offshore, the seabed may be displaced sufficiently to cause a tsunami. It can also trigger landslides and occasionally, volcanic activity.

1. Natural earthquakes are caused by sudden disturbances in the tectonic movement of the earth’s crust.
2. It is a series of vibration on the Earth’s surface caused by the generation of elastic (seismic) waves due to sudden rupture within the Earth during the release of accumulated strain energy
3. The study of earthquake is called seismology.
4. The instrument used to record the earthquake is called seismograph.
5. Earthquake prediction is a branch of the science of seismology concerned with the specification of the time, location, and magnitude of future earthquakes within stated limits.
6. Richer is the unit of measurement which shows the intensity of earthquake.
7. The point of origin of earthquake inside the Earth is called hypocenter.
8. The point on the surface of the Earth vertically above the origin place is called epicentre.
9. Indian Meteorological Department (IMD) is concerned with detecting and locating earthquakes.
10. The earthquakes are normally accompanied by volcanoes.
11. Tsunami (large wave) is due to the sea bed earthquake.

Figure 3.5: Earthquake

Causes of earthquake

1. Movement of tectonic plates.
2. Volcanic eruption.
3. Manmade water bodies like dams.
4. Underground nuclear testing.
5. Lowering of water table.

Earthquakes on record

1. San Francisco Earthquake

   1906; 700 people died; 25,000 people became homeless.

2. Alaska Earthquake

   March 27, 1964; 114 people died.

3. Gujarat Earthquake

   It is also known as the Bhuj earthquake, occurred on 26 January, 2001 at 08:46 am. This earthquake reached 7.7 on the moment magnitude scale and killed between 13,805 and 20,023 people (including 18 in southeastern Pakistan), injured another 167,000 and destroyed nearly 340,000 buildings. In order to support the reconstruction and rehabilitation of the city, the Government of Gujarat announced a US$2.5 million package to revive small, medium, and cottage industries. The World Bank and the Asian Development Bank also provided loans worth $300 million and $500 million respectively for their rehabilitation and normal life.

Do's during earthquake

1. Take shelter under a desk, table or bed during an earthquake.
2. Provide help to others and develop confidence.
3. Shut off kitchen gas.
4. Keep stock of drinking water, food stuff and first aid arrangements.
5. If you are in a moving vehicle, stop and stay in vehicle.
6. Heavy objects, glasses should be kept on lower shelf.
7. Turn on radio or TV to get latest information.
8. Make plan and preparation for emergency relief.

Figure 3.6: Taking shelter under a desk during earthquake

Dont's during earthquake

1. Do not get panicky.
2. Do not use candles, matches, etc. and do not switch off any electric mains immediately after an earthquake.
3. Do not spread and believe in rumours.
4. Do not run through or near buildings during an earthquake.

Richer scale

The magnitude of an earthquake is measured by Richter scale. It was devised by Charles F. Richter of California.

1. The Richter scale works on the principle of a pendulum.
2. The instrument is firmly fixed on the ground. A small weight hangs on a string. When there is earthquake, the weight swings. The swinging of the pendulum depends on the intensity of earthquake.
3. When the Richter is less than 4.9, the effect is less.

4. When the Richter is between 5 and 6.9, the effect is moderate.
5. The effect will be great when the Richter is from 7 to 7.9.
6. When it is 8 and more the effect is very great.
7. The Richter scale measures the forces involved and the effects of the earthquake.

Impact of Earthquake

1. Death of human beings.
2. Death of domestic animals.
3. Injury to human beings and domestic animals.
4. Collapse of buildings.
5. Damage of roads, railway lines, etc.
6. Damage to electric lines.
7. Disruption of telecommunication.
8. Failure of dams.
9. Dust and debris

CYCLONE

Cyclone is a violent and destructive whirl wind moving round a calm central area.It is a large scale air mass that rotates around a strong center of low atmospheric pressure. They are characterized by inward spiraling winds that rotate about a zone of low pressure and numerous thunderstorms.

A cyclone is also named as

Tornado
Hurricane
Depression
Storm, etc

1. It is a natural hazard or natural calamity.
2. It is an intense whirl in the atmosphere with very strong winds circulating around it.
3. It is circulating in anticlockwise direction in the Northern hemisphere and in clockwise direction in the southern hemisphere.

4. The word ‘cyclone’ is derived from a Greek word ‘cyclos’ meaning coils of a snake.
5. The cyclone has a central low pressure area. From the centre, the pressure increases outwards.
6. The amount of pressure drop in the centre and the rate at which it increases outward gives the intensity of the cyclones and the strength of winds.
7. A full grown cyclone has a diameter of 150 to 1000 km and 10 to 15 km high.
8. The central calm region of the cyclone is called ‘eye’. The diameter of the eye varies from 30 to 50 km.
9. The eye is free from clouds and has light winds. It is a calm area.
10. Around the eye ,there is a violent area called wall cloud region.
11. The wall cloud region has gale (strong winds), thick clouds, strong rains, thunder and lightning.
12. Away from the wall cloud region, the wind speed gradually decreases.
13. The gale produced by the cyclone causes confused sea with waves as high as 20 metres.
14. Torrential rains, thunder and lightning join with gale.
15. The sea and the atmosphere are in chaos (confusion).
16. The cyclone moves 300 to 500 km in a day. The speed may be 31 to 222 km/hour. The speed of cyclone is usually denoted in knots. One knot is equal to 1.85 km/hour.
17. The sea becomes turbulent and it surges as high as 12 metres.
18. When the cyclone hits the coast, the sea splashes upto 30 km inland causing heavy destructions.

Figure 3.7: Cyclone

Cyclones of India

a. Gaja Cyclone

Recently another very severe cyclonic storm namely **Gaja** made a landfall in South India (Vedaranyam) in November 2018 . 46 people killed by the storm mainly in the Thiruvarur, Thanjavur and Pudukottai district. About 18000 hectares of coconut trees were uprooted and 56000 hectares of crops and trees were destroyed by this cyclone. A sum of 1146 crores was released as financial assistance by the National Disaster Response Fund (NDRF) for the relief and rehabilitation activities in cyclone affected areas.

b. Vardah cyclone

Very severe **Vardah** cyclone in the year December 2016 (formed over the Malay Peninsula) made landfall close to Chennai. It claimed 18 lives, uprooted 1 lakh trees and caused extensive damage to roads supplies and power infrastructure inChennai. It also affects the land and air transport in Chennai. Central Government announced Rs 264.11 crores for immediate relief.

c. Thane Cyclone

1. Thane Cyclone hit Tamilnadu and Pondicherry on 29,30 December 2011.
2. It killed 46 people, 39 from Tamilnadu and 7 from Pondicherry.
3. It uprooted trees, damaged roads, buildings, electric and telephone lines.
4. It damaged agricultural crops, cash crops, etc.
5. Tamilnadu Government announced Rs. 150 crores and Central Government announced Rs.750 crores for immediate relief.
6. An expert committee of Central Government surveyed the damages and submitted the report.

d. Calcutta Cyclone

October, 1737; 3 lakhs people died; 12 metre high surge; earthquake accompanied.

e. Midnapore Cyclone

October, 1942;gale wind speed 225 km/h.

f. Rameswaram Cyclone

1. December 23rd ,1964; Wiped out Dhanuskodi from the Indian map; A passenger train which left Rameswaram, was washed out with all the passengers by the cyclone.
2. The cyclone of 1573,separatedRameswaram from Tamilnadu.

g. Bangladesh Cyclone

November 8 to 13, 1970; Storm surges at 5 metres height ;3 lakhs people died.

h. Andhra Cyclone

Novermber 14 to 20,1977 ;Nizampatnam, 10,000 people died;storm surge of 5 metres high.

Cyclone prone areas of India

1. North Orissa
2. West Bengal Coasts
3. Andhra Pradesh coast between Ongole and Machilipatnam
4. Tamilnadu coast, South of Nagapatnam
5. Maharashtra coast, North of Harnai and adjoining Gujarat coast.
6. Coastal belt around the Gulf of Bombay.
7. Coastal belt around the Gulf of Kutch.

Destructions caused by cyclones

1. Cyclones produce strong winds. These generate storm surges. This causes abnormal rise of sea level. Seawater inundates low lying areas of coastal regions.
2. Drowning of human beings.
3. Drowning of livestock.
4. Erosion of beaches.
5. Destruction of vegetation.
6. Reduction of soil fertility.
7. Damage of villages.
8. Damage of buildings.
9. Damage of communication system.
10. Damage of roads.
11. Loss of property and crops.

12. Disconnection of electricity.
13. River floods.
14. Submergence of low lying areas. In 1964,Thanuskody was swallowed by the sea. The cyclone of 1573 caused the submergence of land between Rameswaram and Tamilnadu.
15. Pollution of drinking water.
16. Fog is formed.
17. Problems in air traffic.

LANDSLIDES

A Landslide is a sudden flow down of a large mass of Earth, rock, mud and debris along the side of a slope. It is common natural disaster often in hilly terrain, which cause huge loss of natural resources and human life. It is mainly attributed due to the natural factors like earthquakes and rainfall in these hilly regions. It may also occur on stable areas due to other human activities such as irrigation, lawn watering, draining of reservoirs, leaking pipes and improper excavating or grading on hill slopes. It is a serious geological hazard and also a natural calamity.

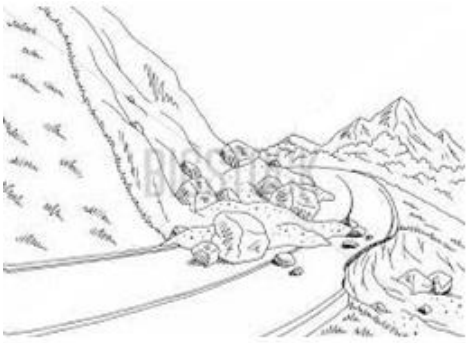


Figure 3.8: Landslides

Causes of landslide

The landslide is caused by natural and man-made factors.

1. Earthquake.
2. Excessive rainfall.
3. Snow melt.
4. Rapid change in temperature. This can cause alternate shrinking and expansion of soil formations.

5. Deforestation.
6. Forest fires. They take away slope vegetation making erosion easier.
7. Mining of Earth.
8. Excavation
9. Pumping and draining groundwater.
10. Over sloping hillsides.
11. Rapid snow melt.
12. Erosion by rivers.
13. Ocean waves and tides.
14. Saturation of rock and soil slopes of heavy rains.
15. Excess weight from accumulation of rain.
16. Floods
17. Steep slopes.
18. Undercutting of banks by rivers.
19. Absence of adequate surface drainage.
20. Quarrying.

Types of landslides

The landslides are of three types, namely

slides

falls and

flows.

1. In slides, materials move as a coherent block of thee earth material. *Eg*.Rock slip.
2. Falls include free fall of materials. *Eg*.Soilslip.
3. In flows, there is mixing of materials within the moving mass. *Eg*. Flow of mud, debris.

Sliding forces

Landslide is caused by the following forces:

1. Angle of slope

i. Landslide will be more on steep slopes.

ii. All materials have an angle of repose. i.e.,an angle at which the material will remain stable.

iii. Loose dry rock remains in place at angles upto 30^0. But wet clay will slip at more than one or two degrees of inclinations.

2. ***Water Pressure***

The pressure exerted by water encourages landslide.

3. ***Earthquake***

The trembling of earthquake triggers landslide.

Clues to landslides

Landslides are recognized by the following clues:

1. Abnormal terrain configurations.
2. Unusual wetted surface.
3. Break in hillside.
4. Bulging of downslopes.
5. Cracks in buildings.
6. Leaks in dams and reservoirs.
7. Tilted trees.

Prevention of landslides

1. Drainage facility.
2. Construction of retaining walls.
3. Rearing vegetation.
4. Removing unstable slopes.
5. Slopes should not be overloaded.
6. Sensitive slopes should not be cut out.

Impacts of landslides

1. Drowning and death of human beings.
2. Blocking roads, rails and transport.
3. Blocking of rivers, channels, etc. resulting in floods.
4. Damage to vegetation.
5. Damage to buildings.

Risky areas of landslide

1. Western Himalayas – UP, Himachal Pradesh, Jammu and Kashmir.
2. Eastern Himalayas – West Bengal, Sikkim, Arunachal Pradesh.
3. Naga – Arakkan Mountain belt – Nagaland, Manipur, Mizoram, Tripura, etc.
4. Western Ghats – Nilgris, Maharashtra, Goa, Karnataka, Kerala.

Some dreadful landslides in History

In 2008, Wenchuan earthquake happened in China that caused more than 15,000 geohazards in the form of landslides, rock falls, and debris flows, which resulted in about 20,000 peoples death. The most affected parts of landslide in India are Himalayas, Westerns Ghats, Nilgris, and Vindhyas. On 30 July 2014, a landslide occurred in the village of Malingaon, Maharashtra, by a burst of heavy rainfall, killed 151 peoples and damaging 45 houses

TSUNAMI

Tsunami' is a Japanese word meaning harbour waves, because they damaged harbours mostly.They are also called seismic sea waves. They are killer waves. It is a series of waves caused by the displacement of large volume of a body of water caused by seismic activities. It is a series of waves coming one after another. In tamil it is called 'aazhiperalai'.

1. They have a small amplitude (wave height) when they are in the deep sea.
2. They move very silently under the sea. They do not affect the ships or boats because they have a swell of only 12 inches.
3. That is why,they pass unnoticed in the sea.
4. They have very long wavelength (crest to crest) of about 100 to 700 km; but the normal waves have a wave length of only 30 to 100 metres. Hence Tsunami is called a wave train.
5. Though they are silent in the sea, they move fast at a speed of a jet plane, 500 to 800 km.
6. They grow in height when they reach shallow waters.
7. When they approach the shore, they rise in sea level with a turbulent and chaotic surface.
8. Tsunamis are common in the pacific ocean attacking mainly Japan, Alaska, Hawaiian islands, California (USA),etc.

9. It is new to Indian Ocean and Indians.

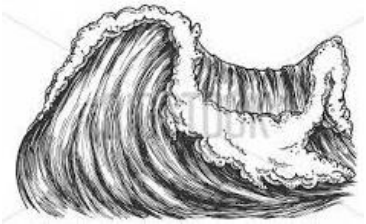


Figure 3.9: Tsunami (aazhiperalai)

Causes to tsunami

1. Deformity of sea floor.
2. Earthquake under the sea.
3. Valcanoes
4. Landslides in the sea.
5. Movement of tectonic plates.

Impacts to tsunami

1. Tsunami swallow the coastal areas.
2. They wash away the shore constructions.
3. The coastal vegetation is damaged.
4. They uproot the trees.
5. They kill human beings and animals.
6. They damage buildings and bridges.
7. Seashore huts, hotels, etc. are damaged.
8. Light houses are damaged.
9. Fishing boats and fish nets are damaged.
10. Cars, buses and trucks are washed away.
11. Corals are damaged.
12. Islands are submerged.

Tsunami hits only after a natural warning signal. A few minutes prior to tusnami, the sea recedes and rapid withdrawal of water from the beaches exposing the sea floor. After 5 to 30 minutes, sea water retreats with loud sound and surge capable of extending hundreds of meters inland.

As the tsunami is caused mainly by earthquake under the sea, the earthquake is monitored under the sea by seismographic sensors. They send message to satellites. From the satellites, the warning message is conveyed to people through TV's, radios, etc.The people should run away quickly from low lying land to elevated places. Coastal areas must be grown with thick vegetation and trees. They will slow down the speed of tsunami waves into the land. Barriers, in the form of huge granites(stones) must be laid along the sea shore.

Case Studies - Asian Tsunami - (2004 Tamil Nadu Tsunami)

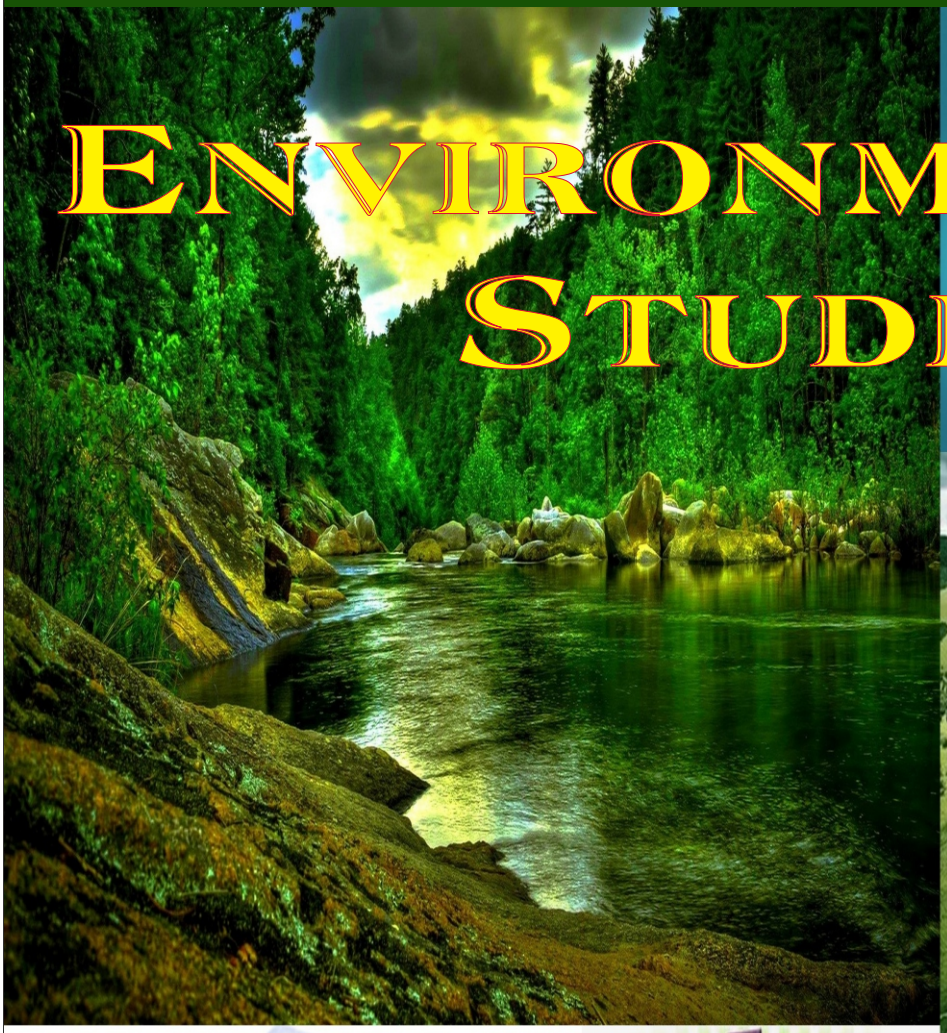
On December 26th, 2004 nearly at 8.30am, the day after the Christmas; people were enjoying on the sea shore of Kanyakumari and Chothavilai beach. Suddenly the sea receded for about 500m. The sea floor was exposed. The rocks were green with sea plants. Crabs were running. Starfishes were crawling; seashells were exposed. Fishes were jumping and struggling for their life. People , struck with wonder, walked on the seafloor and started collecting alive fishes, starfishes, seashells etc. without knowing that they were going to be swallowed by killer waves of 'aazhiperali'.

Within the next 10 minutes Tsunami waves of 15 feet heigh swept the area with a roaring sound and a speed of 700kms. All the people were swallowed and killed; trees were uprooted; Buildings were destroyed; Bridges were damaged. The waves reached a distance of 500 to 700m inland and retreated washing away everything on land incliding humans and their belongings.

The killer waves orginated from the Indonesian coast with a result of an earthquake of 8.9 Richter scale at 6.25am. The waves travelled along the Indian ocean at a speed of 700kms and hit the coasts of Tamil Nadu, Srilanka, Andaman Nicobar Island, Kerala, Andra Pradesh, Indonesia, Thailand, Malaysia and Maladives.

The 2004 Tsunami killed about 3lakhs people.

Environmental Studies



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(An Autonomous Institution Affiliated to Madurai Kamaraj University
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Sivakasi – 626 123.

The Seeds of "the Standard Fireworks Rajaratnam College for Women" were sown five decades ago in the formidable memory of the eponymous Philanthropist Thiru.N.R.K Rajaratnam, a renowned fireworks industrialist and business magnate. From modest beginnings, the development of the institution is well pronounced and its commitment towards upliftment of rural women gets only strengthened through time. In the academic year 2017-18, the college enters into the glorious Golden Jubilee milestone and the laudable tradition of women empowerment still continues.

Vision

To be a premier institution offering quality higher education for aspiring rural women.

Mission

To help students grow strong with high ethical and moral caliber.

To empower rural women with

- ✓Academic excellence
- ✓Communicative competence
- ✓Entrepreneurial skill
- ✓Eco-consciousness
- ✓ Evolving technologies

To promote research culture. To produce wholesome citizens to contribute towards nation building.

Environmental studies

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Dr. (Mrs.) D. Sasireka, M.Sc., M.Phil., Ph.D.,

Principal

SFR College for Women

Sivakasi

FOREWORD

SFRC one of the premier Institutions of higher education, has mainstreamed and mandated environmental studies at under graduate level as they are the critical stakeholders and who would translate knowledge into wise application for solutions pertaining to environmental issues. Existence of life depends on the most abundant resources of the planet—land, air, and water. At present the world is faced with one of the most paradoxical situations in its history—feeding the burgeoning population while conserving the resources for consumption by the present population has been predicted to be unsustainable. Environment is not a single subject, it is an integration of several subjects that include both science and social studies. It is essentially a multidisciplinary approach and its components include Biology, Geology, Chemistry, Physics, Engineering, Sociology, Health Sciences, Anthropology, Economics, Statistics and Philosophy. Thus, the scope of environmental studies extremely wide and covers some aspects of nearly every major discipline. The need for sustainable development is a key to the future of mankind. Continuing problems of pollution, solid waste disposal, degradation of environment, issues like economic productivity and national security, Global warming, the depletion of ozone layer and loss of biodiversity have made everyone aware of environmental issues. In this situation the authors have brought out this edition with amazing consistency to enrich the social standards of life of stakeholders. Their credential efforts are duly acknowledged.

It is my privilege to acknowledge the Dynamic Diplomats of the members of Management Committee as the academic success of our institution is mainly due to their healthy concoction of innovation, planning and perseverance with farsightedness to visualize and anticipate changes to the tune of the present globalized academic sector.

D.Sasireka

Dr. (Mrs.) T. Palaneeswari, M.Com., M.Phil., Ph.D.,

Principal,

The Standard Fireworks Rajaratnam College for Women

Sivakasi

FOREWORD

SFRC stands as a dynamic testimony for its devoted service towards the cause of higher education. It has mandated environmental studies into under graduate curriculum. In the era of advance living standard of the human being, our environment is getting affected to a great extent by the means of air pollution, noise pollution, deforestation, water pollution, soil pollution, acid rain and other dangerous disasters created by the human beings through technological advancement. Other issues threatening mankind are overpopulation, Climate change, Urban sprawl, Global warming, Hazardous waste, Biomedical wastes, e-waste and loss of biodiversity that have made everyone aware of environmental issues. The degradation of the environment has become a serious problem for the existence of human beings. Everyone must know how to protect our environment to keep it safe forever as well as ensure the nature's balance on this planet to continue the existence of life. There is a need for information that clarifies modern environmental concepts such as the need to conserve biodiversity, the need to lead more sustainable lifestyles and the need to use resources more equitably. Environmental studies take a multidisciplinary approach to the study of human interactions with the natural environment. It integrates different approaches of the humanities, social sciences, biological sciences and physical sciences and applies these approaches to investigate environmental concerns. At this juncture, the efforts put forth by the authors to enable the students to understand the complexities of the environment and to adapt appropriate activities and pursue sustainable development which are harmonious with the environment, should be highly acknowledged. It is my honour to acknowledge the magnanimous members of the Management Committee for their untiring support in all means to bring innovation in curriculum.

T.Palaneeswari

PREFACE

Environmental studies is a multidisciplinary scholastic field which analytically studies human interaction with the environment in the welfare of solving complex problems. It is an open field of study that comprises the natural environment, the built environment, and the sets of relationships amid them. Environmental Studies have significant liberty in designing a course of study, that encourages active involvement, and that fits their specific aptitudes, needs and interests. The Environmental Studies affords a well-formed fundamental education to organize students for entry-level places in government or non-governmental organizations. In India it is a self righteousness over the last few years for creating the environmental awareness by inculcating the newer environmental concepts in to prescribed curricular processes. Environmental education is not an inert. Without doubt the environment is constantly changing with the changing time. So we must aware that the actions doing by ourselves are the reason for irreversible climatic change. This textbook is written to convey about an awareness of a variety of environmental distress. It tries to generate a pro-environmental approach and a behavioral pattern in society that is based on creating sustainable lifestyles. The Authors are obliged to the Management and Principal for their unvarying encouragement and support.

Authors

THE STANDARD FIREWORKS RAJARATNAM COLLEGE FOR WOMEN
SIVAKASI (AUTONOMOUS)
PART IV – NON MAJOR COURSE
GLES21 - ENVIRONMENTAL STUDIES
SEMESTER II
(For those admitted in June 2017 and later)

Contact hours per week : 02
Total number of hours per semester : 30
Number of Credits : 02

Objectives

To enable the learners to
- Live in harmony with nature
- Acquire awareness on environmental issues
- Understand the inter- relatedness of man, his culture and Mother Nature
- Analyze case studies and participate in solving environmental problems

UNIT I (10 Hrs)

Introduction to Environmental Studies: Introduction, Uses of Environment, Importance of environmental studies, Scope of environmental studies, Environmental studies as a Multidisciplinary Subjects, Need for Public Awareness. Natural Resources: Types, Forest Resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources.

UNIT II (10 Hrs)

Ecosystem: Concept, Function, Structure, Aquatic Ecosystem, Terrestrial Ecosystem, biogeochemical cycles, biomesh. Biodiversity: Introduction, Value of biodiversity, biodiversity at global level, conversion of biodiversity, conversion of wild life.

UNIT III (10 Hrs)

Environmental Pollution: Types (air, water, soil, noise, radioactive, thermal and nuclear hazards) Waste management: solid, hazardous waste management. Environmental legislation and acts. Human population and environment: Introduction, environment and human health, value education, human rights, role of information technology in environment and human health.

(Study Material will be provided)

Text Book:

1. Arumugam. A., Kumaresan .V (2015) **Environmental Studies**, Published by Saras

References:

1. Eracha Bharucha (2008) **Text Book of Environmental Studies** University Press, Hyderabad
2. Agarwal, S.P (2006) **Environmental Studies**, Narosha Publishing House, Kolkatta
3. Manoharachary, C. and Jyarama Reddy,P (2006) **Environmental Studies** B.S. Publication, Hyderabad
4. Sharma, P.D (2005) **Ecology and Environment**, Rastogi Publication, Meerut
5. Sastri, M.N (2005) **Environmental Studies**, Himalaya Publishing House, Mumbai.

CONTENTS

1. INTRODUCTION TO ENVIRONMENTAL STUDIES

Ms. S. Subha Ranjani

1.1. Definition of Environmental Studies

The word environment is derived from the French word ***'environ'*** meaning surroundings. Hence, everything surrounding us is called "**ENVIRONMENT**". Every organism is surrounded by materials and forces that constitute its environment. It is the environment from where every organism must derive its requirement. The environment creates favourable conditions for the existence and development of living organisms.

The survival of any organism requires a steady supply of materials and removal of waste products from its environment. The degradation of the environment has become a serious problem for the existence of human beings. Pollution of soil, water and air causes harm to living organisms as well as loss to valuable natural resources. Environmental studies involve educating the people for preserving the quality of environment.

1.2 Uses of Environment

The environment serves man in the following respects:

- Provides substratum for man to live.
- Supplies food.
- Supplies oxygen for respiration.
- Supplies water.
- Supplies carbon dioxide for photosynthesis.
- Supplies energy resources such as coal, petrol, diesel, etc.

1.3 Importance of Environmental Studies

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

1. It is necessary to appreciate and adopt the idea of "*development without destruction of the environment*"

2. Knowledge about "*various types of environments & different environmental hazards*"

3. Playing an effective role in protecting the environment by "*demanding changes in law and enforcement systems*".

4. Having a "*positive impact*" on "*quality of life*".

5. Creating a "*concern and respect for the environment*".

6. Providing knowledge for *conserving biodiversity.*

7. Giving idea about the more *sustainable way of living.*

1.4 Scope of Environmental Studies

Scope means coverage, end aimed at purpose, intention, outlook, purview and sphere of observation. The scope of environmental studies is vast and wide.

It includes:

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

There was a time when environment meant only sanitation and health. Today, the environment is conceived in its totality and a holistic approach is designed while planning a better quality of life stressing upon sustainable development. Human activities have been drastically changing the ecological balance of practically every component of the environment. This makes the importance and scope of the study of environment wider in volume and deeper in depth.

1.4.1 Environmental studies Teaches us deforestation and forest conservation

Increasing population, along with widespread poverty, has generated pressure on our natural resources. Of the 329 m hectare of the total land area in the country, it is estimated that about 174 m. ha. is degraded, this consists of agricultural as well as non-agricultural lands and forest resources. The forest resources are threatened due to overgrazing and other forms of exploitation, both for household and commercial needs, encroachments, unsustainable practices like unscientific cultivation and development activities. This leads to increasing destruction and degradation of forests and tree lands.

Environmental science teaches how forest can be conserved. National afforestation and Eco-development programmes provide methods of forest wealth conservation, because trees and plants are the life and blood of human civilization. They have served and are serving man-kind in various ways from the days of yore (ancient times). Medha Patkar and Sunder Lai Bahuguna, the leader of the Chipko Movement, (a movement started to stop the cutting of forests) rightly pointed out that preservation of trees and plants alone can save the human species from environmental pollution. The first and foremost advantage of forests is that they absorb carbon dioxide, provide water and control soil erosion. To save trees is to save civilization.

1.4.2 Environmental Studies teach us Diversified Ecologies

Conservation ecology deal with the application of ecological principles to the proper management of resources leading to sustained yields of useful resources to human welfare. Resource ecology deals with the renewable and non-renewable resources and their judicious management. Pollution ecology deals with problems associated with the movements of pollutants in the environment, environmental deterioration and the maintenance of its cleanliness. System ecology deals with the analysis and modeling of ecological systems. Radiation ecology is concerned with radio-active substances, radiation and the environment. Paleoecology deals with organisms and their environment in the geological past.

1.4.3 Environmental studies as a Multidisciplinary Subject

The environment is complex and actually made up of many different environments, including natural, constructed and cultural environments, environmental studies is the inter disciplinary examination of how biology, geology, politics policy studies, law, geology, religion engineering, Chemistry and Economics combine to inform the consideration of humanity's effects on the natural world. By studying environmental science, students may develop a breadth of the interdisciplinary and methodological knowledge in the environmental fields that enables them to facilitate the definition and solution of environmental problems.

The science of Environment studies is a multidisciplinary science because it depends on various disciplines like Chemistry, Physics, Engineering, Sociology, Health Sciences, Anthropology, Economics, Statistics, Geology and Philosophy medical science, etc. It is the science of physical phenomena in the environment. It is inherently a multidisciplinary field that draws upon not only its core scientific areas, but also applies knowledge from other non-scientific studies such as economic, law and social science.

1. Physics:

- To understand the flux of material and energy interaction.
- To construct mathematical models of environment.

2. Chemistry:

- To understand the molecular interactions in the system.

3. Biology:

- To describe the effects within the plant and animal kingdom and their diversity.

4. Atmospheric Science:

- To examine the phenomenology of the Earth's gaseous outer layer with emphasis upon interrelation to other systems.

- It comprises meteorological studies, greenhouse gas phenomena, airborne contaminants, sound propagation phenomena related to noise pollution, and even light pollution.

5. Ecology:

- To analyse the dynamics among an interrelated set of populations, or a population and some aspects of its environment.
- The ecological studies deals with endangered species, predator interactions, effects upon populations by environmental contaminants, or impact analysis of proposed land development upon species viability.

6. Environmental Chemistry:

- To study the chemical alterations in the environment.
- Principal areas of study include soil contamination and water pollution.
- The topics of analysis involve chemical degradation in the environment, multi-phase transport of chemicals and chemical effects upon biota.

7. Geo-science:

- It includes environmental geology, environmental soil science, volcanic phenomena and evolution of the earth's crust.
- In some classification systems, it can also embrace hydrology including oceanography.

8. Mathematics and Computer Science:

- It will help in environmental modeling and analysis of environment related data.

9. Economics:

- It deals with economical aspects of various components of environment.

10. Law:

- It helps in framing of environment related laws, Acts, rules and their monitoring.

11. Social Science:

- It helps in dealing with population and health related issues.

An understanding of the working of the environment requires the knowledge from wide ranging fields. The Table 1 below shows a list of topics dealt commonly in air pollution and the related traditional fields of knowledge illustrating the interdisciplinary nature of the subject.

Table 1 Interdisciplinary Nature of Environmental Science:

Air Pollution	**Major subject/ Topic knowledge required**
Nature and reaction of air pollutants	Chemistry and Chemical engineering
Effects of air pollutants on human beings, animal and plants	Physics, Chemistry, Zoology, Botany and various branches of life science.

Effect of air pollutants on materials	Meteorology, Thermodynamics, Geography
Effect of climate on air pollution	Mathematical modeling.
Air pollution control devices	Physics, chemistry and various branches of Engineering
History of air pollution and air pollution episodes	History
Economic impacts of air pollution	Economics and Demography
Sociological impacts of air pollution	Sociology
Alternative fuels	Various branches of Physical sciences
Conservation of resources and pollution control	Various branches of physical and political sciences
Ozone hole and global warming	Almost all fields under the sun has got something to contribute to the understanding and prevention of these phenomenon

1.5 Need for Public Awareness:

Increasing population, urbanization and poverty have generated pressure on the natural resources and lead to a degradation of the environment. To prevent the environment from further degradation, the Supreme Court has ordered and initiated environmental protection awareness through government and non-government agencies. Environmental pollution cannot be prevented by laws alone. Public participation is equally important with regard to environmental protection.

Environmental Education is a process of learning by giving an overall perspective of knowledge and awareness of the environment. It sensitizes the society about environmental issues and challenges interested individuals to develop skills and expertise thereby providing appropriate solutions. Climate change, loss of biodiversity, declining fisheries, ozone layer depletion, illegal trade of endangered species, destruction of habitats, land degradation, depleting ground water supplies, introduction of alien species, environmental pollution, solid waste disposal, storm water and sewage disposal pose a serious threat to ecosystems in forest, rural, urban and marine ecosystems.

Both formal and informal education on the environment will give the interested individual the knowledge, values, skills and tools needed to face the environmental challenges on a local and global level.

1.6 Environmental Public Awareness

Awareness shapes a hierarchy of values, and at the same time has an influence on the sense of responsibility for inappropriate choice of values and indifference towards wrongdoing. Public awareness of the environment means the ability to emotionally understand the surrounding world, including the laws of the natural environment, sensitivity to all the changes occurring in the environment, understanding of cause-and-effect relationships between the quality of the environment and human behaviour, an understanding of how the environment works as a system, and a sense of responsibility for the common heritage of the Earth, such as natural resources - with the aim of preserving them for future generations.

Environmental public awareness comes from a result of general knowledge, specialist knowledge of a particular problem and also sensitivity to, and a sense of, responsibility for the environment. Environmental public awareness is shaped throughout the whole life of particular people living in a given local community, performing specific work and having definite personal characteristics which have a deciding effect on their sense of responsibility and ability to emotionally perceive the environment as having value in itself. The knowledge acquired during school education and then systematically improved in adulthood, is an essential factor in heightening the environmental awareness of an individual and, at the same time, an indispensable condition for the development of a pro-ecological lifestyle.

To undertake actions aimed at increasing environmental public awareness regarding the protection of lakes and water reservoirs, answers should be known to the following questions:

1.6.1Who shapes the attitude and awareness of members of the community?

- Parents,
- Teachers, colleagues, acquaintances,
- Fellow-workers,
- Leaders,
- Media,
- Moral authorities,
- Scientists
- Politicians.

1.6.2Where is public awareness of the environment formed and shaped?

- Home,
- Nurseries, schools, schools of higher education,
- Churches and religious organizations,
- Professional environment, workplace, and associations.

1.6.3What shapes and increases the environmental public awareness?

- Schools and academic manuals,
- Messages transmitted through mass media,
- Children, youth, daily, popular and specialist press,
- Television and radio programmes,
- Films, including documentary films,
- Internet,
- Own experience and observations,
- Work for organizations and
- Social status of the family and affluence.

Basic and specialist knowledge of an environmentally aware individual with respect to protection of lakes and water reservoirs should include:

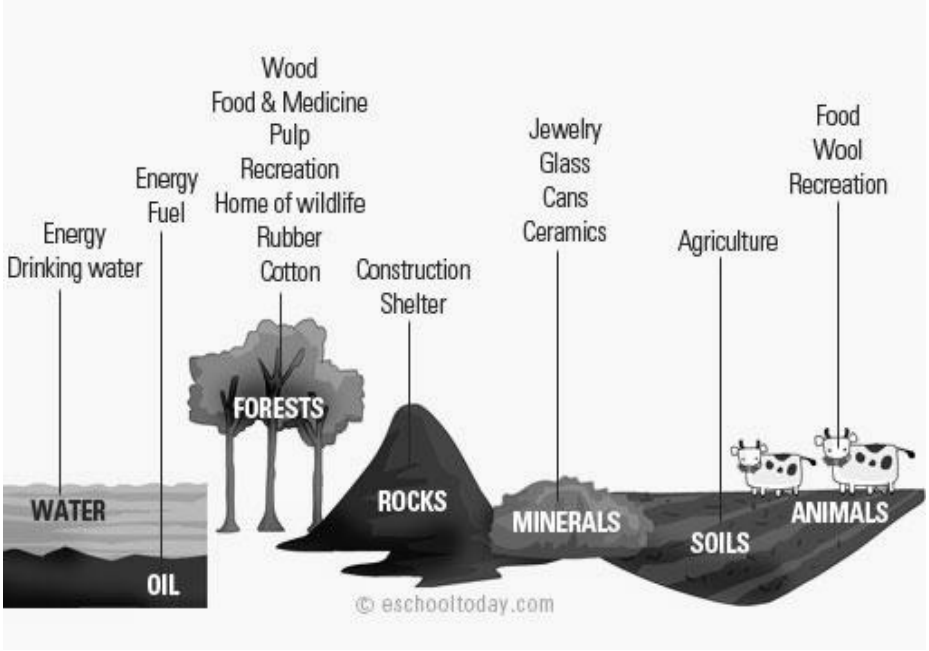
- basic notions in the field of environmental protection, including in particular the protection of lakes and water reservoirs and aquatic ecology,
- knowledge of inter-relationships of particular elements of the environment, including the relationship between air pollution, soil contamination, and the quality of surface and underground water,
- understanding of relationships between people and their environment,
- understanding of the notion of eutrophication, its causes and environmental implications for the entire ecosystem, including cause-and-effect relationships between human activity and the quality of surface waters,
- knowledge of methods for the elimination of effects of water pollution, including the elimination of major pollution sources responsible for eutrophication, including:
    - the way domestic wastes discharged to surface waters are responsible for eutrophication of lakes and reservoirs and how individual households can reduce the danger of excessive fertilization of lakes and waters by informed selection and use of household chemical products,
    - the types of industrial wastewater discharged to surface waters are responsible for eutrophication of lakes and reservoirs,
    - the way surface runoff is responsible for contamination of water in lakes and reservoirs.

The environmentally-aware individual should be conscious about the needs and demands posed by different sectors of society and the government so that he/she can make a better judgment before and during his/her participation in a given programme or activity.

1.7 Natural Resources:

Natural resources are the wealth of the earth. They are the raw materials available in nature and useful to human beings, animals and plants.

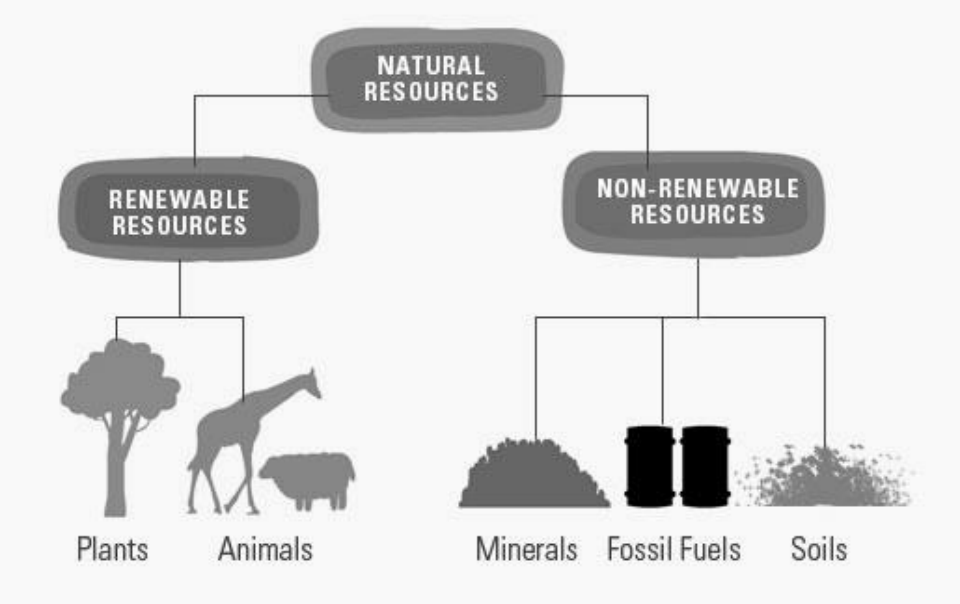
Eg. Water, air, land, palnts, animals, coal, petroleum, minerals, forest, wood, etc.



1.7.1 Types of resources

The natural resources are of two types, namely

1. Renewable resources.
2. Non-renewable resources.



Renewable resources

Renewable resources are replenished after their use. They are available continuously. Eg. Water, aquafood, forest, grassland, plants, animal, etc.

Animals are reproduced by reproduction. Water is formed repeatedly by rains. Trees are produced by planting and replanting. So they are renewable.

Based on chemical nature, natural resources are classified into

1. Organic renewable resources
2. Inorganic renewable resources.

The organic renewable resources contain carbon. They include coal, petroleum, natural gases, forest, aqua food, etc.

The inorganic renewable resources do not contain carbon. They include air, water, minerals, sunlight etc.

Non-renewable resources

Non-renewable resources are those that cannot be replaced after their use. They are available in limited amount. Examples include coal, petroleum, iron, natural gas, all mining products, etc. Minerals are also non-renewable because even though they form naturally in a process called the rock cycle, it can take thousands of years, making it non-renewable. Some animals can also be considered non-renewable, because if people hunt for a particular species without ensuring their reproduction, they will be extinct.

Non-renewable resources can be called **inorganic resources** if they come from non-living things. Examples include minerals, wind, land, soil and rocks. Some non-renewable resources come from living things — such as fossil fuels. They can be called **organic** non-renewable resources.

Certain resources can be repeatedly used. These resources are called **cyclic resources.** Eg. Water can be used repeatedly. The water used in the industry comes out as industrial waste. It is purified and used again and again.

The natural resources may be **abiotic** or **biotic resources**.

Abiotic resources are obtained from organisms. They are organic in nature. Eg. forest, grassland, crops, animals, etc.

The natural resources are classified into ***4 spheres,*** namely

1. **Atmosphere**

The atmosphere forms the air. It acts as the protective shell over the Earth.

Nitrogen is the most predominant gas in the atmosphere and it constitutes 78.09% of total gases.

2. **Hydrosphere**

The hydrosphere is the water. 70% of the Earth's surface is occupied by water.

3. **Lithosphere**

Lithosphere is the land. It is the soil. The lithosphere is composed of 47% oxygen, 28% silicon, 8% aluminium, 5% iron and 4% sodium, 4% potassium, 4% magnesium and 4% calcium.

4. **Biosphere**

Biosphere is the life of the Earth. It is formed of plants, animals and microbes. It is found in atmosphere (air), hydrosphere (water) and in the lithosphere (land). It is the living natural resources. The biosphere has the following uses:

- The biosphere supplies food.
- Plants supply O_2 by photosynthesis.
- The crop supply plant food. Eg. Rice, wheat, etc.
- The animals supply animal food. Eg. Milk, egg, mutton, chicken, fish, etc.
- Trees supply firewood.
- Timber is used for making furniture.
- Rubber, on which cycles, cars, buses, etc.

1.8 FOREST RESOURCES

The word 'forest' is derived from the Latin word 'foris' means 'outside'. A forest is a natural, self-sustaining community characterized by vertical structure created by presence of trees. Trees are large, generally single-stemmed, woody plants. Forest can exist in many different regions under a wide range of conditions, but all true forests share these physical characteristics. Many animals need forests to live and survive. Forests are very important and grow in many places around the world. They are an ecosystem which includes many plants and animals.

About one- third of world's land surfaces are covered with forests. It forms about 4028 million hectares in the World. In India also $1/3^{rd}$ of the land is covered by forests. The total area of forest in Tamilnadu is about 21,000 square kilometers. A tropical rain forest in India occurs in **Assam**.

Forests are classified into **two types** based on the **shape of leaves.** They are:

1. Needle leaf forests or coniferous forests (soft wood forests).
2. Broad leaf forests (hard leaf forests).

1.8.1 Needle leaf forests

Needle leaf forest is composed largely of straight trunked, conical tress with relatively short branches, and small, narrow, needlelike leaves. These trees are conifers. So, they are called coniferous forests. They have **soft wood.** Hence, they are also called **soft wood forests.** The common trees are **pine trees.**

1.8.2 Broad leaf forests

In broad leaf forests the dominant trees have broad leaves. They have **hard wood.** Hence they are also called hard wood forests. Eg. Teak, Rose wood, etc.

The forests are classified into two types based on the shedding of their leaves. They are

1. Evergreen forests
2. Deciduous forests.

Evergreen forests

Evergreen forests remain greenish throughout the year. They grow new leaves continuously when the old leaves shed one by one. **Silent valley** in Kerala is an evergreen forest.

The evergreen forests are of two types. They are

1. Tropical evergreen forests
2. Temperate evergreen forests.

1. Tropical Evergreen Forests

- Tropical evergreen forests are green forests located in the tropical countries, near the **equator.**
- **Western Ghats** is a tropical evergreen forest. They **retain leaves** throughout the year.
- They are usually found in areas receiving more than 200 cm of rainfall in a year
- They have a temperature of 15° C to 18° C.
- They have tall trees. And they are hard wood trees.
- They occupy 7% of the earth's land surface.
- They harbour more than half of the world's plants and animals.
- The common trees are Rosewood, Bamboo, Mahogany, Ebony, Reeds, etc.

2. Temperate Evergreen Forests

- Temperature evergreen forests are green forests of mid latitudinal coastal regions.
- They retain leaves throughout the year.
- The trees are tall
- These forests include **broad leaved trees** as well as **needle- leaved trees.** (Coniferous forests).
- These forests are dominated by pine trees
- The temperate evergreen forests are under threat because of logging, mining, oil and gas development, hydroelectric projects, etc.
- The common trees are Pine, Oak, Eucalyptus, etc.

Deciduous forests

The deciduous forests shed their leaves once in a year. Certain forests shed their leaves during summer season. They are called **tropical deciduous forest**. Some other forests shed their leaves during winter season. These forests are called **temperate deciduous forests.**

Rain Forests

Rain forests are characterized by more than 200cm of rainfall per year.

They are ever green forests.

Rain forests are of two types namely:

1. Tropical rain forests
2. Temperate rain forests.

Benefits of Forests

The benefits of forests are classified into three types. They are

1. Commercial Benefits.
2. Ecological Benefits.
3. Aesthetical Benefits.

1. Commercial Benefits

Timber: Wood is used for making furniture, tool-handles, railway sleepers, matches, ploughs, bridges, boats etc.

Fuel Wood: Wood is used as a source of energy for cooking and for keeping warm.

Bamboos: These are used for matting, flooring, baskets, ropes, rafts, cots etc.

Paper: Wood and Bamboo pulp are used for manufacturing paper (Newsprint, stationery, packing paper, sanitary paper)

Rayon: Bamboo and wood are used in the manufacture of rayon (yarns, artificial silk-fibres)

Forest Products: Tannins, gums, drugs, spices, insecticides, waxes, honey, horns, musk, ivory, hides etc. are all provided by the flora and fauna of forests.

Fruits: Fruit trees are an important source of income and food for the rural household. Mango, orange, pear, jackfruit and many others grow wild in the forest.

Medicinal use: Even today man is dependent on the forest for herbs and plants to fight against disease. Of all the medicinal trees found in India, the neem is the most important. Leaves, bark, and other parts of many other trees also have medicinal value and are used to make various ayurvedic medicines.

Fibre: Plant fibre has many different uses. Soft fibres such as jute are derived from the stems of the plant. Hard fibre from the leaves of hemp and sisal are used to make fabrics for various applications. Coir, another form of fibre from the fruit of the coconut, is used to make ropes.

Floss: The fruits of many species of Indian trees produce silky floss. The most common of these is simal. It is used to make cotton, wool, mattresses, and pillows.

Essential oils: Tropical grasses such as lemon grass, citronella, and khus are the source of essential oils. Oil is distilled from the wood of various species such as sandalwood and pine. Oil is also derived from the leaves of certain plants and trees such as eucalyptus, camphor, wintergreen, and pine. These oils are used for making soaps, cosmetics, incense, pharmaceuticals, and confectionery.

2. Ecological Benefits

The following are the ecological benefits of forests.

2.1 Producers

Forest trees, shrubs, herbs, grasses, etc. are the producers of the forest ecosystem. They synthesize sugars using sunlight. The food stored in the plants form the food for all animals of the forest.

2.2 Lungs of the Earth

Forest plants remove CO_2 from the air, use it for photosynthesis and released O_2. O_2 is used by all animals and plants for respiration. During respiration CO_2 is consumed by plants. Thus plant help to renew the air. Hence the forests are said to be the **lungs of the earth.**

2.3. Balance of O_2 and CO_2

Forest plants maintain a balance of O_2 and CO_2 in the air through photosynthesis.

2.4. Reducing Global Warming

CO_2 is a **green house gas** which increases the temperature of the earth. But forest consumes CO_2 and reduces global warming.

2.5. Precipitation

Forests cause precipitation. About 80% of moisture of the atmosphere comes from tropical Forests. This moisture saturates the atmosphere with water vapour causing rainfall.

2.6. Storehouse of water

Forest is a store house of rain water. It acts like a **giant sponge** in absorbing water. The rain water percolates the forest soil and goes into the ground water and the surface water runoff to lakes.

2.7. Prevention of floods

The forest plants and their roots resist the movement of surface run off and hence floods are prevented.

2.8. Prevention of soil Erosion

The roots of forest trees bind the soil particles firmly and hence soil erosion is prevented.

2.9. Soil Fertility

The falling leaves of forest decompose to form compost for the forest soil.

2.10. Habitat for wild Animals

A forest is a good shelter for the wild animals. They also provide food.

2.11. Reserve of Wild Genes

Forest forms a shelter for wild genes of plants and animals.

3. Aesthetic Benefits

- Forest is the house of tribals.
- Tribal live in huts made of forest materials.
- Herbal medicines are obtained from forest.
- Honey is collected from forests.
- Aromatic oils are obtained from forests.
- Tribal collect spices from forest

1.9 CONSERVATION OF FORESTS

Forests are most affected through human activities. Forests are destroyed by civilization, urbanization, agriculture, fire, felling of trees, grazing, plant diseases, etc. **Deforestation** leads to serious ecological imbalance. Hence it is inevitable to take necessary steps to conserve forests. Conservation of forests requires the following steps:

1. Protection from fire
2. Prevention of fire
3. Regulation of tree-felling
4. Regulation of grazing
5. Fencing
6. Protection from wild animals
7. Control of pests and diseases
8. Growing tolerant species

1. Protection from fire

Large areas of forests are destroyed by fire accidents. Forests can be protected from fire by the following methods.

1. Starting fire- extinguishing organization

2. Dividing forest into blocks separated by fire lines. Fire lines may have a width up to 100 feet or more. The vegetation in the fire lines must be cleared off. This will prevent the extension of fire from one block to another.

3. Construction of fire- resistant belts along the railway line, roads and paths from which fire may start and spread.

4. All materials that easily catch fire should be removed from belts around dangerous spots.

5. People must be educated about the dangers of forest fire.

2. Prevention of Fire

Fire can be prevented by spotting it out at the initial stage itself. This can be done by appointing look-out men near dangerous spots.

3. Regulation of Tree-felling

'Felling' refers to the cutting of trees for timber and firewood. The shrinkage of forests can be prevented by the regulation of felling as follows:

1. A sufficient number of trees must be reserved per acre for regeneration.
2. Sufficient intervals between felling must be given for regeneration.
3. Felling must be limited to specific areas.

4. Regulation of Grazing

Forests are exposed to destruction through grazing by wild domestic animals. Grazing is regulated by allowing only a reasonable number of stocks during specific times in the year.

5. Fencing

Forest destruction can be prevented by constructing fences all around.

6. Protection from wild animals

Wild animals cause severe damage to forest vegetation, seedlings and saplings. They prevent regeneration. Therefore facilities should be provided for regeneration atleast in some areas.

7. Control of pests and diseases

Insects cause severe damage to forests. They can be controlled by two methods. They are as follows:

1. Spraying insecticides like DDT.
2. Biological control by rearing and propagating the enemies of pests.

8. Growing tolerant species

Forest conservation is made efficient by growing plants tolerant of diseases, fire and grazing.

1.10 DEFORESTATION

Deforestation is the permanent destruction of indigenous forests and woodlands. The term does not include the removal of industrial forests such as plantations of gums or pines. Deforestation has resulted in the reduction of indigenous forests to four-fifths of their pre-agricultural area.

1.10.1 Causes of Deforestation

- Logging –cutting wood.
- Unauthorized and illegal felling of trees.
- Illegal felling and selling of precious forest wood.

- Conversion of forests into agricultural lands.
- Conversion of forests into industries and residential areas.
- Construction of dams.
- Submergence of forests.
- Hydroelectrical projects.
- Collection of raw materials for heavy industries.

1.10.2 Impacts of Deforestation

- Deforestation threatens tribal people.
- Fertility of soil is decreased.
- Causes soil erosion.
- Accelerates desertification.
- Floods
- Land slides.
- Droughts
- Reduced rainfall
- Global warming increases due to increase of CO_2
- Climate changes
- Wild habitat is modified.
- Migratory birds and butterflies suffer.
- Loss of biodiversity.

1.10.3 Prevention of Deforestation

- Afforestation –planting of new trees.
- Forest fire should be prevented.
- Felling of trees should be regulated.
- Grazing is regulated.
- Pests and diseases are controlled.
- Social forestry.

1.10.4 Overexploitation of Forests

Overexploitation is over harvesting.

It refers to harvesting a forest to a point of diminishing returns.

It leads to resource destruction and biodiversity extinction

1.10.5 Causes of overexploitation

- Population explosion.
- Increasing demand for timber, pulp, minerals, fuel wood, food, herbal medicines.
- Expansion of urban, agricultural, industrial and residential areas.

- Construction of dams.
- Hydro electrical projects.
- Logging.
- Mining.
- Quarrying.
- Charcoal making.

1.11 Water resources

Water is the mother of life. It is the **liquid gold.** It is the Universal solvent.

Water is an inorganic compound formed of hydrogen and oxygen. (H_2O)

Water is a very important prerequisite for drinking, agriculture and domestic purposes. Hence, **river banks** are the world's most populous regions. Man, animals and plants cannot live without water

Water surface is called as **hydrosphere.** Water exists in three forms, namely liquid, solid (ice), and vapour (steam).

Water is available from the following sources: Precipitation (rain), Lakes, Ground water, Rivers, Ponds, and Seas. It may be hard water or soft water.

The water may be freshwater, seawater or brackish water. In fresh water, the salt content is less than 0.2% in seawater it is 32%. In brackish water, the salt content varies from 0.2% to 32%

Salt water is converted into potable water by **reverse osmosis.**

1.12 Sources of Water:

The important sources of water can be classified into two groups:

Surface Water:

Surface water is found in rivers, lakes, or other surface impoundments. Surface water is naturally replenished by precipitation and naturally lost through discharge to evaporation and sub-surface seepage into the ground. Surface water is exposed to many different contaminants, such as animal wastes, pesticides, insecticides, industrial wastes, algae and many other organic materials.

Ground Water:

Ground water is the water trapped beneath the ground. Rain that soaks into the ground, rivers that disappear beneath the earth and melting snow are but a few of the sources that recharge the supply of underground water. Ground water may contain any or all of the contaminants found in surface water as well as the dissolved minerals it picks up during its long stay underground. Other sources of water, which have not yet been tapped but represent a potential source, are saline lakes, saline springs, snow and ice fields.

Causes of over utilization of Ground water

1. Scarcity of surface water.
2. Increasing population.
3. Utilization of water for domestic purposes, irrigation and industries.
4. Lowering of water table.
5. Decreasing percolation of water due to urbanization, concrete drainage, buildings paving the floor, etc.
6. Failure of precipitation.

Effect of over utilization of ground water

Increasing population increases the demand for ground water. Hence ground water is withdrawn excessively all over the world. This causes the following effects.

1. Lowering of Water Table

The ground water is sucked out from open wells and bore wells by powerful suction pump which leads to the **lowering of water table.**

2. Subsidence

The sinking in of surface land is called **subsidence.**

Withdrawal of pore fluids, usually ground water, is a common cause of ground subsidence.

Subsidence results in damage of buildings, fracture of pipes, reverse flow of canals, etc.

3. Intrusion of Salt Water

Over exploitation of ground water, lead to the intrusion of salt water into the open wells and bore wells.

4. Greater Energy for Lifting Water

Due to the lowering of water table the water level goes down deep in the open wells and bore wells which require greater energy for lifting the water.

5. Construction of Deeper Wells

When water table goes down, we should construct ***deep*** open wells and bore wells. This will meet extra cost.

6. Polluted Water

When water table goes down, deep bore wells withdraw water containing ***fluorides*** and ***arsenic.***

Fluorides in water cause ***spotting*** and ***discoloration*** of teeth. It also causes a disease called ***fluorosis*** characterized by ***gastroenteritis, skin irritation*** and ***deformation*** **of bones.**

Excessive arsenic causes ***arsenicosis*** characterized by darkening of skin.

7. Landslides

Lowering of water level causes landslides.

8. Drying of wells

When water table goes down, the wells dry up.

1.13 Conflicts over water

- ❖ Conflict is the fight or dispute in getting water between states or countries.
- ❖ There are two types of conflicts over water. They are ***national conflicts*** and ***international conflicts***
- ❖ The *National conflicts* occur between states in our country.

  Eg. 1. *Mullaiperiar Dam conflicts* between Tamilnadu and kerala
  2. *Hogenakkal falls* water dispute between Tamilnadu and Karnataka.
  3. *Cauveri River water conflict* between Tamilnadu and Karnataka.
  4. *Siruvani Water conflict* between Tamilnadu and Kerala.
  5. *Krishna River Water conflict* between Karnataka and Andhra.

- ♦ The *International conflicts* occur between countries.

  Eg. 1. *Indus river water conflict* between India and Pakistan.
  2. *Bhramaputra river water conflict* between India and Bangladesh.
  3. *Colorado river water conflict* between USA and Mexico.

- ♦ The water conflict is caused by the
  1. Consumption of water.
  2. Flowing of river between states or between nations.
  3. Construction of dams
  4. Construction of power station.
  5. Water pollution.

1.14 Uses of water

1. Life originated in water. so water is the ***mother of life***
2. Plants use water for survival. Without water the plants dry and die.
3. Animal drink water. Without water the animals die.
4. Water is the *house (medium)* for aquatic plants and animals.
5. It is the *universal solvent.* Many compounds dissolve in it.
6. Water is used for *irrigation* in agriculture.
7. Man uses water for drinking, cooking, bathing, etc.
8. Water is used in industries.

1.15 Drought

Drought is a continuous dry weather when there is not enough rainfall in an area. It occurs when the monsoon fails. A country is forced to face a worst drought when the rainfall has been 35% less than normal level.

During the drought the weather is dry, dry winds blow over the land and there is a scarcity of water for drinking, irrigation and industrial uses. Therefore, food production declines several folds, leading to famine.

Causes of Drought

1. Low rainfall and failure of rainfall.
2. Geographical location of the country which is not favouring rainfall.
3. Over utilization of ground water.
4. Lowering of water table.
5. Limited number of perennial rivers.
6. Deforestation.
7. Poor water holding capacity of soils.
8. Lack of enough ground water sources.

Effects of Drought

1. Drying of land.
2. Desertification.
3. Drying of ponds and rivers.
4. Scarcity of water.
5. Loss of forest trees.
6. Drying of grasses
7. Loss of crops.
8. Famine.
9. Loss of wet lands.
10. Failure of agriculture.
11. Loss of raw materials for industries from agriculture.
12. Degradation of natural resources.
13. Migration of people.
14. Loss of business.
15. Loss of wild life habitat.
16. Lack of food and drinking water for man and wild animals.
17. Loss of income.
18. Loss of human life.

1.16 Desertification

Desertification is the degradation of arid and semi arid lands into desert. It is a process of *land degradation* and *land destruction.*

The land becomes *unfertile* and unsuitable for cultivation.

The *productivity* of land gradually decreases. The desertification is very severe when the productivity is decreased to more than 50%.

13% of the total land area of the world is deserts. It forms about $1/7^{th}$ of the total land.

The present desert area is about 1,900 Mha (Million hectare). About hundred years back it was only 950Mha. Thus in hundred years, the deserts of the world become doubled. It is estimated that about 6 Mha lands are converted into desert every year. This will produce an annual increase of about 3% of the dessert area.

Causes of Desertification

Desertification is caused by the following factors:

- Very low rain fall.
- Failure of monsoon.
- Dry climatic conditions
- Drought.
- Severe soil erosion.
- Depletion of ground water.
- Salination of land.
- Complete loss of vegetation.
- Over gauzing.
- Over utilization of forest cover.
- Destruction o forest.
- Mining.
- Quarrying.

Impacts of Desertification

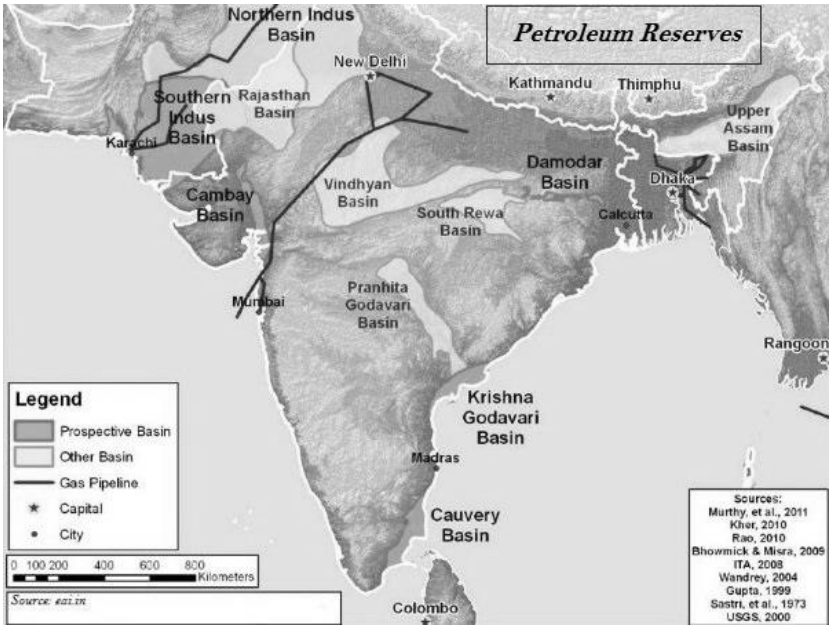
- Loss of biodiversity.
- Loss of vegetation.
- Loss of productivity.
- Loss of employment opportunity.
- Migration of people

1.17 Mineral resources

- ***Minerals*** are naturally ***inorganic*** substances which do not contain carbon.
- Minerals are ***non-renewable resources.***
- The study of minerals is called ***mineralogy.***
- On the basis of chemical and physical properties, minerals are grouped as −
  - **Metallic** minerals and
  - **Non-metallic** minerals.
- Major examples of ***metallic minerals*** are iron, copper, nickel, silver, gold, etc.

- Metallic minerals are further sub-divided as **ferrous** and **non-ferrous** metallic minerals.
- The minerals containing iron is known as ferrous and without iron is known as non-ferrous (copper, bauxite, etc.).
- Depending upon the origination, non-metallic minerals are either organic (such as fossil fuels also known as mineral fuels, which are derived from the buried animal and plant, e.g. such as coal and petroleum), or **inorganic minerals,** such as mica, limestone, graphite, etc.
- The minerals exhibiting radioactivity are called *radioactive minerals.* Eg. P^{32}
- Minerals used in the industries are called industrial minerals.
- The minerals obtained from the land are called *terrestrial minerals.* Eg. Aluminium, copper, silver, gold, platinum, etc.
- The minerals obtained from the sea are called marine minerals.
- Marine minerals are of three types, namely *terrigenous minerals, bigenous minerals and chemogenous minerals.*
- *Terrigenous minerals* are derived from land. Eg. Monacite.
- *Bigenous minerals* are present in the sea floor and they consist of shell and skeletal debris of marine organism. They contain mainly calcium carbonate.
- *Chemogenous minerals* contain manganese, nickel, cobalt and copper.

Distribution of Minerals



- Minerals are unevenly distributed on the earth's surface.
- All minerals are exhaustible in nature, i.e., will exhaust after a certain time.
- However, these minerals take long time to form, but they cannot be replenished immediately at the time of need.

- More than 97% of **coal** reserves occur in the valleys of Damodar, Sone, Mahanadi, and Godavari rivers.
- **Petroleum** reserves in India are located in the sedimentary basins of Assam, Gujarat, and Mumbai High (i.e. off-shore region in the Arabian Sea.
- Some new petroleum reserves are also found in the Krishna-Godavari and Kaveri basins

1.18 Food Resources

- Food is anything eaten to satisfy appetite and to maintain growth and physiological processes.
- Food is ***natural resource.***
- Food is inevitable for man, animals and plants.
- Plants eat inorganic substances such as *water*, *mineral*, CO_2, etc., and synthesize starch by photosynthesis. The starch is stored in the leaves, fruits and seeds.
- The food stored in the plants form the food for the man and all other animals of the World. If the plants are not there, man and animals starve and die. Man and all other animals depend on plants and plant products for their survival.
- The animals eating plants are called ***herbivores.*** Eg. *Cow*, *Sheep*, etc.
- The animals eating other animals are called ***carnivores.*** Eg. *Lion, Tiger, Fox,* etc
- Based on the diet, human beings are classified into 3 groups, namely ***vegetarian, eggtarian and non-vegetarian.***
- Vegetarians eat only plant food. Eggtarians eat egg along with plant food. Non-vegetarians eat flesh along with plant food.

Balanced Diet

A balanced diet contains all the nutrients necessary for maintaining vital activities. It should contain carbohydrates, amino acids, fats, vitamins and minerals.

The carbohydrate supplies energy. The energy value of food is called ***calorie.***

The energy requirement of man is 2800 calories and of women is 2200 calories. The energy requirement of boys is 3000 calories and of girls is 2200 calories.

The protein requirement is as follows:

Man	55g
Women	45g

The fat requirement is 50 to 100 gms per day.

Malnutrition

Malnutrition is the deficiency or excess of one or more nutrients causing diseases. It is caused by *under-nutrition* or *over-nutrition* or *imbalance.*

Malnutrition causes the following diseases:

1. Kawashiorkor is caused by protein deficiency. It is characterized by oedema, growth failure, muscle wasting, anaemia, etc.
2. Marasmus is caused by the deficiency of proteins and carbohydrates. It is characterized by growth retardation.
3. Obesity is caused by over eating. It is caused by overweight.
4. Anaemia is caused by the deficiency of iron, Vitamin B12 and folic acid.
5. Night blindness (Nyctalopia) is caused by the deficiency of Vitamin A.
6. Rickets (low shaped leg bones and pigeon chest) is caused by the deficiency of Vitamin D.
7. Pellagra (rough skin) is caused by the deficiency of Vitamin B5, Nicotinic acid.

Agriculture and Food Production

- Food is produced by agriculture.
- Agriculture is the cultivation of crops.
- It is the farming of plants.
- The aim of Agriculture is to create ***green revolution.*** The first green revolution was achieved in 1960s.
- The high yielding Mexican wheat and dwarf rice developed by the IRRI are responsible for this revolution.
- The food production in Agriculture is increased by the modernization of techniques.
- Agriculture is classified into two types. They are:
    1. *Traditional agriculture.*
    2. *Modern agriculture.*

Traditional agriculture is the ancient method followed generation after generation. It involves less area, less manpower, organic manure, mixed crops and less production.

The traditional agriculture causes the following impacts:

1. *Deforestation*
2. *Soil erosion*
3. *Depletion nutrients.*

Modern agriculture is the intensive method involving high technology, large area, heavy machine power, fertilizers, pesticides, hybrid seeds, tissue culture seedlings and high production.

Impacts of Modern Agriculture on Environment

- Agriculture needs *water*. Water is sucked out recklessly from underground. This decreases the *level of water table.*

- ♦ Over exploitation of underground water brings in saltwater causing *salinization* of freshwater.
- ♦ The chemical *fertilizers* pollute the water and soil. The nitrate of the chemical fertilizer leaches into the soil ground water and contaminate the drinking water.
- ♦ Irrigation in Agriculture leads to *water logging.*
- ♦ The *pesticides* applied on crop plants enter the human body through food chain and cause ill effects.
- ♦ Agriculture leads to the *erosion of nutrient rich top soil.*
- ♦ In Agriculture, high yielding hybrid crop plants are produced and cultivated. Hence the traditional varieties and wild varieties are not cultivated and in the course of time they become extinct. This leads to *genetic erosion.*
- ♦ Extension of cultivation leads to the destruction of natural vegetation.
- ♦ In agriculture lands there is top soil erosion which fills up reservoirs.

1.19 Effects of Fertilizer

- ✓ Fertilizers are *chemical* (synthetic) *nutrients* used to increase productivity. They contain *macronutrients* such as N, P and K. When these are used in excess *deficiency of micronutrients* in the soil is caused. This will decrease production.

Eg. In Punjab and Haryana there is decrease in the micro nutrient ***Zinc*** due to the excessive use of fertilizers.

- ✓ The excess of fertilizers are washed by water and they accumulate in ponds. This accelerates the excessive growth of water plants and algae. The excessive growth of water plants is called ***eutrophication.***
- ✓ The nitrates of fertilizers percolate into the soil and contaminate the *ground water.* When the concentration of nitrates excess 45 mg/L, it causes *blue baby disease* in children. It is characterized by vomiting, darkening of skin and even death.
- ✓ In adults, it causes gastric and bladder *cancer.*
- ✓ Chemical fertilizers form *air pollutants.*
- ✓ They damage *ozone umbrella.*
- ✓ They increase *global warming.*
- ✓ They influence *acidification* and *salinisation* of soil.
- ✓ They cause a higher incidence of *insect pests.*

1.20 Effects of Pesticides

Pesticides are chemicals used to kill unwanted plants and animals (pests). They are also called ***biocides.***

The pesticides are the following types:

Insecticides kill *insects.*

Herbicides kill *herbs.*

Fungicides kill *fungi.*

Weedicides kill *weeds.*

Nematicides kill *nematodes.*

Miticides kill *mites.*

Chemically, pesticides are classified into three groups, namely

1. *Organo chlorines* - DDT, Endirne, Endosulfan, etc.
2. *Organo phosphates* - Malathion, Parathion, etc.
3. *Carbomates* - Sevin

The pesticides cause the following impacts:

1. Some pesticides kill not only a pest but also ***useful*** and ***beneficial plants*** and ***animals.***

2. Pesticides produce resistant pests. They become immune to modern pesticides. Hence, they are called ***super pests.***

3. The pesticides, applied on the crop plants enter through the root system. They remain in the vegetables, fruits and nuts. They enter the body of animals and humans when they are eaten. They remain accumulated in the body. This accumulation of pesticides is called ***bioaccumulation.***

4. The pesticide accumulation increases many times as it passes from the lower trophic level to the higher trophic level of the food chain. This is called ***biological magnification.***

5. Organochlorine causes *egg shell thinning.* This causes *breaking of eggs* before laying.

6. Heavy application of pesticides in forest area causes the ***extinction*** of some forest species.

7. Pesticide causes *cancer.*

8. They cause *birth defects, genetic damages* and *nervous problems.*

9. They cause *drowsiness* and *confusion.*

10. They cause *vomiting, diarrhoea, headache* and *breathing problems.*

Though pesticides are harmful, they are inevitable for agriculture. So, pesticides are controlled by the following methods:

1. Altering the time of planting.
2. Integrated pest management.
3. Controlling adjacent crops and weeds.
4. Intercropping
5. Rotation of crops
6. Biological control-Introducing predators, parasites and disease causing organisms of pest.

7. Releasing sterile males of pest.
8. Planting disease resistant crops.
9. Installing *pheromone traps.*

1.21 Water Logging

Water logging is the ***stagnation*** of water on land.

Causes of Water Logging

- ♦ Excessive irrigation
- ♦ Waste water flowing on hand.
- ♦ Severe rainfall
- ♦ Poor percolation of water in the soil due to *silt* and *clay.*
- ♦ Poor drainage

Impact of Water Logging

- Unsustainable plant life.
- Breeding of pest like mosquitoes
- Bad odour
- The evaporation of water increases the *salinity* of the soil.
- Spread of diseases.

Control of Water Logging

- ♦ Pumping out stagnant water.
- ♦ Controlled irrigation
- ♦ Prevention of water leakage
- ♦ Proper drainage

1.22 Salinity

Accumulation of salts on the soil is called ***salinity.***

Causes of Salinity

Salinity is caused by ***evaporation*** of stagnant water.

Impacts of Salinity

- o The soil becomes ***alkaline.***
- o Ground water pollution.
- o Poor growth of plants.
- o Crop yield is decreasing.
- o Decomposers are affected.

Remedy

- ❖ Improving land drainage.
- ❖ Planting salt resistant plants.
- ❖ Facilitating percolation.

Water Logging

Water logging affects a number of biological and chemical processes in plants and soils that can affect crop growth in the short and long term.

Over irrigation causes water logging and salinity. This resulted in the decrease of crop production and economic loss.

1.23 Overgrazing

Overgrazing is the intensive grazing of grassland for extended periods without giving sufficient recovery periods. It is caused by *cattle, sheep, goat,* or *wild animals.*

Causes

- High ***density*** of farm animals.
- Uncontrolled grazing.
- Poor grassland management.
- Poor management of live stock.
- Continuous or rotational grazing.

Impacts of Overgrazing

- Overgrazing reduces palatable *plant leaf areas* which reduce interception of sunlight and plant growth.
- Plants become *weakened.*
- Plants have *reduced root length.*
- The reduced root length plants *die* during dry seasons.
- *Weed seeds* germinate.
- *Unpalatable grasses* dominate.
- Animals run *short of pasture.*
- *Health* and *vigour* of cattle are reduced.
- Soil is *exposed* between plants causing *soil erosion.*
- *Soil depth* is reduced.
- *Soil fertility* is reduced.
- Loss of *biodiversity.*
- Desertification.

Remedy

- Grass management
- Grassland management
- Live stock management
- Live stock marketing
- Grazing management
- Sufficient recovery time between bites.

- Applying organic manure.

1.24 Energy Resources

Energy is the capacity to work. Eg. Sunlight, coal, petrol, wind, water power, nuclear energy, fuel gas etc.

Energy is required to do everyday life. It is needed for cooking, heating, cooling, lighting, fans, TV, grinder, industries, etc. it is required for automobiles.

The energy resources may be renewable or non-renewable.

The renewable energy sources are available continuously. They are also called sustainable energy resources. Eg. Sunlight, wind, wood, hydropower, tidal power, etc.

The non-renewable energy resource cannot be replenished after their use. Eg. Coal, petrol, fuel gas, nuclear fuels, Etc.

Fire is the energy used for cooking. When ancient man discovered fire, he used wood to produce fire. Then wood was replaced by coal. Then coal was replaced by oil and fuel gas. Now oil and gas are replaced by alternate energy such as

Wood → Coal → Oil → Gas → Alternate energy (solar, wind, tidal, etc.)

Renewable Energy Resources (Non-Conventional Energy Resources)

Renewable energy resources are generated continuously in nature. They can be used again and again. They are inexhaustible. Eg. Solar energy, Hydro power, Geothermal energy, Wind energy, Tidal energy, Wood, Animal dung, kitchen waste, Agricultural waste, Municipal waste.

The renewable energy is also called non-conventional energy.

The renewable energy has the following advantages:

- Unlimited supply
- Sustainable
- Reliable

Non Renewable Energy Resources (Conventional Energy Resources)

Non renewable energy resources cannot be regenerated when they are exhausted. They are finite in quantity and cannot be reproduced. They have accumulated over millions of years. They cannot be produced in human life time, so they are exhausted after some years. Eg. Coal, Natural Gas, Petroleum, Nuclear fuels etc.

The non renewable energy resources are also called **conventional energy resources.**

1.25 Alternate Energy Resources

The energy generated from alternatives to fossil fuels is called **alternate energy.**

Alternate energy resources do not cause air pollution. They are **eco-friendly resources.** These are the energy resources other than those derived from fossil fuels.

Most of the alternate sources of energy are renewable.

Eg. Solar energy, Hydro electric energy,Wind energy, Tidal energy, Geothermal energy, Biogas Hydrogen, Nuclear power

Solar energy is the energy which the earth receives from the Sun. The solar power generation is done by using a series of photovoltaic cells where the solar rays are converted into electricity.

The power of the wind is harnessed to propel the blades of wind turbine attached to an electric generator to generate wind energy.

Hydro electrical energy is obtained from waterfalls.

Tidal energy is obtained from waves and tides of the sea.

Geothermal energy is the heat energy obtained from the high temperature present inside the earth.

Biogas is obtained from the fermentation of animal dung and organic wastes.

Hydrogen is used as a fuel for aircrafts, space ships and vehicles.

Environmental Impact of Alternate Energy Resources

An alternate energy resource is the alternative energy resources to fossil fuels.

Eg. Solar energy, tidal energy, wind energy, hydropower, geothermal energy, biomass energy, nuclear power, etc.

The use of alternate energy resources causes the following environmental impacts.

- The leakage from radioactive power plants causes mass killing of human beings, animal, and plants.
- Nuclear power plants cause air pollution, water pollution, and land pollution.
- The disposal of nuclear wastes is risky and costly.
- Hydroelectric projects need the construction of dams which cause submergence of land and forest.
- Exploitation of tidal power causes estuarine pollution.

Use of Energy in Human Life

- Sunlight is the primary energy source on the Earth. The plants trap Sun's energy and synthesize food. This food is used by all animals including man.
- The Sun warms up the Earth through heat energy.
- The Sun's energy causes evaporation causing clouds and rain.
- Sunlight generates electricity in a solar cell.
- Domestic animals are used for mechanical work. A donkey carries load; an ox pulls a cart; a camel carries man.
- Electric energy is used in radio, TV, grinder, etc.
- Electric energy is used for light and for rotating a fan.
- Electric energy is used in agriculture and industry.
- Automobiles use Coal, Petrol, diesel, electricity as energy.

- Electricity is produced from wind energy through wind mill, tidal power (water power), nuclear energy, etc.
- In the kitchen heat energy is used for cooking. Heat is generated from fire wood, gas, electricity, etc.

1. Solar Energy

- Sunlight is the solar energy. It forms the major energy source for the plants.
- Solar energy is the best source of renewable energy to the world.
- Plants synthesize starch with the help of sunlight. All animals in the world depend on the energy stored by the plants.
- The solar energy is also used for solar cooker, solar light, solar calculator, etc.
- Solar cells generate electricity using sunlight. They are pollution free.
- In solar cells two layers of silicon are used.
- Solar cells are used for-Calculators, Electric appliances, Radios, Water pumping, Electric lights Weather stations, Street lights, Cars.

2. Fossil Fuel

Fossil fuels are a great source of energy because they originate from living things. Fossil fuel or conventional sources of energy are found exhaustible in nature. Fossil fuel is a general term for buried combustible geologic deposits of organic materials, formed from decayed plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the earth's crust over hundreds of millions of years.

3. **Coal**

Coal is a ***fossil fuel.*** It is a ***non-renewable*** natural resource. It is found under the earth. It is an ***organic compound.*** It is a ***black product*** formed by organic decomposition of plants materials millions of years ago. Coal is found in stratified beds.

The coal is of four types, namely

1. *Anthracite*
2. *Bituminous coal*
3. *Sub- bituminous coal*
4. *Lignite.*

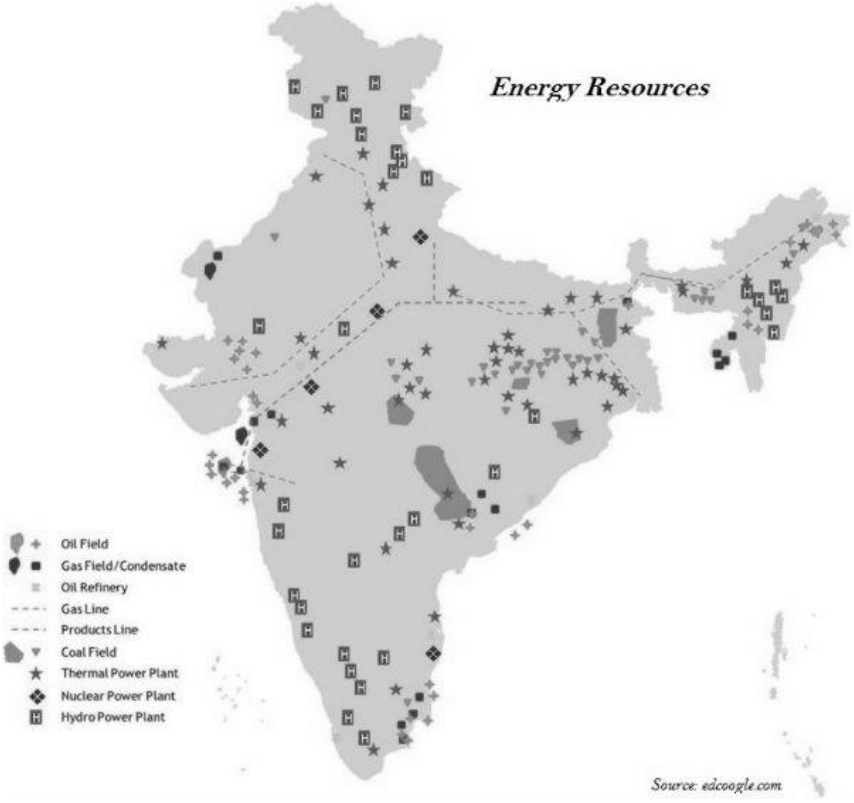
Anthracite is the ***hard coal.*** It has the lowest moisture content, highest carbon content and highest heat value.

Bituminous coal is the most abundant one.

Lignite is the brown coal. It has 50% water content, low carbon content and low heat value.

Coal is collected by underground mining methods.

- The most important *Gondwana* coal fields of India are located in Damodar Valley region.
- Raniganj, Jharia, Bokaro, Giridih, and Karanpura are major coalfields of Jharkhand-Bengal coal belt.
- Jharia is the largest coal field followed by Raniganj.
- The brown coal or lignite are found in the coastal areas of Tamil Nadu, Pondicherry, Gujarat, and Jammu and Kashmir.



4.Oil

Oil is a non-renewable resource. Oil is the most abundant fluid in the Earth's crust, next to water.

It is a *hydrocarbon* in nature coming under *fossil fuel.* Example: Mineral oil.

It is otherwise known as *mineral oil.*

The crude oil is the *petroleum.* It is formed by the decomposition of buried plants, millions of year ago.

Crude oil is refined to produce *petrol, diesel, kerosene, propane, gasoline, jet fuel, heating oil, motor oil, roadtar, paraffin, wax, petroleum jelly,* etc.

Hydrocarbons of liquid and gaseous states varying in chemical composition, color, and specific gravity are collectively known as petroleum resource.

Petroleum industries produce various by-products; for example, fertilizer, synthetic rubber, synthetic fiber, medicines, vaseline, lubricants, wax, soap, and cosmetics.

Crude petroleum normally occurs in sedimentary rocks of the tertiary period.

5. Natural Gas

Natural Gas is a *fossil fuel.*

It is a *hydrocarbon* and it found together with oil in oil wells. It accumulates above the oil.

Methane is a natural gas. It is used for domestic and industrial purposes.

Natural gas is of two type namely, *dry gas* and *wet gas.*

Dry gas contains lower hydrocarbons. Eg. Methane.

Wet gas contains higher hydrocarbons. Eg. Propane, butane, etc.

6. Wind energy

Wind is the *renewable* natural energy resource.

Wind is an inexhaustible source of energy. It is a perennial source and is available day and night. It is used to generate *electric current.*

The blow of wind is allowed to rotate the blades of a windmill. The windmill is coupled to a turbine. This generates electricity.

The pioneer in generating electricity by using windmill is Denmark. Windmills are most abundant in Gujarat, Tamilnadu, and Andhra Pradesh.

Muppandal (Tamilnadu) has the highest concentration of windmills in Asia and it ranks third in the World.

The windmill has a vertical pillar with three blades. The force of winds rotates the blades. The blades rotate a wheel. The wheel is connected to a generator to generate electricity. The speed of the wind should be 10 to 20 km/hour.

In rural areas, small windmills are used for pumping water, threshing, winnowing, cutting wooden logs, battery charging, etc.

Significance of wind energy

- Eco-friendly.
- Does not cause pollution.
- Cheap.

7. Wind mills

Windmills exploit wind energy for producing electricity. In Tamilnadu Kavalkinaru is famous for windmills. Here more than 400 Mw of electricity is produced.

Hydroelectric Energy

The flowing water produces electricity. So water is a hydropower. It is a renewable energy resource. In olden days water wheels were used to rotate wheels of the power generators. The following are the important hydropower projects in India:

1. Narmatha
2. Damodar Valley
3. Iddiki
4. Bhakra Nangal
5. Nagarjuna Sagar

8. Tidal Energy

The potential energy of the tides is called tidal energy

The tide is caused by the attraction of the Moon and the Sun.

The rise of sea water level is known as high tide and the fall of the sea water level is called low tidal range

The tidal energy is used for producing electricity. A dam (barrage) is constructed across an estuary. An estuary is the junction of river and the sea. It is the place where the river opens into the sea.

In the opening of the dam, a turbine is installed. During high tide, sea water flows into the estuary through the opening of dam rotating the turbine.

During low tide the estuarine water flows into the sea rotating the turbine.

The rotation of turbine produces electricity.

9. Nuclear Energy

The energy of an atomic nucleus is called nuclear energy. The energy is obtained from the fission or fusion, especially when used to generate electricity. Nuclear energy can be used to generate electricity. But first the energy must be released. It can be released from atoms in two ways: nuclear fusion and nuclear fission. In nuclear fusion, energy is released when atoms are combined or fused together to form a larger atom. This is how the sun produces energy. In nuclear fission, atoms are split apart to form smaller atoms, releasing energy. Nuclear power plants use nuclear fission to produce electricity.

10. Biomass Energy

The energy obtained from plants and animals is called ***biomass energy*** or ***bioenergy.***

11. Biogas

Biogas is a mixture of gases produced by anaerobic bacterial fermentation of organic matter. It is also called gobar gas. It consists of methane, CO_2, hydrogen sulphide, carbon monoxide, O_2, H_2 and N_2.

12. Biodiesel

Biodiesel is made from vegetable oils. It is used as a substitute for diesel. It is used in cars, trucks, buses, aeroplanes, trains, etc.

13. Hydrogen as an alternate source of energy

Hydrogen fuel is a renewable energy resource. Hydrogen is an alternate source of energy. It is produced by dissociation of water.

$$2H_2O \longrightarrow 2\,H_2 + O_2$$

It is produced by photolysis or electrolysis or thermal dissociation of water. Hydrogen possesses high calorific value. Enormous amount of hydrogen can be produce from sea water.

1.26 Land Resources

Land resources mean the resources available from the land, thus the agricultural land which contain natural fertilizer for growth of the products sown; the underground water, the various minerals like coal, bauxite, gold and other raw materials.

The main constituent of land is soil. The word soil is derived from Latin word "Solum" meaning the substratum in which the plant grows.

Land Resources in India enclose approximately 1.3 million sq miles and is a cape, protruding into the Indian Ocean, in between the Bay of Bengal on the east and Arabian Sea on the west. Indian land resources are segmented into varied relief features, 43% of land area is plain region; Indian mountain region constitutes 30% of the area, where as plateaus account for 27 % of the total surface area on the nation.

Categories of Land

- Land under settlements (i.e. rural and urban), infrastructure (i.e. roads, canals, industries, shops, etc.) are kept under the category of Non-Agricultural Land.
- Barren hilly terrains, desert lands, ravines, etc. normally are not suitable for cultivation, hence, they are known as Barren and Wastelands.
- The land owned by the village panchayat comes under 'Common Property Resources'.
- Any land, which is left fallow (uncultivated) for more than five years is categorized as Culturable Wasteland.

- The land, which is left without cultivation for one or less than one agricultural year is known as Current Fallow.
- The physical extent of the land on which crops are sown and harvested is known as Net Sown Area.
- Land use pattern changes with time and the nature of economic activities carried out in that region.
- As a result of increase in population, change in income levels, available technology, and associated factors, pressure on land increases and marginal lands come under use.
- When secondary and tertiary sectors grow much faster than primary sector, then agricultural land changes into non-agricultural land.
- Likewise, India has undergone major changes within the economy over the past four or five decades, and it has influenced the land-use changes in the country.
- Because of the changing structure of the Indian economy, the rate of increase of non-agricultural land is very fast.

Soil erosion:

Soil erosion is a naturally occurring process that affects all landforms. In agriculture, soil erosion refers to the wearing away of a field's topsoil by the natural physical forces of water and wind or through forces associated with farming activities such as tillage.

Erosion, whether it is by water, wind or tillage, involves three distinct actions – soil detachment, movement and deposition. Topsoil, which is high in organic matter, fertility and soil life, is relocated elsewhere "on-site" where it builds up over time or is carried "off-site" where it fills in drainage channels. Soil erosion reduces cropland productivity and contributes to the pollution of adjacent watercourses, wetlands and lakes.

Soil erosion can be a slow process that continues relatively unnoticed or can occur at an alarming rate, causing serious loss of topsoil. Soil compaction, low organic matter, loss of soil structure, poor internal drainage, salinisation and soil acidity problems are other serious soil degradation conditions that can accelerate the soil erosion process.

Soils of India

1. Alluvial Soils:

These are formed by the deposition of sediments by rivers. They are rich in humus and very fertile. They are found in Great Northern plain, lower valleys of Narmada and Tapti and Northern Gujarat. These soils are renewed every year.

2. Black Soils:

These soils are made up of volcanic rocks and lava-flow. It is concentrated over Deccan Lava Tract which includes parts of Maharashtra, Chhattisgarh, Madhya Pradesh, Gujarat, Andhra Pradesh and Tamil Nadu. It consists of Lime, Iron, Magnesium and also Potash but lacks in Phosphorus, Nitrogen and Organic matter.

3. Red Soils:

These are derived from weathering of ancient metamorphic rocks of Deccan Plateau. Its redness is due to iron composition. When iron content is lower it is yellow or brown. They cover almost the whole of Tamil Nadu, Andhra Pradesh, Chhattisgarh, Karnataka, Maharashtra and parts of Orissa.

4. Laterite Soils:

These soils are formed due to intense leaching and are well developed on the summits of hills and uplands. They are commonly found in Kerala, Tamil Nadu, Maharashtra, Chhattisgarh and hilly areas of Orissa and Assam.

5. Mountain Soils:

These soils are formed as a result of the accumulation of organic matter derived from forest growth. They are found in Himalayan region and vary in different regions according to altitude. Tea is grown in those areas which receive sufficient rainfall.

6. Desert Soils:

In the desert regions of Rajasthan, soils are not well developed. As evaporation is in excess of rainfall, the soil has a high salt content and saline layer forms a hard crust. These soils are generally sandy and deficient in organic matter.

2. ECO SYSTEM

Ms.M.Manonmani

2.1 CONCEPTS OF AN ECOSYSTEM

Organisms (the living entities) and the environment (all surroundings in which any organization or living system operates and includes air, water, land, humans, plants, animals, resources, etc.) are interrelated and interact upon each other so that a flow of energy leads to a clearly defined trophic (nutrient requiring) structure, biotic diversity, and material cycles (i.e., exchange of materials between living and non-living sectors). The whole earth and its parts, viz., land surface, water bodies, atmosphere as well as living organisms, are working in an integrated system, which not only directs but also determines the pattern of life and is also an indicator of environmental relationship with living organisms.

The term '*ecosystem*' was coined by A.G. Tansley in 1935, who defined it as "*the system resulting from the integration of all the living and non-living factors of the environment*". The term 'ecosystem' is now accepted and most preferred, where 'eco' implies the environment, and 'system' means interdependent, interacting complex.

In fact, our earth has giant ecosystem in the form of the biosphere, where abiotic and biotic components are constantly acting and reacting upon each other, bringing forth structural and functional changes in it. The biosphere is a vast ecosystem and difficult to study as a whole, therefore, for the convenience of study, it can be divided into the following major sub-divisions:

1. *Terrestrial* as forest, grassland, desert, mountains, etc.
2. *Aquatic (*water-open): (a) fresh water which many be lotic (running-water like spring, stream, rivers) or *lentic* (standing water like lake, pond, swamp, pools, etc.); and (b) *marine* such as deep sea or shallow sea, delta, etc.

2.2 ECOSYSTEM FUNCTION

The functional pattern of an ecosystem is a very important and basic aspect of study, because all its components are dynamic in one way or the other and are responsible for the creation of an unique state of man-environment relationship as well as a habitat, different from other regions. Major functions of an ecosystem which ensures its stability are as follows.

(i) It regulates flow rate of biological energy including production and respiration rates.

(ii) It regulates flow rates of materials in terms of mass balance as nutrients or materials cycles.

(iii) It fixes limit of tolerance for each organism in an ecosystem because each organism has certain limits of tolerance towards various factors of environment and only within specified limits, the organisms survive.

(iv) It regulates modification of environment because the environment is modified by the organisms according to their needs. The carrying capacity of the ecosystem determines the size of organism's population that can survive in the particular ecosystem.

(v) It regulates species diversity because the nature strives for greater diversity i.e., greater variety of organisms in a system, which leads to its stability.

(vi) It controls alteration of any one component because it is holocoenotic in which one component affects the other components.

2.3 COMPONENTS OF THE ECOSYSTEM

The two major components of ecosystem are:

- the *biotic components* comprising all living organisms, and
- the *abiotic components* including the physical (non-living) environment.

1. **Biotic components:** In an ecosystem, organisms are usually divided into two categories on the basis of their nutritional (trophic) relationship. These are:

   (a) Autotrophs: These are those organisms which can produce their own food. These are green plants (with chlorophyll) and certain bacteria, which obtain their energy from the sun and through photosynthesis, produce food. Since these organisms produce food for all the other organisms, they are known as *'producers'.*

   (b) Heterotrophs: These are those organisms which depend directly or indirectly upon the autotrophs for their food, thus known as '*consumers'.* The consumers are of two types: *herbivores* (plant eaters) and *carnivores* (meat eaters).

Functionally, the biotic components can be divided into three types, viz., producers, consumers and decomposers.

(i) **Producers:** These are the autotrophic members of the ecosystem which are green plants and capable of synthesizing food from non-living simple inorganic substance. They include flowering plants, algae, and diatoms. These also include chemosynthetic bacteria. In water, they are rootless algae floating or submerged in water. All the sources of energy are derived from these green plants directly or indirectly.

(ii) **Consumers:** These are heterotrophic members of the ecosystem, which eat up other living organisms. Consumers include animals which feed on other organisms or particulate organic matter (food) produced by producers.

Primary consumers or *herbivores* in the the ecosystem depend upon the green plants for their food. *Secondary consumers* or *carnivores* depend on other animals.

(iii) **Decomposers:** These include microorganisms like bacteria and fungi, which attack on the dead bodies of producers and consumers, and decompose them into simpler compounds and also release inorganic nutrients. These inorganic substances together with other organic substances are then utilized by the producers for the synthesis of their own food. The producers from the *first trophic level,* herbivores form the *second trophic level* and carnivores form the *third trophic level.* Trophic structures may also be described in terms of amount of living matter called standing crop in all the trophic levels.

Producers produce their own food like plants, which are primary producers, while man and animals obtain food from plants. Similarly consumers are also primary, secondary or tertiary. Man, cow, goat, etc., are primary consumers, while meat eaters are secondary consumers. Tertiary consumers are those animals which eat secondary consumers such as snakes eat frogs, peacocks eat snakes, etc. Among decomposers those bacteria, fungi, etc., have been included which are responsible for decomposition of a product and release inorganic nutrients in the environment.

2. Abiotic Components: The physical environment with its several interacting variables constitutes the abiotic component of ecosystem. It consists of (i) the lithosphere, i.e., the solid mineral matter of the earth, (ii) the water in the oceans, rivers, lakes, etc., or in other words, the hydrosphere, (iii) the gaseous mixture in the air (the atmosphere), and (iv) the radiant solar energy.

2.4 AQUATIC ECOSYSTEMS

Aquatic ecosystems deal with biotic community present in water bodies Aquatic organisms have the same basic need as the terrestrial organisms for their growth, development, maintenance and reproduction. However, the difference lies in the form in which certain resources are made available to the organisms in the two environments. In terrestrial ecosystems, carbon dioxide and oxygen are present in gaseous form but in aquatic ecosystems these are made available in dissolved state in water. Vertical stratification of organisms in aquatic ecosystems is influenced mostly by change in depth, light, temperature, pressure, salinity, oxygen and carbon dioxide concentration. Depending upon the quality and nature of water the aquatic ecosystems are categorized into: (i) freshwater ecosystems, and (ii) marine ecosystems. Fresh water ecosystems can

further be divided into two categories: (i) standing water or lentic ecosystems (lake, pond, swamp), and (ii) running water or lotic ecosystems (river, spring, stream).

Freshwater ecosystems

Although freshwater ecosystems occupy a small portion of the earth's surface, they are of great importance to man because they provide drinking water as well as water for domestic and industrial needs. The important freshwater ecosystems are:

Pond and lake ecosystems

A pond is good example of standing freshwater ecosystem, which exhibits a self-sufficient, self- regulating system. A pond is a place where living organisms not only live but interact with abiotic and biotic components, thus forming an ecosystem which is different from other systems. However, the ponds are often exposed to tremendous anthropogenic pressure which affects significantly the biotic and abiotic component of this ecosystem.

Lakes are usually big standing freshwater bodies. They have a shallow water zone called *littoral zone*, an open-water zone where effective penetration of solar light takes place, called *limnetic zone* and where light penetration is negligible, called *profundal zone.*

The different components of these ecosystems are as follows:

Abiotic Component: These are the inorganic as well as organic substances present in the bottom soil or dissolved in water. In addition, to the minerals some dead organic materials is also present.

Biotic Component:

(i) **Producers:** It includes submerged, free-floating and amphibious macrophytes (like *Cratophyllum, Hydrilla, Utricularia, Wolfia, Spirodella, Eichhornia, Azolla, Typha, etc.,)* and minute floating and suspended lower phytoplanktons (like *Ulothirx, Spirogyra, Oedogonium., etc.).*

(ii) **Consumers:**

(a) **Primary Consumers:** These are zooplanktons (ciliates, flagellates, other protozoans, small crustaceans) and benthos.

(b) **Secondary Consumers:** These are the carnivores like insects and fishes feeding on the herbivores.

(c) **Tertiary Consumers:** These are the large fishes feeding on small fishes.

(iii) **Decomposers:** These are microorganisms like bacteria, fungi and actinomycetes.

Marine or ocean ecosystem

These are gigantic reservoirs of water covering nearly 70% of earth earth's surface. This ecosystem is different from freshwater ecosystem mainly because of its

salty water also because the sea is deep, continuous and water is in continuous circulation. Most of the marine water is at a temperature of 2-3 C, devoid of light and 62% is under high pressure (> 100 atm.). The trophic structure of the marine ecosystems starts from the smallest autotrophs, like planktons and neutons, and end with larger animals, like giant fish, squids and whales. Microscopic phytoplankton and associated bacteria create a complex food web that can extend long distance and extreme depths. In a marine ecosystem, the ecology of shallow and deep waters as well as estuarine part is different from each other. The components of marine ecosystems are:

Abiotic Component: High Na-,Ca-,Mg, and K-salt concentrations, variable dissolved oxygen content, light and temperature make a unique physicochemical condition in marine water. The concentration of dissolved nutrients remains low, which constitute an important limiting factor to determine the size of marine populations.

Biotic component:

(i) **Producers:** It includes phytoplankton (diatom, dinoflagillates), large seaweeds (mainly algae-like chlorophyceae, phaeophyceae and rhodophyceae; angiosperms like *Ruppia, Zostera, Posidonia,Enhalus,* etc.), and mangrove vegetations (like *Rhizophora, aricennia, Carapa, Ageiceros,*etc.).

(ii) **Consumers:**

(a) Primary Consumers: These are herbivorous and feed directly on producers (crustaceans, mollusks, fish etc.).

(b) Secondary consumers: These are the carnivorous fishes (Herring, Sahd, and Mackerel).

(c) Tertiary Consumers: These are micro-organisms like bacteria and fungi.

Estuarine ecosystem

Estuaries are semi-enclosed coastal body of water connected on the one side with open sea and with freshwater river on the other side. It is a transition zone which is strongly affected by tidal action and within this, seawater is mixed with freshwater from river. It is characterized as an ecosystem having fluctuating water level. Therefore, the organisms present in estuaries show a wide range of tolerance to temperature (known as *eurythermal)* and salinity (known as *euryhaline).* Typically, estuarine communities consist of endemic species confined to the estuarine zone only. Estuaries are highly and offer high food potential for human beings due to the nutrient and energy inputs from both seawater and river water. The components of estuarine ecosystems are:

Abiotic component: A mixture of fresh and marine ecosystems.

Biotic component:

(i) **Producers:** Macrophytes (marsh grasses, seaweeds, sea grasses, benthic algae and phytoplankton)

(ii) **Consumers:** Oysters, crabs, several kinds if shrimp and many commercial sport fish.

(iii) **Decomposers:** These are microorganisms like bacteria and fungi.

2.5 TERRESTRIAL ECOSYSTEMS

Important features of terrestrial ecosystems are:

1. Moisture is the major limiting factor of this ecosystem, thus have to face the problem of dehydration.
2. Evapotranspiration is an energy dissipating process, unique to terrestrial environment.
3. Extremes of temperature are more pronounced.
4. Rapid circulation of air equalizes oxygen and carbon dioxide contents throughout the globe.
5. Strong skeletal systems are present in terrestrial plants and animals.
6. Important geographical and topographical elements constitute discontinuity.
7. Soil acts as highly developed ecological subsystem.

Forest ecosystem

Predominant vegetation of this ecosystem is trees, interspread with a large number of species of herbs, shrubs, climbers, lichens, algae and wide variety of animals and birds. Forest is composed of trees, shrubs or any other woody vegetation. Forests occupy roughly 40% of the land. In India, the forest cover is roughly 19% of the total land area. The forest ecosystems are of great concern from the environmental point of view. This is tertiary ecosystem. The different components of this ecosystem are as follows:

Abiotic Component: These are the inorganic as well as organic substances present in the soil. In addition to the minerals some dead organic materials is also present.

Biotic Component: The living organisms present in the food chain occur in the following order:

(i) **Producers:** It includes trees, climbers, epiphytes, shrubs and ground vegetation.

(ii) **Consumers:**

(a) Primary consumers: These are herbivores that include the animals feeding on tree leaves like ants, flies, beetles, leaf hoppers, bucks, spider, and other insects along with larger grazing animals like deer, neelgai, elephants, rabbit, monkeys, moles, squirrels, shrews, flying foxes, fruit bats, mongooses, etc.

(b) Secondary Consumers: These are the carnivores like snakes, lizards, fox, wolf, jackals, birds, etc. feeding on the herbivores.

(c) Tertiary Consumers: These are the top carnivores like lion, tiger, etc. that feed on the secondary consumers.

(iii) **Decomposers:** These are wide variety of microorganisms including fungi, algae, bacteria, actinomycetes etc.

Grassland ecosystem

Predominant vegetation of this ecosystem is grass species, but sometimes allows the growth of a few trees and shrubs. These are two types of grasslands. One developed under the influence of climate is called natural grasslands. The other type of grassland, which is found in india also, has developed due to the degradation of natural vegetation due to human activities and is thus anthropogenic in nature. Natural grasslands are developed by a mean annual rainfall between 250-750 mm, a high rate of evaporation, and seasonal and annual droughts. Grasslands occupy about 24% of the earth's surface. The different components of this ecosystem are as follows:

Abiotic Component: These are the inorganic as well as organic substances present in the soil. In addition to the minerals some dead organic materials is also present.

Biotic Components: The living organisms present in the food chain occur in the following order:

(i) **Producers:** It includes grasses, few forbs (herbaceous flowering plant), shrubs and ground vegetation.

(ii) **Consumers:**

(a) Primary Consumers: These are herbivores that include the animals feeding on grasses like cows, buffaloes, deer, sheep, rabbit, mouse, insects, termites, and millipedes which feed on the leaves of grasses.

(b) Secondary Consumers: These are the carnivores like snakes, lizards, fox, wolf, jackals, birds, etc. feeding on the herbivores.

(c) Tertiary Consumers: These are the hawks and top carnivores like fox, jackal, lion, tiger, etc. that feed on the secondary consumers.

(iii) **Decomposers:** These are wide variety of microorganisms including fungi, algae, bacteria, actinomycetes etc. They decompose the dead organic matter and help to bring minerals back to the soil, thus making them available to the producers.

Desert ecosystem

Desert ecosystem occurs in regions where evaporation exceeds precipitation. Mean annual rainfall is either below 250 mm or if it is more, it occurs at a time getting rapidly evaporated and leaving a long period of drought. Scarcity of rainfall may be due

to: (i) high sub-tropical pressure, as in Sahara and Namib in Africa, Australian deserts, and Thar deserts in Rajasthan, India; (ii) geographical position in rain shadows; or (iii) cold deserts at high altitudes as in Tibetan, Gobi, Bolivia deserts. Vegetation in these ecosystems is almost absent or sparsely disposed. Due to extremes of water scarcity and temperature, the biota is much more varied, the succulents which store water, and the desert shrubs, which have developed numerous features to adapt desertic condition. The different components of this ecosystem are as follows:

Abiotic Component: Due to high temperature and very low rainfall, the organic substances are poorly present in the soil.

Biotic Component: The living organisms present in the food chain occur in the following order:

(i) **Producers:** These are shrubs (especially bushes), succulent plants (cacti), a few species of xerophytic grasses and trees, with lower plants like lichens and xerophytic mosses.

(ii) **Consumers:** Insects, reptiles, nocturnal rodents, biers, camels etc, are the main consumers.

(iii) **Decomposers:** Due to poor vegetation with a very low amount of dead organic matter, decomposers are poor in desert ecosystems with only few species of thermophilic fungi and bacteria.

2.6 BIOGEOCHEMICAL CYCLE:

A biogeochemical cycle is the movement of matter within or between ecosystems caused by living organisms, geological forces, or chemical reactions. The cycling of nitrogen, carbon, sulfur, oxygen, phosphorus, and water are examples.

Some of the major biogeochemical cycles are as follows:

(i) Water Cycle or Hydrologic Cycle

(ii) Carbon-Cycle

(iii) Nitrogen Cycle

(iv) Oxygen Cycle.

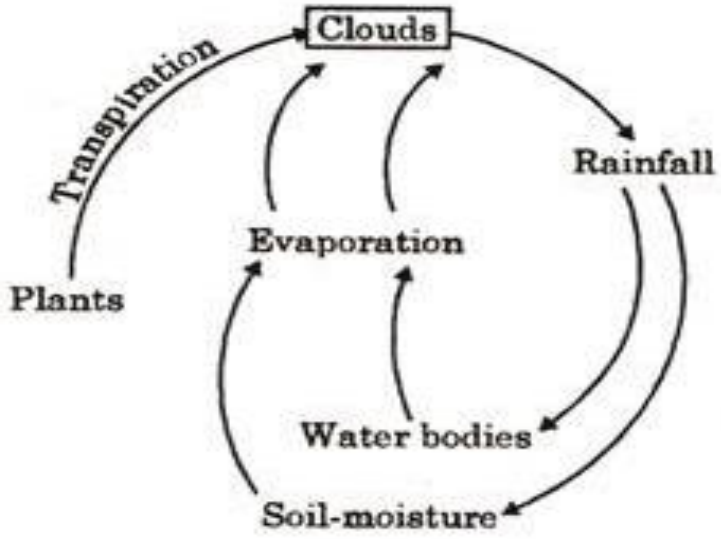
This cyclic exchange of nutrient material between the living organisms and their non-living environment is called biogeochemical cycle. As indicated by the name the nutrients circulate through life (bio) and through earth (geo) repeatedly (cycle). The biogeochemical (material or nutrient) cycles conserve the limited source of raw materials in the environment.

Common Biogeochemical Cycles are:

Water Cycle or Hydrologic Cycle:

In this cycle

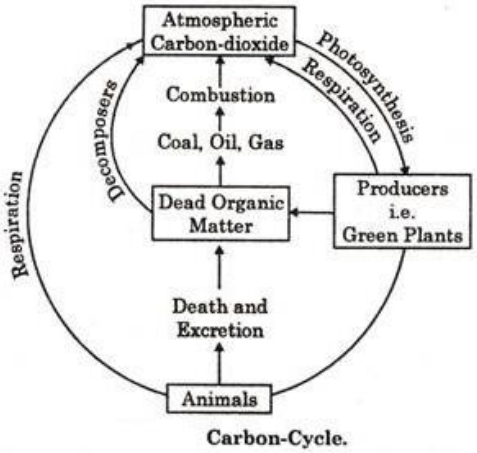
(a) Water from the transpiring plants, oceans, rivers and lakes evaporates into the atmosphere.
(b) These water vapours subsequently cool and condense to form clouds and water.
(c) Water returns to the earth as rain and snow.



Water-cycle.

Carbon-Cycle:

Most of the carbon dioxide enters the living world through photosynthesis. The organic compounds synthesized are passed from the producers (green plants) to the consumers (herbivores and carnivores). During respiration, plants and animals release carbon back to the surrounding medium as carbon-dioxide. The dead bodies of plants and animals as well as the body wastes, which accumulate carbon compounds, are decomposed by micro-organisms to release carbon dioxide.
Carbon is also recycled during burning of fossil fuels.

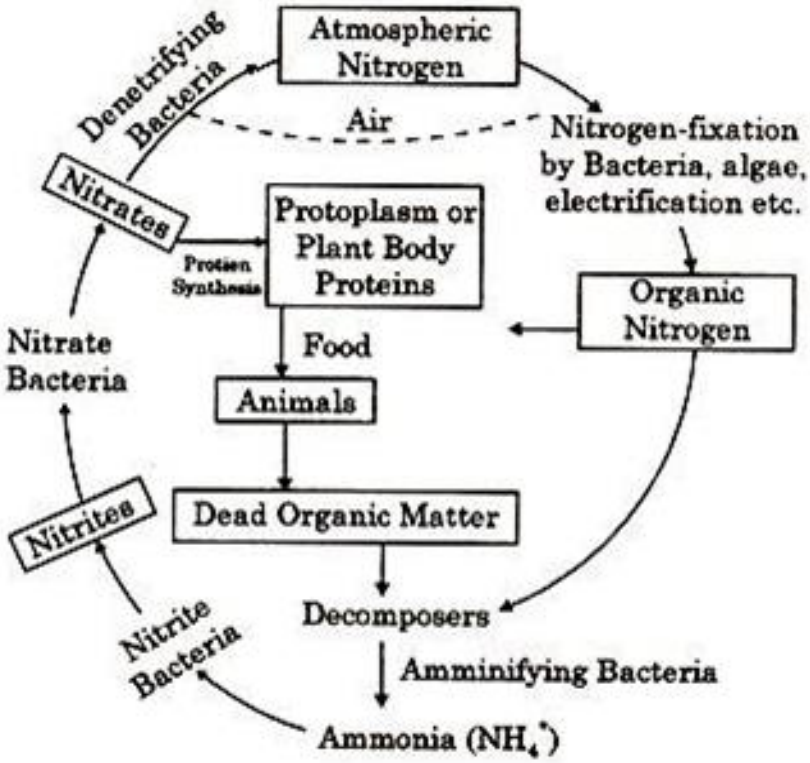


Carbon-Cycle.

Nitrogen Cycle:

Nitrogen of the atmosphere is in the elemental form and cannot be used as such by living organisms. It has to be "fixed" i.e. combined with other elements such as hydrogen, carbon or oxygen to become usable for the green plants.

Nitrogen is continuously entering into the air by the action of denitrifying bacteria and returning to the cycle through the action of lightening and electrification.

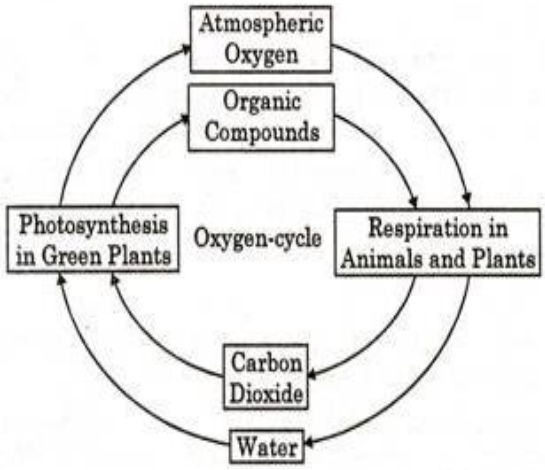


Nitrogen-Cycle

Oxygen Cycle:

Oxygen required for respiration in plants and animals enters the body directly from the surrounding medium (air or water).

Oxygen returns to the surroundings in the form of Carbon-dioxide or water. It also enters the plant body as carbon dioxide and water during photosynthesis and is released in the form of molecular oxygen as a by-product in the same process for use in respiration. Thus, the cycle is completed.



Oxygen-Cycle

Ecosystem is a functional system which in a balanced condition is self-sufficient and self-regulating. A balanced ecosystem is essential for the survival of all living organisms. Organisms at each trophic level in a food chain are preyed upon by an organism at the next higher trophic level, for example, herbivores feed on the plants and in turn are eaten by the predators.

If the numbers of herbivores increase in a specific area, there will be a rapid destruction of the vegetation, which in turn will eventually destroy the herbivores (due to lack of food). So, the population of herbivores is kept in check by predators such as lions and tigers.

Through these interactions in the food web, the population of each species, is held in check by the carrying capacity of the environment i.e. the environment's ability to provide space and food to the organisms, and the ecosystem maintains its balance (ecological balance or balance of nature).The tendency of the biological systems to resist change and to remain in a state of dynamic equilibrium is known as homeostasis (homeo = same; stasis = standing).

2.7 BIOMES

A biome is a large, relatively distinct, regional type of ecosystem with a distinctive climate, soil conditions, and a biological community adapted to those conditions. There are seven major types of biomes including the coniferous forest, temperate deciduous forest, desert, grassland, rainforest, shrub land and tundra each with unique features, though it is important to note that biomes blend in places and these blended areas also have specific names. Biomes are a terrestrial ecosystem.

A large community of plants and animals that occupies a distinct region defined by its climate and dominant vegetation is called as Biomes. Grassland, tundra, desert, tropical rain forest, and deciduous and coniferous forests are all examples of **biomes**.

Biomes are very large ecological areas on the earth's surface, with fauna and flora (animals and plants) adapting to their environment. Biomes are often defined by abiotic factors such as climate, relief, geology, soils and vegetation.

A **biome** is a massive ecosystem. It is named after the climax of vegetation. Eg. A biome with dominance of grasses is called as grassland biome. A biome with dominance of trees is called as Forest biome.

2.8 BIODIVERSITY

Introduction

The great variety of life on earth has provided for man's needs over thousands of years. This diversity of living creatures forms a support system which has been used by each civilization for its growth and development. Those that used this "bounty of nature" carefully and sustainably survived. Those that overused or misused it disintegrated. Science has attempted to classify and categorize the variability in nature for over a century. This has led to an understanding of its organization into communities of plants and animals. This information has helped in utilizing the earth's biological wealth for the benefit of humanity and has been integral to the process of 'development'.

This includes better health care, better crops and the use of these life forms as raw material for industrial growth which has led to a higher standard of living for the developed world. However this has also produced the modern consumerist society, which has had a negative effect on the diversity of biological resources upon which it is based. The diversity of life on earth is so great that if we use it sustainably we can go on developing new products from biodiversity for many generations. This can only happen if we manage biodiversity as a precious resource and prevent the extinction of species. The diversity of life on earth is so great that if we use it sustainably we can go on developing new products from biodiversity for many generations. This can only happen if we manage biodiversity as a precious resource and prevent the extinction of species.

Definition

Biological diversity or biodiversity is that part of nature which includes the differences in genes among the individuals of a species, the variety and richness of all the plant and animal species at different scales in space, locally, in a region, in the country and the world, and various types of ecosystems, both terrestrial and aquatic, within a defined area.

What is biodiversity?

Biological diversity deals with the degree of nature's variety in the biosphere. This variety can be observed at three levels, the genetic variability within a species, the variety of species within a community, and the organisation of species in an area into distinctive plant and animal communities constitutes ecosystem diversity.

Biodiversity is the natural biological capital of the earth. Biodiversity is a contraction of biological diversity, term for variety or diversity within the biological world. In its most general sense, biodiversity refers to all aspects of variety in the living world. Specifically, the term maybe used to describe the number of species, the amount of genetic variation or the number of community types present in an area.

It indicates all the inherited variations of living organisms living in a broad area. It can be defined as the variety and variability of life. It can be observed at gene level, species level and ecosystem level.

Value of Biodiversity

The value of biodiversity in terms of its commercial utility, ecological services, social and aesthetic value is enormous. We get benefits from other organisms in innumerable ways. Sometimes we realize and appreciate the value of the organism only after it is lost from this earth. The multiple uses of biodiversity or biodiversity value may be classified as follows.

Consumptive use value

These are direct use values where the biodiversity products can be harvested and consumed directly e.g. fuel, food , drugs, fibre etc

a) **Food**: A large of Wild plants are consumed by human beings as food. About 80,000 edible plant species have been reported from the wild. Food crops have been domesticated from wild tropical plants.
b) **Drugs**: Many drugs are obtained from plants. They are called herbal medicines. Sidha, Ayurveda and Unani are concerned with herbal medicines. The wonder drug Penicillin, an antibiotic is obtained from fungus called *penicillium*. Quinie is obtained from chinchona tree. It is used to treat malaria. Recently Vinblastin and Vincristine two anticancerious drugs have been obtained from *Catharanthus* plant, which possesses anticancer alkaloids.
c) **Fuels**: Our forests have been used since ages for fuel wood. The fossial fuels like coal, petroleum and natural gas are also products of fossilized biodiversity. Gobar gas is obtained from cow dung.

Productive use value

These are the commercially usable values where the product is marketed and sold. It may include number of wild gene resources that can be traded for use by

scientists for introducing desirable traits in the crops and domesticated animals**.** These may include the animal products like tusks of elephants, musk from musk deer, silk from silk worm, wool from sheep, fir of many animals, lac from lac insects etc, all of which are traded in the market. Many industries are dependent upon the productive use values of biodiversity e.g. the paper industry, plywood industry, railway sleeper industry, silk industry, textile industry, ivory works, leather industry, pearl industry etc.

Social Value

These are the values associated with the social life, customs, religion and psycho spiritual aspects of the people. Many of the plants are considered holy and sacred in our country like Tulsi, Peepal, Mango, Lotus, Bael etc. The leaves, fruits or flowers of these plants are used in worship. Thus the social life, songs, dances, and customs are closed woven around the wildlife. Many animals like cow, snake, bull, peacock, owl etc. also have significant place in our psycho – spiritual arena and thus hold special importance. Thus biodiversity has distinct social value, attached with different societies.

Ethical value

It is also known as existence value. It involves ethical issues like "all life must be preserved". It is based on the concept of "Live and Let live". If we want our human race to survive then we must protect all biodiversity because biodiversity is valuable. Many of the plants are considered as Ethical value like, smoking cigarettes, beedi, and pipes made from *Nicotina tobaccum* is one of the major health issue in recent year and latex of *Calotropis procera* is used to induce abortion in some areas.

Aesthetic value

The use of plants and animals in beautifying the surrounding is said to be their Aesthetic value. Biodiversity includes attractive species of plants, animals, and birds which give a natural beauty to the habitat, Examples – Ornamental plants are grown in hanging baskets in rooms and home gardens to beautify the surrounding and Ornamental fishes having various colours are grown in glass containers to enhance the beauty of the indoor environment.

Many people from far and wide spend a lot of time and money to visit wilderness area where they can enjoy the aesthetic value of Biodiversity and this type of tourism is now known as eco – tourism. Examples eco – tourism, Zoo, Museum and parks etc.

Optional value

Optional value refers to keeping of different species of organisms to fulfil the specific wishes of people in future. The wish may either be concerned with protection of environment or with protection of health. In these cases biodiversity alone is the right choice for getting the wishes filled. Examples, The effect of Tsunami is reduced by growing trees in the coastal area

In cyclone prone areas, dense vegetation is grown to reduce the speed of wind so that people can escape from direct effects of cyclones. Some poisonous plants are grown along the margin of farms to prevent the entry of cattle in the farm. Genetically engineered plants, animals and microbes give many valuable products which protect the health.

Ecosystem service value

Recently non consumptive use value related to self-maintenance of the ecosystem and various important ecosystem services has been recognized. It refers to the services provided by the ecosystems like prevention of soil erosion, prevention of floods, maintenance of soil fertility, cycling of nutrients, fixation of nitrogen, cycling of water, their role as carbon sinks, pollutant absorption and reduction of the threat of global warming etc.

Different categories of biodiversity value clearly indicate that ecosystem, species and genetic diversity all have enormous potential and a decline in biodiversity will lead to huge economic, ecological and socio – cultural losses.

2.9 BIODIVERSITY AT GLOBAL LEVELS

There are at present 1.8 million species known and documented by scientists in the world. However, scientists have estimated that the number of species of plants and animals on earth could vary from 1.5 to 20 billion. Of these only 1.5 million have been identified which include 3, 00,000 species of green plants and fungi, 9, 00,000 species of insects 40,000 species of vertebrates and 5, 00,000 species of microorganisms. Thus the majority of species are yet to be discovered.

Most of the world's bio-rich nations are in the South, which are the developing nations. In contrast, the majority of the countries capable of exploiting biodiversity are Northern nations, in the economically developed world. These nations however have low levels of biodiversity. Thus the developed world has come to support the concept that biodiversity must be considered to be a 'global resource'. However, if biodiversity should form a 'common property resource' to be shared by all nations, there is no reason to exclude oil, or uranium, or even intellectual and technological expertise as global assets. India's sovereignty over its biological diversity cannot be compromised without a revolutionary change in world thinking about sharing of all types of natural resources.

Countries with diversities higher than India are located in South America such as Brazil, and South East Asian countries such as Malaysia and Indonesia. The species found in these countries, however, are different from our own. This makes it imperative to preserve our own biodiversity as a major economic resource. While few of the other 'megadiversity nations' have developed the technology to exploit their species for biotechnology and genetic engineering, India is capable of doing so.

Throughout the world, the value of biologically rich natural areas is now being increasingly appreciated as being of unimaginable value. International agreements such as the **World Heritage Convention** attempt to protect and support such areas. India is a signatory to the convention and has included several protected Areas as World Heritage sites. These include Manas on the border between Bhutan and India, Kaziranga in Assam, Bharatpur in U.P., Nandadevi in the Himalayas, and the Sunderbans in the Ganges delta in West Bengal.

India has also signed the **Convention in the Trade of Endangered Species (CITES)** which is intended to reduce the utilization of endangered plants and animals by controlling trade in their products and in the pet trade.

The tropical rainforests are the earth‘s largest storehouse of biodiversity and are inhabited by millions of species of plants, animals, birds, insects, microorganisms etc. According the opinion of the scientists, about 80% of global biodiversity live in tropical foresets, which is only 7% of the total land surfaces.

2.10 CONSERVATION OF BIODIVERSITY: INSITU AND EX-SITU

The conservation on biological diversity held in June 1992 stressed the need of the conservation of biodiversity for sustainable development and perpetuation of human beings on the earth. It has also pointed that this can be achieved through *in situ* and *ex situ* conservations.

The biodiversity convention defines *in situ* conservation as “the conservation of ecosystems and natural habitats, and the maintenance and recovery of viable populations of species in their natural surroundings and, in case of domesticated of cultivated species, in the surroundings where they have developed their distinctive properties”. The biodiversity convention defines *ex situ* conservation as “the conservation of components of biological diversity outside their natural habitats”.

In-situ conservation

Biodiversity at all its levels, genetic species and as intact ecosystems, can be best preserved *in situ* by setting aside an adequate representation of wilderness as ‘Protected Areas’. These should consist of a network of National Parks and Wildlife Sanctuaries with each distinctive ecosystem included in the network. Such a network would preserve the total diversity of life of a region.

In the past National Parks and Sanctuaries in India were notified to preserve major wildlife species such as tigers, lions, elephants, and deer. The objective of these areas should be expanded to the preservation of relatively intact natural ecosystems, where biological diversity – from microscopic unicellular plants and animals, to the giant trees and major mammals – can all be preserved.

However species cannot be protected individually as they are all inter dependent on each other. Thus the whole ecosystem must be protected. The view point of biologists deals with areas that are relatively species rich, or those where rare, threatened or endangered species are found, or those with 'endemic' species which are not found elsewhere. As rare endemic species are found only in a small area these easily become extinct due to human activity. Such areas must be given an added importance as their biodiversity is a special feature of the region.

Animals such as elephants require different types of habitat and feed during different seasons. They utilize open grasslands after the rains when the young grass shoots are highly nutritious. As the grasses dry, the elephants move into the forest to feed on foliage from the trees. A Protected Area that is meant to protect elephants must therefore be large enough and include diverse habitat types to support a complete complement of inter linked species.

Wildlife Sanctuaries and National Parks of India:

There are 589 Protected Areas in India of which 89 are National Parks and 500 are Wildlife Sanctuaries. They include a variety of ecosystems and habitats. Some have been created in order to protect highly endangered species of wild plants and animals found nowhere else in the world.

The Great Himalayan National Park is the largest sanctuary in this ecosystem and is one of the last homes of the beautiful snow leopard. **Dachigam Sanctuary** is the only place where the rare Hangul or Kashmir stag is found. There are several Sanctuaries in the Terai region, **Kaziranga National Park** is the most famous which has elephant, wild buffalo, gaur, wild boar, swamp deer, and hog deer, in large numbers, as well as tiger and leopard. Its bird life is extremely rich and includes ducks, geese, pelicans and storks. The **Manas Sanctuary**, in addition to the above Terai species, also includes the rare golden langur and the very rare pygmy hog, the smallest wild boar in the world. The florican is found only in a few undisturbed grasslands in the Terai sanctuaries.

In the sal forests of Madhya Pradesh, there are several Protected Areas. **Kanha** offers a wonderful opportunity to observe wild tigers from elephant back. It is the only Protected Area in which a sub species of the Barasingha is found.

Bharatpur is one of the most famous water bird sanctuaries in the world. Thousands of ducks, geese, herons, and other wading birds can be seen here. This is the only home of the very rare Siberian crane which migrates to India every winter. During the last 20 years, the 30 or 40 Siberian cranes have dwindled to only 2 or 3. During 2002 -2003 no cranes were seen and it is possible that this beautiful bird will never again come to India.

In the Thar desert, the wild life is protected in the **Desert National Park.** Here large numbers of black buck, neelgai and chinkara can be seen. The Great Indian Bustard lives in these arid lands.

Ranthambor was the most well-known sanctuary for observing tigers in the wild till about 3 or 4 years ago. Since then many tigers have been killed by poachers.

The **Great and the Little Rann of Kutch** has been made into sanctuaries to protect the very rare wild ass, the flamingo, the star tortoise and the desert fox.

In Gujarat, the **Gir Sanctuary** protects the last population of the majestic Asiatic lion. This thorn and deciduous forest is also the home of large herds of chital, sambhar, and nilgai.

The Sanctuaries of the Western Ghats and associated hill ranges protect some of the most diverse forest types in the country. The few examples of highly threatened species include the Malabar giant squirrel, the flying squirrel and a variety of hill birds, several species of amphibians, reptiles and insects. These regions are also rich in highly endemic plant life. Sanctuaries such as **Bhimashankar, Koyana, Chandoli and Radhanagari** preserve this rich flora in Maharashtra, **Bandipur, Bhadra, Dandeli, Nagarhole,** etc. in Karnataka, and **Eraviculum, Perambiculum, Periyar, Silent Valley**, in Kerala.

In the Nilgiri Hills the rich forest Sanctuaries protect some of the last pockets of the Indian elephant in South India. Examples include **Bandipur, Madhumalai, Wynad** and **Bhadra.** During the last 10 years, a large number of the great tusker elephants of this region have been ruthlessly killed for their ivory. Now very few of these magnificent animals are left in these jungles.

Two important sanctuaries meant for preservation of coastal ecosystems are the **Chilka Lake** and **Point Calimere.** The **Sunderbans** protect the largest mangrove delta in India. The **Marine National Park** in Gujarat protects shallow areas in the sea, islands, coral reefs and extensive mudflats.

Over a hundred Protected Areas have been created in the Andaman and Nicobar Islands to preserve their very special island ecosystems.

The need for an Integrated Protected Area System (IPAS):

Protected Areas, to be effective, must be established in every bio-geographic region. A relatively larger representation must be included of highly fragile ecosystems, areas of high species diversity or high endemism. Protected Areas must also be integrated with each other by establishing corridors between adjacent areas wherever possible so that wildlife can move between them.

In our country, which has a rapidly growing human population, it is not easily feasible to set aside more and more land to create Protected Areas. The need to provide a

greater amount of land for agricultural and other needs has become an increasing cause of concern in land and resource management. This forms a major impediment for creating new Protected Areas. Having said this, there is an urgent need to add to our Protected Areas to preserve our very rich biological diversity. Much of the natural wilderness has already undergone extensive changes. The residual areas that have high levels of species richness, endemism or endangered plants and animals must be notified as National Parks and Wildlife Sanctuaries. Other areas can be made into Community Conserved Areas which are managed by local people.

The International Union for Conservation of Nature and Natural Resources states that it is essential to include at least 10% of all ecosystems as Protected Areas if biodiversity is to be conserved in the long-term.

India has only 5% of land in its 589 Protected Areas in 2004. However much of this includes plantations of sal or teak, which were developed for timber in the past and are thus relatively poor in diversity and have a low level of 'naturalness'. There are only a few good grasslands left in our country that are notified as Protected Areas. Some are overgrazed wastelands in areas that were once flourishing grasslands.

Most of these areas have a low biological value and need careful management to allow them to revert to a more 'natural' state, with their full complement of plants and animals. Only a few wetlands have been made into Sanctuaries. These require better management.

A major strategy to reduce impacts on the biodiversity of the PAs should be to provide a sustainable source of resources for local people living around them. A Protected Area curtails their traditional grazing practices and access fuelwood sources. These resources must be provided by developing them in buffer areas. Plantations of fuel wood and good grassland management in areas outside Protected Areas can help reduce the pressure on the habitat of wildlife in the Protected Area. Management must ensure that local people derive a direct economic benefit from the presence of the PA. Involving local people in Protected Area management and developing tourist facilities that support the income generation for local people helps in involving their support for the Protected Area.

A carefully designed management plan which incorporates an **'eco-development'** component aimed at providing a source of fuel wood, fodder and alternate income generation for local people is an important aspect of PA management. There are several species of plants and animals that survive without protection outside our current network of PAs. As it is not practical to notify more PAs without affecting the lives of people, alternate strategies such as Community Reserves or Community Conserved Areas need to be created. These should be managed by local people to bring about the conservation of

biodiversity while using the area's resources in an equitable and sustainable way. A Community Conserved Area must have specific conservation goals that can be achieved without compromising the area's utilitarian potential.

A major drive for conservation of biological diversity can only come from a mass environmental education program on the value of protecting our dwindling biological resources.

Ex-situ conservation

Conservation of a species is best done by protecting its habitat along with all the other species that live in it in nature. This is known as in-situ conservation, which is conserving a species in its own environment by creating National Parks and Wildlife Sanctuaries. However, there are situations in which an endangered species is so close to extinction that unless alternate methods are instituted, the species may be rapidly driven to extinction. This strategy is known as ex-situ conservation, i.e. outside its natural habitat in a carefully controlled situation such as a botanical garden for plants or a zoological park for animals, where there is expertise to multiply the species under artificially managed conditions. These breeding programs for rare plants and animals are however more expensive than managing a Protected Area.

There is also another form of preserving a plant by preserving its germ plasm in a gene bank so that it can be used if needed in future. This is even more expensive.

When an animal is on the brink of extinction, it must be carefully bred so that inbreeding does not lead to the genetic makeup becoming weak. Breeding from the same stock can lead to poorly adapted progeny or even inability to get enough offspring.

Modern breeding programs are done in zoos that provide for all the animal's needs, including enclosures that simulate their wild habitats. There may also be a need to assist breeding artificially. Thus while most zoos are meant to provide visitors with a visual experience of seeing a wild animal close up, and provide the visitors with information about the species, a modern zoo has to go beyond these functions that include breeding of endangered species as a conservation measure.

In India, successful ex situ conservation programs have been done for all our three species of crocodiles. This has been highly successful. Another recent success has been the breeding of the very rare pygmy hog in Gauhati zoo. Delhi zoo has successfully bred the rare Manipur brow antlered deer.

However the most important step of a successful breeding program is the reintroduction of a species into its original wild habitat. This requires rehabilitation of the degraded habitat and removal of the other causes such as poaching, disturbance, or other manmade influences that have been the primary cause of reducing the population of the species.

Objectives of ex – situ Conservation:

Guldager (1975) has suggested four major objectives of ex – situ Conservation

1. Conservation of genotype frequency of original populations.
2. Avoiding the loss of any allele in the population.
3. Protection of original populations from selection pressure of evolution.
4. Preservation of genotype modified by man.

2.11 CONVERSION OF WILDLIFE

Conservation is the practice of protecting wild plant and animal species and their habitats. The cultivated plants and non-domesticated animals of the nature are called Wild life. Wildlife conservation is the practice of protecting animal species and their habitats. They are like our innocent and ignorant day old babies. They need nurture and nursing. The goal of wildlife conservation is to ensure that nature will be around for future generations to enjoy and also to recognize the importance of wildlife and wilderness for humans and other species alike. Many nations have government agencies and NGO's dedicated to wildlife conservation, which help to implement policies designed to protect wildlife. Numerous independent non-profit organizations also promote various wildlife conservation causes. Wildlife conservation has become an increasingly important practice due to the negative effects of human activity on wildlife. An endangered species is defined as a population of a living species that is in the danger of becoming extinct because the species has a very low or falling population, or because they are threatened by the varying environmental or prepositional parameters.

1. Knowledge of Wild life

For the proper management of wild life a thorough knowledge of the ecology of wild animals is essential.

2. Appointment of officials

The management of wild life is made effective by appointing suitable officials. These officials should have inherent love for wild life and they should be given required training.

3. Restriction of hunting

When license for hunting is given, clear instruction should be given to hunters not to hunt the endangered species.

4. Habitat improvement

Habitats of wild life improved by constructing water holes and salt licks and by raising plantations of better and nourishing todder grasses and trees.

5. Clonal bank

The cells of rare species of plants are collected, preserved and stored safely. In case these plants become extinct the preserved cells can be cultured and grown into plants. This called cloned bank.

6. Provision for shelter and cover

The survival of world animals can be encouraged by providing natural shelter and cover. This can be achieved by rearing herbs and shrubs.

7. Plant protection

New plants can be introduced from other areas to favor wild life.

8. Game farming

The endangered species can be reared in protected areas and then they can be released in their natural habitat. Eg. The marine turtles lay their eggs on the sea shore. The eggs can be collected and hatched in the laboratories and the young ones are released in to the sea.

9. Disease control

Veterinary experts should be appointed to take care of wild life.

10. Protective laws

Restrictive laws should be framed at the Government level to prevent conditions which are favoring extinction of species. India was the first country to enact the Wild Life Protection Act, 1972. The Wild birds and Animals protection act 1887, and the Forest Act 1927, help to conserve wild life in India.

The Wild Life Protection Act, 1972 prohibits the hunting of females from natural population. Chief wild life wardens and authorized officers are appointed to watch the health of wild animals, trapping, shooting, transporting and export. They are empowered to give punishments to person's committing crimes relating to depletion of wild life.

3. ENVIRONMENTAL POLLUTION

Ms.G.Sona

3.1 INTRODUCTION

Any undesirable change in the physical, chemical and biological nature of environment (Air, water and soil) is known as **pollution**. The substances which could cause pollution are called **pollutants.** A pollutant may be a solid or liquid or gaseous substance present in greater amount than natural abundance. Pollution is explained as any substance introduced into the environment that adversely affects the usefulness of resources.

Pollution can be in the form of solid, liquid or gaseous substance. Pollution causes damage to human, plant and animal life. The nature and concentration of pollutant determine the severity of effect of pollution. Pollution is defined as the excess discharge of any substance into the environment which affects adversity quality of environment and causing damage to humans, plants and animals.

Types of Pollutants

Ecologically, pollutants can be divided into three types

1. Degradable or non – persistent pollutants
2. Slowly degradable or persistent pollutants
3. Non – degradable pollutants.

Degradable or non – persistent pollutants

- The pollutants that can be rapidly decomposed by natural processes is called degradable or non-persistent pollutants.
- Slowly degradable pollutants or persistent pollutants
- Some pollutants remain in environment for longer time because they decompose very slowly by the natural processes.
- Example: plastics, pesticides, etc.

Non-degradable pollutants: Some pollutants cannot be decomposed by natural processes are called non-degradable pollutants.

Example – Lead, mercury, nuclear wastes etc.

Classification of pollution

The environment pollution is divided into following types

- Air pollution
- Water pollution
- Soil Pollution
- Marine pollution
- Noise pollution
- Thermal pollution
- Nuclear hazards

3.2 TYPES OF POLLUTION

3.2.1 AIR POLLUTION

Air pollution is most crucial from the public health point of view because every individual person breath 22,000 times a day and inhaling about 15-22 kg air per day. Polluted air causes physical ill effects to the life existing on earth. Besides, it also has great impact on environment by serving as a major cause for green house effect / global warming, ozone layer depletion and acid rain etc. The major air pollutants and their effects are discussed below:

- **Carbon Monoxide** (CO) is a gas produced by the process of in complete burning of carbon based fuels including petrol, diesel and wood. It lowers the amount of oxygen carrying capacity of blood. Exposure to even 0.001 % CO for several hours together causes impaired perception, slow reflexes; head ache drowsiness and blurred vision. In large doses it can cause even death.
- **Carbon Dioxide** (CO_2) is a principal green house gas emitted as a result of human activities such as burning of coal, oil and natural gases. It produces adverse effects only at very high levels.
- **Chloroflurocarbons** (CFC) are the gases, released mainly from the air conditioning and refrigerating systems. When released into air it reaches the stratosphere and comes in contact with other gases, which leads to the reduction of ozone layer.
- **Lead** (Pb) is present in petrol (0.56g / l), diesel, batteries, paints, hair dye products etc. It affects the traffic policemen who are vulnerable to automobile exhausts and children who play with toys coated with leaded paints in

particular. The toxic dose is 0.8 ppm for adult and 0.6 ppm for children. It causes nervous and digestive disorders and even cancer

- **Ozone** (O_3) is naturally present in the upper layer of the atmosphere acting as a shield and protects the earth from the harmful ultra violet rays of sun. However, at ground level, it is a pollutant with highly toxic effects. Vehicles and industries are the major sources of ground level ozone emissions. It causes eye irritations and also lowers the resistance to cold and pneumonia.
- **Nitrogen Oxide** (NOx) is being released into air during the process of burning of fuels including petrol, diesel and coal. It makes the children susceptible to respiratory disorders like influenza / common cold. Besides, smog and acid rain caused by nitrogen oxide have got greater environmental concern.
- **Suspended Particulate Matter** (SPM) is a solid component present in air in the form of smoke, fly ash, pieces of asbestos, dust and vapour. They can remain suspended in air for extended periods. It serves as a major source of haze which reduces the visibility. The particulates are characterized as follows.

  Aerosol - Particles suspended in air
  Mist - Aerosol with liquid droplet
  Dust - Aerosol with solid particles (dust particles and ash)
  Smoke - Solid particles / mixture of solid and liquid particles
  Fum - Aerosol produced by the condensation of hot vapors of metals
  Plume - Geometrical form of smoke coming out of chimney
  Fog - Aerosol with water droplet
  Smog - Mixture of smoke and fog

  On breathing the finer of these particles, they would lodge in lungs and cause bronchitis and asthma.
- **Sulphur Dioxide** (SO_2) a major contributor of acid rain is being released from burning coal, mainly in thermal power plants
- Some industrial processes, such as production of paper and smelting of metals also produce sulphur dioxide. It causes lung diseases.
- **Photochemicals** are the **compounds** which are formed in combination with some pollutants under the influence of UV radiation. E.g. PAN (Peroxy Acetyl Nitrate). It affects photosynthesis of plants.

- **Control Measures**

Air pollutants should be confined at the source itself. This can be achieved by adopting any of the strategies mentioned below:

- Modifying of the processes in such a way that the pollutants are not formed beyond the permissible limits.
- Reducing the concentration / dilution of pollutants before getting released into the environment.
- Adopting Green Chemistry Technology where the substances which would produce more toxic elements are replaced with less toxic substances.

3.2.2 WATER POLLUTION

The economic growth of several countries around the world is being determined also by water as it is essential for drinking, irrigation, industrial purposes etc., Quality of water is very much important for all of these purposes. As water is a great solvent, various elements are found dissolved in it. When water contains certain substances more than the acceptable level, it is said to be polluted. The sources of water pollution may be classified as **point** and **non – point sources**.

- **Point Sources of Water Pollution**

When a source **of pollution is readily identified** with its entry point it is known as point source of pollution. E.g. Municipal and industrial discharges.

- **Non - point Sources of Water Pollution**

When a **source of pollution cannot be identified**, it is said to be non – point source of pollution. E.g. Acid rain and agricultural runoff.

- **Causes of Water Pollution**

- **Pathogens**

The pathogens are **disease causing agents** which include bacteria , virus etc., They may cause some **water borne diseases** such as cholera , typhoid, fever, dysentery, etc.

- **Organic Wastes / O_2 Depleting Wastes**

The organic wastes are decomposable by aerobic (oxygen demanding) bacteria. To degrade the organic wastes, aerobic bacteria utilize O_2 present in water. The amount of oxygen required to break down the organic wastes is known as Biological **Oxygen Demand** (BOD). When water is highly polluted, the oxygen available in water would be completely utilized by the aerobic bacteria. This leads to an increase in BOD level in water. The aquatic life is not possible when BOD of water is 4 ppm (parts per million) and above (BOD of pure water is 1ppm).

- **Inorganic Pollutants**

These are **water soluble phosphates and nitrates**. The major source of these inorganic pollutants is agricultural runoff which contains fertilizers, pesticides, etc. The excessive addition of these nutrients to water is known as eutrophication**.** This condition would promote the growth of algae to form a algal bloom. As a result the quality, taste and smell of water would change. Besides, the O_2 level would also be depleted and water

becomes unsuitable for fishes and other aquatic animals. There is also another possibility of these pollutants getting accumulated into the biological systems (bioaccumulation) and also they reach human through **food chain** as mentioned below:

Inorganic Pollutants

Figure 6.1: Food Chain

At each level of food chain, these pollutants are increasingly concentrated in biological systems. This process is known as **biomagnifications.** Thus pollutants are becoming major threat to life.

- **Water Soluble Organic Chemicals**

Acids, salts and compounds of toxic metals like Mercury, Lead, Copper etc., discharged by the industries may cause the diseases / disorders as listed below:

- ✶ Hg (Mercury) -Mina Mata Disease
- ✶ Cd (Cadmium) -Itai Itai
- ✶ Al (Aluminium) -Aluminosis
- ✶ Zn(Zinc)&Cu(Copper) -Hyperkeratosis
- ✶ Sn (tin) -Stanosis
- ✶ Pb (Lead) -Plumbism

- **Oil**

Leakage or spilling of either crude petroleum or refined petroleum (fuel oil, gasoline and other by products) primarily destroys aquatic life as it forms a thin layer which prevents the interaction of oxygen with water. However, some toxic chemicals would be evaporated. Nevertheless, the heavy oil components like naphtha and asphalt which sink into ocean floor is believed to cause greatest long term effect on aquatic life.

- **Suspended Matters**

The suspended matters would interfere with the penetration of sunlight in water. Thereby the productivity of aquatic plants would be greatly reduced. This condition would warrant ecological imbalance.

- **Thermal Pollutants**

In a thermal power station, approximately 700 million gallons water is being used by a Plant per day which is then discharged into the nearby water body. This would cause a rise in temperature by 15°C than the normal level. This condition would decrease the solubility of O_2. Further, the rise in temperature affects the breeding (reproduction) cycle of aquatic life and also making them susceptible to diseases.

- **Groundwater Pollution**

Groundwater is a vital source of drinking water. EPA (Environmental Protection Agency) estimates that 2 % of a country's usable ground water is moderately or severely polluted. The two major sources of ground water pollution are leaks of hazardous organic chemicals from underground storage tanks and seepage of toxic heavy metal pollutants from landfills, dumps and lagoons.

- **Control Measures**

Water pollution can be controlled by adopting the methods suggested below.

- Prevention of the discharge of untreated industrial / domestic wastes into nearby water bodies.
- Replacement of chemical fertilizers with biofertilizers (*Rhizobium*, *Azotobacter*, *Azospirillum* etc.) and pesticides with biopesticides (*Bacillus* Sp.)

3.2.3 SOIL POLLUTION

The unfavourable substances dumped on soil would cause soil pollution. Besides, pollutants in air and water which reach the soil would also serve as the source of pollution. The major source of soil pollution and their effects are discussed below:

- **Sources**

- **Pesticides / Weedicides**

The wide range of various pesticides, insecticides, fungicides, herbicides and weedicides such as aldrin, endrin, malathion, etc. are employed in intensified agricultural practices. As these toxic chemicals are fat soluble hydrocarbons, they tend to accumulate in the living organisms and get concentrated at each trophic level. Hazards of these pollutants are listed below:

- Affect not only the target organisms but also the other beneficial microorganisms.
- Interfere with the photosynthesis and metabolic activities of plants.
- Damage the central nervous system and cause cerebral hemorrhage

- **Chemicals**

The toxic metallic pollutants, salts, acids and alkalis of industrial discharges and the precipitates of acid rains pollute the soil. An example for the chemical pollutant is fluoride which inhibits photosynthesis in plants and also causes abscission of leaves and fruits. In human beings the fluorides cause mottling of teeth, week bones, and knocking of knees etc.

- **Fertilizers**

The chemical fertilizers added to soil would interfere with soil microbial communities and thus affect the soil quality. Further, they would also detoriate the soil quality by enhancing the salt content.

- **Human and Animal Wastes**

In both under developed and developing countries these wastes would create unhygienic conditions. The pathogenic **organisms** found in these wastes would ultimately cause health hazards like amoebiasis (dysentery) cholera etc., in domesticated animals and human beings.

- **Discarded Materials**

Man discards materials like rugs, leather, plastics, glass, paper, concrete materials, e-waste, components of machineries etc., on land. This would make land barren.

- **Hazardous Wastes**

Vast amounts of hazardous **electronic wastes**, **plastics** and **metal scrap wastes** are being burned or discarded in the fields, irrigation canals and water ways across developing countries in Asia. This practice would pollute the natural environment. It is noteworthy that millions of kilogram of electronic wastes of computers and televisions are being generated in developed countries every year. Of which, 50 – 80 % is being shipped for recycling in countries like India, China and Pakistan. On recycling process, the heavy metals like lead, mercury, cadmium etc., are being released into soil which in turn would pose health hazards.

- **Plastics**

With the revolution in modern life, plastic consumption triples every decade. The throwaway culture of these non biodegradable petrochemical based plastics causes serious environmental problems. On accumulation of these wastes, the aesthetic qualities of cities and forest are greatly affected. It prevents the percolation of rain water. On burning, these wastes release **dioxin** which is highly carcinogenic.

- **Nuclear / Radioactive Wastes**

Radioactive elements from nuclear power plants and mining units reach through water.

- **Salination of Soil**

The increase in the concentration of soluble salts in soil is known as **salination**. The salinity would reduce the fertility of the soil. About 6000 - 8000 hectares of farm land turns saline every year in Punjab alone. The major causes of soil salinity are:

  - Aquaculture practices like prawn culture in agricultural farms
  - Inflow of water from sea at coastal regions
  - Excessive use of alkaline fertilizers
  - Improper drainages

- **Control Measures**

To maintain the soil quality and fertility the following suggestions are made:

- Minimize the use of chemical fertilizers and pesticides
- Adopt improved cropping techniques
- Prefer organic farming practices
- Plant soil binding grasses to prevent soil erosion
- Construct wind breaks at 1000 m interval along the sea shore
- Plan for wind shields by planting vegetation in 7 to 9 rows in a zig zag pattern with 5 m space between each row and tree.
- Burry the nuclear wastes in a insulated concrete sealed drums at 1000 fathoms deep into sea.
- Adopt proper discharge practices for the technological wastes
- Store the low radioactivity materials for some time before disposal
- Treat the wastes before disposal
- Recycle the wastes

3.2.4 NOISE POLLUTION

Noise may not seem as harmful as the contamination of air or water, but it is a pollution problem that affects human health and can contribute to a general deterioration of environmental quality. Noise is undesirable and unwanted sound. All sound is not noise. It may be considered as music to one person and may be noise to another. Noise is defined as 'unwanted or offensive sound that unreasonably intrudes into our daily activities'. Sound is measured in a unit called the decibel (dB). The permitted noise level is 125 decibels as per the Environment Protection Rules 1999.

Sources of noise pollution:

There are numerous sources but may be broadly classified into two classes such as indoor and outdoor.

- Outdoor - Industries/factories, vehicular movements such as car, motor, truck, train, tempo, motor cycle, aircrafts, trains, Construction work, defense equipments, explosions, playing of loudspeakers during various festivals etc. The higher the speed of an aircrafts the greater the noise pollution. The invention of supersonic aircrafts has added more noise for the persons who live near aerodromes. Another source of noise pollution connected with aero planes has been scaring away of birds. Satellites are projected into space with the help of high explosive rockets also contributes to noise pollution.

- Indoor - Loudly played radio or music systems, and other electronic gadgets etc.

Effects of noise pollution:

Noise pollution cause emotional or psychological effects like irritability, anxiety and stress. Lack of concentration and mental fatigue are significant health effects of noise. It has been observed that the performance of school children is poor in comprehension tasks when schools are situated in busy areas of a city and suffer from noise pollution.

Effects of Noise Pollution on Physical Health:

Physical damage to the ear and the temporary hearing loss often called a temporary threshold shift (TTS). People suffering from this condition will be unable to detect weak sounds. However, hearing ability is usually recovered within a month of exposure. Permanent loss, usually called Noise Induced Permanent Threshold Shift (NIPTS) represents a loss of hearing ability from which there is no recovery. Below a sound level of 80 dB hearing loss does not occur at all. However temporary effects are noticed at sound levels between 80 and 130 dB. A sound level of 150 dB or more can physically rupture the human eardrum and >180dB can kill a person. In additions to hearing losses, excessive sound levels can cause harmful effect on the circulatory system by raising blood pressure and altering pulse rates.

Noise control techniques:

Make sure that all openings are acoustically sealed. In industries, different types of absorptive material can be used to control interior noise. Noise reduction can be done by using rigid sealed enclosures around machinery lined with acoustic absorbing material. Regular maintenance of operating machinery will help to control noise pollution. Improper installation of machines sometimes is the reason for bearing noise problems. Traffic volume and speed also have significant effects on the overall sound. Thus proper highway planning and design are essential for controlling traffic noise. Establishing lower speed limits for highways that pass through residential areas, limiting traffic volume and providing alternative routes for truck traffic are effective noise control measures.

3.2.5 THERMAL POLLUTION

Thermal pollution is defined as – rising air/water temperature so that it becomes harmful to human being and other organisms. Thermal power station, Nuclear power plants and Petroleum refiners, Domestic sewage are the sources of thermal pollution.

Effects of Thermal pollution

Thermal pollution affects aquatic ecosystems in a variety of ways. In general, the species composition changes as species tolerant of warmer waters replace those unable to adapt. This transition is often accompanied by as overall decrease in species richness. For example, attached algae in heated effluents were reported to show an increase in biomass but a decrease in the number of species represented. Fish can be particularly susceptible to effects of thermal pollution because their body temperature fluctuates with that of the surrounding water. For this reason, an increase in water temperature causes an increase in the metabolic rate of fish. This enhanced metabolism requires more oxygen. However, the amount of dissolved oxygen present in water is inversely related to its temperature. The lack of dissolved oxygen at higher temperatures can lead to cold water conditions. Toxic chemical becomes soluble at high temperatures. Thermal pollution disrupts natural reproductive cycle of water animals by premature hatching of eggs.

Control measures for thermal pollution

Thermal water pollution can be avoided by precooling the warm water prior to its discharge. For example, cooling ponds and cooling towers are often used for this purpose in the electricity generating industry. Return the heated water away from ecological sensitive zone.

3.2.6 RADIOACTIVE AND NUCLEAR HAZARDS

Radioactivity is produced by the spontaneous decay of the isotopes of some elements, whose nuclei are unstable. The radiation can take a number of different forms. In some cases it is as particles and in others it is electromagnetic.

Five types of radiation may occur: alpha particles, beta particles, neutrons gamma rays and x-rays. An alpha particle is large, consisting of two neutrons and two protons, whereas a beta particle is an electron. Gamma and X-rays have no mass. The type of

particle emitted is important in controlling exposure. Type of radiation is not the only factor affecting the management of radioactive substances. The rate of emission is also extremely important.

Nuclear reactors

Commercial and military reactors both operate by the fission of uranium or plutonium atoms. The reaction create a range of new elements or radio nuclides some of these are heavier than uranium, others are lighter, and all have different properties to the original element.

The containment of nuclear reactors is sufficient to prevent almost all releases to the wider environment. The most likely route of release is, however, through the cooling-water system and under normal operating conditions small traces of contamination will occur. Nuclear installations also result in atmospheric discharges in a few instances, through to the release of very large quantities of material, e.g. from the Chernobyl accident. It is usually accidental discharges from nuclear plants, rather than their routine operation, which release most radio nuclides.

Effect of Radionuclides in the Environment

There is a very wide degree of response to radioactive substances by different plant and animal species. Releasing radioactive substances into the natural environment poses may long-term risks, especially as the aims would be to supply sufficient does to cause significant adverse effects. Much recent understanding of the impacts on the natural environment has come from examination of the results of unplanned releases, e.g. the Chernobyl accident or from nuclear tests.

3.3Waste management: solid and hazardous waste management

SOLID WASTE

The combined effects of population explosion and changing modern living standards have had a cumulative effect in the generation of a large amount of various types of wastes. Solid waste can be classified into different types depending on their source.

- Municipal solid waste (MSW)
- Industrial waste

- Hazardous waste
- Biomedical or hospital waste: as infectious waste.
- Agricultural waste

Solid waste management:

Municipal Solid Waste (MSW): The term municipal solid waste (MSW) is generally used to describe most of the non-hazardous solid waste from a city, town or village that requires routine collection and transport to a processing or disposal site. Sources of MSW include private homes, commercial establishments and institutions, as well as industrial facilities. However, MSW does not include wastes from industrial processes, construction and demolition debris, sewage sludge, mining waste or agricultural wastes. MSW is also called as trash or garbage. In general, domestic waste and MSW are used as synonyms. Municipal solid waste contains a wide variety of materials. It can contain food waste (like vegetable and meat material, leftover food, eggshells etc.), which is classified as wet garbage as well as paper, plastic, tetra pack, plastic cans, newspaper, glass bottles, cardboard boxes, aluminum foil, metal items, wood pieces, etc., which is classified as dry garbage. The different types of domestic wastes generated and the time taken for them to degenerate is illustrated in the table given below.

Table: Domestic wastes and their degeneration time

Common domestic wastes	**Approximate time taken for degeneration**
Organic kitchen waste vegetables, fruits	1—2 weeks
Paper, cardboard paper	15 days—1 month
Cotton clothes	2—5 months
Woolen clothes	about a year
Metal cans, tin, aluminum	100—500 years
Plastics	1 million years

India's urban population slated to increase from the current 330 million to about 600 million by 2030, the challenge of managing municipal solid waste (MSW) in an environmentally and economically sustainable manner is bound to assume gigantic

proportions. The country has over 5,000 cities and towns, which generate about 40 million tonnes of MSW per year today. According to the estimates of The Energy Research Institute (TERI), MSW could well touch 260 million tonnes per year by 2047.

The functional elements of MSW management

The municipal solid waste industry has four components: recycling, composting, land filling, and waste-to-energy via incineration. The primary steps are generation, collection, sorting and separation, transfer and disposal/utilization. *Waste generation* encompasses activities in which materials are identified as no longer being of value and are either thrown out or gathered together for disposal. The functional element of *Collection* includes not only the gathering of solid waste and recyclable materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be a materials processing facility, a transfer station or a landfill disposal site. *Waste handling and separation* involves activities associated with waste management until the waste is placed in storage containers for collection. Handling also encompasses the movement of loaded containers to the point of collection. Separating different types of waste components is an important step in the handling and storage of solid waste at the source. The types of means and facilities that are now used for the recovery of waste materials that have been separated at the source include curbside collection, drop off and buy back centers.

Transfer and transport involves two main steps. First, the waste is transferred from a smaller collection vehicle to larger transport equipment. The waste is then transported, usually over long distances, to a processing or disposal site. Today the disposal of wastes by land filling or land spreading is the ultimate fate of all solid wastes, whether they are residential wastes collected and transported directly to a landfill site, residual materials from materials recovery facilities (MRFs), residue from the combustion of solid waste, compost or other substances from various solid waste processing facilities. A modern sanitary landfill is not a dump; it is an engineered facility used for disposing of solid wastes on land without creating nuisances or hazards to public

health or safety, such as the breeding of insects and the contamination of ground water. Municipal solid waste can be used to generate *energy*. Several technologies have been developed that make the processing of MSW for energy generation cleaner and more economical than ever before, including landfill gas capture, combustion, pyrolysis, gasification, and plasma arc gasification.

HAZARDOUS WASTES

Hazardous wastes are those that can cause harm to human and the environment. Wastes are classified as hazardous if they exhibit any of four primary characteristics based on physical or chemical properties of toxicity, reactivity ignitability and corrosiveness.

Toxic wastes

Toxic wastes are those that are poisonous in small or trace amounts. Some may have acute or immediate effect on human or animals. Carcinogenic or mutagenic toxic wastes cause biological changes in the children of exposed people and animals. *Eg*: pesticides, heavy metals.

Reactive wastes

Reactive wastes are those that have a tendency to react vigorously with air or water are unstable to shock or heat, generate toxic gases or explode during routine management. *Eg*: Gun powder, nitroglycerine.

Ignitable waste: Ignitable wastes are those that burn at relatively low temperatures ($<60^{o}$ C) and are capable of spontaneous combustion during storage transport or disposal. *Eg:* Gasoline, paint thinners and alcohol.

Corrosive wastes: Corrosive wastes are those that destroy materials and living tissues by chemical reactions. *Eg:* acids and base.

Infectious wastes

Infectious wastes include human tissues from surgery, used bandages and hypoderm needles hospital wastes.

Sources: Chemical manufacturing companies, petroleum refineries, paper mills,

smelters and plastic other industries. PCBs (Polychlorinated biphenyls) are resistant to fire and do not conduct electricity which makes them excellent materials for several industrial purposes. Rainwater can wash PCBs out of disposal areas in dumps and landfills thus contaminating the water. PCBs do not break open very rapidly in the environment and thus retain their toxic characteristics. They cause long-term exposure problems to both human and wildlife.

Effects: As most of the hazardous wastes are disposed off or in land, the most serious environmental effect is contaminated ground water. Once ground water is polluted with hazardous wastes, it is very often not possible to reverse the damage. Pesticides form residues in the soil that are washed into streams which then carry them forward. When the contaminated water is consumed by humans and animals the residues persist in the form of PCBs (poly chlorinated biphenyls) are concentrated in the kidneys and liver and cause damage; they cause reproductive failure in birds and mammals. Exposure can occur through ingestion, inhalation and skin contact, resulting in acute or chronic poisoning. Lead, mercury and arsenic are hazardous substances which can be often referred to as heavy metals. Most of the lead absorbed by people is stored in the bones. Lead can affect red blood cells by reducing their ability to carry oxygen and shortening their life span. Lead may also damage nervous tissue, resulting in brain disease. Mercury is used in production of chlorine and as a catalyst in the production of some plastics.

Mercury build up in body over long period of time is known to cause brain damage. Minamata disease occurs due to mercury poisoning. Vinyl chloride is a chemical that is widely used in plastic manufacture. A long continuous exposure in humans can cause deafness, vision problem circulation disorders and bone deformities.

Control: Common methods for disposing of hazardous wastes are land disposal and incineration. Industries need to be encouraged to generate less hazardous waste in the manufacturing process. Although toxic wastes cannot be entirely eliminated, technologies are available for minimizing recycling and treating the wastes. Integrated pest management practices (IPM) reduce the usage of pesticides. Substitute

the use of PCBs and vinyl chloride with chemicals that are less toxic.

INDUSTRIAL WASTES

Industrial wastes contain more of toxic materials and require special treatment.

Source: Food processing industries, metallurgical chemical and pharmaceutical units, breweries, sugar mills, paper and pulp industries, fertilizer and pesticide industries are major ones which discharge toxic wastes during the processing of scrap materials, tailings, acids etc.

Effect: Most common observation is that the health of the people living in the neighborhood of dumping sites is severely affected. The exposure may cause disorders of nervous system, genetic defects, skin diseases and even caner. The liquid effluents discharged by the industries contain inorganic and organic pollutants and they enter into water bodies causing destruction of fish, formation of sediments, pollution of ground water and release of foul odours.

Control: Waste minimization technologies have to be developed. Source reduction, recycling and reuse of materials need to be practiced on a large scale.

Hazardous waste should not be mixed up with general waste. Source reduction involves altering the design, manufacture or use of products & materials to reduce the amount and toxicity of materials that get thrown away. Local communities and voluntary organizations should educate the industrialists as well as the public about dangers of pollution and the need to keep the environment clean. Land filling, incineration and composting technologies to be followed. Biogas is obtained from solid waste treatment of industrial and mining waste is done for the recovery of useful products.

Waste production can be minimized by adopting the 3 R's principle: Reduce, Reuse, Recycle

- Reduce the amount and toxicity of garbage and trash that you discard.
- Reuse containers and try to repair things that are broken.
- Recycle products wherever possible, which includes buying recycled products

i.e. recycled paper books, paper bags etc.

These are processes that involve integrated waste management practices (IWM). They can reduce the wastes generated by approximately 50 %.

Reduce (Waste prevention): Waste prevention, or "source reduction," means consuming and discarding less, is a successful method of reducing waste generation. Backyard composting, double sided copying of papers, purchasing durable, long- lasting environmentally friendly goods, products and packaging that are free of toxics, redesigning products to use less raw material production and transport packaging reduction by industries are the normal practices used and have yielded substantial environmental benefits. It reduces the generation of waste and is generally preferred method of waste management that goes a long way toward saving the environment.

Re-use: Re-use is the process, which involves reusing items by repairing them, donating them to charity and community groups, or selling them. Reusing products is an alternative to recycling because the item does not need to be reprocessed for its use again. Using durable glassware, steel using cloth napkins or towels, reusing bottles, reusing boxes, purchasing refillable pens and pencils are suggested.

Recycling: The process of recycling, including composting, has diverted several million tons of material away from disposal. Recycled materials include batteries, recycled at a rate of 93%, paper and paperboard at 48%, and yard trimmings at 56%. These materials and others may be recycled through drop off centers, buy-back programs, and deposit systems. Recycling prevents the emission of many greenhouse gases that affect global climate, water pollutants, saves energy, supplies valuable raw materials to industry, creates jobs, stimulates the development of greener technologies, conserves resources for our children's future, and reduces the need for new landfills and combustors. Recycling can create valuable resources and it generates a host of environmental, financial, and social benefits. Materials like glass, metal, plastics, and paper are collected, separated and sent to processing centers where they are processed into new products. The advantages of recycling and conservation of resources is necessary for future generation, prevents emissions of greenhouse gases and pollutants, saves energy, supplies valuable raw materials

to industries, stimulates the development of greener technologies, reduces the need for new landfills and incinerators.

3.4 ENVIRONMENTAL LEGISLATION AND ACTS:

Following is a list of major Environmental Acts and Rules applicable in India.

- The Water (Prevention & Control of Pollution) Act 1974 (as amended upto 1998).
- The Water (Prevention &control of Pollution) cess Act, 1977(as amended by Amendment Act 1991).
- The Air (Prevention & Control of Pollution) Act 1981 as amended by Amendment Act 1986
- Environment (Protection) Act 1986.
- Hazardous Waste (Management & Handling) Rules 1989.
- The Public Liability Insurance Act 1991.
- Environment Protection Amendment Rule 1983.
- Manufacture, Storage and Import of Hazardous Chemicals (Amendment) Rules 1984.
- The Factories Act 1984.
- The Forest Conservation Act 1980.
- The Notification on Environment Impact Assessment 1994.

3.5 THE ENVIRONMENT (PROTECTION) ACT (EPA)

The Environment (Protection) Act, 1986 not only has important constitutionals implications but also an international background. The spirit of the proclamation adopted by the United Nations Conference on Human Environment, held in Stockholm in June 1972, was implemented by the Government of India by creating this Act.

Although there were several existing laws that dealt directly or indirectly with environmental issues it was necessary to have a general legislation for environmental protection because the existing laws focused on very specific types of pollution, or specific categories of hazardous substances, or were indirectly related to the environment through laws that control land use, protect our national parks and sanctuaries and our wildlife. However, there was no overarching legislation and certain areas of environmental hazards were not covered. They were also gaps in areas that were potential

environmental hazards and were essentially related to the multiplicity of regulatory agencies. Thus, there was a need for an authority to study, plan and implement the long-term requirements of environmental safety, and direct and coordinate a system of appropriate response to emergencies threatening the environment,

This Act was thus passed to protect the environment, as there was a growing concern over the deteriorating state of the environment. As impacts grew considerably environmental protection became a national priority in the 1970s. While the wider general legislation to protect our environment is now in place, it has become increasingly evident that our environmental situation continues to deteriorate. We need to implement this Act much more aggressively if our environment is to be protected. The presence of excessive concentrations of harmful chemicals in the atmosphere and aquatic ecosystems leads to the disruption of food chains and a loss of species. Public concern and support is crucial for implementing the EPA. This must be supported by an enlightened media, good administrators, highly aware policy makers, informed judiciary and trained technocrats who together can influence and prevent further degradation of our environment. Each of us has a responsibility to make this happen.

THE AIR (PREVENTION & CONTROL OF POLLUTION) ACT:

The Air (Prevention and control of pollution) Act was enacted in 1981 to implement the recommendations of the conference held at Stockholm in 1972 to deal with problems relating to air pollution. Later, Noise has also been included in pollution by Amendments Act, 1987. The Act specifically empowers State Government to designate air pollution areas and to prescribe the type of fuel to be used in these designated areas. According to this Act, no person can operate certain types of industries including the asbestos, cement, fertilizer and petroleum industries without consent of the State Board. The Board can predicate its consent upon the fulfillment of certain conditions. The Government passed this Act in 1981 to clean up our air by controlling pollution. It states that sources of air pollution such as industry, vehicles, power plants, etc., are not permitted to release particulate matter, lead, carbon monoxide, sulfur dioxide, nitrogen oxide, volatile organic compounds (VOCs) or other toxic substances beyond a

prescribed level. To ensure this, Pollution Control Boards (PCBs) have been set up by Government to measure pollution levels in the atmosphere and at certain sources by testing the air. This is measured in parts per million or in milligrams or micrograms per cubic meter. The particulate matter and gases that are released by industry and by cars, buses and two wheelers is measured by using air-sampling equipment. This Act is created to take appropriate steps for the preservation of the natural resources of the Earth which among other things includes the preservation of high quality air and ensures controlling the level of air pollution. The main objectives of the Act are as follows:

(a) To provide for the prevention, control and abatement of air pollution.

(b) To provide for the establishment of central and State Boards with a view to implement the Act.

(c) To confer on the Boards the powers to implement the provisions of the Act and assign to the Boards functions relating to pollution.

Air pollution is more acute in heavily industrialized and urbanized areas, which are also densely populated. The presence of pollution beyond certain Limits due to various pollutants discharged through industrial emission is monitored by the PCBs set up in every state.

Powers and Functions of the Boards

Central Pollution Board: The main function of the Central Board is to implement legislation created to improve the quality of air and to prevent and control air pollution in the country. The Board advises the Central Government on matters concerning the improvement of air quality and also coordinates activities, provides technical assistance and guidance to State Boards and lays down standards for the quality of air. It collects and disseminates information in respect of matters relating to air pollution and performs functions as prescribed in the Act.

State Pollution Control Boards: The State Boards have the power to advise the State Government on any matter concerning the prevention and control of air pollution. They have the right to inspect at all reasonable times any control equipment, industrial plant, or manufacturing process and give orders to take the necessary steps to control pollution.

They are expected to inspect air pollution control areas at intervals or whenever necessary. They are empowered to provide standards for emissions to be laid down for different industrial plants with regard to quantity and composition of emission of air pollutants into the atmosphere. A State Board may establish or recognize a laboratory to perform this function.

Penalties: The persons managing industry are to be penalized if they produce emissions of air pollutants in excess of the standards laid down by the State Board. The Board also makes applications to the court for restraining persons causing air pollution.

THE WATER (PREVENTION & CONTROL OF POLLUTION) ACT:

The government formulated this act in 1974 to prevent the pollution of water by industrial, agricultural and household wastewater that can contaminate our water sources. Wastewaters with high levels of pollutants that enter wetlands, rivers, lakes, wells as well as the sea are serious health hazards. Controlling the point sources by monitoring the levels of different pollutants is one way to prevent pollution, by punishing the polluter. Individuals can also do several things to reduce water pollution such as using biodegradable chemicals for household use, reducing the use of pesticides in gardens, and identifying polluting sources at work places and in industrial units where oil are or other petroleum products and heavy metals are used. Excessive organic matter, sediments and infecting organism from hospital wastes can also pollute our water. Citizen needs to develop a watchdog force to inform authorities to appropriate actions against different types of water pollution. However, preventing pollution is better than trying to cure the problems it has created, or punishing offenders.

The main objectives of the Water Act are to provide for prevention, control and abatement of water pollution and the maintenance or restoration of the wholesomeness of water. It is designed to assess pollution levels and punish polluters. The Central Government and State Government have set up PCBs to monitor water pollution.

The Water Act 1974 with certain amendments in 1978 is an extensive legislation with more than sixty sections for the prevention and control of water pollution. Among

other things, the Act provides for constitution of central and State Boards for preventing water pollution, power to take water samples and their analysis, discharge of sewage or trade effluents, appeals, revision, minimum and maximum penalties, publication of names of offenders, offences by companies and Government departments, cognizance of offences, water laboratories, analysis etc. Prevention and control of water pollution is achieved through a permit or 'consent administration' procedure. Discharge of effluents is permitted by obtaining the consent of the State Water Board, subject to any condition they specify. Any person who fails to comply with a directive of the State cannot, however, entertain in suit under this Act unless the suit is brought by, or with the sanction of the State Board.

WATER POLLUTION CESS ACT 1977:

According to this Act, anyone consuming water has to pay certain amount of cess depending on 1. Whether the industry is using water for industrial cooling, spraying in mine pits or boilers feed, 2. for domestic purposes, 3. in processing, whereby water gets polluted and pollutants are easily biodegradable, and 4. in processing whereby water gets polluted and the pollutants are not easily bio-degradable and are toxic. Those industries that had installed a suitable treatment plant for the treatment of industrial effluents can get a rebate of 70 per cent on the cess payable.

FOREST CONSERVATION ACT

The Forest Conservation Act of 1980 was enacted to control deforestation. The Act gave the Government and Forest Department the power to create Reserved Forests, and the right to use Reserved Forests for Government use alone. It also created Protected Forests, in which the use of resources by local people was controlled. Conservation of the forests as a natural heritage finds a place in this act, which includes the preservation of its biological diversity and genetic resources. It also values meeting the needs of local people for food, fuel wood, fodder and Non Timber Forest Produce or NTFPs. It gives priority to maintaining environmental stability and ecological balances. It expressly states that the network of Protected Areas should be strengthened and extended. It ensured that forestlands could not be de-reserved without prior approval of

the Central Government, This was created as some states had begun to de-reserve the Reserved Forests for non-forest use. These states had regularized encroachments and resettled 'project Affected people' from development projects such as dams in these de-reserved areas. The need for a new legislation became urgent. The Act made it possible to retain a greater control over the frightening level of deforestation in the country and specified penalties for offenders.

Penalties for offences in Reserved Forests:

- No person is allowed to make clearing or set fire to a reserved forest. Cattle are not permitted to trespass into the reserved forest, cutting, collecting of timber, bark or leaves, quarrying or collecting any forest products is punishable with imprisonment for a term of six months or with a fine which may extended to Rs 500 or both.

Penalties for offences in protected Forests:

- A person who commits any of the following offences like cutting of trees, stripping the bark or leaves of trees, set fire to such forests or permits cattle to damage any tree, shall be punishable with imprisonment for a term which may extended to six months or with a fine which any extended to Rs 500 or both.
- Any forest officer even without an order from the magistrate or a warrant can arrest any person against whom a reasonable suspicion exists.

WILD LIFE (PROTECTION) ACT, 1972, amended in 1983, 1986 and 1991:

The act is aimed to protect and preserve wild life. Wild life refers to all animals and plants that are not domesticated. India has rich wild life heritage; it has 350 species of mammals, 1200 species of birds and about 20,000 known species of insects. Some of them are listed as 'endangered species' in the Wild life (Protection) Act. The Act envisages national parks and wild life sanctuaries as protected areas to conserve wild life. Wild life populations are regularly monitored and management strategies formulated to protect them. The Act covers the rights and non-rights of forest dwellers too- it provides restricted grazing in sanctuaries but prohibits in national parks. It also prohibits the collection of non-timber forest produce which might not harm the

system. The rights of forest dwellers recognized by the Forest policy of 1988 are taken away by the Amended Wild life Act of 1991.The act, a landmark in the history of wildlife legislation in our country by which wildlife was transferred from State list to concurrent list in 1976, thus giving power to the Central Government to enact the legislation. In India, nearly 134 animal species have been regarded as threatened. A National Wildlife action plan has been prepared whose objective is to establish a network of scientifically managed areas such as national parks, sanctuaries and biosphere reserves, to cover representative and viable samples of all significant biogeographic subdivisions within the country.

The major activities and provisions in the act can be summed up as follows:

1. It defines the wildlife related terminology.

2. It provides for the appointment of wildlife advisory board, wildlife warden, their powers, duties etc.

3. Under the Act, comprehensive listing of endangered wildlife species was done for the first time and prohibition of hunting of the endangered species was mentioned

4. Protection to some endangered plants like Beddome cycad, Blue Vanda, Ladies Sliper Orchid, Pitcher plant etc. is also provided under the Act.

5. The act provides for setting up of National Parks, Wild life Sanctuaries etc.

6. The Act provides for the constitution of Central Zoo Authority.

7. There is provision for trade and commerce in some wildlife species with license for sale, possession, transfer etc.

8. The Act imposes a ban on the trade or commerce in scheduled animals.

9. It provides for legal powers to officers and punishment of offenders.

10. It provides for captive breeding programme for endangered species.

Several conservation projects for individual endangered species like lion (1972), tiger (1973), crocodile (1974), and brown antlered deer (1981) were started under this Act. The Act is adopted by all states in India except J&K, which has its own Act.

3.6 HUMAN POPULATION AND ENVIRONMENT:

INTRODUCTION:

POPULATION GROWTH, VARIATION AMONG NATIONS

Needs of the huge number of human beings cannot be supported by the Earth's natural resources, without degrading the quality of human life. In the near future, fossil fuel from oil fields will run dry. It will be impossible to meet the demands for food from existing agro systems. Pastures will be overgrazed by domestic animals and industrial growth will create ever-greater problems due to pollution of soil, water and air. Seas will not have enough fish. Larger ozone holes will develop due to the discharge of industrial chemicals into the atmosphere, which will affect human health. Global warming due to industrial gases will lead to a rise in sea levels and flood all low-lying areas, submerging coastal agriculture as well as towns and cities. Due to the depletion of fresh water will create unrest and eventually make countries going to war. The control over regional biological diversity, which is vital for producing new medicinal and industrial products, will lead to grave economic conflicts between biotechnologically advanced nations and the bio- rich countries.

Degradation of ecosystems will lead to extinction of thousands of species, de-stabilizing natural ecosystems of great value. These are only some of the environmental problems related to an increasing human population and more intensive use of resources that we are likely to face in future. These effects can be averted by creating a mass environmental awareness movement that will bring about a change in people's way of life. Present development strategies have not been able to successfully address these problems related to hunger and malnutrition.

3.7 POPULATION EXPLOSION – FAMILY WELFARE PROGRAM

In response to our phenomenal population growth, India seriously took up an effective Family Planning Program which was renamed the Family Welfare Program. Slogans such as 'Hum do hamare do' indicated that each family should not have more than two children. It however has taken several decades to become

effective. However the use of contraceptive measures is higher in developed countries – 68%, and lower in developing countries - 55%. India and China have been using permanent sterilization more effectively than many other countries in thedeveloping world. Informing the public about the various contraceptive measures that are available is of primary importance. This must be done actively by Government Agencies such as Health and Family Welfare, as well as Education and Extension workers. It is of great importance for elected representatives of the people – Ministers, MPs, MLAs at Central and State levels – to understand the great and urgent need to support Family Welfare.

The media must keep people informed about the need to limit family size and the ill effects of a growing population on the world's resources. The decision to limit family size depends on a couple's background and education. This is related to Government Policy, the effectiveness of Family Welfare Programs, the educational level, and information levels in mass communication.

The greatest challenge the world now faces is how to supply its exploding human population with the resources it needs. It is evident that without controlling human numbers, the Earth's resources will be rapidly exhausted. As population expands further, water shortages will become acute. Soil will become unproductive. Rivers, lakes and coastal waters will be increasingly polluted. Water related diseases already kill 12 million people every year in the developing world. By 2025, about 48 countries will be starved for water. Air will become increasingly polluted. Air pollution already kills 3 million people every year. The first 'green revolution' in the '60s produced a large amount of food but has led to several environmental problems.

Now, a new green revolution is needed, to provide enough food for our growing population, that will not damage land, kill rivers by building large dams, or spread at the cost of critically important forests, grasslands and wetlands. The world's most populous regions are in coastal areas. These are critical ecosystems and are being rapidly destroyed. Global climate change is now a threat that can affect the very survival of high population density coastal communities. In the sea, fish populations are

suffering from excessive fishing. Once considered an inexhaustible resource, over fishing has depleted stocks extremely rapidly. It will be impossible to support further growth in coastal populations on existing fish reserves.

Human populations will inevitably expand from farm lands into the remaining adjacent forests. Many such encroachments in India have been regularized over the last few decades. But forest loss has long-term negative effects on water and air quality and the loss of biodiversity is still not generally seen as a major deterrent to human well-being. The extinction of plant and animal species resulting from shrinking habitats threatens to destroy the Earth's living web of life.

Energy use is growing, both due to an increasing population, and a more energy hungry lifestyle that increasingly uses consumer goods that require large amounts of energy for their production, packaging, and transport. Our growing population also adds to the enormous amount of waste. With all these linkages between population growth and the environment, Family Welfare Programs have become critical to human existence. The Family Welfare Program advocates a variety of measures to control population.

3.8 ENVIRONMENT AND HUMAN HEALTH

Environment related issues that affect our health have been one of the most important triggers that have led to creating an increasing awareness of the need for better environmental management. Changes in our environment induced by human activities in nearly every sphere of life have had an influence on the pattern of our health. The assumption that human progress is through economic growth is not necessarily true. We expect urbanization and industrialization to bring in prosperity, but on the down side, it leads to diseases related to overcrowding and an inadequate quality of drinking water, resulting in an increase in waterborne diseases such as infective diarrhoea and air borne bacterial diseases such as tuberculosis. High-density city traffic leads to an increase in respiratory diseases like asthma.

Agricultural pesticides that enhanced food supplies during the green revolution have affected both the farm worker and all of us who consume the produce. Modern

medicine promised to solve many health problems, especially associated with infectious diseases through antibiotics, but bacteria found ways to develop resistant strains, frequently even changing their behavior in the process, making it necessary to keep on creating newer antibiotics. Many drugs have been found to have serious side effects. At times the cure is as damaging as the disease process itself. Thus development has created several long-term health problems. While better health care has led to longer life spans, coupled with a lowered infant mortality, it has also led to an unprecedented growth in our population which has negative implications on environmental quality. A better health status of society will bring about a better way of life only if it is coupled with stabilizing population.

Environmental health as defined by WHO, comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social, and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that adversely affect the health of present and future generations. Our environment affects human health in variety of ways.

Millions of children die every year due to diarrhoea from contaminated water or food. An estimated 2000 million people are affected by these diseases and more than 3 million children die each year from waterborne diseases across the world. In India, it is estimated that every fifth child under the age of 5 dies due to diarrhoea. This is a result of inadequate environmental management and is mainly due to inadequate purification of drinking water. Wastewater and/or sewage entering water sources without being treated leads to continuous gastrointestinal diseases in the community and even sporadic large epidemics. Large numbers of people in tropical countries die of malaria every year and millions are infected. An inadequate environmental management of stagnant water, which forms breeding sites of Anopheles mosquitoes, is the most important factor in the spread of malaria. Millions of people, mainly children, have poor health due to parasitic infections, such as amoebiasis and worms. This occurs from eating infected food, or using poor quality water for cooking food. It is estimated that 36% of children in low-

income countries and 12% in middle income countries are malnourished. In India, about half the children under the age of four are malnourished and 30% of newborns are significantly underweight. Hundreds of millions of people suffer serious respiratory diseases, including lung cancer and tuberculosis, from crowded homes and public places. Motor vehicle exhaust fumes, industrial fumes, tobacco smoke contribute to respiratory diseases.

Millions of people are exposed to hazardous chemicals in their workplace or homes that lead to ill health due to industrial products where controls are not adhered to. Tens of thousands of people in the world die due to traffic accidents due to inadequate management of traffic conditions. Poor management at the accident site and inability to reach a hospital within an hour causes a large number of deaths, especially from head injuries.

• Basic environmental needs such as clean water, clean air and adequate nutrition which are all related to environmental goods and services do not reach over 1000 million people living in poverty.

• Several million people live in inadequate shelters or have no roof over their heads especially in urban settings. This is related to high inequalities in the distribution of wealth and living space.

• Population growth and the way resources are being exploited and wasted, threaten environmental integrity and directly affects health of nearly every individual.

• Health is an outcome of the interactions between people and their environment. Better health can only come from a more sustainable management of the environment.

Definition of Health Impact Assessment (HIA) by WHO: Health impact assessment is a combination of procedures, methods and tools by which a policy, program or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population.

Globalisation and infectious disease:

Globalization is a world-wide process which includes the internationalization of communication, trade and economic organization. It involves parallel changes such

rapid social, economic and political adjustments. Whilst globalization has the potential to enhance the lives and living standards of certain population groups, for poor and marginalized populations in both the non-formal as well as formal economic sectors of developing countries, globalization enhances economic inequalities.

Tuberculosis (TB) kills approximately 2 million people each year. In India the disease has re-emerged and is now more difficult to treat. A global epidemic is spreading and becoming more lethal. The spread of HIV/AIDS and the emergence of multidrug-resistant tuberculosis are contributing to the increasing morbidity of this disease. TB is a contagious disease that is spread through air. Only people who are sick with pulmonary TB are infectious. When infectious people cough, sneeze, talk or spit, they emit the tubercle bacilli into the air. When a healthy person inhales these, he gets infected by the disease. Symptoms include prolonged fever, coughing and weight loss. It is estimated that, left untreated, each patient of active tuberculosis will infect on an average between 10 to 15 people every year. But people infected with TB will not necessarily get sick with the disease. The immune system can cause the TB bacillus which is protected by a thick waxy coat, to remain dormant for years. When an individual's immune system is weakened, the chances of getting active are greater.

Malaria is a life-threatening parasitic disease transmitted by mosquitoes. The cause of malaria, a single celled parasite called plasmodium, was discovered in 1880. Later it was found that the parasite is transmitted from person to person through the bite of a female Anopheles mosquito, which requires blood for the growth of her eggs. Malaria symptoms appear about 9 to 14 days after the mosquito bite, although this varies with different *Plasmodium* sp. Malaria produces high fever, headache, vomiting and body ache. If drugs are not available for treatment, or the parasites are resistant to them, the infection can progress rapidly to become life-threatening. Malaria can kill by infecting and destroying red blood cells (anemia) and by clogging the capillaries that carry blood to the brain (cerebral malaria) or other vital organs. Malaria parasites are developing unacceptable levels of resistance to drugs. Besides

this, many insecticides are no longer useful against mosquitoes transmitting the disease. Good environmental management by clearing pools of stagnant water during the monsoons is effective in reducing the number of mosquitoes.

WATER BORNE DISEASES

Arid areas with rapidly expanding populations are already facing a crisis over water. Conservation of water and better management is an urgent need. The demand and supply balance is a vital part of developing sustainable use of water. This is being termed the 'Blue Revolution' and needs Governments, NGOs and people to work together towards a better water policy at International, National, State, regional and local levels. Locally good watershed management is a key to solving local rural problems. Present patterns of development are water hungry and water wasters.

There are 4 major types of water related diseases:

1. Water borne diseases:

These are caused by dirty water contaminated by human and animal wastes, especially from urban sewage, or by chemical wastes from industry and agriculture. Some of the diseases, such as cholera and typhoid, cause serious epidemics. Diarrhoea, dysentery, polio, meningitis, and hepatitis A and E, are caused due to improper drinking water. Excessive levels of nitrates cause blood disorders when they pollute water sources. Pesticides entering drinking water in rural areas cause cancer, neurological diseases and infertility. Improving sanitation and providing treated drinking water reduces the incidence of these diseases.

2. Water based diseases:

Aquatic organisms that live a part of their life cycle in water and another part as a parasite in man, lead to several diseases. In India, guinea worm affects the feet. Round worms live in the small intestine, especially of children.

3. Water related vector diseases:

Insects such as mosquitoes that breed in stagnant water spread diseases such as malaria and filariasis. Malaria that was effectively controlled in India has now come back as the mosquitoes have become resistant to insecticides. In addition,

anti-malarial drugs are now unable to kill the parasites as they have become resistant to drugs. Change in climate is leading to the formation of new breeding sites. Other vector born diseases in India include dengue fever and filariasis. Dengue fever carries a high mortality. Filariasis leads to fever and chronic swelling over the legs. Eliminating mosquito breeding sites when pooling of water occurs in the monsoon, using fish to control mosquito larval populations, are ways to reduce these diseases without using toxic insecticides that have ill effects on human health.

4. Water scarcity diseases:

In areas where water and sanitation is poor, there is a high incidence of diseases such as tuberculosis, leprosy, tetanus, etc. which occur when hands are not adequately washed.

Arsenic in drinking water: Arsenic in drinking water is a serious hazard to human health. It has attracted much attention since its recognition in the 1990s of its wide occurrence in well- water in Bangladesh. It occurs less frequently in most other countries. The main source of arsenic in drinking water is arsenic-rich rocks through which the water has filtered. It may also occur because of mining or industrial activity in some areas. WHO has worked with other UN organizations to produce a state-of-the-art re- view on arsenic in drinking water.

Water with high concentrations of arsenic if used over 5 to 20 years, results in problems such as colour changes on the skin, hard patches on the palms and soles, skin cancer, cancers of the bladder, kidney and lung, and diseases of the blood vessels of the legs and feet. It may also lead to diabetes, high blood pressure and reproductive disorders. Cholera and dysentery cause severe, sometimes life threatening and epidemic forms of these diseases.

Effects on health: Diarrhoea is the frequent passage of loose or liquid stools. It is a symptom of various gastrointestinal infections. Depending on the type of infection, the diarrhoea may be watery (for example in cholera caused by *Vibrio cholera*) or passed with blood and mucous (in dysentery caused by an amoeba, *E. Histolytica*). Depending

on the type of infection, it may last a few days, or several weeks. Severe diarrhoea can become life threatening due to loss of excessive fluid and electrolytes such as Sodium and Potassium in watery diarrhoea. This is particularly fatal in infants and young children. It is also dangerous in malnourished individuals and people with poor immunity.

Causes of diarrhoea:

Diarrhoea is caused by several bacterial, viral and parasitic organisms. They are mostly spread by contaminated water. It is more common when there is a shortage of clean water for drinking, cooking and cleaning. Basic hygiene is important in its prevention. Water contaminated with human feces surrounding a rural water source, or from municipal sewage, septic tanks and latrines in urban centers, are important factors in the spread of these diseases. Feces of domestic animals also contain microorganisms that can cause diarrhoea through water.

Diarrhoea is spread from one individual to another due to poor personal hygiene. Food is a major cause of diarrhoea when it is prepared or stored in unhygienic conditions. Fish and seafood from polluted water is a cause of severe diarrhoea. The infectious agents that cause diarrhoea are present in our environment. In developed countries where good sanitation is available, most people get enough safe drinking water. Good personal and domestic hygiene prevents this disease which is predominantly seen in the developing world.

Risks due to chemicals in food

Food contaminated by chemicals is a major worldwide public health concern. Contamination may occur through environmental pollution of the air, water and soil. Toxic metals, PCBs and dioxins, or the intentional use of various chemicals, such as pesticides, animal drugs and other agrochemicals have serious consequences on human health. Food additives and contaminants used during food manufacture and processing adversely affect health.

Cancer and environment

Cancer is caused by the uncontrolled growth and spread of abnormal cells that

may affect almost any tissue of the body. Lung, colon, rectal and stomach cancer are among the five most common cancers in the world for both men and women. Among men lung and stomach cancer are the most common cancers worldwide. For women, the most common cancers are breast and cervical cancer. Cancer is preventable by stopping smoking, providing healthy food and avoiding exposure to cancer-causing agents (carcinogens). Early detection and effective treatment is possible for a further one-third of cases. Most of the common cancers are curable by a combination of surgery, chemotherapy (drugs) or radiotherapy (X-rays). The chance of cure increases if cancer is detected early.

3.9 VALUE EDUCATION

Value education in the context of our environment is expected to bring about a new sustainable way of life. Essentially, environmental values cannot be taught. They are inculcated through a complex process of appreciating our environmental assets and experiencing the problems caused due to our destruction of our environment. The problems that are created by technology and economic growth are a result of our improper thinking on what 'development' means. Since we put a high value only on economic growth, we have no concern for aspects such as sustainability or equitable use of resources. This mindset must change before concepts such as sustainable development can be acted upon.

Values in environment education must bring in several new concepts. They deal with a love and respect for nature. These are the values that will bring about a better humanity, one in which we can live healthy, productive and happy lives in harmony with nature.

Environmental Values:

Every human being has a great variety of feelings for different aspects of his or her surroundings. Environmental Ethics is the scientific looking of various issues related to the individuals on the environment. The Western, modern approach values the resources of Nature for their utilitarian importance alone. Environmental values are inherent in feelings that bring about sensitivity for preserving nature as a whole. There

are several writings and sayings in Indian thought that support the concept of the oneness of all creation, of respecting and valuing all the different components of nature. Our environmental values must translate to pro conservation actions in all our day to day activities. Values lead to a process of decision making which leads to action. For value education in relation to the environment, this process is learned through an understanding and appreciation of nature's oneness and the importance of its conservation. Environmental values must also stress on the importance of preserving ancient structures. The characteristic architecture, sculpture, artworks and crafts of ancient cultures is an invaluable environmental asset. It tells us where we have come from, where we are now, and perhaps where we should go. Architectural heritage goes beyond preserving old buildings, to conserving whole traditional landscapes in rural areas and streetscapes in urban settings. Unless we learn to value these landscapes, they will disappear and our heritage will be lost.

As environmentally conscious individuals we need to develop a sense of values that are linked with a better and more sustainable way of life for all people. The positive feelings that support environment include a value for Nature, cultures, heritage, and equity. We also need to become more sensitive to aspects that have negative impacts on the environment. These include our attitude towards degradation of the environment, loss of species, pollution, poverty, corruption in environmental management, the rights of future generations and animal rights. Several great philosophers have thoughts that have been based on, or embedded, in pro environmental behavior. Mahatma Gandhi and Rabindranath Tagore are among the internationally well-known scholars whose thought have included values that are related to environmental consciousness. We need to appreciate these values to bring about a better way of life on earth for all people and all living creatures.

Valuing Nature:

The most fundamental environmental sentiment is to value Nature herself. We need to develop a sense of values that lead us to protect what is left of the wilderness by creating effective National Parks and Wildlife Sanctuaries. However this cannot be

done to the detriment of the millions of tribal or indigenous people who live in wilderness ecosystems. There are thus conflicting values that need to be balanced carefully. On the one hand we need to protect natural ecosystems, while on the other, we must protect the rights of local people. Way of life on earth for all people and all living creatures.

Valuing cultures

Every culture has a right to exist. Tribal people are frequently most closely linked with Nature and we have no right to foist on them our own modern way of life. The dilemma is how to provide them with modern health care and education that gives them an opportunity to achieve a better economic status without disrupting their culture and way of life. This will happen only if we value their culture and respect their way of life.

Human heritage

The earth itself is a heritage left to us by our ancestors for not only our own use but for the generations to come. There is much that is beautiful on our Earth - the undisturbed wilderness, a traditional rural landscape, the architecture of a traditional village or town, and the value of a historical monument or place of worship. While we admire and value the Ajanta and Ellora Caves, the temples of the 10th to 15th centuries that led to different and diverse styles of architecture and sculpture, the Moghul styles that led to structures such as the Taj Mahal, or the unique environmentally-friendly Colonial buildings, we have done little to actively preserve them. As environmentally conscious individuals we need to support for the protection of the wilderness and our glorious architectural heritage.

3.10 HUMAN RIGHTS

Several environmental issues are closely linked to human rights. These include the equitable distribution of environmental resources, the utilization of resources and Intellectual Property Rights (IPRs), conflicts between people and wild- life especially around PAs, resettlement issues around development projects such as dams and mines, and access to health to prevent environment related diseases.

Equity

One of the primary concerns in environmental issues is how wealth, resources and energy must be distributed in a community. We can think of the global community, regional community issues, national concerns and those related to a family or at the individual level. While economic disparities remain a fact of life, we as citizens of a community must appreciate that a widening gap between the rich and the poor, between men and women, or between the present and future generations must be minimized if social justice is to be achieved. Today the difference between the economically developed world and the developing countries is unacceptably high. The access to a better lifestyle for men as against women is inherent in many cultures. People who live in wilderness communities are referred to as ecosystem people. They collect food, fuel wood, and non-wood products, fish in aquatic ecosystems, or hunt for food in forests and grasslands. When land use patterns change from natural ecosystems to more intensively used farmland and pastureland the rights of these indigenous people are usually sacrificed. Take the case of subsidies given to the pulp and paper industry for bamboo which makes it several times cheaper for the industry than for a rural individual who uses it to build his home.

Nutrition, health and human rights

There are links between environment, nutrition and health which must be seen from a human- rights perspective. Proper nutrition and health are fundamental human rights. The right to life is a Fundamental Right in our Indian constitution. Nutrition affects and defines the health status of all people, rich and poor. It is linked to the way we grow, develop, work, play, resist infection and reach our aspirations as individuals, communities and societies. Malnutrition makes people more vulnerable to disease and premature death. Poverty is a major cause as well as a consequence of ill-health. Poverty, hunger, malnutrition and poorly managed environments together affect health and weaken the socio- economic development of a country. Nearly 30% of population, especially those in developing countries infants, children, adolescents, adults, and older persons are affected by this problem. We must ensure

that our environmental values and our vision are linked to human rights and create laws to support those that need a better environment, better health and a better lifestyle.

Intellectual Property Rights and Community Biodiversity Registers:

Traditional people, especially tribal living in forests, have used local plants and animals for generations. This storehouse of knowledge leads to many new 'discoveries' for modern pharmaceutical products. The revenue generated from such 'finds' goes to the pharmaceutical industry that has done the research and patented the product. This leaves the original tribal user with nothing while the industry could earn billions of rupees. To protect the rights of indigenous people who have used these products, a possible tool is to create a Community Biodiversity Register of local products and their uses so that its exploitation by the pharmaceutical industry would have to pay a royalty to the local community.

Traditional Medicine: Traditional medicine refers to health practices, approaches, knowledge and beliefs that incorporate plant, animal and mineral based medicines, frequently of local or regional origin. It may be linked to spiritual therapies, manual techniques and exercises. Traditional medicine has maintained its popularity in all regions of the developing world and its use is rapidly spreading in industrialized countries. Yoga is known to reduce asthma attacks. Traditional Medicine has been found to be effective against several infectious diseases.

3.11 WOMEN AND CHILD WELFARE

There are several environmental factors that are closely linked to the welfare of women and children. Each year, close to eleven million children worldwide is estimated to have died from the effects of disease and inadequate nutrition. Most of these deaths are in the developing world. In some countries, more than one in five children dies before they are 5 years old. Seven out of ten childhood deaths in developing countries can be attributed to five main causes, or a combination of them. These are: pneumonia, diarrhoea, measles, malaria and malnutrition. Around the world, three out of every four children suffer from at least one of these conditions. Most respiratory diseases

are caused by or are worsened by polluted air.

There are strong connections between the status of the environment and the welfare of women and children in India. Women and girls are often the last to eat, as their role in traditional society is to cook the family meal and feed their husband and sons first. This leads to malnutrition and anemia due to inadequate nutrition. The girl child is given less attention and educational facilities as compared to boys in India. Thus, they are unable to compete with men in later life. This social-environmental divide is a major concern that needs to be corrected throughout the country.

Poverty-environment-malnutrition*:* There is a close association between poverty, a degraded environment and malnutrition. The Department of Women and Child Development was set up in the year 1985 as a part of the Ministry of Human Resource Development to give the much needed impetus to the holistic development of women and children. As the national machinery for the advancement of women and children, the department formulates plans, policies and programmes, enacts/amends legislation, guides and coordinates the efforts of both governmental and non-governmental organizations working in the field of Women and Child Development.

Child Development: Government of India proclaimed a National Policy on Children in August 1974 declaring children as, "supremely important assets". The policy provided the required framework for assigning priority to different needs of the child. The programme of the Integrated Child Development Services (ICDS) was launched in 1975 seeking to provide an integrated package of services in a convergent manner for the holistic development of the child. For the holistic development of the child, the department has been implementing the world's largest almost unique and outreach programme of Integrated Child Development services (ICDS) providing a package of services comprising of the following:

- Supplementary nutrition,
- Immunization,
- Health check-up and referral services,
- Pre -school non- formal education.

HIV/AIDS:

The Human Immuno deficiency Virus (HIV) causes Acquired Immunodeficiency Syndrome (AIDS) through contact with the tissue fluids of infected individuals, especially through sexual contact. It is not a disease but a weakness in the body that results in the body being unable to fight off illnesses. The immune system of a person with AIDS is weakened to such a point that medical intervention is necessary to prevent or treat the deterioration in the body and the entire system. AIDS is the most serious stage of HIV infection. It results from the destruction of the infected person's immune system. As it reduces an individual's resistance to disease, it causes infected individuals to suffer from a large number of environment related diseases and reduces the ability of infected individuals to go about their normal lives. Our immune system is our body's defense system. Cells of our immune system fight off infection and other diseases. If the immune system does not work well, we are at risk for serious and life-threatening infections and cancers. HIV attacks and destroys the disease-fighting cells of the immune system, leaving the body with a weakened defense against infection and cancer. HIV/ AIDS have a serious impact on the socioeconomic fabric of society.

HIV Test

The only way to know infected person is to be tested for HIV infection. Many people who are infected with HIV do not have any symptoms at all for many years. The following may be warning signs of infection with HIV:

- Rapid weight loss, dry cough
- Recurring fever or profuse night sweats, profound and unexplained fatigue
- Swollen lymph glands in the armpits, groin, or neck, diarrhea that lasts for more than a week, white spots or unusual blemishes on the tongue, in the mouth, or in the throat
- Pneumonia, red, brown, pink, or purplish blotches on or under the skin or inside the mouth, nose, or eyelids
- Memory loss, depression, and other neurological disorders

However, no one should assume they are infected if they have any of these

symptoms. Each of these symptoms can be related to other illnesses. The symptoms of AIDS are similar to the symptoms of many other illnesses. AIDS is a medical diagnosis made by a doctor based on specific criteria established.

Transmission of HIV

HIV transmission can occur when body fluids of an infected person enters the body of an uninfected person. The most common ways that HIV is transmitted from one person to another:

1. By having sexual intercourse with an HIV-infected person.
2. By sharing needles or injection equipment with an injection drug user who is infected with HIV.
3. From HIV infected women to babies before or during birth, or through breast-feeding after birth.
4. HIV can also be transmitted through transfusions of infected blood or blood clotting factors.
5. Some health care workers have become infected after being stuck with needles containing HIV infected blood or, less frequently, after infected blood contact with the worker's open cut or through splashes into the worker's eyes or inside his or her nose.

PREVENTION:

1. However, the most important measure to prevent AIDS is the proper use of condoms that form a barrier to the spread of the virus.
2. Using disposable needles.
3. Transfusion of uninfected blood.
4. Organizing AIDS awareness on prevention and management of disease.

3.12 ROLE OF INFORMATION TECHNOLOGY IN ENVIRONMENT AND HUMAN HEALTH

The understanding of environmental concerns and issues related to human health has exploded during the last few years due to the sudden growth of information

technology. The computer age has turned the world around due to the incredible rapidity with which IT spreads knowledge. IT can do several tasks extremely rapidly, accurately and spread the information through the world's networks of millions of computer systems. Information technology has also increased the pace of discovery. The capacity of establishing and maintaining worldwide databases has linked environmental, researches around the globe. The advancement in computer, communication, satellite and other technological developments have enabled engineers or environmentalists to gather relevant information simultaneously from many sources. The information is utilized for developing and early warning system and to forecast any eventuality much earlier. A large amount of information is easily available through Remote Sensing technology, Geographical Information System (GIS) and Global Positioning System (GPS) that is being used for various environmental studies.

Ministry of Environment of Government of India has established an Environmental Information System (ENVIS) in 1982. This has been established as a decentralized information system network whose purpose is collection, storage, retrieval and dissemination of environmental information to decision makers, policy makers, planners, scientists, engineers, environmentalists, researchers and general public all over the country. The ENVIS network has its focal point in the Environmental ministry along with thirteen subject oriented centers, known as ENVIS Centers, set up in the various institutions, organizations of the country in the priority areas of environment like pollution control, toxic chemicals, energy and environment, environmentally sound and mangroves, corals and lagoons, media and environment etc.

New communication links are particularly vital to make use of such information sources as Geographic Information Systems (GIS), a computer based system for gathering, manipulating, and analyzing environmental data. GIS databases are commonly established with information obtained from remote surveys via satellite and a variety of atmospheric and ground level surveys. GIS software packages and databases, which have almost unlimited applications, have a crucial relevance for

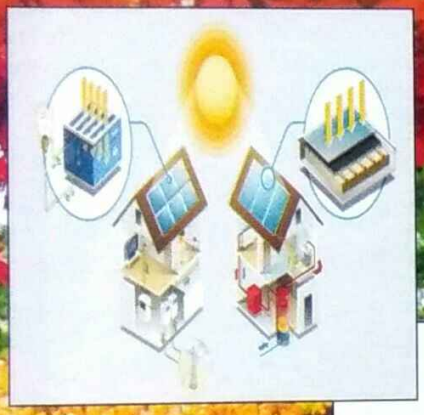
national and local environmental management and learning.GIS is a tool to map Land use patterns and document change by studying digitized top sheets and/or satellite imagery. Once this is done, an expert can ask a variety of questions which the software can answer by producing maps which helps in land use planning.

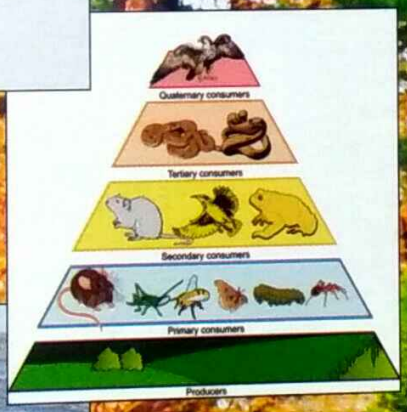
Online healthcare information about Medicare and various related web sites guide consumers to a wide variety of health information available including the full text of clinical practice guidelines, and consumer brochures developed. A number of centers for disease control & prevention are functioning and the public health service maintains their websites.

The Internet with its thousands of websites has made it very simple to get the appropriate environmental information for any study or environmental management planning. This not only assists scientists and students but is a powerful tool to help increase public awareness about environmental issues.

Specialized software can analyze data for epidemiological studies, population dynamics and a variety of key environmental concerns. The relationship between the environment and health has been established due to the growing utilization of computer technology. This looks at infection rates, morbidity or mortality and the etiology (causative factors) of a disease. As our knowledge expands, computers will become increasingly efficient.

Environmental Studies





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FOREWORD

SFRC one of the premier Institutions of higher education, has mainstreamed and mandated environmental Studies at under Graduate Level as they are the critical stakeholders and who would translate knowledge into wise application for solutions pertaining to environmental issues. In this milieu, the Authors have brought out this edition with amazing consistency to enrich the social standards of life of the stakeholders. Their credential efforts are duly acknowledged.

It is my privilege to acknowledge the Dynamic Diplomats of the members of Management Committee as the academic success of our institution is mainly due to their healthy concoction of innovation, planning and perseverance with farsightedness to visualize and anticipate changes to the tune of the present globalized academic sector

D. Sasireka

PREFACE

The unprecedented explosion of Scientific and Technological Innovations in current panorama has changed many social aspects of life. With this accountability the authors have designed this edition based on three criterion viz., Components of Environment, Environmental Issues and Environmental Governance for the benefit of Students' Community.

The Authors are indebted to the Management and Principal for their constant encouragement and support.

We express our sincere thanks to Dr. (Mrs.) T. Palaneeswari, M.Com. M.Phil., Ph.D., Associate Professor, Department of Commerce and Ms. S. Subha Ranjani, M.Sc., M. Phil., Assistant Professor, Department of Microbiology for having assisted to bring out this issue.

Authors

THE STANDARD FIREWORKS RAJARATNAM COLLEGE FOR WOMEN, SIVAKASI (AUTONOMOUS)
PART IV – VALUE ADDED COURSE
14UES21- ENVIRONMENTAL STUDIES
SEMESTER II
(For those admitted in June 2014 and later)

Contact hours per week : 03
Total number of hours per semester : 45
Number of Credits : 02

Objectives

To enable the learners to

1. live in harmony with nature
2. acquire awareness on environmental issues
3. understand the inter- relatedness of man , his culture and mother nature
4. analyze case studies and participate in solving environmental problems

Unit -I (9hrs)

Environmental Education: Formal Environmental Education, Environmental Studies, Non-Formal Environmental Education, Role of Organizations, The Great Indian Personalities as Environmental Conservationists, Responsibilities of Every Citizen. Environment: Types, Components, Segments, Environmental Threats to Life. Ecosystem: Concept, Structure, Functions, Types.

Unit -II (9hrs)

Natural Resources: Classification, Principal Natural Resources, Non renewable, Renewable energy resources. Biodiversity and its Conservation: Classification of Value of Biodiversity, Categories of Threat, Biodiversity Conservation.

Unit -III (9hrs)

Environmental Pollution: Types of Pollution, Classification of Pollutants, Environmental Management, Sewage Treatment, Land Use Management, Disaster Management. Environmental and Social Issues: Acid Rain, Global Warming / Green House Effect / Climate Change, Depletion of Ozone Layer, Nuclear Accidents and Nuclear Holocaust.

Unit -IV **(9hrs)**

The Law and Citizens: Water (Prevention and Control of Pollution) Act, 1974; Air (Prevention and Control of Pollution) Act, 1981; Wild life (Protection) Act, 1972; Forest (Conservation) Act, 1980; Environment (Protection) Act, 1986. Major environmental movements **:** Chipko Movement, Appiko Movement, Silent Valley Movement, International Organizations and Agencies(IUCN, UNESCO, CITES, EEC, EPA, UNEP, ICSU, SACEP), International conferences : Stockholm Conference on Environment (1972), Nairobi Conference (1982), The Earth Summit (1992), Johannesburg Conference (2002).

Unit -V **(9hrs)**

Sustainable Development : Measures, Methods to Develop Sustainable Environment ; Water Conservation and Rain Water Harvesting, Watershed Management, Resettlement and Rehabilitation , Consumerism and waste products, Environmental Ethics.

Text Book:

1. Jayalakshmi,M., Kasthuri,J. and Sriranjini Hirudhayanathan (2011) **Environmental Studies**, Published by CDDC, SFRC, Sivakasi

References:

1. Eracha Bharucha (2008) **Text Book of Environmental Studies** University Press, Hyderabad
2. Agarwal, S.P (2006) **Environmental Studies**, Narosha Publishing House, Kolkatta
3. Manoharachary, C. and Jyarama Reddy,P (2006) **Environmental Studies** B.S. Publication, Hyderabad
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CONTENTS

1. ENVIRONMENTAL EDUCATION

Dr. (Mrs.) J. Kasthuri

1.1 INTRODUCTION

Environmental Education is a process that helps in understanding inter-relationship among man, his culture and his bio-physical surrounding (environment). Through this process of education people can be sensitized about the environmental issues. The Ministry of Environment and Forestry has been implementing several schemes and programme to impart environmental education and to create environmental awareness among the general public.

1.2 OBJECTIVES OF ENVIRONMENTAL EDUCATION

The main objectives of environmental education and training are

- To develop educational / teaching materials and aids in the formal education sector
- To encourage non-governmental organizations, mass media and other concerned organizations for promoting awareness among the people at all levels
- To promote environment education through existing educational / scientific / research institutions
- To ensure training and manpower development in environment education
- To mobilize people's awareness for the preservation and conservation of environment.

1.3 ENVIRONMENTAL STUDIES

Environmental Studies is an emerging branch of Environmental Education. It is multidisciplinary in nature where different ideas, information and inputs of various disciplines are dealt with a holistic approach.

The role of each discipline in the context of Environmental Management and Protection for the sustainable development is being tabulated as follows:

S.No.	Discipline	Role
1.	Life Sciences (Botany, Zoology, Microbiology, Genetics, Biotechnology and Biochemistry)	Facilitate an understanding in the role of biotic component and their interactions.
2.	Physics, Chemistry, Geology, Atmospheric Science, Oceanography and Geography	Reveal the basic concepts and / or Physical and chemical structure of the abiotic component and energy transfer.

3.	Mathematics, Statistics and Computer Science	Serve as effective tools in environmental modeling and management.
4.	Education, Economics, Sociology and Mass Communication	Offer inputs for dealing with socio-economic aspects associated with developmental activities.
5.	Environmental Engineering, Civil Engineering, Hydraulics and Chemical Engineering	Form the basis for various technologies dealing with the control of environmental pollution, treatment of waste and development of cleaner technologies
6.	Environmental Laws	Tools for effective implementation of policies, management and protection of the environment.

1.4 SIGNIFICANCE OF ENVIRONMENTAL STUDIES

Environmental studies have become significant / important:

- To understand the Environmental issues of International importance such as global warming, ozone depletion, acid rain, marine pollution and biodiversity loss.
- To know the problems encountered with the developmental activities such as urbanization, industrial growth, transportation systems, agriculture and housing etc.
- To create awareness among people about natural resources.
- To plan for the development of eco-friendly technologies.

1.5 ENVIRONMENTAL EDUCATION IN INDIA

The programmes conducted as part of Environmental Education are categorized under:

- **Formal Environmental Education**
- **Non-formal Environmental Education**

1.5.1 Formal Environmental Education

Formal environmental education is imparted through academic institutions. The Programmes under Formal Environmental Education are:

- Environment Education in School System / Academic Programmes
- Environmental Appreciation Courses
- Environmental Concepts in Management and Business Studies

- **Environment Education in School System / Academic Programmes**

This project was initiated in 1999 to strengthen environment education in the formal school curriculum. The Hon'ble Supreme Court directed the UGC to introduce a basic course on environment at every level in college education. Accordingly, the matter was considered by UGC and implemented Environmental Studies in all the Universities / Colleges of India.

- **Environmental Appreciation Courses**

Though there are several courses on Environmental Sciences at present in the formal system, there are no structured courses available outside the formal system for people who desire to learn about environmental issues. The Ministry has taken an initiative in this regard and it presently working out a frame work for environmental appreciation courses in consultation with IGNOU.

- **Environmental Concepts in Management and Business Studies**

Realizing that the industry Managers and leaders need to be sensitized towards environmental issues and concepts of Environmental Management so that they can play an important role in introducing environmentally sound practices in their operations, the Ministry has taken an initiative to introduce / enhance environmental concepts in the Business / Management Education. A committee comprising representatives from Management Institutions, All India Council for Technical Education (AICTE), University Grants Commission (UGC), Industrial sector and The Ministry of Environment and Forestry (MoEF) is already looking into various aspects for enhancing / introducing the environmental content wherever necessary.

1.5.2 Non-Formal Environmental Education

Non-formal environmental education is imparted outside the academic institutions. This Programme is to encourage and enhance public participation in activities that intended to conserve, protect, manage and sustain the environment. The Programmes under Non-Formal Environmental Education are:

- National Environment Awareness Campaign (NEAC)
- Eco-clubs / National Green Crops
- Global Learning and Observations to Benefit the Environment (GLOBE)
- Mass Awareness

- **National Environment Awareness Campaign (NEAC)**

The NEAC was launched in mid 1986 with the objective of creating environmental awareness at national level. Under this campaign, nominal financial assistance is being provided to registered NGOs, schools, colleges, universities, research institutions, women organizations, State Government Departments etc. for organizing / conducting awareness raising activities which would include seminars, workshops, training programmes, camps, padha yatras / foot marches, rallies, public meetings, exhibitions, essay / debate / painting / poster competitions, folk dances and songs, puppet shows, preparation and distribution of environmental education resource materials etc. These activities would be followed by the actions like plantation of trees, management of household waste, cleaning of water bodies etc.

- **Eco-clubs / National Green Crops**

The main objectives of this programme are to **educate children** about their immediate environment and impart knowledge about the ecosystems, their interdependence and their need for survival. This Programme was further intensified by raising **National Green Crops** through **Eco Clubs**. The various activities include training of master trainers, developing and distributing educational material, observing environment days, conducting workshops and celebrating events like Eco- Balmela and Mowgli Ustav.

- **Global Learning and Observations to Benefit the Environment (GLOBE)**

The GLOBE is an **International Science and Education Programme**, which stress on hands-on participatory approach. India joined this programme during August, 2000. This programme aimed at **school children**. The students of GLOBE schools are required to collect data about various basic environmental parameters to enhance their scientific understanding of the earth.

- **Mass Awareness**

Under this scheme the great efforts are under way to reach the large population especially in rural areas and make them aware of the environmental problems through media, particularly the **electronic media**. The Doordarshan and few other television channels are proposed to be extensively used for telecasting environment based programmes and infomercials. The efforts taken by the individuals are also encouraged in producing films / documentaries on environment / wildlife related themes in the country through the sponsored organization of a film festival "Vatavaran" by the Ministry.

Besides, the awareness can also be created among the public by observing / celebrating the environmentally significant International days. A few such are

- February 2 : World Wetland Day
- March 21 : World Forestry Day
- April 22 : Earth Day
- June 5 : World Environment Day

1.6 Role of Organizations

There are several Government and Non-Government organizations (NGOs) that are working towards environmental protection of our country. Few such are tabulated with their role.

Organization	Role
I. Government Organization 1. Botanical Survey of India (BSI), Kolkata	Surveys the plant resources

2. Zoological Survey of India (ZSI) Kolkata	Explores and surveys the faunal resources
II. Non Government Organization 3. Bombay Natural History Society (BNHS), Mumbai	Concentrates on preservation of species and ecosystems.
4. World Wide Fund for Nature – India (WWF- I) , New Delhi	Operates Nature Clubs of India Programme for school children
5. Centre for Science and Environment (CSE), New Delhi	Organizes campaigns, workshops and conferences and produces environment related publications.
6. Environmental Education Centre (EEC), Chennai	Conducts variety of programmes to create awareness among the general public on environmental issues.
7. Centre for Environmental Education (CEE), Ahmedabad	Provides wide range of programmes and a variety of educational materials for environmental education.

The other organizations involved in such activities are

- Bharath Vidyapeeth Institute of Environment Education, Pune,
- The Madras Crocodile Bank Trust, Chennai,
- Wildlife Institute of India, Dehradun and
- Uttarkhand Seva Nidhi, Almora.

1.7 The Great Indian Personalities as Environmental Conservationists

Indian Personality	Role
Indira Gandhi - Former Prime Minister	Played a highly significant role in the **preservation of India's wildlife**.
Madhav Gadgil - well- known ecologist	Studied the behaviour of mammals, birds and insects.
S P Godrej	Supporter of wildlife conservation and nature awareness programs.
Anil Agarwal - a journalist	Wrote the first report on the 'State of India's Environment' and founded the Center for Science and Environment that supports various environmental issues.

M C Mehta - environmental lawyer	Filed for Public Interest for supporting the cause of environmental conservation which include protecting the Taj Mahal, cleaning up the Ganges River etc.
M S Swaminathan - agricultural scientist	Concerned with various aspects of biodiversity conservation

1.8 Responsibilities of Every Citizen

Every citizen of India should contribute for the conservation of natural resources by streamlining ourselves by adopting the following measures.

- Use maximum sunlight, instead of electric lights during day time
- Use solar devices, whenever possible
- Use only unleaded fuels
- Use biodegradable materials instead of plastic
- Use bed nets instead of mosquito repellants
- Use green manure over artificial fertilizers
- Use biogas plant
- Save paper by economical usage to prevent the forest from destruction
- Sort your garbage for recycling
- Avoid over-hunting, over-grazing and over-fishing
- Avoid constructing lavatories or pit latrines close to water sources
- Follow the principle of simple living
- Work with municipality to protect the wetland in your area
- Put off electrical gadgets whenever not in use
- Harvest rainwater
- Grow trees
- Think Globally and Act Locally

1.9 Environment

Mrs. Sriranjini Hirudhayanathan

1.9.1 DEFINITION

The word environment is being derived from the **French word** "Environ" which means to encircle or surround . It can be defined as a **surrounding** of an **organism** or a **system**.

1.9.2 TYPES OF ENVIRONMENT

Environment can be conveniently divided into two major types namely,

- Natural Environment
- Artificial / Man Made Environment

- **Natural Environment**

The natural environment is a **self regulating natural mechanism** which controls and balances various natural occurrences. Thus, there exists a **reciprocal relationship among the various components of the environment.** The components are air, water, soil, land, forest, wildlife etc.

- **Artificial / Manmade Environment**

The modifications **brought about by man** in the environment with the intervention of modern scientific technologies like transportation, dam building, housing, industrial revolution, space travel and canalization of energy sources.

1.9.3 COMPONENTS OF ENVIRONMENT

The three major components of environment are biotic (living), **abiotic** (non living) and energy.

- **Biotic Component**

The biotic component includes **all living forms of life** ranging from microorganisms to flora (plants) and fauna (animals) including man.

- **Abiotic Component**

The abiotic component of an environment includes all **nonliving factors** and **substrates / medium** such as air, water, soil, sunlight, temperature, minerals, nutrients, pH (Hydrogen ion concentration) etc.,

- **Energy Component**

Energy is a vital component which maintains life of organisms. It includes, solar energy, thermal, electrical, nuclear energy etc.

1.9.4 SEGMENTS OF ENVIRONMENT

The segments of environment are as follows

- Atmosphere (Air)
- Hydrosphere (Water)
- Lithosphere (Soil)
- Biosphere (Earth)

- **Atmosphere**

The **gaseous layer surrounding the earth** is called atmosphere. It comprises of the principal gases, Nitrogen (79 %), Oxygen (20 %) and Carbon dioxide (0.4 %). The remaining (0.6 %) includes Methane, Hydrogen and trace amount of inert gases *viz.*, Neon, Helium, Krypton and Xenon and moisture content as well. This layer serves as a **protective blanket** and sustains life on earth by absorbing cosmic rays and electromagnetic radiations.

- **Hydrosphere**

It includes all types of **water sources of earth**, such as oceans, seas, rivers, lakes, streams, glaciers, polar ice caps, and groundwater. Although 71 % of the earth crust is covered by water, the great amount (97 %) of total water is found in oceans and seas , only a tiny fraction of water is available in the form of freshwater (3 %). Of which, 2.997 % is being blocked in ice caps or glaciers and only 0.003% is available to us in the form of water vapour, wetlands, soil moisture, groundwater, and freshwater in rivers, streams , lakes and ponds. This makes the freshwater as a very precious resource.

- **Lithosphere**

It is the outer **layer of earth's crust** which consists of **rocks** and **soil**. Various mineral matters and soil are the main composition of this sphere. Lithosphere serves as a prime source of all resources of the earth. Besides, all the plants and animals subsist on this layer.

- **Biosphere**

It denotes the layer where **life is possible**. When compared to other layers it is very thin. In this layer living organisms interact with the environment.

1.9.5 ENVIRONMENTAL THREATS TO LIFE

The environmental threats to life are mainly due to the **traditional** and **modern** hazards which are posed mainly by the ever increasing **human population** and at times by nature too as a result of ecological **imbalances**.

- **Traditional Hazards**

The traditional hazards are mainly due to the lack of awareness, poverty and insufficient developmental plans. Some of which are listed below.

  - Lack of access to safe drinking water
  - Inadequate sanitation at household and community levels
  - Food contamination
  - Indoor air pollution
  - Inadequate solid waste disposal
  - Occupational injury hazards
  - Natural disasters

- **Modern Hazards**

The modern environmental hazards are arising from over exploitation of natural resources and developmental activities due to unprecedented population growth. Few such are listed below:

  - Water pollution in highly populated areas, industrial sites and intensive agricultural practices.
  - Urban pollution due to the automobile exhausts and overcrowding

- Solid and hazardous waste accumulation
- Chemical and radiation hazards
- Outbreak of infectious diseases
- Deforestation, overgrazing and degradation of soil
- Ozone depletion and climate change

1.10. ECOSYSTEM

Dr. (Mrs.) J. Kasthuri

1.10.1 CONCEPT OF ECOSYSTEM

Ecosystem is a functional unit of **Ecology** where the living and non-living components actively interact with one another. The term ecosystem ('Eco' refers to Environment and 'System' refers to a complex – coordinated unit) was first proposed by A.G.Tansley (1935). It varies in size, structure or composition and types. The size of an ecosystem varies from a micro (Ecosystem in cow dung) to mega (Forest ecosystem) level. Each system has its unique functional components. The interaction between or among the organisms is through energy flow and cycling of nutrients.

1.10.2 STRUCTURE OF ECOSYSTEM

The structure of ecosystem is formed of two components namely **abiotic** (nonliving factors) and **biotic** (Living organisms) components. The biotic components depend upon abiotic factors for their survival.

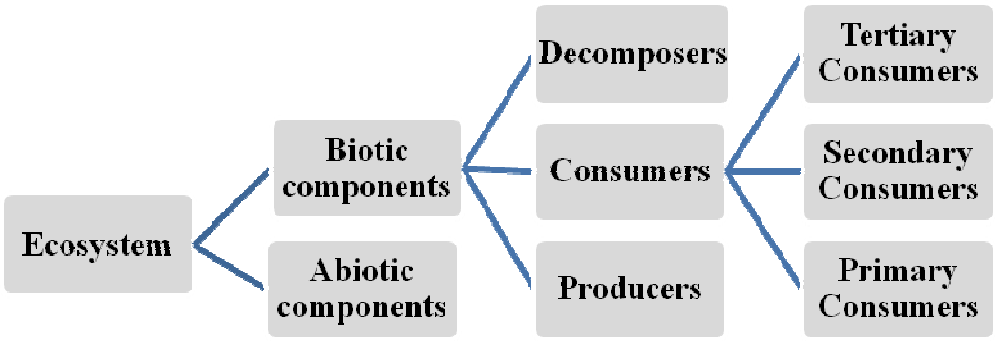


Figure 3.1: Structure of ecosystem

The **abiotic factors** of an ecosystem include water, soil, air, sunlight, temperature, pressure, climate, rainfall, minerals, etc.

The **biotic components** include plants, animals, worms, fungi, bacteria etc., which are being classified under three major groups namely:

- Producers (Plants)

- Consumers (Animals)
- Decomposers (worms , fungi , bacteria)

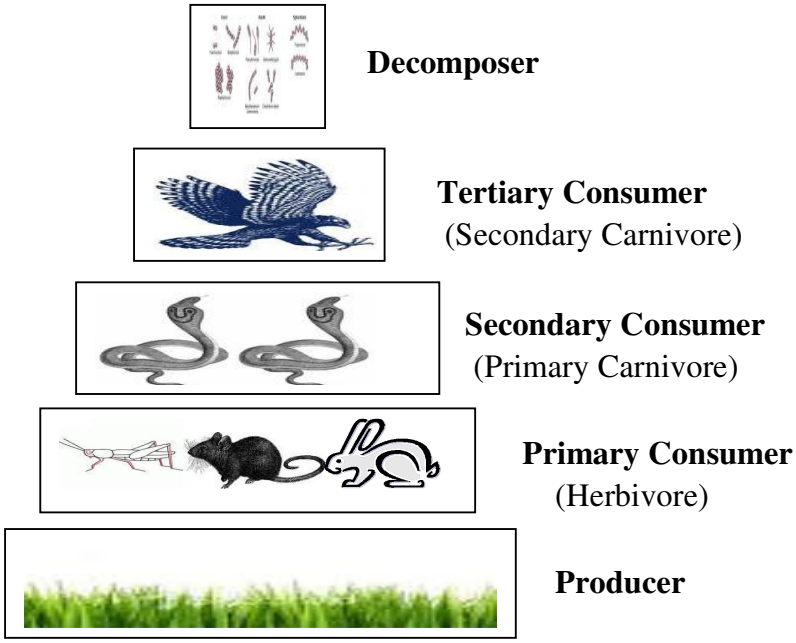


Figure 3.2: Biotic Components of a Terrestrial Ecosystem

Producers

The organisms which carry out **photosynthesis** constitute producers of an ecosystem E.g. Plant, algae and bacteria. Photosynthesis is nothing but the process of transformation of radiant energy (Solar) to chemical energy (Carbohydrates) by the producers. This process requires carbon dioxide and water. This reaction is driven by solar energy, catalyzed by chlorophyll and releases oxygen as a byproduct.

Consumers

The organisms which eat other organisms are called consumers. The consumers are further subdivided in to three types namely, primary consumers, secondary consumers and tertiary consumers.

i. Primary Consumers

The organisms which eat the producers are called primary consumers. As the primary consumers feed only on plants they are also known as herbivores. E.g. Grasshopper, Rat, Rabbit, Cow, Goat, Deer etc.

ii. Secondary Consumers

The organisms which kill and eat the herbivores are called secondary consumers. As they eat only the primary consumers they are also known as primary **carnivores**. E.g. Fox, Wolf, etc.

iii. Tertiary Consumers

The organisms which kill and eat the primary carnivores are called either tertiary **consumers** or **secondary carnivores.** E.g. Lion and Tiger

Decomposers

The decomposers are the organisms that digest the dead organisms with the help of the enzymes and break down them into nutrients. This process of decomposition makes the nutrients available in the soil for the plants to grow. The examples for the decomposers are bacteria, fungi, mold, *actinomycetes* etc., Thus decomposers also facilitates the nutrient cycling between the soil, plants and animals.

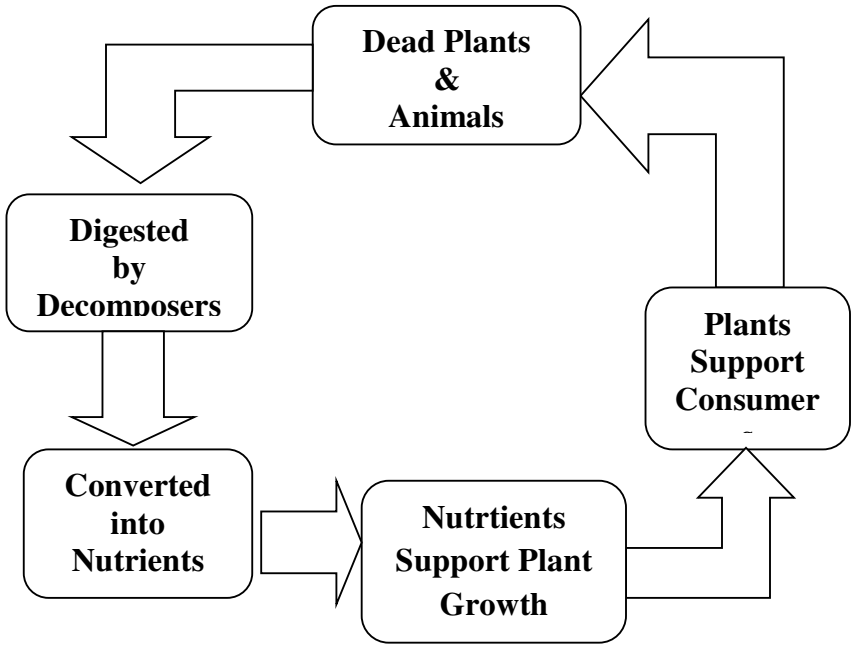


Figure 3.3: Nutrient cycling between soil, plants and animals

1.10.3 FUNCTIONS (DYNAMICS) OF ECOSYSTEM

The functions of ecosystem include the cyclic **movement of nutrient** and energy **flow** between the abiotic and biotic factors. Thus the vital components of functions / dynamics of ecosystem include the following:

- Energy
  - ✶ Primary Production
  - ✶ Secondary Production
  - ✶ Energy flow
- Food Chain and Food Web

- Trophic Levels
- Ecological Pyramids
- Biogeochemical Cycles **/** Nutrient Cycle

Energy

Energy can be defined as a capacity to do work. In a terrestrial ecosystem, the plants (autotrophy) fixes only 3 % light energy as chemical energy. The difference between the total amount of energy taken by the plants and the total amount of carbohydrate (sugar) produced is known as **Gross Primary Production.** The gross primary production less respiration is known as **net primary production.**

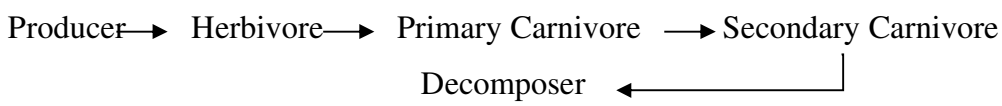
,

Primary Production				
Total amount of energy taken by the plants	**Less**	Total amount of sugar produced by the plants	**=**	Gross Primary Production
Gross Primary Production	**Less**	Respiration	**=**	Net Primary Production

Further, when the producer is being eaten by the herbivore, **Secondary Production** can be defined as the difference between the amount of energy used by the herbivore and the amount of energy lost in metabolic activities. The **Gross Secondary Production** is equivalent to total plant material ingested by the herbivore less the material lost in the feces (excreta).

Secondary Production				
Amount of energy used by the herbivore	**Less**	Amount of energy lost in metabolic activities	**=**	Secondary Production
Total plant material ingested by the herbivore	**Less**	Material lost in the feces	**=**	Gross Secondary Production

Thus the **energy flows** from the producer to decomposer as shown below



Food Chain and Food Web

The energy is transferred from the producer to the consumer by the process of eating and being eaten which constitutes **food chain**.

Plant Rat Snake Hawk

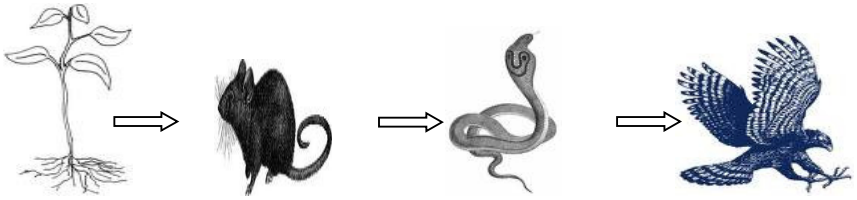


Figure 3.4: Food Chain

Many interlinked food chains together constitute **food web**. The food web is essential for the maintenance of ecological balance.

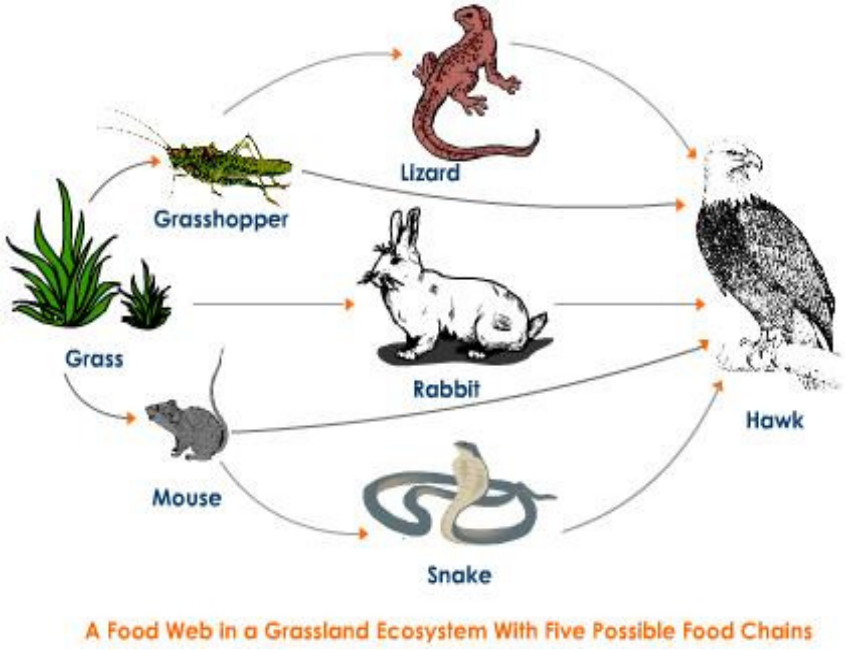


Figure 3.5: Food Web

Trophic Levels

The position of each organism in food chain / food web is being designated as trophic **level** (trophic means food**).** In any food chain / food web, the producers are at the base of an upright pyramid. The herbivores are at the second level and the primary carnivores at the third level and so on.

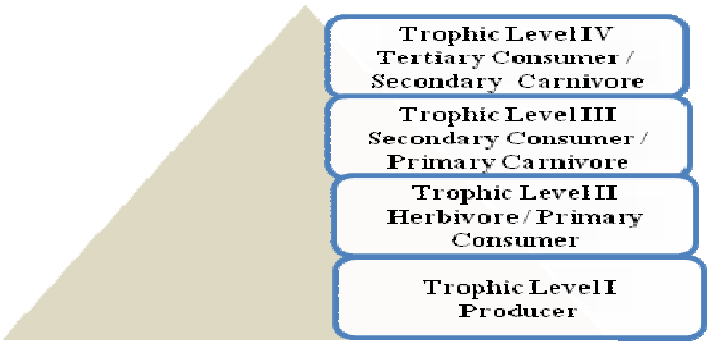


Figure 3.6: Trophic Levels

Ecological Pyramids

The number, biomass and energy of organisms gradually decrease from the producer to the consumer level. This can be represented in the form of a pyramid called **ecological pyramid.**

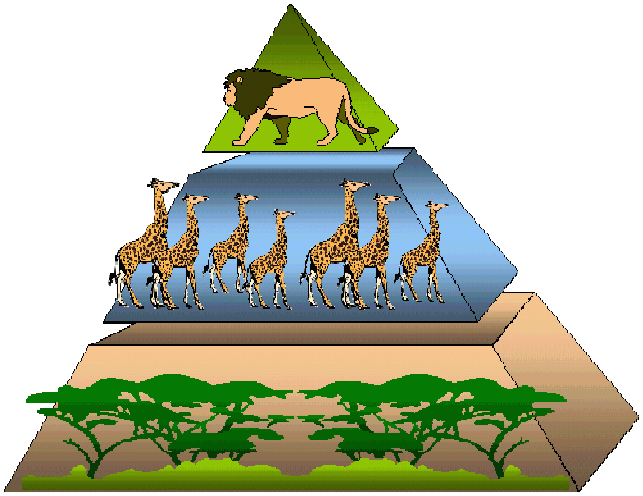


Figure 3.7: Ecological Pyramid of Number and Biomass

During energy flow, at each trophic level about 80 to 90 % of energy is lost and it can also be represented by a pyramid called energy **pyramid**.

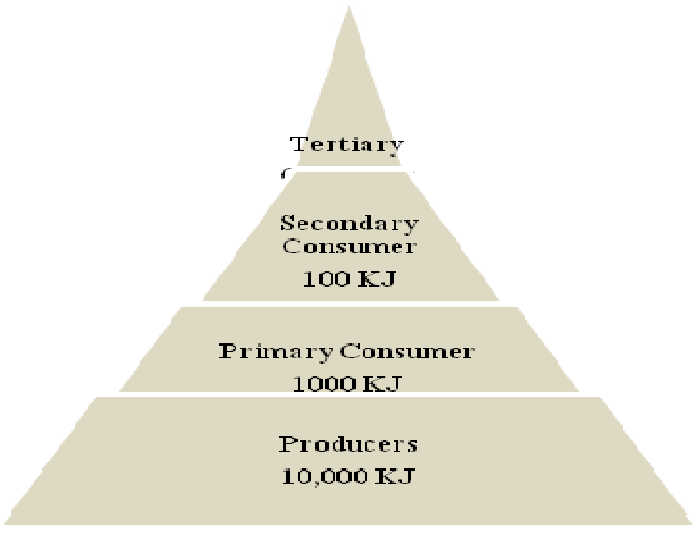


Figure 1

Figure 3.8: Pyramid of Energy

Biogeochemical Cycles / Nutrient Cycle

Cycling of nutrients/gases such as Nitrogen, Oxygen, Carbon, Phosphorus etc., between the biotic and abiotic components is called biogeochemical cycles. The atmospheric Nitrogen (nutrient) reaches the earth through the rain, is being fixed in the soil by the microbial communities. The nitrogen made available in the soil would be exploited by the plants (producers) for their growth. The plants would then serve as food for the herbivores. The food chain continues and gets complicated to form food web. The energy flow which occurs between each trophic level would support the sustenance of life on earth. The decomposers for their turn digest and release nutrients from dead plants, animals and any other organisms, and making the nutrients available on earth. Some nutrients (Nitrogen, O_2) also reach the atmosphere through hydrological cycles.

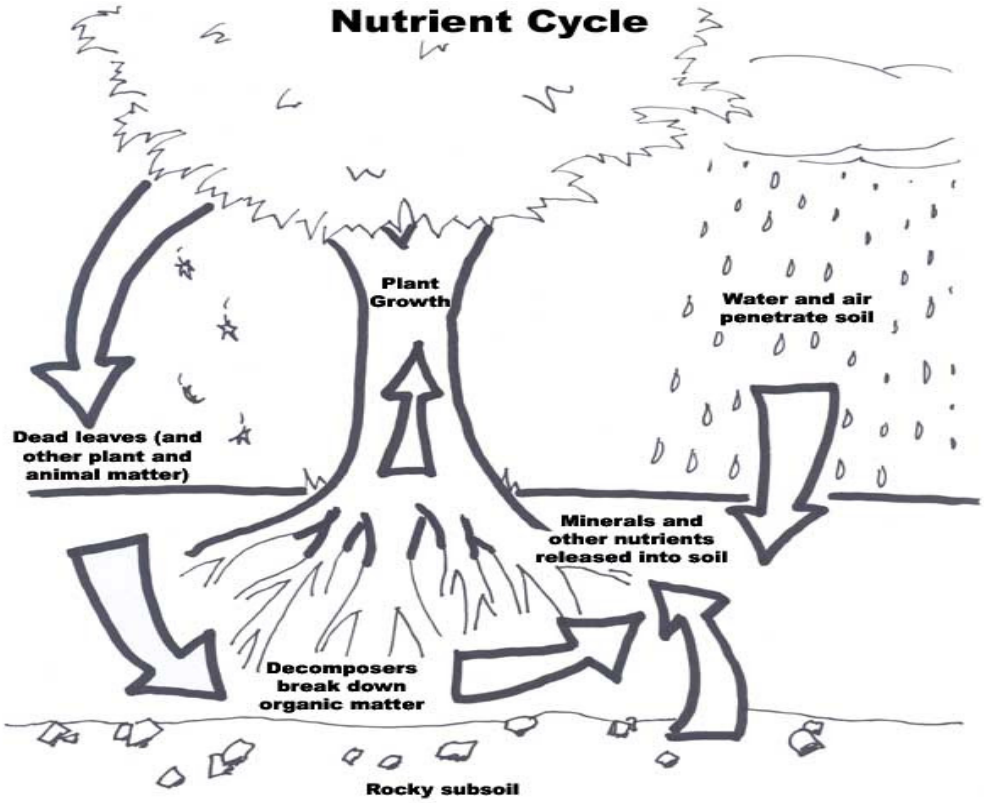


Figure 3.9: Nutrient Cycle

1.10.4 TYPES OF ECOSYSTEMS

Living organisms and non-living environment combine to form ecosystems. Generally an ecosystem consists of physical features and biological features of the components. The following are the types of ecosystems:

- **Aquatic Ecosystem**
- **Terrestrial Ecosystem**

Aquatic Ecosystem

Aquatic ecosystems perform many important environmental functions. They recycle nutrients, purify water, calm floods, recharge ground water and provide habitats for wildlife. Aquatic ecosystems are also used for human recreation, and are very important to the tourism industry, especially in coastal regions.

The aquatic ecosystems are being broadly classified into

i. **Freshwater ecosystem**
ii. **Marine ecosystem**
iii. **Estuarine ecosystem**

i. Freshwater Ecosystems

Freshwater ecosystems cover 0.80% of the Earth's surface and inhabit 0.009% of its total water. They contain 41% of the world's known fish species. There are three basic types of freshwater ecosystems:

a. **Slow-moving water -** ponds and lakes
b. **Rapidly-moving water** - streams and rivers
c. **Wetlands -** areas where the soil is saturated or flooded for at least part of the time

Ponds are the specific type of freshwater ecosystems that are largely based on the autotroph, algae which provide the base trophic level for all life in the pond.

Lakes are big and permanent fresh water bodies with standing water. Many lakes gradually become enriched by nutrients and fill in with organic sediments by a process called **eutrophication.**

The major zones in **river** ecosystems are determined by the velocity of the current. Faster moving turbulent water typically contains greater concentrations of dissolved oxygen, which supports greater biodiversity than the slow moving water of pools.

Wetlands are the most productive natural ecosystems. Due to their productivity, wetlands are often converted into dry land and used for agricultural purposes.

ii. Marine Ecosystems

Marine ecosystems cover approximately 71% of the earth's surface. They are distinguished from freshwater ecosystems by the presence of dissolved compounds, especially salts. Approximately 85% of the dissolved materials in seawater are sodium and chlorine. Seawater has an average salinity of 35 parts per thousand (ppt) of water. Classes of organisms found in marine ecosystems include brown algae, corals and fishes. Environmental problems concerning marine ecosystems include exploitation of marine resources, marine pollution, climate change etc.

iii. Estuarine Ecosystem

Estuaries are the places where rivers meet the sea. It is also called **brackish water zone**. Many different **habitat types** are found in and around estuaries which include shallow open waters, freshwater and salt marshes, sandy beaches, mud and sand flats, rocky shores, oyster reefs, mangrove forests, river deltas, tidal pools and sea grasses.

Estuarine environments foster a **wonderful diversity of wildlife**. Shore birds, fish, crabs and lobsters, marine mammals, clams and other shellfish, marine worms, sea birds, and reptiles are just some of the animals that make their homes in and around estuaries. Besides they also serve as a **breeding ground** for the migratory fishes like eel and salmon fishes.

Further, the **cultural benefits** of estuaries include recreation, scientific studies, education and aesthetic values. Boating, fishing, swimming, surfing and bird watching are just a few of the numerous **recreational activities** that people enjoy in estuaries. They also serve as harbors and ports vital for shipping, transportation and industry.

Terrestrial Ecosystem

Terrestrial ecosystems occupy 144,150,000 km^2 or 28.2%, of Earth's surface. The largest land area is being occupied by the **tropical forests**. In contrast the smallest land areas are occupied by **tundra** and **temperate grassland ecosystems**. Thus, the terrestrial ecosystems are classified as:

i. **Forest ecosystem**
ii. **Grasslands**
iii. **Desert ecosystem**

i. Forest ecosystem

About 40% of our land is occupied by forests. Forests grow in undisturbed areas. Depending upon the rainfall and climatic conditions forests can be of various types:

a. **Tropical Rainforests**

Tropical Rainforests can be defined as a forest in the tropics receiving 4-8 meters rain each year. Tropical rainforests are found in Central and South America, Southeast Asia and islands near it, and West Africa. All tropical rainforests are found along the equator where the temperatures and the humidity remain always high, with the days being equal to the nights. In some regions there can be more than 15 feet of rain a year.

b. Evergreen Forests

Evergreen forests consist entirely or mainly of dense, multi-layered evergreen trees that retain green flora all year round and there is no period of drought or frost.

c. Tropical Evergreen Forests

Tropical evergreen forests usually occur in areas receiving more than 200 cm rainfall and with the temperature range 15 - 30^oC. Found mostly **near**

the equator. They occupy about **7%** of the Earth's land surface and harbour **more than half of the world's plants and animals**. In India, evergreen forests are found on the western slopes of the Western Ghats. It is also found in Assam, Arunachal Pradesh, Meghalaya, Nagaland, Tripura, West Bengal and Andaman and Nicobar Islands. Some of the trees found in Indian tropical evergreen forests are rosewood, mahogany and ebony. Bamboo and reeds are also common.

d. Temperate Evergreen Forests

The temperate evergreen forests are located in the mid-latitudinal coastal region. They are commonly found along the eastern margin of the continents namely, southeastern United States, southern China and in southeastern Brazil. Temperate evergreen forests are characterized by their hardy trees such as oak, pine and eucalyptus.

e. **Temperate Coniferous Forest**

It is a terrestrial biome found in temperate regions of the world with warm summers and cool winters and adequate rainfall. They are common in the coastal areas or regions that have mild winters and heavy rainfall, or mountain areas. Many species of trees inhabit these forests including fir, juniper, pine, redwood and yew. A pine forest is an example of a temperate coniferous forest.

f. Mangroves

Mangrove forests are situated at the sea-land interface in tropical and subtropical latitudes mainly between 25° N and 25° S. They are often known as 'marine tidal forests', 'coastal woodlands' or 'oceanic rainforests'. The life supported by the mangrove forest ecosystem includes algae, barnacles, oysters, sponges and bryozoans, shrimps and mud lobsters and crabs. Mangroves are of valuable ecological and economic resources. They secure life by offering coastal protection against erosion, waves, currents and storms as well natural calamities such as hurricanes and tsunamis and providing livelihood to the coastal people.

ii. Grasslands

Grasslands are the areas where the vegetation is dominated by grasses and non-woody plants. They occur naturally in all continents except Antarctica and cover some 40 % of the earth's surface. Grasslands are used by man for grazing their cattle. Since the grasses which are producers of grasslands grow in large quantities, the variety of consumers is also very high. The **three major types of grasslands** are:

a. Tropical Grasslands

They occur near the **borders of tropical rain forests.** In Africa, the grasslands are known as Savannas, which are tall dense and scattered with shrubs and small trees. The animals on these lands include zebras, giraffes, antelopes etc.

b. Temperate Grasslands

This type of grasslands is usually found on gentle slopped hills. In USA and Canada they are called Prairies**,** in South America they are known as **Pappar** and in Central Europe and Asia they are known as **Steppes**. Since the soil found in these grasslands is very fertile, the lands are sometimes cleared for agriculture.

c. Polar Grasslands

They are found in the polar regions of the Arctic. Severe cold winds and snow restrict the growth of trees. Most of the times there is a thick layer of ice under the soil. The animals in these grasslands are arctic wolf, arctic fox, reindeer etc.

iii. Desert Ecosystem

Deserts are moisture deficit areas which take up about one fifth (20%) of the Earth's land surface. Deserts sometimes contain valuable mineral deposits that were formed in the arid environment. Due to extreme and consistent dryness, some deserts are ideal places for natural preservation of artifacts and fossils. The **major types of desert ecosystems** are:

✶ **Hot deserts**

In **hot deserts,** the temperature in the daytime can reach 45 °C / 113 °F or higher in the summer and drop to 0 °C/32 °F or lower at nighttime in the winter. The largest hot desert is the **Sahara** in northern Africa, covering 9 million square kilometers and 12 countries.

✶ **Cold deserts**

The **Cold deserts** which are covered with snow or ice; the frozen water of cold desert is unavailable to plant life. These cold deserts are more commonly referred to as **tundra** and are characterized by a short season of above-freezing temperatures and a lengthy period with below freezing temperature in a year-round, which makes the land almost completely lifeless.

✶ **Montane deserts**

Montane deserts are normally cold, located in arid places with a very high altitude; the most prominent one is found in the north of the Himalayas, especially in Ladakh region of Jammu and Kashmir, in the Tibetan Plateau.

✶ **Rain shadow deserts**

In some parts of the world, **rain shadow deserts** are formed when the tall mountain ranges block clouds from reaching areas in the direction in which the wind is blowing. As the air moves over the mountains, it cools and moisture condenses, causing precipitation on the windward side. When that air reaches the leeward side, it is dry because it has lost the majority of its moisture, and results in a desert. The **Agasthiyamalai hills** in Tirunelveli come under this category of **rain shadow desert.**

1.10.5 CONCLUSION

Thus any ecosystem has its own self regulating mechanism for its normal functioning unless otherwise perturbed by human beings. We the human being on our part should **conserve the lungs (Forest) and circulatory system (water resources) of the earth** so as to enable all lives to thrive on earth.

2. NATURAL RESOURCES

2.1 DEFINITION

The term **natural resource** can be defined as **a form of energy** and / or **matter** which is essential for the normal functioning and well being of the organisms, populations and ecosystems .

2.2 CLASSIFICATION OF NATURAL RESOURCES

Depending upon the availability and abundance the natural resources are classified as **inexhaustible** and **exhaustible** resources.

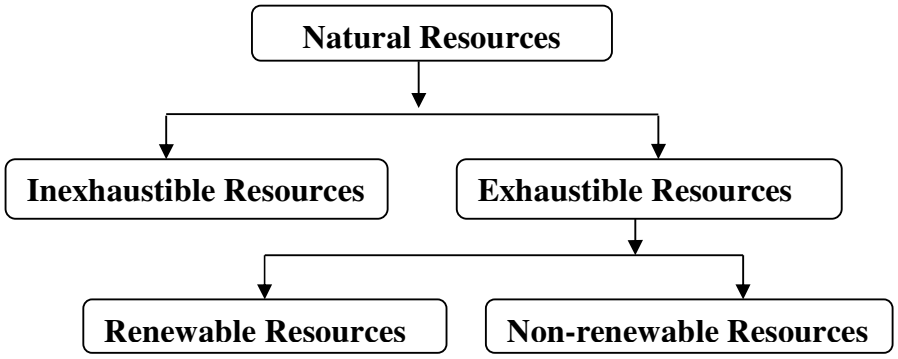


Figure 4.1: Classification of Natural Resources

2.2.1 Inexhaustible Resources

The resources present in unlimited quantities in nature and are not likely to be exhausted easily by human activities are known as **inexhaustible natural resources,** E.g. Solar energy, wind power, tide power, rainfall and atomic energy.

2.2.2 Exhaustible Resources

The natural resources with limited supply on earth are called **exhaustible natural resources** and they can also be exhausted by human activity in the long run, E.g. Coal, petroleum, natural gas, etc. The exhaustible resources are further classified into **renewable** and **nonrenewable** resources.

- ✶ **Renewable Resources**

These resources have the **capacity to reappear** themselves by quick recycling, reproduction, replacement within a reasonable time. E.g. Plants, animals and microorganisms .These resources can be regenerated or increased by taking appropriate actions. For example when forests are destroyed either by

natural forces like fire or drought or by human activities like deforestation, the forests can be rejuvenated.

✶ **Non-renewable Resources**

The natural resources which **cannot be regenerated or recycled** are called **non-renewable resources**, E.g. Fossil fuels (coal, petroleum and gas) and metals. These resources once extracted cannot be regenerated. Man has been utilizing these natural resources for his selfish end from the beginning of civilization. Moreover, increase in population has also resulted in more and more utilization of natural resources.

2.3 PRINCIPAL NATURAL RESOURCES

2.3.1 Forest Resources

Forests are renewable natural resource capable of providing several major and minor forest products and contribute substantially to economic development. The forests conserve a variety of flora and fauna, which form a rich biodiversity and play a vital role in the environmental stability and ecological balance. The forests also provide shelter and means of livelihood for the hilly tribes. They provide employment to people and revenue to Government. They influence the climate by reducing the extremes of temperature; act as rain- holder and rain banker; conserve soil; regulate moisture and flow of rivers; essential for health; purify the air. The trees are the objects of beauty and the forests attract tourists and thus serve as a source of recreation. Some of the approaches towards conserving the forests are as follows.

- Protecting forests from illegal felling, over grazing and fire.
- Protecting wild animals from poaching
- Protecting land area declared as Reserve Forests, Reserve Lands and other areas classified as forest land
- Evolving skill development and employment generation programme to the local people / tribals to improve their socio-economic status
- Involving the local tribal community to conserve and improve the forest resource and manage on sustainable basis for their benefit on participatory approach.
- Undertaking environmental protection works like awareness creation, water-harvesting methods and human resources development, to conserve and enrich their traditional knowledge.
- Promoting the community forestry programme by growing trees on public and community lands. The following practices may be accelerated under this programme.
    - Roadside, Farmhouse and Foreshore planting

- Railway lands and Defense lands afforestation
- Industrial area and Private land afforestation
- Municipal / Town area wastelands afforestation

2.3.2 Water Resources

Of all the planet's renewable resources, water has a unique place as it is essential for sustaining all forms of life, food production (agriculture, aquaculture etc.,), economic development (hydropower generation, livestock production, industrial activities, forestry, fisheries, navigation, recreational activities etc.,) and for general well being.

It is noteworthy that, with the rapid growing population and improving living standards, the pressure on our water resources is escalating and per capita availability of water resources is diminishing alarmingly. This anomaly is mainly due to the following problems faced by any country.

- Climate change associated spatial and temporal variability in precipitation (rainfall)
- Over- exploitation of groundwater and reduction of low flows in the rivers
- Intrusion of salt water in aquifers of the coastal areas.
- Over canal irrigation
- Deterioration of water quality by the increasing pollutant loads from point and non-point sources.

Besides the developmental activities such as construction of dams and reservoirs, land use change, agricultural practices, drainage of swamps, deforestation, urbanization, and improper irrigation practice would make water as a scarce commodity. To sustain life on earth the following strategies may be adopted for effective management of water resources.

- Decision support for water resources management systems
- Knowledge sharing, people's participation, mass communication and capacity building programmes for water conservation at community level
- Judicious use of water
- Recycling of used water
- Constructing waste water treatment plants
- Harvesting of rain water
- Protection of water sheds
- Afforestation

2.3.3 Mineral Resources

Minerals are non renewable natural resources occur as ores in earth. They are mined from earth by man. Mineral sources include all inorganic and organic substances derived from earth. They are basically classified under two

main categorizes called **metallic minerals** (copper, gold, silver, zinc, manganese, iron etc.,) and **non metallic mineral** (graphite, diamond, phosphate rocks, coal, oil, natural gas etc.). The rate of exploitation of minerals is geometrically increasing with the population size. Since, minerals are nonrenewable resources the following practices can be adopted to conserve them.

- Economical usage of minerals
- Making use of less precious substitutes
- Reuse of metals after recycling

2.3.4 Food Resources

99.7 per cent of human food calories are coming from the croplands and less than 0.3 per cent from oceans and other aquatic ecosystems. The continued production of food and adequate food supply are directly dependent on ample fertile land, freshwater and energy, plus the maintenance of biodiversity.

Globally, an average of only 0.22 hectares of cropland per capita is now available for crop production. Each year, more than 10 million hectares of valuable croplands are degraded and lost because of soil erosion. In addition, an added 10 million hectares are being destroyed by salinization resulting from improper irrigation. Thus the combined, world soil erosion and salinization account for the major losses in productive cropland. Along with the loss of cropland and irrigated land, declining trend in use of fertilizer worldwide would suppress the food crop production, especially in developing countries.

The pattern of food demand and need is the result of the combined effects of world population growth: which is being projected as 9 billion by 2050. According to the World Bank and the United Nations, from 1 to 2 billion humans are now malnourished, indicating a combination of insufficient food, low income and inadequate distribution of food. As the world population expands, the food problem will become increasingly severe and the number of malnourished will be conceivably reaching 3 billion.

The following reasonable measures can be taken to enhance global food production

- Ecofriendly approaches to reduce the pressure on natural resources
- Research on environmentally sound farming techniques
- Knowledge and technology transfer should be facilitated from developing countries through appropriate bilateral and multilateral arrangements
- Major efforts must be deployed to improve the efficiency in use of resources
- Training opportunities should also be provided for planning and management of agricultural policies

- An alternative livelihood system focused on small scale and labour intensive enterprises that use local resources and skills
- Access of rural women to agricultural extension and training

- Empowering the community organizations which improve the status of rural women by providing greater incentive to manage and utilize their natural resources in a sustainable way.

2.3.5 Energy Resources

Basically, the energy resources are classified under two categories namely non **renewable** and **renewable energy resources**.

- **Non renewable Energy Resources**

The energy sources which cannot be immediately replenished after exploitation are called **non renewable energy resources**. E.g. Petroleum, natural gas and coal. These three resources are also collectively called **fossil fuels**. About 90 % of the World's energy requirement is met out by these resources only (petroleum 45 %; natural gas 20 %; coal 15 %).

The standard of living of people of any country is considered to be proportional to the energy consumption. The energy consumption has been alarmingly increasing and it will triple by 2025. Americans hold the dubious honour of being the world's leaders in fossil energy use. As per the projections for the year 2040, more than 60 per cent of the oil resources will be depleted. The shortage of supply against demand would urge the dire need to develop renewable energy sources.

- **Renewable Energy Resources**

Any source of energy that can be used without depleting its reserves is called **renewable energy resource.** These sources include **sunlight (solar energy)** and other sources such as **wind, tide and wave, biomass and hydro (Water) and geothermal energy.**

- **Solar Energy**

Tropical countries like India mainly with about 250 – 300 sunny days have the potential to generate 35 MW of power from 1 sq km. In spite of the potential, the major drawback is high startup cost. However, harnessing solar energy for water heating, Cooking, lighting and open air drying applications are common now-a-days. The other applications of solar energy include, solar vehicles, solar desalination systems (convert saline or brackish water into pure distilled water), etc. which are also coming up. The solar energy is chiefly harvested with **photovoltaic cells** which convert light energy directly into electrical energy.

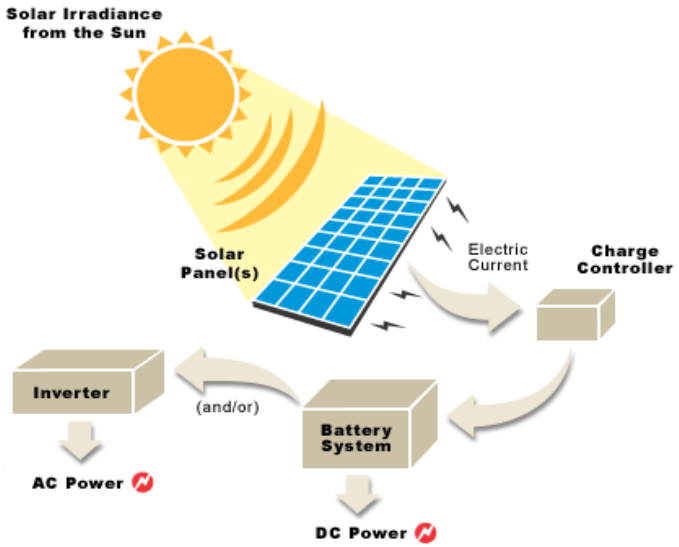


Figure 4.2: Solar Panel converting solar energy into electrical energy

- **Wind Energy**

The wind energy is being harnessed by a wind mill with a vertical pillar and three blades. The blades are rotated by the force of the wind. The blades in turn rotate a wheel connected to a generator which generates electrical energy. Normally the wind mills are established around the oceanic area where the wind speed is about 10 – 20 km per hour.

Figure 4.3: Wind mills erected around oceanic belts

- **Tidal and Wave Energy**

Tides (tidal energy) caused through a combination of forces created by the gravitational pull of the sun and the moon, and the rotation of the earth and energy naturally present in water bodies or in their movement (wave energy) can be used for generation of electricity.

In **tidal energy plants** the **potential energy** of the water body (height difference between low and high tides) would be exploited to rotate an

underwater power turbine to generate the electrical energy .Where as in **wave energy farms** the **kinetic** (dynamic) **energy** of the waves would be employed to generate electricity.

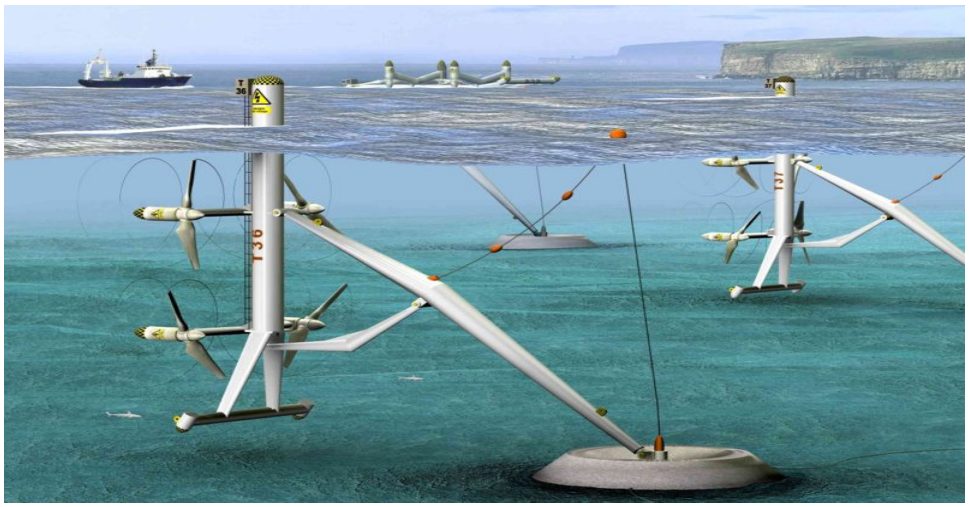


Figure 4.4: Tidal energy plants

- **Biomass Energy**

The energy derived from **living organisms** is called biomass **energy**. It is being used by human beings from time immemorial. The early man generated fire by using the biomass resources such as leaves and wood. Even today in most of the villages, firewood is being used for preparation of food, heating water for bath, etc. The efficiency of such a process is very low as most of the heat is lost to the surroundings. Thus the biomass can be converted into heat and light. Besides the biomass (rice husk, sugarcane molasses, animal wastes etc.) is also being converted into gas (biogas) through a gasifier after combustion. In addition to that the biomass resources are also being exploited for extracting the biofuels E.g. Jatropha Plant : Biodiesel ; Microorganisms : Ethanol .

- **Hydro and Geothermal Energy**

Hydro energy is being derived from water. The water flowing down from a reservoir is being used to rotate the turbines to generate electricity. Besides, the heat prevailing in hot springs where the temperature exceeds 150°C (Hydro thermal Energy) would also be exploited to generate electricity. The **geothermal energy** in turn is being derived from the heat evolved by the molten core of earth. Geothermal energy is being used for boiling water and generates steam to drive turbo generators.

2.3.6 Land Resources

The land area of the Earth covers a total of more than 140 million km^2. These land resources are finite, fragile and non-renewable. They include **soil** - which is essential for agriculture, **land cover** - which is imperative for the environment and landscapes**,** which serve as a basis for human settlement and transport activities. Land aids in the preservation of terrestrial biodiversity, regulation of the hydrological cycle, carbon storage and recycling, and other ecosystem services. It also acts as a store of raw materials, a waste dump and landfill for both solid and liquid wastes.

So far about 2000 million ha of soil, equivalent to 15 per cent of the Earth's land area has been degraded. The degradation of land is mainly due to the climate induced soil erosion, effected by

- water erosion (56 per cent)
- wind erosion (28 per cent)
- chemical degradation (12 per cent)
- physical degradation (4 per cent)

Further, the human- associated activities which cause soil degradation include the following

- overgrazing (35 per cent)
- deforestation (30 per cent)
- agricultural activities (27 per cent)
- overexploitation of vegetation (7 per cent)
- industrial activities (1 per cent)

Besides, the urban areas which occupy only 1 per cent of the Earth's land mass is also being subjected to pressure by urban expansion, including land requirements for industry, transport and leisure activities. In United States alone about 400 000 ha of farm land are lost to urbanization.

The land resources can be protected from soil erosion by adopting the following practices.

- Planting vegetation, trees, ground cover, shrubs and other plants. The roots from these plants will help to hold soil
- Creating windbreaks, which are barrier rows planted along the windward exposure of a plot of land.
- Growing cover crops on farm land which can help to prevent soil erosion due to wind and rain. Legumes (beans) can be used as cover crops.
- Formulation of clear national land-use policy.

2.4 BIODIVERSITY AND ITS CONSERVATION

2.4.1 INTRODUCTION

The variety of animals, plants, fungi and microbial organisms living in a variety of habitats on earth is known as **biological diversity**. This term was first coined by Norse and Mc Manus (1980) and later shortened as **biodiversity** by W.G. Rose (1985). The term biodiversity can also be redefined as species **richness** (number of species present) and **evenness** in different geographical locations. The species which are confined to a particular locality are called **endemic species**. Further, biodiversity in a spot with endemic species is known as **Hot Spots of Biodiversity**. The concept of biodiversity hot spot was first addressed by the British Ecologist, Norman Meyer, (1988). Globally 25 such hot spots are identified which cover an area of 454400 sq km or 0.3 % of the world's land area with 6 % endemic flora (plants). The faunal wealth / endemism of these hot spots include 80 % insects and 90 % primates of the global fauna (animals).

The countries like India, with large proportion of these biodiversity hot spots are referred to as **mega diversity countries**. There are two hot spots in India - one in **Western Ghats** which extends into Srilanka and Indo Burma Region and the other in **Eastern Ghats** which stretches up to the Himalayas. These two hot spots are quite far away from one another and characterized with wide variety of physical features and climatic conditions. In India alone about 1,15,000 species of plants and animals are identified.

2.4.2 CLASSIFICATION OF VALUE OF BIODIVERSITY

The Economists classify the value of biodiversity under two major categories namely **direct** and **indirect** values. Direct value is being further, divided into **consumptive** value, **productive use** value and **nonconsumptive** value. The nonconsumptive value is being again divided into two categories namely, **social** and **ethical values.**

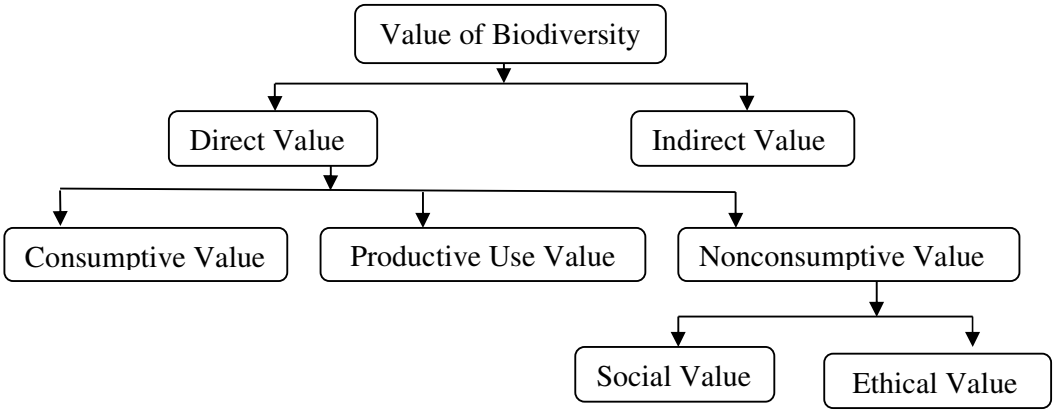


Figure 5.1: Classification of value of biodiversity

2.4.3 Direct Value

- **Consumptive Value**

This category includes a class of **products or produce** which can be directly **consumed** by the **local community.** E.g. i) The biodiversity of a **forest ecosystem** provides livelihood to the **tribals** in terms of food, firewood, fodder, medicines etc., ii) The biodiversity of **aquatic ecosystems** supports the economy of **fisher folk.**

- **Productive Use Value**

All marketable goods of biodiversity is being included under this category. E.g. Antibiotics, pharmaceuticals etc.,

- **Nonconsumptive Value**

This category includes a class of **products or produce** with **social / ethical value** and which **cannot** be consumed. Nevertheless, the benefits can be enjoyed by the society in terms of **ecotourism**.

- **Social Value**

It includes **all life supporting resources** which are preserved by the traditional societies of smaller population size.

- **Ethical Value**

All forms of life conserved and protected based on their value are being included under this sector.

2.4.4 Indirect Value

Indirect value of biodiversity includes the **ecosystem processes** such as decomposition, nutrient cycling etc.

2.5 THREATS TO BIODIVERSITY

The conservative figures predict that at least 1 % of the existing species is lost per decade. Otherwise we are losing two species per an hour. Threats to the biodiversity may include the following:

- Habitat degradation and loss
- Invasion / induction of exotic (non native) species
- Overexploitation of resources
- Global climatic change
- Developmental pressure

2.5.1 Habitat Degradation and Loss

The biological communities fragmented into small patches and surrounded by urban and agricultural lands are subjected to pressure due to the human activity which might lead to the habitat degradation and loss.

2.5.2 Invasion / Induction of Exotic Species

When an exotic species is being invaded / inducted into an environment, it might out compete or prey on native species and destroy them. E.g. in Lake Victoria, when Nile Perch was introduced it destroyed about 400 native species. Similarly, when the exotic plants, Eucalyptus and Casurina , native of Tropical America and Australia respectively were introduced into Indian subcontinent, the fast growth of these plants appeared to be ecologically harmful by suppressing the growth of the native plant species.

2.5.3 Overexploitation of Resources

Over exploitation of natural resources in terms of over deforestation, over hunting / fishing and over industrial scale mining etc. would cause threat to the very survival of both the animal and plant kingdoms.

2.5.4 Global Climatic Change

Recently, the change in the global climate has been identified as one of the major risk factors in causing threat to the species and ecosystems. The environmentalists estimate that the global warming has the potential to destroy 35 % of existing terrestrial habitat.

2.5.5 Developmental Pressure

The major causatives for the threat to biodiversity, under developmental pressure are categorized as follows:

- onstructions
- Forest based industries
- Hydal / Irrigation Projects
- Mining / Oil drilling / Resource extraction
- Pollution
- Road / Rail Transport and Encroachment.

Further, the other threats include, **human induced disasters** such as monoculture forestry, improper practices in land use, dilution of traditional values, deforestation, lack of awareness, human harassment, urbanization, overhunting, imbalanced plantation programme, indiscriminate botanical collections, Genetically Modified Organisms (GMO's), diseases etc. Besides, the **natural disasters** *viz.,* forest fire, flood, cyclone, tsunami, volcano, earthquake, landslide, avalanche (slide down in snowy mountains and rocks), drought etc., would also cause threat to the biodiversity.

2.6 CATEGORIES OF THREAT

International Union for Conservation of Nature and Natural Resources (IUCN) has recognized the threats to life under the following four categories.

Endangered : Taxa in danger of extinction and whose survival is unlikely

Vulnerable : Taxa likely to move into endangered category in near future

Rare : Taxa at risk.

Threatened : Species which are in any one **of** the above categories

The **Botanical Survey of India (BSI)** has listed 427 endangered plant species in its publications in the Floristic synthesis enumerated for **Red Data Book** (A catalogue of taxa facing the risk of extinctions) maintained by IUCN / **World Conservation Union** (WCU). This list of endangered plant species contributes 20% of the floristic wealth of India. Similarly, the **Zoological Survey of India** (ZSI) has reported 81 mammals, 38 birds and 18 reptiles as endangered species and IUCN has recorded a total of 215 endangered animal species.

2.7 BIODIVERSITY CONSERVATION

As the biodiversity extends wide variety of environmental services *viz.*, production of O_2, reduction of CO_2, maintenance of water / hydrological cycle, nutrient cycle / biogeochemical cycle, protection of soil etc., in addition to the food, clothing and housing materials, energy, medicine etc., the conservation of biodiversity is very much essential for the well being and long term survival of mankind. Further, the conservation of biodiversity also has the global concern as it can be linked with the maintenance of ecological stability and productivity, which serve as a main attribute in sustained development and stable national economy.

The two major approaches of biodiversity conservation are i) ***in situ* conservation** and ii) ***ex situ* conservation**.

- ***In situ* Conservation**

It refers to the protection, maintenance and management of plants and animals in their natural habitats through the **Protected Areas** (PAs) which include the National Parks, Sanctuaries, Biosphere Reserves etc.,

- **Protected Areas** (PAs) **and Biodiversity Conservation**

The initial efforts of biodiversity conservation aim at establishment and maintenance of a network of Protected Area System by involving local people in PA Management. The PAs also includes **23 Tiger Reserves** and 14 **Biosphere Reserves.** Today, India has **86 National Parks** and **80 Wild Life Sanctuaries** which spread to an area of about 1.4 Lakh km^2 constituting more than 4 % of the total geographic area of the country and one fifth of the forest area. These PAs are under the management of **Indian Board of Wildlife**. Further, the awareness on bioconservation has been created among the public by observing a **Wild Life Week** in the **First Week of October** every year.

The functional description of the 6 major categories of the PAs is being furnished below.

1. **Strict Nature Reserve / Wilderness Areas** - Science or Wilderness Protection
2. **National Park** - Ecosystem Conservation and recreation
3. **Natural Monument** - Conservation of Specific Natural Features
4. **Habitat / Species Management Areas** - Conservation through Management Intervention
5. **Protected Landscape / Seascape** - Conservation for recreation
6. **Managed Resource Protected Area -** Sustainable use of natural ecosystem.

- ***Ex- situ* Conservation**

The protection of selected or rare plant / animal species **outside the natural habitat** is being referred as *ex situ* conservation which can be targeted by the biotechnological methods, such as the establishment of seed banks / pollen banks / spore banks / Gene banks / Germplasm banks and by adopting plant tissue culture methods.

- **Seed Banks / Pollen Banks / Spore Banks**

The seeds, pollen grains and spores of the endangered plant species are collected from the forests and maintained at viable conditions for further use / crop improvement.

- **Gene Banks / Germplasm Banks**

The gene pool of economically, medically, socially and ecologically important plant species can be conserved at gene banks / germplasm banks. The first Genetic Resource Centre (GRC) of the world was established by N.I.Vavilov at Leningrad (1920). During last two decades, many regional / international GRC's have been started functioning in different countries. The few such are:

- International Rice Research Institute, Manila
- Maize and Wheat Improvement Centre, Mexico
- International Potato Centre, Peru
- National Bureau of Plant Genetic Resources, New Delhi

- **Plant Tissue Culture Method**

This method would permit us to propagate especially the endangered plant species in a large scale. In this case even a single cell or any excised part of a plant (explants) like, leaf disc , petiole, apical shoot, pollen etc., can be grown into a complete plant by providing suitable **culture medium** (MS medium) under laboratory conditions. Advantages of this method are the production of more number of saplings in a limited space and the plants raised from apical shoot are free from viral infections.

- **Cryopreservation**

Cryopreservation is nothing but storage **at reduced temperature**. This method can be adopted for the preservation of germ plasm of animal cells / spermatozoa, microbial cells etc., at **-196°C** in a **liquid Nitrogen Can**. One of the major advantages of this method is the biological activities of the cells can be conserved for a indefinite period.

2.8 CONCLUSION

Biodiversity not only offers economical benefits but also provides a great deal of aesthetic enjoyment and cultural benefits to the people with the whole suite of their resources, benefits, and services. So every individual should have aspiration for the conservation of biodiversity for the mutual benefit.

3. ENVIRONMENTAL POLLUTION

3.1 INTRODUCTION

Any undesirable change in the physical, chemical and biological nature of environment (Air, water and soil) is known as **pollution**. The substances which could cause pollution are called **pollutants.** A pollutant may be a solid or liquid or gaseous substance present in greater amount than natural abundance.

3.2 TYPES OF POLLUTION

3.2.1 AIR POLLUTION

Air pollution is most crucial from the public health point of view because every individual person breath 22,000 times a day and inhaling about 15-22 kg air per day. Polluted air causes physical ill effects to the life exist on earth. Besides, it also has great impact on environment by serving as a major cause for green house effect / global warming, ozone layer depletion and acid rain etc. The major air pollutants and their effects are discussed below:

- **Carbon Monoxide** (CO) is a gas produced by the process of in complete burning of carbon based fuels including petrol, diesel and wood. It lowers the amount of oxygen carrying capacity of blood. Exposure to even 0.001 % CO for several hours together cause impaired perception, slow reflexes, head ache drowsiness and blurred vision. In large doses it can cause even death.
- **Carbon Dioxide** (CO_2) is a principal green house gas emitted as a result of human activities such as burning of coal, oil and natural gases. It produces adverse effects only at very high levels.
- **Chloroflurocarbons** (CFC) are the gases, released mainly from the air conditioning and refrigerating systems. When released into air it reaches the stratosphere and comes in contact with other gases, which leads to the reduction of ozone layer.
- **Lead** (Pb) is present in petrol (0.56g / l), diesel, batteries, paints, hair dye products etc. It affects the traffic policemen who are vulnerable to automobile exhausts and children who play with toys coated with leaded paints in particular. The toxic dose is 0.8 ppm for adult and 0.6 ppm for children. It causes nervous and digestive disorders and even cancer
- **Ozone** (O_3) is naturally present in the upper layer of the atmosphere acting as a shield and protects the earth from the harmful ultra violet rays of sun. However, at ground level, it is a pollutant with highly toxic effects. Vehicles and industries are the major sources of ground level

ozone emissions. It causes eye irritations and also lowers the resistance to cold and pneumonia.

- **Nitrogen Oxide** (NOx) is being released into air during the process of burning of fuels including petrol, diesel and coal. It makes the children susceptible to respiratory disorders like influenza / common cold. Besides, smog and acid rain caused by nitrogen oxide have got greater environmental concern.
- **Suspended Particulate Matter** (SPM) is a solid component present in air in the form of smoke, fly ash, pieces of asbestos, dust and vapour. They can remain suspended in air for extended periods. It serves as a major source of haze which reduces the visibility. The particulates are characterized as follows.

  Aerosol - Particles suspended in air
  Mist - Aerosol with liquid droplet
  Dust - Aerosol with solid particles (dust particles and ash)
  Smoke - Solid particles / mixture of solid and liquid particles
  Fum - Aerosol produced by the condensation of hot vapors of metals
  Plume - Geometrical form of smoke coming out of chimney
  Fog - Aerosol with water droplet
  Smog - Mixture of smoke and fog

  On breathing the finer of these particles, they would lodge in lungs and cause bronchitis and asthma.
- **Sulphur Dioxide** (SO_2) a major contributor of acid rain is being released from burning coal, mainly in thermal power plants. Some industrial processes, such as production of paper and smelting of metals also produce Sulphur dioxide. It causes lung diseases.
- **Photochemicals** are the **compounds** which are formed in combination with some pollutants under the influence of UV radiation. E.g. PAN (Peroxy Acetyl Nitrate). It affects photosynthesis of plants.

- **Control Measures**

Air pollutants should be confined at the source itself. This can be achieved by adopting any of the strategies mentioned below:

- Modifying of the processes in such a way that the pollutants are not formed beyond the permissible limits.
- Reducing the concentration / dilution of pollutants before getting released into the environment.
- Adopting Green Chemistry Technology where the substances which would produce more toxic elements are replaced with less toxic substances.

3.2.2 WATER POLLUTION

The economic growth of several countries around the world is being determined also by water as it is essential for drinking , irrigation , industrial purposes etc., Quality of water is very much important for all of these purposes. As water is a great solvent, various elements are found dissolved in it. When water contains certain substances more than the acceptable level, it is said to be polluted. The sources of water pollution may be classified as **point** and **non – point sources**.

- **Point Sources of Water Pollution**

When a source **of pollution is readily identified** with its entry point it is known as point source of pollution. E.g. Municipal and industrial discharges

- **Non - point Sources of Water Pollution**

When a **source of pollution cannot be identified**, it is said to be non – point source of pollution. E.g. Acid rain and agricultural runoff

- **Causes of Water Pollution**

- **Pathogens**

The pathogens are **disease causing agents** which include bacteria , virus etc., They may cause some **water borne diseases** such as cholera , typhoid, fever, dysentery, etc.

- **Organic Wastes / O_2 Depleting Wastes**

The organic wastes are decomposable by aerobic (oxygen demanding) bacteria. To degrade the organic wastes, aerobic bacteria utilize O_2 present in water. The amount of oxygen required to break down the organic wastes is known as Biological **Oxygen Demand** (BOD). When water is highly polluted, the oxygen available in water would be completely utilized by the aerobic bacteria. This leads to an increase in BOD level in water. The aquatic life is not possible when BOD of water is 4 ppm (parts per million) and above (BOD of pure water is 1ppm).

- **Inorganic Pollutants**

These are **water soluble phosphates and nitrates**. The major source of these inorganic pollutants is agricultural runoff which contains fertilizers, pesticides, etc. The excessive addition of these nutrients to water is known as eutrophication**.** This condition would promote the growth of algae to form a algal bloom. As a result the quality, taste and smell of water would change. Besides, the O_2 level would also be depleted and water becomes unsuitable for fishes and other aquatic animals. There is also another possibility of these pollutants getting accumulated into the biological systems (bioaccumulation) and also they reach human through **food chain** as mentioned below:

Inorganic Pollutants

Figure 6.1: Food Chain

At each level of food chain, these pollutants are increasingly concentrated in biological systems. This process is known as **biomagnifications.** Thus pollutants are becoming major threat to life.

- **Water Soluble Organic Chemicals**

Acids, salts and compounds of toxic metals like Mercury, Lead, Copper etc., discharged by the industries may cause the diseases / disorders as listed below:

✶ Hg (Mercury)	-Mina Mata Disease
✶ Cd (Cadmium)	-Itai Itai
✶ Al (Aluminium)	-Aluminosis
✶ Zn(Zinc)&Cu(Copper)	-Hyperkeratosis
✶ Sn (Stantium)	-Stanosis
✶ Pb (Lead)	-Plumbism

- **Oil**

Leakage or spilling of either crude petroleum or refined petroleum (fuel oil, gasoline and other by products) primarily destroys aquatic life as it forms a thin layer which prevents the interaction of oxygen with water. However, some toxic chemicals would be evaporated. Nevertheless, the heavy oil components like naphtha and asphalt which sink into ocean floor is believed to cause greatest long term effect on aquatic life.

- **Suspended Matters**

The suspended matters would interfere with the penetration of sunlight in water. Thereby the productivity of aquatic plants would be greatly reduced. This condition would warrant ecological imbalance.

- **Thermal Pollutants**

In a thermal power station, approximately 700 million gallons water is being used by a Plant per day which is then discharged into the nearby water body. This would cause a rise in temperature by 15°C than the normal level. This condition would decrease the solubility of O_2. Further, the rise in temperature affects the breeding (reproduction) cycle of aquatic life and also making them susceptible to diseases.

- **Groundwater Pollution**

Groundwater is a vital source of drinking water. EPA (Environmental Protection Agency) estimates that 2 % of a country's usable ground water is moderately or severely polluted. The two major sources of ground water pollution are leaks of hazardous organic chemicals from underground storage

tanks and seepage of toxic heavy metal pollutants from landfills, dumps and lagoons.

- **Control Measures**

Water pollution can be controlled by adopting the methods suggested below.

- Prevention of the discharge of untreated industrial / domestic wastes into nearby water bodies.
- Replacement of chemical fertilizers with biofertilizers (Rhizobium, *Azotobacter, Azospirillum* etc.) and pesticides with biopesticides (Bacillus Sp.)

3.2.3 SOIL POLLUTION

The unfavourable substances dumped on soil would cause soil pollution. Besides, pollutants in air and water which reach the soil would also serve as the source of pollution. The major source of soil pollution and their effects are discussed below:

- **Sources**

- **Pesticides / Weedicides**

The wide range of various pesticides, insecticides, fungicides, herbicides and weedicides such as aldrin, endrin, malathion, etc. are employed in intensified agricultural practices. As these toxic chemicals are fat soluble hydrocarbons, they tend to accumulate in the living organisms and get concentrated at each trophic level. Hazards of these pollutants are listed below:

- Affect not only the target organisms but also the other beneficial microorganisms.
- Interfere with the photosynthesis and metabolic activities of plants.
- Damage the central nervous system and cause cerebral hemorrhage

- **Chemicals**

The toxic metallic pollutants, salts, acids and alkalis of industrial discharges and the precipitates of acid rains pollute the soil. An example for the chemical pollutant is fluoride which inhibits photosynthesis in plants and also causes abscission of leaves and fruits. In human beings the fluorides cause mottling of teeth, week bones, and knocking of knees etc.

- **Fertilizers**

The chemical fertilizers added to soil would interfere with soil microbial communities and thus affect the soil quality. Further, they would also detoriate the soil quality by enhancing the salt content.

- **Human and Animal Wastes**

In both under developed and developing countries these wastes would create unhygienic conditions. The pathogenic **organisms** found in these wastes

would ultimately cause health hazards like amoebiasis (dysentery) cholera etc., in domesticated animals and human beings.

- **Discarded Materials**

Man discards materials like rugs, leather, plastics, glass, paper, concrete materials, e-waste, components of machineries etc., on land. This would make land barren.

- **Hazardous Wastes**

Vast amounts of hazardous **electronic wastes**, **plastics** and **metal scrap wastes** are being burned or discarded in the fields, irrigation canals and water ways across developing countries in Asia. This practice would pollute the natural environment. It is noteworthy that millions of kilogram of electronic wastes of computers and televisions are being generated in developed countries every year. Of which, 50 – 80 % is being shipped for recycling in countries like India, China and Pakistan. On recycling process, the heavy metals like lead, mercury, cadmium etc., are being released into soil which in turn would pose health hazards.

- **Plastics**

With the revolution in modern life, plastic consumption triples every decade. The throwaway culture of these non biodegradable petrochemical based plastics causes serious environmental problems. On accumulation of these wastes, the aesthetic qualities of cities and forest are greatly affected. It prevents the percolation of rain water. On burning, these wastes release **dioxin** which is highly carcinogenic.

- **Nuclear / Radioactive Wastes**

Radioactive elements from nuclear power plants and mining units reach through water. The hazardous effects of radioactive wastes are discussed in detail in Chapter 7.

- **Salination of Soil**

The increase in the concentration of soluble salts in soil is known as **salination**. The salinity would reduce the fertility of the soil. About 6000 - 8000 hectares of farm land turns saline every year in Punjab alone. The major causes of soil salinity are:

- Aquaculture practices like prawn culture in agricultural farms
- Inflow of water from sea at coastal regions
- Excessive use of alkaline fertilizers
- Improper drainages

- **Control Measures**

To maintain the soil quality and fertility the following suggestions are made:

- Minimize the use of chemical fertilizers and pesticides
- Adopt improved cropping techniques
- Prefer organic farming practices

- Plant soil binding grasses to prevent soil erosion
- Construct wind breaks at 1000 m interval along the sea shore
- Plan for wind shields by planting vegetation in 7 to 9 rows in a zig zag pattern with 5 m space between each row and tree.
- Burry the nuclear wastes in a insulated concrete sealed drums at 1000 fathoms deep into sea.
- Adopt proper discharge practices for the technological wastes
- Store the low radioactivity materials for some time before disposal
- Treat the wastes before disposal
- Recycle the wastes

3.3 CLASSIFICATION OF POLLUTANTS

Basically, there are three major types of pollutants based on their biodegradability and the rate of biodegradation.

- Biodegradable / Non persistent pollutants
- Slowly degradable / Persistent pollutants
- Non biodegradable pollutants

- **Biodegradable / Non persistent Pollutants**

The pollutants which can be rapidly broken down by biological processes are called biodegradable / non persistent pollutants. E.g. Domestic sewage and discarded vegetables

- **Slowly degradable / Persistent Pollutants**

The pollutants which take a decade or even longer to degrade are known as slowly degradable / Persistent pollutants. E.g. Pesticides and Plastics

- **Non biodegradable Pollutants**

The pollutants which cannot be degraded by natural processes are called non biodegradable pollutants. E.g. Toxic metals like, Lead, Mercury etc., and nuclear wastes.

3.4 ENVIRONMENTAL MANAGEMENT

With the accountability of conservation of life on earth, the internationally designed methodologies are being adopted by many countries for the treatment and management of the wastes generated. Besides the need for land use management and disaster management are also being discussed below. Further, the provisions in Indian Constitution, Environmental Laws and the Organizations integrated with environmental management are discussed in unit 4.

3.4.1 Sewage Treatment

Municipal sewage disposal and treatment is of major environmental concern. In a treatment plant, sewage undergoes 3 levels of purification as detailed below.

- Primary sewage treatment
- Secondary sewage treatment
- Tertiary sewage treatment

- **Primary Sewage Treatment**

It is a mechanical process in which the debris like sticks, stones, rags, etc., are first filtered. Then the suspended solids are allowed to settle down in a sedimentation tank. These operations remove 60% suspended solids, 30% oxygen demanding wastes, and 10 % nitrogen and phosphorous compounds.

- **Secondary Sewage Treatment**

It is a biological process which involves the aerobic bacteria to remove biodegradable organic wastes. In this process the organic wastes would be pumped into **trickling filters** (crushed stone bed) loaded with aerobic bacteria. The degradation of organic wastes by bacterial cultures will be enhanced by the supply of air. Then the water is allowed to pass through the sedimentation tank where most of the suspended solids settle down as sludge. The sludge is then broken down in an aerobic digester. The incinerated sludge is then disposed by dumping into ocean or landfill or applied to land as fertilizer. The choice of disposal method depends mainly on the nature of sewage.

- **Tertiary Sewage Treatment**

This stage involves a series of both physical and chemical processes. The most common methods adopted are:

- Precipitation
- Filtration
- Reverse osmosis
- Disinfection

- **Precipitation** removes 90 % suspended solids and phosphates
- **Filtration** eliminates organic compounds and remaining suspended solids
- **Reverse osmosis** removes both dissolved organic and inorganic substances
- **Disinfection removes** water coloration and kills some bacteria and viruses.

The treatment strategies for drinking water also remain same as that of waste water but the degree of treatment varies with purity.

3.4.2 Solid Waste Management

Solid waste is a material that becomes useless and hence waste after a short period of use. The solid waste disposal mainly depends upon the following:

- Total population
- Life style of people
- Economy
- Quantity of hi-tech garbage
- Collection and treatment systems
- Inadequate environmental standards
- Lack of enforcement of laws

In India alone about 20 – 30 million tons of garbage (solid waste) is being generated every day. The disposal of ever increasing quantity of garbage has become a menace even in many developed countries.

For planning proper management strategies, it is essential to study the source, type of waste and mode of disposal. The steps involved in the waste management are collection, transfer and safe disposal. From management point of view, some of the following methods of safe disposal can be adopted:

- Recycling
- Incineration
- Composting
- Landfill

- **Recycling**

Some wastes can be reused after subjecting the same to the recycling process. E.g.

- Waste papers on recycling can be used in paper industries
- Plastic wastes and metal scraps can be used in respective industries after recycling
- Recycled sewage can be used for irrigation purposes
- Sludge in combination with coal can be used for generating power
- Agricultural wastes like paddy straw, bagasse of sugarcane can be exploited in paper industries.
- Animal wastes can be exploited in gobar gas plants to obtain gas / fuel and enriched manure
- Reuse of metals recovered from industrial effluents

- **Incineration**

Incineration is nothing but burning the combustible material in a device called **incinerator.** This method has got its own limitations. Because, toxic materials will be released on burning some wastes. E.g. Plastics on incineration release dioxin.

- **Composting**

On composting, the organic wastes shall be converted into manure. The best source of composting is **vermitechnology** where the earthworms are being exploited for this purpose. A city with one lakh population can produce about 18,000 tons of organic manure in a year.

- **Landfill**

The non compostable wastes can be dumped in a low lying areas / landfills. Delhi city alone generates 4000 tons of solid waste per day and disposing the same at 5 landfill sites. The Controlled landfills are cheaper and convenient. The only difficulty encountered with this method is finding out the location for safe disposal site. However, disposal of hazardous materials in landfills would lead to groundwater pollution.

3.4.3 Land Use Management

For the effective land use management practices, services of town planners can be extracted. These planners apply the principle of zoning to regulate the use of land for residential purposes, industrial activities, recreational purposes and commercial functions. This approach would enable the local authorities to locate separate sites for collection of garbage. Thereby the treatment strategies would also become easier.

3.4.4 Disaster Management

The extreme events which exceed the tolerable magnitude within or beyond certain limits make settlement difficult and result in catastrophic loss of property and precious life. The events may include, flood, cyclone, tsunami, volcano, earthquakes etc. The systems which could be adopted in the management practices are described below:

- **Education :** improves the technology of building constructions so as to withstand in extreme conditions.
- **Research** : enables to identify the risky areas by remote sensing.
- **Predictions** : enable to give cautions on changes in the environmental systems.
- **Geographic Information System (GIS) :** provides information about risky/ prone areas and previous experiences of disaster
- **Relief Measures:** include immediate recovery of life on priority basis, removal of debris, extending medical facilities and providing food, clothing and shelter.

3.5. ENVIRONMENTAL AND SOCIAL ISSUES

3.5.1 Introduction

The unprecedented explosion of Scientific and Technological Innovations exert pressure on the environment. As a consequence, some of the major environmental issues are being discussed with social concern.

3.5.2 MAJOR ENVIRONMENTAL ISSUES

A few such are:

- Acid Rain
- Global Warming / Green House Effect / Climate Change
- Depletion in Ozone Layer
- Nuclear Accidents and Nuclear Holocaust

3.5.3 ACID RAIN

It is a precipitation (rain water) with the pH (Hydrogen ion Concentration) value of less than 6. The major cause of acid rain is air pollutants such as Sulphur and Nitrogen. In combination with Oxygen they form their respective oxides (Sulphur oxide & Nitrogen oxide). These oxides then react with water to form acid rain.

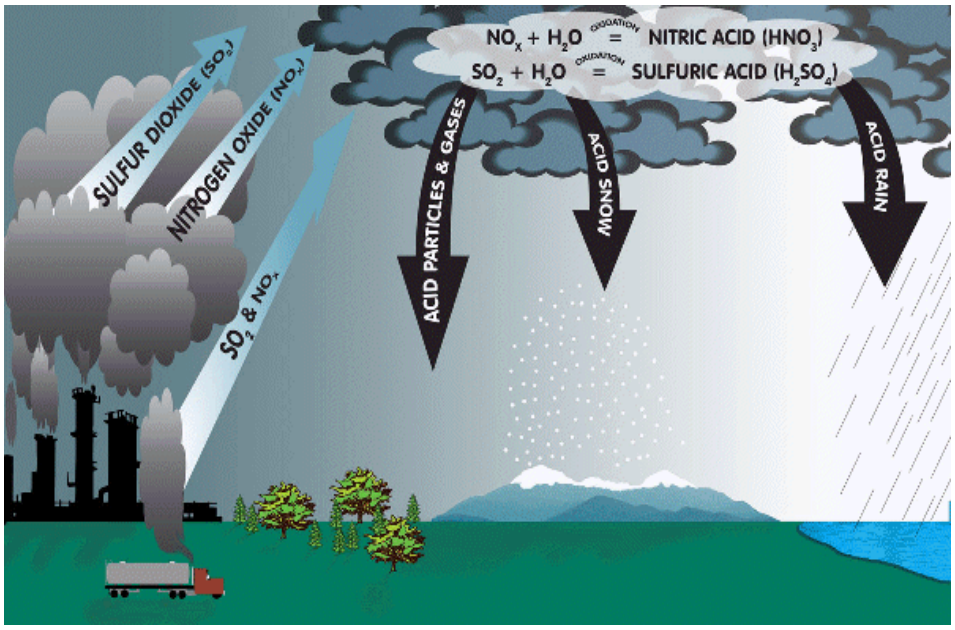


Figure 7.1: Acid Rain

- **Hazardous effects of Acid Rain**
  - Reduces pH of water in natural systems and affects aquatic life due to acid shock

- Reacts with metals present in earth crust and generates their poisonous forms which in turn would endanger life
- Checks the growth of the plants by interfering with photosynthesis
- Affects human health by causing skin diseases and allergy
- Reduces soil fertility by interfering with microbial community
- Deteriorates the buildings by causing stone leprosy. E.g. Taj Mahal on exposure to acid rain , the insoluble calcium carbonate content of Taj Mahal is being converted into soluble calcium sulphate and causes corrosion (stone leprosy) on the marble surface .

3.5.4 Global Warming / Green House Effect / Climate Change

The **green house gases** like, carbon dioxide, methane, methyl chloroform, carbon tetrachloride, carbon monoxide and chlorofluro carbons are being released enormously into the atmosphere form very many industrial sources. These gases trap and retain the low energy radiations reradiated from the earth's surface and warms up the earth (global warming). The temperature of the earth raises by 1.5 to 4.5°C. This process is also known as **Green House Effect** because this mechanism is comparable to that of the one which occurs in a green house (with the glass roof used to maintain plants).

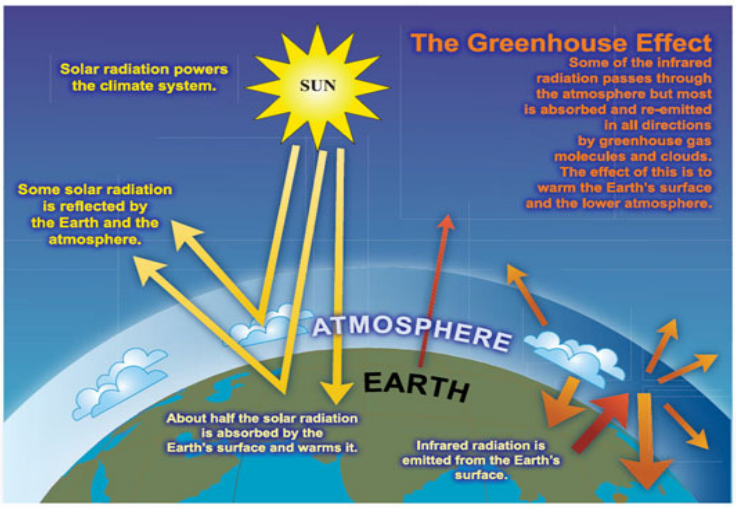


Figure 7.2: Green House Effect

In a green house, when the visible light passes through glass, it partly reflects and partly absorbs the infra red radiation. This mechanism keeps the green house warmer than the natural environment.

The green house effect upon the climate will not be uniform throughout the world. Warming at the poles is likely to be higher than the tropics. The increased warming at the poles will reduce the thermal gradient between the equator and high altitude regions. This would decrease the energy available to heat engine that drives global weather machine and this would alter the

global pattern of wind , ocean currents, extent of polar ice caps and timing and distribution of rainfall.

The inter-Governmental Panel on Climate Change (IPCC) estimates that the water level would be added to all oceans by 25m more by the year 2100. This would lead to the disappearance of low lying cities like Venice, Bangkok and Maldives from the world map.

- **Control Measures**
  - Promoting the green plantation is the best method for the control of global warming. Because, the plants fix CO_2, one of the major green house gases and releases O_2 during photosynthesis. This process would maintain the equilibrium between CO_2 and O_2 level.

3.5.5 Depletion in Ozone Layer

The major cause of depletion of Ozone layer is **Chlorofluorocarbons** (CFC) which is being released by the refrigerators. The depletion of Ozone layer was first reported at Antarctica and later in Australia. In stratosphere, CFC is being broken down into chlorine atoms by UV radiation. These chlorine atoms react with O_3 and releases O_2. Thus, the Ozone layer gets depleted and admits the penetration of harmful UV radiations into earth surface. These UV radiations would cause the increased incidence of skin cancer and cataract.

As a measure to check the depletion of Ozone layer, all nations have accepted to minimize the production / release the damaging gases by signing the Montreal **Protocol** (1987). By their fruitful efforts the Ozone hole is slowly recovering. The United Nations Environment Programme (UNEP) has passed a resolution to observe **16th September** as **International Ozone Day** and **5th October** as **Ozone Safety Day**.

3.5.6 Nuclear Accidents and Nuclear Holocaust

With the advances in technology, the nuclear energy has been identified as the most potential source of clean and cheap energy. Even though, a radioactive isotope in a nuclear reactor releases 3 million times greater high energy radiations than any other fuels it is also equally terrifying.

- **Nuclear Accidents**

The first major nuclear accident occurred in America by 28th March 1979, caused a total of 2,00,000 people to flee from their home. The cleanup cost was alone about one billion US dollars. Luckily no causalities were reported. However, the downwind arose from the reactor resulted in 2 – 10 times higher incidence of leukemia and lung cancer.

Yet another well known nuclear accident occurred in **Chernobyl Power Station** near Kiev, the capital of Ukraine, USSR by April 1986. Where, only 3

% of the reactor core escaped in the form of Cesium134, contaminated the environment and caused a total of 31 deaths within a few weeks. Further, the people of that area suffered from cataracts and lowered immune system. Children who drank the contaminated milk in that area after the disaster were diagnosed with thyroid cancer. This nuclear accident also caused the evacuation of 2,10,000 people from their homes.

Due to the unfortunate turn of events, Germany has decided to not to take up any nuclear plans. They realized that the nuclear accidents would definitely occur, no matter how sophisticated technology advances, or how well trained operators. Further, they strongly believed that these nuclear accidents would cause a potential danger not only to the country's economy but also to the social and political aspects.

Very recently by 11th March 2011 due to the **hit of earthquake and tsunami** on nuclear power plants at **Fukushima, Japan** reported with the radioactive cesium levels high enough to cause concern around 30–50 km from the plant. 800 workers at the plant had been withdrawn. Food grown in the northern area was banned from sale. Tokyo officials temporarily recommended to not to use tap water to prepare food for infants. Plutonium contamination has also been detected in the soil at two sites in the plant. Fortunately, winds swept most of the plume of radioactivity out into the Pacific Ocean, rather than over populated areas. Experts consider it to be the **second largest nuclear accident after the Chernobyl disaster** which a occurred a quarter century ago.

- **Nuclear War**

The use of **nuclear energy** in **war** would pose devastating threats to man and earth. When United States dropped **Uranium bombs** over **Hiroshima** and **Plutonium bombs** over **Nagasaki (**1945) during II **World War**, 90 % people were killed, 10 % injured / handicapped and also destroyed everything in miles around. The effects of the radiation from these nuclear bombs can still be observed in the form of cancer, genetic mutations, congenital deformities etc. The disastrous changes which occurred in the environment as a result of major nuclear war is also known as **Nuclear Winter.**

- **Nuclear Holocaust**

The term **nuclear holocaust** is being derived from Greek, used to describe the **complete destruction of people, flora and fauna by nuclear accidents**. Generally it would also cause **health holocaust**.

Normally, the health holocaust occurs within 5 **years of nuclear accidents**. The exposed people would exhibit several health hazards. The following problems were reported among the exposed people (the general public and 600,000 decontamination workers) of Chernobyl disaster.

- Abnormalities in sexual organs
- Allergies

- Anemia
- Appetite – loss
- Blood pressure
- Birth defects
- Bronchitis
- Cancers in breast, larynx, mouth and thyroid gland
- Cataracts
- Chromosome injuries
- Dizziness
- Disorders in immune system
- Fatigue
- Fever
- Hair loss
- Headache
- Heart Diseases
- Hormonal imbalance
- Leukemia
- Liver Diseases
- Lung diseases
- Metabolic disorders
- Nose bleeds
- Premature death
- Stomach pain
- Tuberculosis
- Vision loss
- Weight gain

- **The Major Causes of Nuclear Disaster are as Listed Below:**
  - Improper designing / maintenance of reactors
  - Mischoice of coolants and fuels. E.g. Light water coolant and enriched Uranium
  - Negligence of operators
  - Hit of earthquake and tsunami on nuclear power plants
- **Control Measures**
  - Safe disposal of nuclear wastes
  - Avoiding the usage of nuclear power for the devastating purposes
  - Adopting technologically sound practices for reactor management.
  -

3.6 Conclusion

On revealing the detrimental effects of the technological innovations every environmental issue should be approached with social concern.

4. THE LAW AND CITIZENS

4.1 Introduction

An awareness on the importance of environment has been created among the people for quite some times. India was among the first to take initiative to amend the constitution which gives statutory powers to the Government of India and State Governments to take appropriate measures to protect the environment. India initiated a number of legislature steps for the protection of environment. They are:

4.2 STATUTORY LEGISLATION TO PROTECT THE ENVIRONMENT

- Water (Prevention and control of pollution) Act, 1974
- Air (Prevention and control of pollution) Act, 1981
- Wild life (Protection) Act, 1972
- Forest (Conservation) Act, 1980
- Environment (Protection) Act, 1986

4.2.1 Water (Prevention and control of pollution) Act, 1974

The Water (Prevention and control of pollution) Act was enacted in 1974 and subsequently amended in 1978 and 1987.

- **Features of the Act**
  - This Act provides for the prevention and control of water pollution.
  - It provides for the establishment of central and state boards and also for joint boards by two or more states for prevention of water pollution.
  - It empowers the states to restrain any person from discharging a pollutant into any water body without the consent of the board.
  - Any contravention of the guidelines would attract penal action including improvement ranging from three months to six years.
  - The Amendment Act, 1978 requires the consent of the board for discharging effluents. Such consent shall be deemed to have been given unconditionally on the expiry of a period of four months from the date of application, unless the consent is refused earlier.

4.2.2 Air (Prevention and control of pollution) Act, 1981

The Air (Prevention and control of pollution) Act was enacted in 1981 to implement the recommendations of the conference held at Stockholm in

1972 to deal with problems relating to air pollution. Later, Noise has also been included in pollution by Amendments Act, 1987.

- **Features of this Act**
  - This act provides for the maintenance of air and the atmosphere free from pollution.
  - It provides for the establishment of central and state control boards to monitor air quality and pollution control.
  - Central board may lay down the standards for the quality of air.
  - It co-ordinates and settle disputes between the State boards in addition to provide technical assistance and guidance.
  - State boards may lay down the standards for omission of air pollutants from industrial units or other sources.
  - It must function as inspectorates of air pollution.
  - They have to examine the manufacturing processes and the control equipments to ensure the standards prescribed.
  - It can advise the State government to declare certain heavily polluted areas as pollution control areas and to prohibit burning of waste products which cause air pollution.
  - This act also aimed to arrest deforestation.

Thus, this act has been effectively implemented and large air pollution by the industries has been checked.

4.2.3 Wild life (Protection) Act, 1972

Wild life refers to all animals and plants that are not domesticated. In India, there are 350 species of mammals, 1200 species of birds, 20000 species of insects. The wild life is declining due to human actions such as hunting wild life for-skin, furs, feathers, ivory etc. In order to save them Wild life (protection) act was passed in 1972.

- **Features of this Act**
  - The act is aimed to preserve and protect wild life.
  - National parks and sanctuaries are protected areas to conserve wild life.
  - Wild life populations are regularly monitored.
  - Major provisions of the act are:
    - Creation of wild life advisory board.
    - Prohibition of hunting.
    - Forming central zoo authority.
    - A ban on trade of scheduled animals.
    - Legal powers to officers to punish offenders.

4.2.4 Forest (Conservation) Act, 1980

Forests play an important role in the economy and wealth of a nation. Forests in India cover 6.4 lakh hectares approximately. But the area is shrinking because of deforestation and man engineered activities like converting forests into cultivable lands to feed the ever increasing population of the country. To conserve them the Forest (Conservation) Act was enacted in 1980 to arrest deforestation.

- **Features of this Act**
  - This act provides that the reserved forests shall not be diverted without the prior permission of the Central Government.
  - The land that has been registered as forest land may not be used for non-forest purposes.
- **Provisions of Amendment Act 1988**
  - Forest departments are forbidden to assign any forest land by way of lease to any private person or non-Government body for re-afforestation.
  - Clearance of any forest land of naturally grown trees for the purpose of re-afforestation is forbidden.
  - The diversion of forest land for non-forest uses is cognizable offence and anyone who violates the law is punishable.

Thus, this Act has made ample provisions for the protection and development of forests.

4.2.5 Environment (Protection) Act, 1986

Environment (Protection) Act was passed by the Central Government on 19th November 1986. This act gives right to the Central Government to fix standards for quality of air, water, soil and noise.

- **Objectives**
  - To co-ordinate the activities of various agencies involved in environmental protection.
  - To create authorities with adequate powers for environmental protection.
  - To regulate the discharge of pollutants and hazardous substances.
  - To speed up the response at the time of accidents threatening the environment.
- **Main provisions**
  - **General Powers of Central Government**
    - Co-ordination of activities carried by State Governments.
    - Planning and doing nationwide programme for environment protection.
    - Setting standards for the quality of air, water, soil and noise.
    - Setting standards for the discharge of pollutants.

- Restriction of areas where industries shall not be constructed.
- Setting standards for the prevention of accidents.
- Setting standards for handling hazardous substances.
- Examination of materials that may cause pollution.
- Carrying out research activities relating to environmental issues.
- Inspection of industries to prevent pollution.
- Collection of matters relating to pollution.

- **Prevention and Control of Pollution**

This act prohibits industry which emits pollutants in excess of standard prescribed.

- **Persons Handling Hazardous Substances**

This act lays down that no person shall handle hazardous substances except in accordance with standard prescribed.

- **Powers to Inspect**

This act gives right to Central Government to appoint any person

- to inspect whether the order of the act is followed.
- to test any equipment, register etc.,

- **Power to take Samples and Analyze**
  - The Central Government has the power to take samples of air, water or soil from any factory.
  - It can establish lab, where samples can be tested.
  - It may appoint analysts for analysis of samples.
  - The report submitted by the analyst may be used as evidence and action may be taken against offenders.

- **Penalty for Contravention**

The punishment for the offence may be 5 years imprisonment or fine of ₹ 100000 or both. In case of continuing offence, additional fine of ₹ 5000 every day and the imprisonment may extend to 7 years.

4.3. Major environmental movements in India and International Organizations in Environmental Protection

4.3.1 INTRODUCTION

The people of India have been protecting the nature since long back. Animals, plants, rivers, air, land and stone are worshipped as deities.

- Earth – as Dhartimata
- River Ganga – as Gangamata
- Air – as Pavandeb

- Banyan tree – as abode of thousands of god
- Cow – as Gaumata

Therefore, the conservation of natural things have been practiced long back.

4.3.2 MAJOR ENVIRONMENTAL MOVEMENTS

- Chipko Movement
- Appiko Movement
- Silent Valley Movement

- **Chipko Movement**

The word Chipko means hugging or embracing. This movement has been based on non-violence. The movement started at Alkananda catchment area of mid-western Himalayas. Deforestation activities were undertaken by the Border Security Force for construction of roads. This caused soil erosion and resulted in flood in Alkananda in July 1970. Thus Chipko movement took place.

- **Appiko Movement**

The villagers of North Karnataka started Appiko movement for protesting against the feeling of trees in forest lands. They told that deforestation would lead the scarcity of fuel and fodder to the villagers. It also would lead to soil erosion and silting problem in river. In September 1983, when axe-men came for cutting the trees, the people embraced the trees and thus the Appiko Movement was launched. The objectives of the movement were:

- To protect the forest from deforestation.
- To encourage the plantation of new trees.
- To conserve natural ecosystems.
- To create an awareness about the importance of forests.
-

- **Silent Valley Movement**

The densely forested valley of Palghat district of Kerala is known as 'Silent valley'. The forest of this valley is so deep, dark and peaceful. The valley extends over 90 kilometers.

In 1973, the planning commission approved a hydel project across the valley to generate 240 MW electricity. A large number of people opposed the project because it would have destroyed a mass of forest along with endangered animals and plants. In 1976, Kerala Sastriya Parishad (KSSP) – a Science organization launched a movement against the implementation of project. Due to opposition and reports from National Committee on Environmental Planning, the Kerala Government call off the project in December, 1980. Thus, the Silent Valley was saved and declared.

4.3.3 INTERNATIONAL ORGANIZATIONS AND AGENCIES

There are a number of international organizations and agencies, which are working in the field of environmental protection in many parts of the world. Each organization has its own motto and working relentlessly to achieve its goal.

- **Major International Issues Concerning the Environment**
  - Climate change, i.e., the depletion of ozone layer, global warming, acid rain, transboundary air and water pollution, etc.
  - Protection of land resources; basically from the deforestation activities, soil erosion, etc.
  - Conservation of biodiversity along with the sustainable development.
  - Protection of fresh water resources.
  - Proper management of hazardous wastes including toxic chemicals.
  - Prevention of illegal traffic in toxic substances and wastes.
  - Improvement in quality of life and health, etc.
- **International Organizations**

There are hundreds of international organizations working in the field of environmental protection. Important organizations are:

- **International Union for Conservation of Nature and Natural Resources (IUCN)**
  - This is an autonomous organization established in 1948 having its headquarters at Morges, Switzerland.
  - Its function is to conserve the natural resources and to take appropriate steps to protect the nature.
  - It works in conjunction with World Wide Fund for Nature (WWF).
  - It plays a major role in conserving biodiversity throughout the world.
- **United Nations Educational, Scientific and Cultural Organization (UNESCO)**
  - This is an UN agency founded in 1945 with its headquarters in Paris, France.
  - It organizes workshops, seminars, symposia, etc., to provide technical support and knowledge to the member countries.
  - It works in the field of environment quality, human settlement and abatement of pollution on a global scale.
- **Convention on International Trade in Endangered Species (CITES)**
  - It works in the field of conservation of endangered species.
  - For India, the Ministry of Environment and Forest functions as nodal agency for implementation of its programmes.

- **European Economic Community (EEC)**
  - This is a community of 12 European nations having sound political and economic base.
  - It serves in framing and implementation of unified policy for environmental improvement and conservation of natural resources.
- **Environmental Protection Agency (EPA)**
  - This is an independent federal agency of the US government, established in 1970.
  - It works in the field of quality improvement in air and water and takes care of waste management.
  - It also deals with the noise, pesticide and radiation problems.
- **United Nations Environment Programme (UNEP)**
  - This is a United Nations agency established in 1972 with its headquarters at Nairobi, Kenya.
  - It formulates the international guidelines for the management of environment.
  - It manages the United Nations Environment Fund to finance the various environmental projects.
  - Some of the agencies like 'Earthscan', 'Earth watch Programme', etc are being funded by UNEP.
- **International Council of Scientific Unions (ICSU)**
  - This is a Paris based non- governmental organization.
  - It promotes and encourages the exchange of scientific information, data and ideas among the various countries of the world.
  - It inculcates the social and political responsibilities among the minds of the scientific community of the world.
- **South Asia Co-operative Environment Programme (SACEP)**
  - This is an organization of seven South-Asia countries like India, Bangladesh, Pakistan, Sri Lanka, Bhutan, Nepal and Maldives.
  - Its main objective is to exchange professional knowledge and expertise among the member countries on different environmental issues.

4.3.4 INTERNATIONAL CONFERENCES

Some controversies have occurred among the developed and developing countries that 70% of the world's income is produced and consumed by just 15% of the people developed countries. Keeping in view of the above facts, it has become imperative to organize some global platforms to discuss the environmental issues. The idea took shape in the form of international conferences held once in a decade. They are:

- Stockholm Conference on Environment (1972)
- Nairobi Conference (1982)

- The Earth Summit (1992)
- Johannesburg Conference (2002)

4.3.4.1 Stockholm Conference on Environment 1972

The first UN conference on human environment was held in Stockholm, Sweden from 5-10th June 1972. It was attended by a large number of NGO groups. The following were discussed:

- Problems relating to depletion of forests resources and mineral and marine resources.
- Problems of air and water pollution.

Motto of the conference: "Only one earth for the entire humanity"

- **Declaration Passed**
  - Natural resources should be conserved.
  - Development process and environmental issues should go together.
  - Pollution should not exceed the capacity of the environment.
  - Marine pollution should be prevented.

Mrs. Indira Gandhi attended the conference. She expressed that the removal of poverty should be the goal of world environmental issues. Population, poverty and environment were interrelated. The relation between poverty and environmental degradation should be dealt with, because, the vast majority of the people were directly dependent on the natural resources of the country.

The developing countries consider the poverty as their main issues, whereas the developed nations are worried for pollution and conservation of natural resources.

The Stockholm conference laid the foundation stone for environmental protection on a global scale.

4.3.4.2 Nairobi Conference 1982

Nairobi conference held at Nairobi (Kenya) in 1982. Representatives of 97 nations attended the conference; the conference was centered on a stock-taking exercise. **Focus:** The main focus of conference is to **preserve the earth's biodiversity.**

4.3.4.3 The Earth Summit 1992

The Earth Summit 1992 was the second international conference sponsored by the United Nations Organization. It is known as the United Nations Conference on Environment and Development. The Earth Summit 1992 was held at Rio de Janeiro, Brazil from June 3-14, 1992. It was the largest gathering of world leaders. Hence, it is popularly known as the Earth Summit.

The motto of this conference is **'our common future'**. The conference was attended by 6000 delegates from 170 countries.

- **Objectives**
  - To create awareness on global warming, deforestation etc.
  - To establish a global partnership for sustainable development.
  - To define relationship between man and nature.
  - To sign treaties.
  - To conserve biodiversity, fresh water and marine resources.
- **North and South blocks**

At Rio de Janeiro, the nations divided themselves into North and South blocks.

- **North Block**
  - It includes industrialized and developed countries.
  - Developed countries such as USA, UK, France, Italy, Germany, Japan and Russia are united under group 7.
  - North expects south to cut down the emission of 20% green house gases.
  - It demands treaty to restrict deforestation.
  - It blames over population and poverty of south as major reasons for deforestation and pollution.
  - It demands payment for share of their advanced technology.
- **South Block**
  - It includes developing and under developed countries.
  - Third world nations of Africa, Asia and South America are united under group 77.
  - It blames north for the emission of green house gases.
  - It opposes a ban on deforestation.
  - It blames north's industrialization as cause for pollution.
  - It expects transfer of technology on non-commercial basis.
- **Outcome of the Earth Summit**

The Earth Summit marked the beginning of co-operation between the rich and poor countries to save the global environment. The major outcome of the Earth summit:

- Rio declaration
- Agenda 21
- Climate change convention
- Biodiversity convention

- **Rio Declaration**

The Rio declaration consists of 27 principles to guide future sustainable development. The important 12 principles are:

1. State Sovereignty
2. Right to development

3. Sustainable development
4. Right to life and a healthy environment
5. Duty not to cause environmental harm
6. International equity
7. Precautionary principle
8. Common but differentiated responsibilities
9. Duty to assess environmental impact
10. Right to public participation
11. Common heritage in mankind
12. Common concern of mankind

- **Agenda 21**

Agenda 21 is a programme run by the UN related to sustainable development. The number 21 refers to 21st century. There are 40 chapters in Agenda 21, divided into four sections. Each section deals with:

Section I **:** Social and Economic Dimensions
Section II **:** Conservation and Management of resources
Section III **:** Strengthening the role major groups
Section IV **:** Means of Implementation

The implementation of Agenda 21 was to involve action at international, national, regional and local levels.

- **Climate Change Convention**

It is a useful tool to minimize global warming. The nations agreed to limit emissions of all green house gases. But USA is unwilling to accept any target date. The south block is unwilling to limit its CO_2 environment.

- **Biodiversity Convention**

It has 3 main goals.

1. Conservation of bio-diversity
2. Sustainable use of its components
3. Fair and equitable sharing of genetic resources

The nations agreed to undertake surveys towards the conservation of bio-diversity. This treaty is an agreement to preserve bio-diversity. The countries of the world can be brought under four groups:

- Bio-diversity – rich and Bio-technology – rich countries
- Bio-diversity – poor and Bio-technology – poor countries
- Bio-diversity – rich and Bio-technology – poor countries
- Bio-diversity – poor and Bio-technology – rich countries

The gene-rich countries of the South block are poor but they are willing to share their bio-diversity and bio-technology. But USA is not willing to share their biotechnology.

The Earth Summit was not successful as major treaties were not signed by all the nations participated in the Summit.

4.3.4.4 Johannesburg Conference 2002

World summit on sustainable Development, held at Johannesburg (South Africa) from August 26 to September 4, 2002. The main agenda of this conference was reduction of greenhouse gases.

4.4 CONCLUSION

The major environmental movements and international organization established their frame work for continual improvement, encourage innovations and bring awareness about the environmental performance.

5. SUSTAINABLE DEVELOPMENT

5.1 INTRODUCTION

Until two decades ago , the world looked at **economic status** alone as a **measure of human development.** Thus, countries that were economically well – developed and where people were relatively richer were called 'advanced' nations. Most countries of North America and Europe, which had become industrialized at an earlier stage, are economically more advanced. They not only exploited their own natural resources rapidly, but also used the natural resources of developing countries to grow even larger economies. So as development progressed, the rich countries got richer while the poor nations got poorer. However, even the developed countries have begun to realize that their lives were being seriously affected by the environmental consequences of development based on economic growth alone. This form of unsustainable **development** did not add quality to life as the environmental conditions had begun to deteriorate.

Most development specialists began to realize the fact that the economic growth alone could not bring about a better way of life for people unless otherwise the environmental conditions get improved. Development strategies which prioritizes only the economic considerations have begun to suffer from serious environmental problems due to air , water and soil pollution, waste management, deforestation and a variety of other ill effects that seriously affected peoples' well- being and health. Disparity between the 'have' and the 'have- not' at the national and global levels should be eradicated. The disparity in the lifestyles between the rich and poor was made worse by unsustainable development strategies.

The current strategies of economic development are exploiting the resources of the world so rapidly that our future generations will have serious environmental problems , much worse than those we are facing at present . Thus, current development strategies have come to be considered unsustainable for the world's long term development. The newer concept of development has been evolved as "**Sustainable development".** The nations of the world realized these issues early at the **Rio Conference** in 1992.

5.2 SUSTAINABLE DEVELOPMENT

The term sustainable means prolonged**.** The World Commission on Environment and Development defines sustainable development as "**Development that meets the needs of the present generation without compromising the ability of future generation to meet their needs**".

5.2.1 MEASURES TO BE TAKEN TO ATTAIN THE SUSTAINABLE DEVELOPMENT

In the revolutionized global scenario, technology has become as a necessary evil. Hence, the emphasis should be prioritized to evolve ecofriendly/ green technologies. Besides, while dealing with natural resources, 3R methods [Reduce (minimize), Reuse and Recycle] should be adopted to establish sustainable development. Creating awareness among the people should become a mandatory practice, which would definitely bring about attitudinal changes among the public. In this context, the present educational systems which incorporate the environmental component even at primary level would also contribute to a great extent.

The programme of achieving sustainable development should be scheduled and adopted by the various departments of a Government sector. The action plan should be executed not only by the government but also with the collective efforts of nongovernmental and social organizations and the general public as well.

To ensure sustainable development, any activity that is expected to bring about economic growth must also consider its environmental impacts so that it is more consistent with long term growth and development. Many development projects such as dams, mines, roads, industries and tourism development – have severe environmental consequences and these must be studied even before they started to function. Thus for every project, there must be scientifically and honestly done Environmental Impact Assessment (EIA), without which the project must not be cleared.

If we see that a development project or an industry is leading to serious environmental problems, it is our duty to bring this to the attention of authorities such as the local administration, the Forest Department or Pollution Control Board to look into the issue. Further, if new development projects are being planned in and around the place where we live , it is our duty to see that whether the project has been brought about in accordance with environmental safe guards or not? While we all need to think globally, we need to act locally.

If new projects of a large size are to be passed, the government has made it compulsory to publish the summary report of the Environmental Impact Assessment (EIA) and conducts a 'Public Hearing' . It is essential that all of us , as a responsible citizens should read, evaluate and respond to such public hearings held in our area and make comments on the possible impacts of the project. We should not blindly support the economic growth of one sector of the society at the cause of environmental degradation .

5.2.2 METHODS TO DEVELOP SUSTAINABLE ENVIRONMENT

The following methods are being adopted to develop sustainable environment.

- Checking land degradation
- Water management
- Control of population explosion
- Pollution control
- Waste management
- Management of urban and industrial areas
- Conservation of biodiversity
- Use of alternative energy sources
- Awareness creation among people
- Global partnership

5.3 WATER CONSERVATION AND RAIN WATER HARVESTING

5.3.1 Water Conservation

Conserving water has become a prime environmental concern. Clean water is becoming increasingly scarce globally. As deforestation and desertification spreads due to extensive changes in land use, the once perennial rivers are also becoming increasingly seasonal. In many areas, the small streams run dry soon after the monsoon.

When we waste water, we do not realize that it affects the lives of all of us in so many different ways. Water has to be equitably and fairly distributed so that household use, agriculture and industry will get a share of water. Its overuse and abuse due to various activities that waste water or pollute has led to a serious shortage of potable drinking water. Thus, water conservation is linked closely with overall human well - being.

Water conservation is generally accepted to mean “the minimization of loss or waste, preservation, care and protection of water resources and efficient and effective use of water. The following are the objectives of water conservation.

- Economic efficiency
- Social development
- Social equity
- Environmental protection
- Sustainability of water supply and services
- Political acceptability

Many water conservation and demand management strategies applied around the world today can be grouped into four categories based on the approach employed in economical, institutional, technological and behavioural aspects.

5.3.2 Rainwater Harvesting

The Government has taken some programmes to conserve water through rainwater harvesting. Instead of allowing the rainwater to drain into sea, it should be allowed to seep into earth and to store as ground water. The water that is stored in the rainy season may be used during other seasons.

Thus the techniques for keeping the rain water in reserves are termed as rain water harvesting. Rain water can be harvested in the following ways:

- By digging ponds and tanks
- By building embankments and check dams
- By making arrangements for storage of rain water on roof tops
- By constructing reservoirs in parks and public places and covering them with concrete slabs
- Building plans should be approved only when there is a provision for water harvesting
- Adequate grounds should be left free to facilitate rainwater to percolate into the ground
- Rural areas where open spaces are abundantly available should be encouraged to provide water harvesting facilities and provisions
- Artificial rain making and desalination of sea water are used to overcome water scarcity.

To get more water through rains we should grow more trees and conserve our forest resources. The process of rainwater harvesting is simple and economical. It helps in meeting the increased demand for water, particularly in urban areas and prevents flooding on roads.

5.3.3 WATERSHED MANAGEMENT

Watershed approach is being adapted as a national strategy for an integrated and comprehensive development of drought – prone and rain fed areas. Watershed is not a technology but a concept which integrates conservation, management and budgeting of rainwater through simple but discrete hydrological units. Watershed can be conceived as a geographical unit of land that drains into a common point. An ideal size of watershed will be 500 hectares. It is being carved out through the interaction of rainwater with land and comprises of arable and non-arable lands and natural drainage lines. Besides, construction of small dams can hold backwaters which will provide for the wild life habitat and stock watering facilities.

Thus the management of rainfall and resultant runoff in a single unit of land is called watershed **management.** Thus the practice of watershed management includes soil and water management and developing vegetative cover. For the best outcome, the local community can be educated and involved in watershed management practices.

When the natural drainage pattern of a watershed unit is managed efficiently with the participation of local community, water would be made available throughout the year. The availability of water would enhance not only the socioeconomic status of the local community in terms of increased crop production but also secures their health status by making the availability of the most precious clean drinking water.

- **Objectives of Watershed**
  - Conservation, upgradation and optimum utilization of natural resources, land water and vegetation in an integrated manner
  - Generation of huge employment opportunities in the backward rain-fed areas to ensure livelihood security of the poorest sector
  - Enhancement of productivity , through the management of land and rain water
  - Evolving a network of runoff management structures for maintaining ground water level ; recycling water for irrigation and domestic purposes.
  - Promotion of social forestry and horticultural activity .
- **Impact of Watershed Management**

The watershed approach improves the soil condition and water status of an area, increases cropping intensity with good yield and favours the overall ecological improvement.

5.4 RESETTLEMENT AND REHABILITATION

5.4.1 Resettlement

Resettlement is an act of shifting of people from their place to a new area by providing shelter. The occasions which require resettlement are as follows:

- Natural disasters such as earthquake, tsunami, volcano, flood, cyclone, forest fire etc.
- Drought and outbreak of diseases
- Construction of dams, highways, National parks, Wildlife sanctuaries etc.,
- War and Nuclear accidents

✶ **Issues in Resettlement**

The problem arises only when people are enforced to shift from their place while executing some developmental projects such as laying of National Highways , Construction of National Parks, dams, etc. The few such issues are

- Non preparedness of the people
- Non adaptiveness to the proposed place ,especially among the tribal people

- Investments on establishment of residential areas, supply of food, employment etc.

5.4.2 Rehabilitation

The facilities extended to the resettled people to fulfill their basic needs for their life security is called rehabilitation. The activities involved in rehabilitation are as follows:

- Construction of houses in colonies
- Providing free medical services, food, cloth etc.,
- Extending Psychological services
- Providing social security and protection
- Generating employment
- Making the availability of civil supplies at subsidy
- Evolving free education schemes to their wards

✶ **Rehabilitation Policy**

In some cases rehabilitation practice would also become a risk factor for the life of rehabilitants. E.g. On resettlement, Jarawa Tribe of Andaman Island could not accustom with the newer social environment and their population size is being diminishing notably. Hence, while formulating National Policy on rehabilitation and resettlement of life for the cause of the development projects the following elements should be considered / included.

- The extent of damage or loss and inconveniences likely to be caused to the mankind
- Rehabilitation and resettlement of human life
- Rehabilitation on a minimum dislocation basis
- Rehabilitation prioritized with social justice and balanced development
- Centering the rehabilitation approaches in par with the rehabilitants

5.5 CONSUMERISM AND WASTE PRODUCTS

Consumers are those who utilize various products, natural resources and services. Consumerism refers to a movement whereby the rights and powers of consumers are established and protected. In modern era, the level of consumption has increased manifold and the advent of industrial revolution also supports consumerism substantially. The increased consumption, endorse the nation's economy.

Further the population size is also being correlated with consumption. Ironically, in the poor developing countries, the rate of increase in population is low but there is no corresponding increase in the resources. The result is poverty, undernourishment, malnutrition, disease and death. But in developed countries, the rate of increase in population is low but there is abundance of resources and people adapt a luxurious life style and consumption of resources

is also high. In both the cases the generation of waste is high and this causes a tremendous impact on the environmental conditions, because of increased pollution.

Globalization on its part has brought in newer products from various countries, may be even at cheaper prices than prevailing in developing countries. But we should not ignore the fact that globalization has also globalized waste generation; dumping of food wastes, packaging materials, automobiles, hazardous emissions, e-wastes, nuclear wastes, etc. The modern equation is 'the more one consumes the more he pollutes'. The developed countries consume most and thus pollute most.

- Increased income and enhanced standards of life have similarly become more and more connected with pollution and waste generation. The consumers should be educated to protect the globe's environment.
- The local government should make successful efforts to manage forest, water and other natural resources.
- The process of production should become more ecofriendly and application of new technologies should be towards better environmental gravity.
- A logic pricing of natural resources could be thought of (pricing use of water, minerals, etc.,)
- The market should be tamed to minimize waste generation
- Land reforms, education, better health care, population control and change in consumption patterns have to be promoted.

Awareness must be created among the people not only about their rights as consumers, but also their duty to maintain a healthy and safe environment. There should be a movement that helps better quality of life, reasonable consumption and sustainable environment management. The polluters have to pay the price of pollution. The non polluters should be able to see that there are no further pollutions to the environment.

5.6 ENVIRONMENTAL ETHICS

Environmental Ethics is the scientific looking of various issues related to the rights of individuals on the environment. It deals with the issues related to the rights of individuals that are fundamental to life and well – being. It also deals with the rights of other living creatures that inhabit the Earth.

It is a moral relationship of human beings with the environment. It is concerned with the do's and don'ts of the human beings to the environment. In, 1985, Anil Agarwal published the first report on the Status of India's Environment. It emphasized that India's environmental problems were caused by the excessive consumption patterns of the rich.

Ethical Issues

The report highlights the following ethical issues that are related to environmental concerns.

- Environmental destruction is largely caused by the consumption pattern of the rich
- The worst sufferers of environmental destruction are the poor
- Even where nature is being 'recreated', as in afforestation, it is for the benefit of the rich.
- Even among the poor, the worst sufferers are women
- There cannot be proper economic and social development without a holistic understanding of society and nature
- If we care for the poor, we cannot allow the Gross Nature Product to be destroyed any further. Conserving and recreating nature has become our highest priority.
- We cannot save the rural environment or rural people dependent on it, unless we can bring about sustainable urban development.

Maintenance of Environmental Ethics

Environmental ethics can be maintained by adopting the following approaches:

- Equitable utilization of natural resources
- Equity among the Northern and Southern countries
- Equity among people of rural and urban areas
- Equity for males and females
- Conservation of resources for future generations
- Ethical rights of animals
- Conservation of traditional value systems
- Prevention of sacrifice of animals in poojas
- Prevention of hunting and poaching
- Regulation of felling of trees
- Considering the life of plants and animals
- Prevention of ecoterrorism
- Use of ecofriendly items
- Keeping the environment neat and clean

5.7 CONCLUSION

Thus the effective management practices, falling in line with the ecofriendly concept of consumerism and adhering strictly to environmental ethics would set free us from the fear for the risks related to the environmental threats to life.

List of Project Topics

1. Rain water harvesting
2. Clean coal Technology
3. Nuclear energy
4. The effect of acid rain
5. Go Green
6. Value of Biodiversity
7. Threats to Biodiversity
8. Biodiversity Conservation
9. Measures taken for Green Computing
10. E- Waste Management
11. Usage of Natural Fertilizers
12. Garbage Management
13. Food waste Management
14. Impact of Modern Technology on Environment
15. Extinction of Wild life.

Question Bank

UNIT- I

1. Environmental Education studies the interrelationship between man, culture and _____ environment
   a) socio-physical **b) bio-physical**
   c) socio-psychological d) bio-sociological

2. The Ministry of Environment and Forestry conducted programmes on Environmental Education and Training as formal and _____
   a) Informal **b) Non-formal**
   c) Future d) Complex

3. _____ facilitates an understanding in the role of biotic component and interaction
   a) Life Sciences b) Physical Science
   c)Mathematical Science d) Environmental Laws

4. Environmental studies help in the development of _____ technologies
   a) socio-friendly b)bio-friendly
   c) eco-friendly d) scientific

5. Formal Environmental Education is given to public through _____ Institutions
   a) Academic b) Non-academic
   c) Commercial d) Non-Commercail

6. The Environmental education in schools and colleges were introduced in _____ by UGC
   a) 19991 **b) 1999** c)1989 d)1988

7. Environmental Appreciation Courses are introduced for people outside the formal education system, by the Ministry and _____
   a) IGNOU b) INGOU c) IGNUO d) INGUO

8. The Environmental concept in Management and business studies was introduced by the _____ of India.
   a) Ministry b) AICTE c) UGC d) MoEF

9. Non-Formal Environmental Education program encourages the _____

participation in environmental protection activities.

a) private **b) public** c) corporate d) economic

10. NEAC was launched in 1986 to create environmental awareness at _____ level.

a) international **b) national** c) social d) economic

11. GLOBE is an International Science and Education Programme started in _____ for school children.

a) 1999 **b) 2000** c)2001 d) 2002

12. Mass awareness about Environmental Education to the public can be done through _____ media.

a) print b) audio c) video **d)electronic**

13. _____ is celebrated as World Environmental Day.

a) Feb 2 b) March 21 c) April 22 **d) June 5**

14. Our former Prime Minister, _____ played a significant role in the preservation of India's wild life

a) Indira Gandi b) Rajivi Gandhi

c) Manmohan Singh **d) Jawaharlal Nehru.**

15. Sunderlala Bahugna the _____ guided the conservation action called

Chipko movement.

a) Former Prime Minister b) Ecologist

c) Wild Life Conservationist **d) Gandhian Environmentalist**

16. The term Environment is derived from the _____ word , "Environ".

a) Latin **b) French** c) Greek d) Spanish

17. Our Environment can be broadly classified as Natural environment and _____ environment.

a) Artificial b) Biological c) Neutral d) structural

18. The natural environment is a self regulation _____ mechanism , which controls and balances the natural occurrences.

a) natural b)artificial c) political d) social

19. Three major components of environment are _____, _____ and energy

a) natural, artificial **b) biotic, abiotic** c)nuclear, molecular
d) sky,earth

20. Biotic component includes all _____ forms
a) living b) non-living c) energy d) power

21. Abiotic component includes all _____ forms
a) living **b) non-living** c) thermal d) electrical

22. The energy component maintains the _____ of the organism
a) life b) energy c) ability d) power

23. The segments of the environment are Atmosphere, Hydrosphere, Lithosphere and
_____

a) Biosphere b) Autosphere c) Diagnosphere d) Nonosphere

24. The gaseous layer surrounding the earth is called _____
a) Atmosphere b) Hydrosphere c) Lithosphere

d) Biosphere

25. _____ is the outer layer of the earth is crust
a) Atmosphere b) Hydrosphere **c) Lithosphere**
d) Biosphere

26. Various Minerals and Soils are the main composition of the _____
a) Atmosphere b) Hydrosphere **c) Lithosphere**
d) Biosphere

27. _____ is the layer, where living organisms interact with the environment.
a) Atmosphere b) Hydrosphere c) Lithosphere
d) Biosphere

28. The two types of environmental threats are classified as _____ and _____
a) new , old b) positive, negative **c) traditionl, modern** d) direct, indirect

29. The reasons for environmental threats are _____ population and ecological imbalances.
a) increasing b) decreasing c) stagnant d) poor

30. The traditional environmental hazards are due to lack of _____, poverty and inefficient development plans.
a) awareness b) intelligence c) education d) money.

31. The modern environmental problems are due to over exploitation of _____ resources and raining population
a) natural b) artificial c) neutral d) biological

32. All the components of environment are _____
a) Dependent b) Independent **c) Interdependent** d) Flexible.

33. The term Eco-System was first proposed by _____.

a) **A.G.Tansley** b) M.C.Mehta c) S.P.Godrej d)Madhav Gadgil

34. The biotic components in eco-system refers to the _____.

a) non-living factors b) water c) minerals d) **living factors**

35. The organisms which carry out photosynthesis constitute the _____ of an ecosystem.

a) Primary consumers b) Tertiary consumers c) **Producers** d) Decomposers

36. Which among the following is an example for tertiary consumers?

a) **Lion** b) Grasshopper c) Cow d) Bacteria

37. Many interlinked food chains together constitute _____.

a) Ecological balance b) **Food web** c) Ecosystem c) Food cycle

38. There are _____ types of Freshwater ecosystems.

a) Five b) Six c) Two d) **Three**

39. Marine ecosystems cover _____ of the Earth's surface.

a) 82% b) 81% c) **71%** d) 72%

40. _____ forests are mostly near the equator.

a) **Tropical evergreen** b) Evergreen c) Mangroves d) Coniferous

41. Grasslands are known as _____ in Africa.

a) Polar grasslands b) **Savannahs** c) Steppes d) Tundra

42. _____ is the largest hot desert.

a) Tundra b) Montane c) **Sahara** d)Agasthiyamalai

43. _____ are organisms that digest the dead organisms.

a) Producers b) Consumers c) Tertiary Consumersd) **Decomposers**

44. _____ are the places where rivers meet the sea.

a) **Estuarines** b) Oceans c) Marine ecosystems d) Aquatic ecosystems

45. Polar grasslands are found in the polar regions of the _____.

a) Antarctic b) Jammu c) Ladakh d) **Arctic**

46. The position of each organism in food chain/food web is being designated as _____.

a) Nutrient cycle b) **Trophic level** c) Ecological pyramids

d) Biogeochemical cycles

47. There are ____ basic types of ecosystems.

a) Three b) Four c) Five d) **Two**

48. Cold Deserts are commonly referred to as _____.

a) Sahara b) Steppe c) Savannah d) **Tundra**

49. Tropical Evergreen forests receive _____ rainfall.

a) 100cm b)250cm c) 150cm d)**200cm**

50. Agasthiyamalai is an example of _____ desert.

a) **rain shadow** b) cold c)Montane d) hot

Unit: II
Natural Resources

1. Which one of the following is non metallic mineral?
   a) Oil b) Copper c) Silver d) Gold
2. Hydro thermal energy is being derived from _____
   a) **water** b) petroleum c) natural gas d) Solar energy
3. Tides can be used for the generation of _____
   b) **electricity** b) heat c) light d) rain
4. The solar energy is chiefly harvested with _____
   c) **photovoltaic cell** b) daniel cell c) solar panel d) wind mill
5. The biofuels are extracted from _____
   d) **Jatropha plant** b) Coconut trees c) bacteria d) Fungi
6. The energy used to drive turbo generators is _____
   a) biomass energy b) tidal energy c) **geothermal energy** d) Wind energy
7. An example for renewable energy resource is _____
   e) **Plants** b) gas c) petroleum d) coal
8. In India, there are _____ National Parks.
   a) 56 b) **86** c) 78 d) 97
9. IUCN refers to _____.
   a) Indian Union for Conservation of Nature and National Resources
   b) **International Union for Conservation of Nature and National Resources**.
   c) Indian Union for Council of Nature
   d) International Union for Conservation of Nature

10. Cryopresevation can be carried out at _____

a) 0 ^{0}C b) -72^0 C c) -98 ^{0}C d) **-196 ^{0}C**

11. Which one of the following is an exhaustible resource?

a)Coal b) Water c) Plants d) Microorganisms.

12. The natural resources which cannot be recycled are called

a) Renewable resource **b) Non- renewable resource** c) Exhaustible resource

d) Forest resource

13. Which one of the following is metallic mineral?

a) Coal b) Natural gas **c) Gold** d) Graphite.

14. How many litres of gasoline energy is consumed by an average American in every year?

a) 5700 litres b)6500 litres c)8500 litres **d)9500 litres**

15. The energy derived from living organisms are called _____

a)Bio mass energy b)Tidal energy c) Geothermal energy d)Wind energy.

16. How many percent of the Earth's land mass is occupied by the Urban area?

a) 3% **b)1%** c)11% d)5%

17. What is the extent of degradation due to over grazing?

a) 680 million ha b)580 million ha c)550 million ha d)780 million ha

18. Normally winds mills are established around _____

a) Hill area b) Desert area c**) Oceanic area** d) Plateau area

19. The energy derived from molten core of earth is _____

a) Tidal energy **b) Geothermal energy** c) Bio mass energy d) Kinetic energy

20. The species which are confined to a particular locality are called.

a)Endemic species b) Global species c) Exotic species d) Endangered species

21. Wild life week has been observed on the first week of _____

a) September b) November **c) October** d) December.

22. How many hot spots are identified globally?

a) 35 **b)25** c)30 d)45

23. Which one of the following plant is exotic?

a) Eucalyptus b) Pipal c) Teak d) Sal

24. The Protected Areas are under the management of _____.

a) Botanical Survey of India b) Indian Union Council for Nature

c) Indian Board of Wildlife d) Zoological Survey of India

25. How many plant and animal species are identified in India?

a) 1,25,000 **b)1,15,000** c)1,35,000 d) 1,50,000

26. Where is the International Potato Centre?

a) Peru b) Mexico c) New Delhi d) Manila

27. The biodiversity of aquatic ecosystems supports the economy of _____.

a) Fisher folk b) Tribals c) Nomads d) Hunters

28. GRC refers to _____

a) Geographical Research Centre **b) Genetic Resource Centre**

c) Gem Resource Centre d) Grain Research Centre

29. Where is the International Rice Research Centre?

a) New Delhi b)Singapore c) Mexico **d) Manila**

30. How many hot spots in India?

a)4 b)5 c)3 **d)2**

31. Where is the National Bureau of Plant Genetic Resources?

a) **New Delhi** b) Singapore c) Mexico d) Manila

32. How many numbers of mammals and birds are considered as endangered species by ZSI?

a) 38, 81 b) 38, 18 c) 81, 18 d) **81, 38**

33. Which category of threat refers “Taxa at risk”?

a) Endangered b) Vulnerable **c) Rare** d) Threatened

34. Which category of threat is referred to as “Taxa to be moved into endangered category in future”?

a) Endangered **b) Vulnerable** c) Rare d) Threatened

35. Global warming has the potential to destroy ____ of existing terrestrial habitat.

a) 45% b) 50% **c) 35%** d) 40%

36. What is the extent of degradation due to Deforestation?

a) 680 millian ha **b) 580 millian ha** **c)** 137 millian ha d) 550 millian ha

37. What is the extent of degradation due to Fuel wood consumption?

a) 680 millian ha b) 580 millian ha **c) 137 millian ha** d) 550 millian ha

38. How many percent of overgrazing cause soil degradation?

a) 45% b) 50% **c) 35%** d) 40%

39. How many percent of deforestation cause soil degradation?

a) 45% **b) 30%** c) 35% d) 40%

40. Solar energy, wind power, rainfall belongs to _____ resources category.

a) Exhaustible b) **Inexhaustible** c) Cultural d) Non-renewable

41. Petroleum and natural gas belongs to _____ resources category.

a) **Exhaustible** b) Inexhaustible c) Renewable d) Non-renewable

42. Plants, animals and micro-organisms belong to _____ resources category.

a) Renewable Energy b) Non-renewable Energy c) Non-renewable d) **Renewable**

43. Petroleum , Natural gas and Coal resources are collectively called _____

a) Metallic minerals b) **Fossil fuels** c) Non-metallic minerals d) Non-renewable

44. Globally, an average of only _____ hectares of cropland per capita for crop production.

a) 0.45 b) **0.22** c) 0.55 d) 0.2

45. The species which are confined to a particular locality are called _____ species.

a) Exotic b) **Endemic** c) Endangered d) Vulnerable

46. All marketable goods of biodiversity are being included under _____ category

    a) Consumptive value b) Ethical value c) Social Value d) **Productive use value**

47. Antibiotics are examples for _____

    a) Consumptive value b) Ethical value c) Social Value d) **Productive use value**

48. All life supporting resources preserved by societies of smaller size comes under _____ category

    a) Consumptive value b) Ethical value c) **Social Value** d) Productive use value

49. All forms of life conserved & protected based on their value comes under _____ category

    a) Consumptive value **b) Ethical value** c) Social Value d) Productive use value

50. _____ value of biodiversity includes the ecosystem processes such as decomposition and nutrient cycling.

    a) **Indirect** b) Direct c) Social d) Productive use

Unit III

Environmental Pollution

1) The substances which cause pollution are called _____.
   a) Pollution b) **Pollutants** c) Degradable d) Persistent
2) There are _____ types of pollutants based on their biodegradability and the rate of biodegradation.
   a) 2 b) **3** c) 5 d) 4
3) The pollutants which can be rapidly broken down by biological processes are called _____ pollutants.
   a) **Biodegradable** b) Persistent c) Non Biodegradable d) Slowly degradable

4) The pollutants which take a decade or even longer to degrade are known as _____ pollutants

a) Biodegradable b) Non Persistent

c) Non Biodegradable d) **Slowly degradable**

5) A Class of pollutants which cannot be degraded by natural processes are called _____ pollutants.

a) Biodegradable b) Persistent c) **Non Biodegradable** d) Non persistent

6) Every individual person breath 22,000 times a day and inhaling about _____ air per day.

a) 15 – 21 kg b) 14 – 22 kg c) **15 – 22 kg** d) 15 – 20 kg

7) _____ causes nervous and digestive disorders and even cancer.

a) Ozone b) **Lead** c) CFC d) CO_2

8) _____ released from burning coal is a major contributor of acid rain.

a) **Sulphur dioxide (SO_2)** b) CFC c) CO_2 d) CO

9) _____ is a principal greenhouse gas emitted as a result of human activities such as burning of coal, oil and natural gases.

a) Ozone b) Lead c) CFC d) **CO_2**

10) The _____ are disease causing agents which include bacteria, virus etc.,

a) Lead b) **Pathogens** c) Organic Wastes d) O_2

11) The increase in the concentration of soluble salts in soil is known as _____.

a) **Salination** b) Bio magnification c) Depletion d) Deforestation

12) Secondary Sewage treatment is a _____ process

a) Chemical b) **biological** c) physical d) environmental

13) Which of the following is the water borne disease caused by pathogens?

a) **Cholera** b) head ache c) Weak bones d) Cerebral haemorrhage

14) _____ can be used in paper industries by recycling.

a) **Waste papers** b) Plastic wastes c) Sludge d) Animal wastes

15) One of the major causes of soil salination is _____ in agricultural land.

a) Horticulture b) Agriculture c) Poultry Culture d) **Prawn Culture**

16) The excessive addition of nutrients to water is known as _____.

a) Incineration b) **Eutrophication** c) Magnification d) Accumulation

17) Any undesirable change in the physical, chemical and biological nature of environment is known as _____.

a) **pollution** b) accumulation c) depletion d) incineration

18) The best source of converting the organic wastes into manure is _____.

a) **vermitechnology** b) salination c) deforestation d) afforestation

19) GIS stands for _____.

a) Geological Information System b) Geographic Indian System

c) **Geographic Information System** c) Geographic Information Science

20) _____ Sewage treatment removes both dissolved organic and inorganic substances.

a) Precipitation b) Filtration c) **Reverse Osmosis** d) Disinfection

21) The major cause of acid rain is air pollutant such as _____.

a) Hydrogen b) Nitrogen c) Sulphur d) **both (b) & (c)**

22) _____ reacts with water to form acid rain.

a) Oxygen b) Hydrogen c) **Oxides** d) None of the above

23) pH is _____.

a) Hydrogen concentration b) Ion concentration

c) **Hydrogen ion concentration** d) None of the above

24) Which of the following are green house gases?

a) Carbon tetrachloride b) Chlorofluro carbon

c) Methyl chloroform d) **All the above**

25) IPCC stands for _____.

a) Inter Governmental Panel on Climate Change

b) Indian Government Panel on Climate Change

c) International Government Panel on Climate Change

d) None of the above

26) Promoting the _____ is the best method for control of global warming.

a) Grazing b) **Green plantation** c) Green house gases d) None of the above

27) The major cause of depletion of ozone layer is _____.

a) Carbon monoxide b) Chlorine c) Fluoride d) **ChloroFluroCarbon**

28) The depletion of ozone layer was first reported in _____.

a) Australia b) America c) **Antartica** d) Arctic

29) CFC is being broken down into chlorine atoms by _____ radiation.

a) **Ultra Violet** b) Infra Red c) both (a) & (b) d) None of the above

30) UNEP stands for _____.

a) United Nations Education Program b) United Nations Eco Program

c) United Nations Exotic Program d) **United Nations Environment Program**

31) International Ozone Day is observed on _____.

a) 8th November b) 5th July c) 16th September d)1st December

32) Ozone safety day is observed on _____.

a) 8th November b) 5th July c) **5th October** d) 26th January

33) Cesium____ is the radioactive element that caused 31 deaths in Chernobyl.

a) 133 b) 124 c) 114 d) **134**

34) _____ bombs were dropped over Hiroshima by US.

a) **Uranium** b) Titanium c) Helium d) Plutonium

35) _____ bombs were dropped over Nagasaki by US.

a) Uranium b) Titanium c) Helium d) **Plutonium**

36) The term nuclear holocaust is derived from _____.

a) **Greek** b) Latin c) French d) Russian

37) Nuclear holocaust will cause _____.

a) **Health holocaust** b) Atomic holocaust

c) both (a) & (b) d) None of the above

38) Health holocaust occurs within _____ years of nuclear holocaust.

a) 6 b) 9 c) 10 d) **5**

39) Montreal Protocol was signed by all nations in the year _____.

a) **1987** b) 1985 c) 1965 d) 1995

40) The temperature of the earth rises by _____ due to global warming.

a) **1.5 – 4.5C** b) 2.5 - 5.5C c) 1.5 – 6.5C d) 0.5 – 1.5C

41) _____ is the example for biodegradable pollutants.

a) Discarded vegetables b) Lead c) Plastics d) Nuclear waste

42) _____ is the example for non - biodegradable pollutants.

a) Mercury b) Fruits c) Bio – fertilizer d) smoke

43) _____ is the example for Persistent pollutants.

a) Paper b) Pesticides c) Domestic sewage d) Mercury

44) _____ gas is released from the air conditioning and refrigerating systems.

a) CFC b) SO c) Pb d) CO

45) _____ is present in petrol.

a) Lead b) CFC c) Oil d) SPM

46) _____ technology is used to replace more toxic elements with less toxic elements.

a) Green Chemistry b) White Chemistry c) Blue Chemistry d) Yellow Chemistry

47) In a thermal Power Station _____ million gallons water is used by a Plant per day.

a) 700 b) 200 c) 1500 d) 600

48) _____ is a bio – fertilizer.

a) Rhizobium b) Urea c) Bacillus d) pencillin

49) To construct wind breaks trees should be planted in _____ pattern.

a) linear b) cyclic c) zig zag d) triangular

50) Chernobyl Power Station is in _____.

a) USA b) UK c) USSR d) India

UNIT – IV

The Law and Citizens

1) The Water (Prevention and Control of Pollution) Act was enacted in _____

a) 1970 b) 1972 c) **1974** d) 1976

2) _____ provides for the prevention and control of water pollution.

a) Water (Prevention and Control of Pollution) Act, 1974

b) Air (Prevention and Control of Pollution) Act, 1981

c) Wild life (Protection) Act, 1972

d) Forest (Conservation) Act, 1980

3) Water (Prevention and Control of Pollution) Act, 1974 was amended in

a) 1968 and 1986 b) **1978 and 1987** c) 1987 and 1997 d) 1997 and 2007

4) The Air (Prevention and Control of Pollution) Act was enacted in

a) 1961 b) 1971 c)**1981** d)1991

5) The Air (Prevention and Control of Pollution) Act was enacted in 1981 to implement the recommendations of the conference held at _____ in 1972.

a) Stockholm **b)**Alkananda c) Kenya d) Sri Lanka

6) The conference held at Stockholm in 1972 deal with the problems relating to _____ pollution.

a) Water b) Noise c) **Air** d) Soil

7) _____ has also been included in pollution by Air Amendments Act, 1987.

a) Water b) **Noise** c) Air d) Soil

8) _____ provides for the maintenance of air and the atmosphere free from pollution.

a) Environment (Protection) Act, 1986 b) Forest (Conservation) Act, 1980

c) Air (Prevention and Control of Pollution) Act, 1981 d) Wildlife (Protection) Act, 1972.

9) _____ aimed to arrest deforestation.

(a) Water (Prevention and Control of Pollution) Act, 1974

(b) Air (Prevention and Control of Pollution) Act, 1981

(c) Environment (Protection) Act, 1986

(d) Forest (Conservation) Act, 1980

10) _____ may lay down the standards for the quality of air.

a) Industrial units b) Non-Government body c) **Central Board** **d)**State Board

11) _____ declare certain heavily polluted areas as pollution control areas and prohibit burning of waste products which cause air pollution.

a) State Government **b)** Central Government

c) International Organisations Agency d) Environmental Protection

12) Air (Prevention and Control of Pollution) Act, 1981 function as inspectorates of _____ pollution.

a) Water b) Noise c) **Air** d) Soil

13) Wildlife (Protection) Act was passed in _____

a) 1952 b) 1962 c) **1972** **d)** 1982

14) _____ refers to all animals and plants that are not domesticated.

a) Wildlife **b)** Forest **c)** Environment **d)** Natural resources

15) In India, there are 20,000 species of _____

a) Mammals b) Birds c) **Insects** d) Pesticide

16) The Wildlife is declining due to _____

a) Human actions **b)** Pollution **c)** Deforestation **d)** Nuclear Energy

17) National parks and sanctuaries are protected areas to conserve _____

a) Wildlife **b)** Water **c)** Human Beings **d)** Healthy Environment

18) Human beings hunt wild life for _____

a) Water b) **Feathers** c) Equipment d) Environmental protection

19) Forming central zoo authority is the major provision of

(a) Forest (Conservation) Act, 1980

(b) Environment (Protection) Act, 1986

(c) Wildlife (Protection) Act, 1972

(d) Water (Prevention and Control of Pollution) Act, 1974

20) Forests in India cover _____ lakh hectares approximately.

a) 4.4 b) 5.4 c) **6.4** d) 7.4

21) Forest (Conservation) Act was enacted in 1980 to arrest _____

a) Hunting wildlife b) Pollution c) **Deforestation** d) Radiation problems

22) Reserved forests shall not be diverted without the prior permission of the _____

a) State Government b) **Central Government**

c)Non-Government Organisations d) District collector

23) Environment (Protection) Act, 1986 was passed by the Central Government on _____

a) 17th November 1982 b) 18th November 1984

c) **19th November 1986** d) 20th November 1988

24) _____ gives right to the Central Government to fix standards for quality of air, water, soil and noise.

a) Wildlife (Protection) Act, 1972 b) Forest (Conservation) Act, 1980

c) Air (Prevention and Control of Pollution) Act,1981 d) **Environment (Protection) Act, 1986**

25) _____ has the power to take samples of water or soil from any factory.

a) NGOs b) State Government c) **Central Government** d) International Organizations

26) Nairobi conference was held at _____ in 1982.

a) **Kenya** b) USA c) Africa d) Germany

27) _____ is an UN agency founded in 1945 with its headquarters in Paris, France.

a) **UNESCO** b) CITES c) EEC d) EPA

28) IUCN is an autonomous organization established in the year_____

a) 1942 b) **1948** c) 1975 d) 1967

29) The motto of the conference 'The Earth Summit 1992' is_____

a) Only one earth for the entire humanity b) Preserve the earth's biodiversity

c) **Our common future** d) Reduction of greenhouse gases

30) _____ is a useful tool to minimize global warming.

a) **Climate change convention** b) Biodiversity convention

c) Rio declaration d) Agenda 21

31) How many nations attended the Nairobi Conference?

a) 97 nations b) 87 nations c) 79 nations d) 81 nations

32) The movement started at Alkananda catchment area of mid–western Himalayas is ____

a) Chipko b) Appiko c) Silent Valley d) Mount Everest

33) The Action plan for the 21st century of the earth summit conference is referred as ___

a) Agenda 22 b) Agenda 23 **c) Agenda 21** d) Agenda 24

34) Chipko movement has been based on _____

a) non-violence **b) violence** **c)** sacrifice **d)** freedom

35) The villagers of South Asia stared _____ movement

a) Chipko b) Mount Everest c) Silent Valley **d) Appiko**

36) The main agenda of Johannesburg Conference was _____

a) Reduction of global warming **b)Reduction of greenhouse gases**

c) Reduction of ozone depletion d) Reduction of CO_2

37) The motto of Earth Summit Conference is _____

a) Our common future b) Our bright future c) Our valuable future d) Our own future

38) The name of the Paris-based nongovernmental organization is _____

a) ICSU b) IUCN c) EEC d) UNESCO

39) The Earth summit conference was attended by _____ delegates.

a) 6000 b) 8000 c) 7500 d) 5000

40) The Earth summit conference was attended by _____ countries

a) 170 b) 180 c) 175 d) 150

41) The Rio declaration consists of _____ principles.

a) 27 b) 18 c) 17 d) 15

42) World summit on sustainable development held at _____

a) Johannesburg b) Mumbai c) New delhi d) Kenya

43) The south block is unwilling to limit its _____ environment.

a) CO_2 b) NO_2 c) SO_2 d) SiO_2

44) The first UN conference on human environment was held in _____

a) Stockholm b) Johannesburg c) New delhi d) Kenya

45) The Environmental Protection Agency (EPA) was established in the year _____

a) 1970 b) 1980 c) 1985 d) 1950

46) The UNEP agency was established in the year _____

a) 1972 b) 1980 c) 1975 d) 1970

47) The Nairobi conference held at Nairobi (Kenya) in _____

a) 1982 b) 1980 c) 1975 d) 1990

48) The Johannesburg conference was held in _____

a) 2002 b) 2000 c) 2001 d) 1999

49) The European Economic Community (EEC) is a community of _____ nations

a) 12 European b) 12 african c) 12 asian d) 12 australian

50) The IUCN having headquarters at _____

a) Morges b) Gujarat c) Rajasthan d) New delhi

UNIT V

Sustainable Development

1) Economically Well developed Countries are called as _____

a) advanced nations b)Low nation c)high advanced nation d)all the above

2) Which one of the following is an economically advanced country?

a)USA b)East Asia c)West Bengal d)Asia

3) The Developed Countries have to face problems like _____.

a) pollution b)economic c)population d)vehicles

4) The term 'sustainable' means _____

a)Short **b)prolonged** c)live d)earth

5) Which methods are used to establish sustainable development?

a)2P b)4S **c)3R** 4)1M

6) E1A is the abbreviation of _____

a)Environmental Issue Arise **b)Environmental Impact Assessment**

c)Empower Integrad Assay d)none of the these

7) Which one of the following method is being adapted to develop sustainable environment?

a)pollution Control b)Economic Control c)population control d)all the above

8) The E1A conducts _____ for new projects through Government

a) Novel creation b)awareness **c)public hearing** d)journal release

9) Rain Water is harvested by

a) digging ponds and tanks b).Industry c).chemical reuse d).all the above

10) Water Conservation today can be grouped into four categories based on _____

a)Technology b).awareness c).Countries d).Industry

11) Rainwater Harvesting is used to prevent _____

a) flooding water on roads b) poverty c) diseases d) a and c

12) The management of rainfall and resultant runoff in a single unit of land is called as _____

a)watershed management b)Soil Management c)Developing countries d)all the above

13) Which one of the following is the objective of watershed management?

a) enhancement of productivity b)soil condition c)water status d) ecological improvement

14) What is the impact of watershed management?

a) Water harvesting **b) ecological improvement** c) empower development d) none

15) An ideal size of watershed will be _____ hectares

a) 300 b) 800 **c) 500** d) 100

16) The availability of water increases _____ production

a)crop b)fish c)industrial d)all the above

17) Deforestation and desertification develop due to _____.

a) extensive changes b)product changes c)soil changes d)water changes

18) The World nations realized environmental issues early at the _____

a)Rio conference b)Rainwater harvesting c)usage conference d)none of these

19) RIA conference was held at _____

a)1994 **b)1992** c)1882 d)1989

20) The Programme of sustainable development is adopted by the various departments of _____.

a) Private sector b) E1A **c)Government Sector** d)all the above

21) The development projects that lead to serious environmental problems are reported to the _____

a) Forest department b) Social Workers c) Employers d) b and c

22) Global partnership is one of the methods of _____

a)sustainable environment b)unsustainable environment

c) economic management d)pollution

23) Which one of the following is the objective of water conservation?

a)social equity b)political acceptability c)social development **d)all the above**

24) The process of rainwater harvesting is simple and _____.

a) Better b) safe **c) economic** d) usage

25) Water shed concept integrates _____

a) economic **b)conservation** c)industry d)pollution

26) The status of India's environment emphasizes on India's _____ problems

a) Education **b) Environmental** c) Simple d) Basic needs

27) The techniques for keeping the rain water in reserves are known as _____

a) Acid-rain harvesting b) Land harvesting

c) **Rain water harvesting** d) Water Shed management

28) The management of rainfall and resultant runoff in a single unit of land is called_____

a) Rain shed Management b) **Water Shed management**

c) Land Management d) Forest management

29) _____ are those who utilize various products, natural resources and services.

a) Manufacturers b) Retailers c) **Consumers** d) Producers

30) _____ refers to a movement whereby the rights and powers of consumers are protected.

a) **Consumerism** b) Human Rights c) Labour Union d) Women Rights

31) Among the following, which is not a natural disaster?

a) Earth Quake b) Tsunami c) **Nuclear Holocaust** d) forest fire

32) Rehabilitation is the facilities rendered to the _____ of the people to ensure life security.

a) **basic needs** b) job c) money d) land

33) _____ is a moral relationship of human beings with the environment.

a) **Environmental ethics** b) Moral ethics c) Professional ethics d) Fundamental ethics

34) _____ is an act of shifting people from their place to a new area by providing shelter.

a) Rehabilitation b) **Resettlement** c) Restoration d) Reservation

35) The facilities provided to people to satisfy their needs in the new area is _____

a) **Rehabilitation** b) Resettlement c) Restoration d) Reservation

36) The worst sufferers of environmental destruction are the _____ people.

a) Rich b) Upper-middle class c) Middle-class d) **Poor**

37) 'Non preparedness of the people' is one of the issues in _____.

a) Rehabilitation b) Reformation c) **Resettlement** d) Reservation

38) In 1985, _____ published the first report on the status of India's Environment.

a) Anil Kapoor b) **Anil Agarwal** c) Ajith Agarwal d) Anil Rafi

39) Environmental ethics can be maintained by adapting the use of_____

a) eco friendly items b) plastics c) natural resources d) hunting animals.

40) _____ is the scientific looking of various issues related to the individuals on the environment.

a) Moral Ethics b) **Environmental Ethics** c) Work Ethics d) cultural ethics

41) _____ is linked closely with overall human well-being.

a) Land conservation b) Forest conservation

c) **Water conservation** d) Resource conservation

42) Expand EIA

a) Environmental Issue Assessment b) **Environmental Impact Assessment**

c) Environmental Induced Assessment d) Environmental Immediate Assessment

43) Water Conservation and demand management strategies can be grouped into _____ categories.

a) Five b) **Four** c) Ten d) Six

44) _____ of sea water is used to overcome water scarcity.

a) **Desalination** b) Salination c) Jon concentration d) Mineral resources

45) _____ must be created among the people to maintain a healthy and safe environment.

a) Consumerism b) **Environment Awareness**

c) Land Management d) Forest management

46) Consumerism and waste product- Awareness must be created among the _____

a) Students b) **people** c) animals d) all

47) The first report on the status of India's Environment was published by Anil Agarwal in _____

a) 1999 b) **1985** c) 1975 d) 1795

48) _____ on its part has brought in newer products from varies countries.

a) **Globalisation** b) Localisation c) Privatisation d) Utilisation

49) The increased consumption endorse the nation's _____

a) Education b) **Economy** c) sources d) all

50) Environmental destruction is largely caused by the _____ pattern of the rich.

a) Education b) Economy c) work d) **Excessive Consumption**